Observational Study

Medicine

OPEN

The effect of close and intensive therapeutic monitoring of patients with poorly controlled type 2 diabetes with different glycemic background

Ayşe Naciye Erbakan, MD[a,*], Müzeyyen Arslan Bahadır, MD[a], Fatoş Nimet Kaya, MSC[a], Büşra Güleç, MD[a], Miraç Vural Keskinler, MD, PhD[a], Özge Faydalıel, MD[a], Banu Mesçi, MD[a], Aytekin Oğuz, MD[a]

Abstract

Patients with type 2 diabetes who have HbA1c values ≥ 10% have different previous glycemic trends, including new diagnosis of diabetes. We aimed to assess the efficacy of 3 months of intensive and facilitated antihyperglycemic treatment in patients with different glycemic backgrounds. In this observational study, patients with type 2 diabetes and poor glycemic control (indicated by an HbA1c level of > = 10%) were divided into groups based on their previous HbA1c levels (group 1; newly diagnosed type 2 diabetics, group 2; patients with previously controlled but now deteriorated HbA1c levels, group 3; patients whose HbA1c was not previously in the target range but was now above 10%, and group 4; patients whose HbA1c was above 10% from the start). Patients received intensive diabetes management with close monitoring and facilitated hospital visits. For further analysis, patients who were known to have previously had good metabolic control (either did not have diabetes or had previously had an HbA1c value < =7) and patients who had prior poor metabolic control were analyzed separately. Of the 195 participants [female, n = 84 (43.1%)], the median age was 54 years (inter-quantile range [IQR] = 15, min = 29, max = 80) and the median baseline HbA1c was 11.8% (IQR = 2.6%, min = 10%, max = 18.3%). The median duration of diabetes was 10 years (IQR = 9, min = 1, max = 35) when newly diagnosed patients were excluded. The ≥ 20% reduction in HbA1c at month 3 was observed in groups 1 to 4 in 97%, 88.1%, 69.1%, and 55.4%, respectively. The percentage of patients who achieved an HbA1c level of 7% or less was 60.6%, 38.1%, 16.4%, and 6.2% in the groups, respectively. The rate of those who achieved an HbA1c of 7% or less was nearly 50% of patients with type 2 diabetes mellitus who had previously had good metabolic control, whereas successful control was achieved in only 1 in 10 patients with persistently high HbA1c levels. Patients' glycemic history played an important role in determining their HbA1c levels at 3 months, suggesting that previous glycemic management patterns may indicate future success in diabetes control.

Abbreviations: BMI = body mass index, IQR = inter-quantile range, T2DM = type 2 diabetes mellitus.

Keywords: glycemic control, poorly controlled diabetes, type 2 diabetes

1. Introduction

Type 2 diabetes mellitus (T2DM) is one of the most common chronic diseases worldwide, affecting approximately 537 million adults.[1] Maintaining good glycemic control and controlling additional risks are recommended to prevent or delay complications and mortality associated with diabetes. Leading authorities, including the American Diabetes Association and the European Association for the Study of Diabetes, recommend an HbA1c level of 7% or less if it can be achieved safely.[2] According to the UKPDS study, a 1% lower HbA1c resulted in remarkable reductions in microvascular complications, myocardial infarctions, and diabetes-related deaths by approximately 37%, 14%, and 21%, respectively.[3]

However, glycemic control remains a challenge for many patients with T2DM. Only 55.3% of patients in the United States achieve good glycemic control.[4] The term "poor glycemic control" is not clearly defined, as it includes patients with HbA1c levels above target without upper limits or gradations. This makes it difficult to determine the prevalence of poorly controlled diabetes and associated factors. It also results in a heterogeneous group of patients with different glycemic values and likely different characteristics affecting their diabetes control. Even in patients with "persistently poorly controlled diabetes mellitus", which is used to describe patients with consistently high HbA1c levels despite diabetes treatment, the HbA1c threshold varies between 8.5% and 9.5%.[5,6] For this study, we

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[a] *Department of Internal Medicine, Prof Dr Suleyman Yalcin City Hospital, Istanbul Medeniyet University, Istanbul, Turkey.*

**Correspondence: Ayşe Naciye Erbakan, Department of Internal Medicine, Prof Dr Suleyman Yalcin City Hospital, Istanbul Medeniyet University, Istanbul, 34722, Turkey (e-mail: erbakan553@hotmail.com).*

How to cite this article: Erbakan AN, Arslan Bahadır M, Kaya FN, Güleç B, Vural Keskinler M, Faydalıel Ö, Mesçi B, Oğuz A. The effect of close and intensive therapeutic monitoring of patients with poorly controlled type 2 diabetes with different glycemic background. Medicine 2023;102:50(e36680).

Received: 12 October 2023 / Received in final form: 22 November 2023 / Accepted: 24 November 2023

http://dx.doi.org/10.1097/MD.0000000000036680

defined poorly controlled diabetes as having an HbA1c level of 10% or higher.

We queried whether past glycemic courses could indicate the likelihood of achieving glycemic targets, and identifying individuals who may require interventions beyond lifestyle modifications. The objective of this study was to assess the effectiveness of intensive antihyperglycemic treatment in patients who have HbA1c values ≥ 10% and are either newly diagnosed, experiencing recent deterioration, or have long-standing poor glycemic control. We evaluated the relationship between this approach and their historical glycemic data while also considering other risk factors contributing to poor metabolic control.

2. Methods

This prospective observational study was conducted with patients with type 2 diabetes with an HbA1c level of 10% or more who presented to the Diabetes Outpatient Clinics between August 1, 2021 and December 31, 2021. The study protocol was approved by the Istanbul Medeniyet University Goztepe Training and Research hospital ethics committee (No:2021/0413) and conducted in accordance with the Declaration of Helsinki. All participants gave their informed consent. The participants were excluded if they had a diagnosis of other types of diabetes, acute infection or inflammation lasting more than 1 week, acute metabolic decompensation, inability to attend follow-up, endocrine disease other than thyroid, or active oncologic treatment.

Primary endpoints: Changes in the mean HbA1c level from baseline to the 3rd month after enrollment, changes in HbA1c of 20% or more, and the ratio of patients achieving HbA1c target of 7% or less in predefined groups with different glycemic histories. Given the relatively brief duration of 3 months, a significant enhancement in HbA1c levels is considered to be a change of 20% or higher.[7]

Secondary endpoints: The effects of baseline characteristics on HbA1c changes, namely education, mindful eating, depression and daily physical activity. This analysis was conducted to evaluate the ability of participants' baseline characteristics to predict changes in HbA1c levels over time. The aim was to examine the influence of different risk factors on goal attainment. Although all participants received lifestyle change training, it is essential to consider that factors other than what was taught could influence how effectively participants implemented these changes. Education level was selected as one of the secondary measures because it falls into the category of social determinants that affect health outcomes.[8] Education is widely recognized as an influential factor in adapting to change. Lifestyle changes often include adopting healthy eating habits, managing weight, engaging in regular exercise, and quitting smoking. While mindful eating is a reflection of awareness in choosing what to consume for healthy living, assessing daily physical activity is one of the ways to evaluate exercise background. Depressive symptoms have been linked to difficulties in managing blood glucose levels and lower adherence to diet and exercise recommendations.[9]

3. Study design

Patients with type 2 diabetes and poor glycemic control (as indicated by an HbA1c level of ≥ 10%) were invited to participate in the study. Of the 321 participants who met the inclusion criteria, 266 consented to participate in the study.

4. Patient groups

Participants were divided into groups based on their previous HbA1c levels and their glycemic histories. There was an interval of at least 3 months between previous HbA1c measurements; the most recent measurements were usually taken 6 months before participation. At least 3 HbA1c measurements were evaluated to assess glycemic history. Group 1 consisted of patients diagnosed with type 2 diabetes within 1 month and who had no previous record of diabetes or antidiabetic medication usage, and were referred to as "newly diagnosed patients." Participants in Group 2 had previously been diagnosed with type 2 diabetes. Prior to their involvement in the study, they had consistently maintained their HbA1c level below or equal to 7% for at least 3 consecutive occasions separated by more than 3 months apart. As their HbA1c level is now ≥ 10%, they were identified as the "previously controlled group." Participants in Group 3 had previously been diagnosed with type 2 diabetes, and their HbA1c levels were consistently between 7 and 9.5% on several occasions more than 3 months apart prior to participation in the study. However, their current HbA1c level has now risen above 10%, indicating a worsening of their condition compared to previous measurements. They were identified as the group that "previously off target but now worsened." The final group, Group 4, consisted of patients with a previous type 2 diabetes diagnosis and all previous HbA1c levels above 10%, termed "poorly controlled from the start." Both Group 1 and Group 2 were known to have good metabolic control before (either had no diabetes or had previous HbA1c levels ≤7) and were grouped as Group A for further analysis, whereas Group 3 and 4 were grouped as Group B, who had poor metabolic control for at least more than a year before enrollment ("persistently poorly controlled"). The groups were compared according to patient characteristics (age, sex, education level, depression status, dietary awareness, exercise characteristics), demographic findings, medications, and anthropometric and biochemical data.

Groups 1 to 4, and Groups A and B were used for analysis. Also, other subgroups were used for analysis: patients who reached the target HbA1c level of 7% or less or were still higher than 7%; and patients who had a 20% percent or higher HbA1c reduction at the end of the 3rd month or not. In addition, possible factors associated with the findings were evaluated.

5. Intervention

At baseline, the duration of diabetes, demographic characteristics, level of education, and concomitant diseases of all participants were recorded. The participants' diabetes type, their previous laboratory analyses, their medications, the dose of their medications, and the regularity of their intake were further investigated using the hospital prescription system, the National Medula electronic health system called e-Pulse, and the National Medula electronic prescription system (//medeczane.sgk.gov.tr/doktor/login.jsp). Their previous HbA1c values were used in forming the patient groups. A detailed physical assessment with anthropometric measurements was performed, including waist circumference, height, and body weight. All participants completed 3 different questionnaires, listed below, and then underwent predetermined laboratory tests, including concentrations of c-peptide and HbA1c.

The study participation started after the patients' questionnaires were completed. All patients visited a certified diabetes nurse educator and dietitian at least once and repeated as needed, based on the requirements of the medical practitioner or the patients themselves. The diabetes follow-up visits were continued by their respective physicians, who were internists specializing in diabetes. All visits, including following physicians', were dependent on the initiative of the physicians and patients. Participants were invited to the diabetes clinic at regular intervals to facilitate their visits. They also could reach the medical team by phone at their convenience. Since all participants were affiliated with the social health institution, there were no problems in performing diagnostic tests and obtaining medication. Diagnostic inquiries and treatment applications were conducted following current diabetes guidelines. The most significant aspect of this study was enhancing accessibility

for patients to their doctors and nurses, along with intensifying their treatment regimen. Participants were called again 3 months after enrollment in the study to collect the most recent biochemical data.

6. Anthropometric and laboratory measurements

The same physician measured body weight, waist circumference, and height using standard measuring instruments. Waist circumference was measured as defined by the World Health Organization. The body mass index (BMI) was calculated as weight (in kilograms) divided by height (in square meters).

7. Questionnaires

Three different questionnaires, the mindful eating questionnaire, the General Practice Physical Activity Questionnaire, and the Beck depression inventory questionnaire were completed before the enrollment of participants. These questionnaires aimed to determine individuals' mindfulness for eating, whether they have depression or not, and if they have, then the degree of their depression, and to evaluate their daily physical activity. We used the validated Mindful Eating Questionnaire in Turkish, which consists of 30 items rated 1 (never) to 5 (always), evaluating 7 eating behavior and mindfulness constructs with higher scores indicating greater degrees of mindful eating.[10] We used the total score for analysis. The Turkish version of the Beck Depression Index scale, which is a 21-item (multiple-choice) self-assessment inventory created to provide a quantitative assessment of the intensity of depression, was used in our study.[11] The items were evaluated on a scale ranging from zero to 3, depending on the severity of the symptoms; higher scores indicate more depressive symptoms. Grades of depression are based on score cutoffs: no depression (0–9 points), mild (10–16 points), moderate (17–24 points), and severe (>25 points). The General Practice Physical Activity Questionaire is a short questionnaire on daily physical activity (evaluating physical exercise, cycling, walking, housework/childcare, and gardening); the physical nature of the occupational activity; and walking pace. It is recorded into "active," "inactive," "moderately inactive" or "moderately active" Physical Activity Index categories.[12] Participants were also asked if they had been taking their medications as advised, if they were following their diet counseling, and about their exercise habits.

8. Analytical measurements

All blood tests, including fasting C-peptide and HbA1c were taken after 10 to 14 hours of fasting, and tested in the central hospital laboratory. The hexokinase technique was used to determine fasting glucose concentrations. The kinetic Jaffe technique was used to measure serum creatinine. An enzymatic (without *P*-5'-P, NADH) technique was employed to determine ALT concentrations. Enzymatic methods were used to quantify fasting plasma total cholesterol, HDL and LDL cholesterol, and triglyceride concentrations (Abbott Architect c16000 and c8000, Abbott). For HbA1c measurements, a Tosoh HLC-723 G8 (Tosoh G8) (variant-mode) ion exchange high-performance liquid chromatography system (Tosoh, Japan) was employed. The C-peptide was quantified in the Abbott Architect I2000 autoanalyzer (Abbott Laboratories, Abbott Park, IL, USA) using a chemiluminescence microparticle immunoassay.

The glomerular filtration rate was estimated using the Chronic Kidney Disease Epidemiology Collaboration equation formula,[10] and the presence of proteinuria was evaluated using the protein/creatinine ratio in the spot urine.

9. Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY, USA) software package. Descriptive statistics were obtained, quantitative variables were characterized using mean, maximum (max), and minimum (min) values, and percentages were used for qualitative variables. Whether the distributions were normal or not was determined by Kolmogorov-Smirnov analysis. Normal distributions were reported as mean values, and Student *t* test was used for intergroup comparisons. Pearson chi-square test was used for comparative analysis of qualitative variables; however, Fisher exact test was used if the sample size was small (≤5). Non-parametric continuous variables were recorded as medians and compared using Mann-Whitney *U* tests. IQR result was also given for the values recorded as the median. If there are more than 2 groups, comparisons were made with one-way ANOVA; if the distribution was normal, post hoc evaluation was performed with Tukey; if not, with Games-Howell, and in-group and intergroup comparisons were made. $P < .05$ was considered statistically significant. A post hoc power analysis was conducted for the study, revealing that with a medium effect size and an alpha error value of 0.05, the 4 groups calculated power was 83%.

10. Results

10.1. Participant characteristics

Among 266 participants, 195 participants (73.3%) completed the study. The 71 patients (26.7%) who failed to attend the follow-ups were connected via telephone, and repeatedly invited, but failed to attend. It is also noticed that these participants did not seek any other medical help and had no laboratory results in the system, though all of them had HbA1c levels above 10%. Of the patients who did not participate in follow-up, 11 were in group 1, 13 in group 2, 26 in group 3, and 21 in group 4. Of the 195 participants, 43.1% (n = 84) were female. Median age was 54 years (IQR = 15, min = 29, max = 80) and median baseline HbA1c was 11.8% (IQR = 2.6%, min = 10%, max = 18.3%). Median diabetes duration was 10 years (IQR = 9, min = 1, max = 35) when the newly diagnosed patients were excluded. Baseline characteristics are outlined in Table 1.

At baseline, 53 participants (33 newly diagnosed and 20 in other groups) were not using any antidiabetic medications. Thirteen participants were on insulin preparations alone; 48 had oral antidiabetic medications and insulin, and 81 had antidiabetic medications other than insulin. The mean antidiabetic medication other than insulin use was 1.91 + –0.8 in these 129 participants. At the end of the 3rd month, only 8 participants were on insulin, 136 had insulin and other antidiabetic medications, and 51 had non-insulin medications. The mean antidiabetic medication besides insulin use was 2.71 + –0.82 in these 187 participants.

In Group 1, which consists of patients with newly diagnosed type 2 diabetes, there were 33 participants (16.9%). The number of participants in Groups 2, 3 and 4 were 42 (21.5%), 55 (28.2%) and 65 (33.3%), respectively. The follow-up period was 3 months (12–15 months). Table 2 compares the groups in terms of baseline HbA1c levels, 3rd month HbA1c levels, the percentage of participants who have an HbA1c decrease of more than 20%, and the percentage of participants who reach an HbA1c level below 7%.

There was a statistically significant difference between all groups in terms of baseline HbA1c, 3rd month HbA1c, total HbA1c difference, the percentage of patients with a decrease in HbA1c levels of more than 20%, and the percentage of patients with a decrease in HbA1c below 7%. Group 1 participants had the highest baseline HbA1c levels (median 13.1%, IQR = 2.7, min = 10.2%, max = 17.5%), while Group 4 had

Table 1

Baseline characteristics of the patients.

Baseline characteristics	Participants
Diabetes course, n (%)	
Newly diagnosed T2DM	33 (16.9%)
Patients with previously controlled T2DM	42 (21.5%)
T2DM patients whose HBA1c were previously not on target but now worsened	55 (28.2%)
T2DM patients whose HbA1c were ≥ 10% for a long time	65 (33.3%)
HbA1c%, median (IQR)	11.8 (2.6)
C-peptide, median (IQR)	2.45 (1.84)
Creatinine (mg/dL), median (IQR)	0.76 (0.28)
Comorbidities, n (%)	
Hypertension	81 (41.5%)
Coronary heart disease	29 (14.9%)
Chronic renal failure	
Stage 4–5	1 (0.5%)
Stage 3	17 (8.7%)
Prior medications	
Newly diagnosed T2DM	33 (16.9%)
No medication but have T2DM	20 (10%)
In medication users (n = 142)	
Insulin usage	61 (43%)
Antidiabetic agents other than insulin	129 (91%)
Antidiabetic agent other than insulin per patient (n)	1.91 + –0.8
GLP-1 analogues	4 (2.1%)
Lipid-lowering agent users (%)	48 (24.6%)

IQR = inter-quantile range, T2DM = type 2 diabetes mellitus.

the highest 3rd month HbA1c levels (median 9.3%, IQR = 2.4, min = 5.8%, max = 14.5%). The highest difference between baseline HbA1c and 3rd month HbA1c levels was in Group 1 (median 6.2%, IQR = 2.2, min = 0.7%, max = 11.6%). The percentage of participants with a decrease in HbA1c of more than 20% (97.0%) and those with a decrease in HbA1c below 7% (60.6%) were also the highest in Group 1. The comparison between groups is given in Table 2. The comparison of Group A (n = 75), which consisted of Groups 1 and 2 and was known to have normal or good metabolic control before, and Group B (n = 120), which consisted of Groups 3 and 4 and had poor metabolic control before, is given in Table 3. Between the groups, there were statistically significant differences for baseline HbA1c levels ($P = .05$), HbA1c levels in the 3rd month ($P < .001$), the difference between baseline and 3rd month HbA1c levels ($P < .001$), patients with HbA1c levels <7% at the end of the 3rd month ($P < .001$) and the Beck depression scale ($P = .001$).

While baseline HbA1c was statistically higher in Group A than Group B (median 12.2% vs median 11.7%, $P = .05$), 3rd month HbA1c was statistically higher in Group B than Group A (median 7.1% vs 8.9%, $P < .001$) (Tablo 3). At the end of the 3rd month, the proportion of patients with HbA1c <7% was statistically higher in Group A than in Group B (52.0% vs 10.8%, respectively, $P < .001$). The presence of depression in patients in Group A was statistically lower than in Group B ($P = .001$). There was an almost significant difference between the 2 groups regarding education levels ($P = .07$). It was found that participants in Group A had higher secondary or higher education compared to Group B (48% vs 35%). There was no statistically significant difference between the groups regarding age, gender, BMI, c-peptide levels, total mindful eating score, and physical activity.

Group A and B participants were evaluated separately in 2 subgroups according to whether the target of 7% and below HbA1c levels was achieved at the end of the 3rd month (Table 4). In this subgroup analysis, there was a statistical difference in c-peptide levels between the groups in Group B ($P = .01$). In other variables, no difference was found in the in-group comparisons.

The in-group comparisons between the patients who had ≥20% decrease in their HbA1c levels at the end of the 3rd month and those who had not are given in Table 5. A statistical difference was observed between the initial HbA1c levels of Group A and Group B when compared according to the cutoff of a 20% decrease in HbA1c levels (respectively, $P = .04$ and $P < .001$). In both Group A and Group B, patients with a 20% or greater HbA1c reduction had significantly higher basal HbA1c levels than patients with a <20% reduction. Also, in this subgroup, BMI was statistically different between the groups ($P = .03$), having a lower BMI in the 20% or greater reduction in the HbA1c group than the <20% decrease in the HbA1c group (28.8 ± 0.5 and 30.5 ± 0.9, respectively). There were no differences in other variables.

Regardless of their group, all the participants together were then grouped and compared according to the decrease in HbA1c of less than or more than 20% at the end of the 3rd month (Table 6). There were statistically more women in the group with more than 20% decrease in HbA1c levels in contrast to the group with <20% decrease in HbA1c levels ($P = .01$), and the initial HbA1c level was statistically higher ($P < .001$). In addition, the group with a more than 20% decrease in HbA1c had a statistically significant lower BMI than the group with a <20% decrease in HbA1c ($P = .09$). Apart from this, no statistical difference was found between these 2 groups.

11. Discussion

Our research aimed to investigate the impact of intensified monitoring and facilitated hospital visits in patients with

Table 2

Comparison between the groups based on their previous HbA1c levels.

	Group 1 (n = 33)	Group 2 (n = 42)	Group 3 (n = 55)	Group 4 (n = 65)	*P* value*	p1	p2	p3	p4	p5	p6
Baseline HbA1c, median (IQR)	13.1 (2.7)	11.5 (2.3)	11.8 (2.7)	11.4 (2.4)	**.004**	**0.04**	*0.08*	**0.005**	0.969	0.955	0.699
3rd mo HbA1c, median (IQR)	6.7 (1.6)	7.4 (1.8)	8.5 (2.4)	9.3 (2.4)	**<.001**	0.104	**<0.001**	**<0.001**	**0.002**	**<0.001**	0.234
HbA1c difference, median (IQR)	6.2 (2.2)	4.2 (3.3)	3.3 (3.3)	2.4 (2.5)	**<.001**	**0.004**	**<0.001**	**<0.001**	0.152	**<0.001**	*0.07*
>20% decrease in HbA1c, n (%)	32 (97.0)	37 (88.1)	38 (69.1)	36 (55.4)	**<.001**	0.440	**0.001**	**<0.001**	*0.09*	**<0.001**	0.411
HbA1c ≤7% n (%)	20 (60.6)	16 (38.1)	9 (16.4)	4 (6.2)	**<.001**	0.214	**<0.001**	**<0.001**	*0.08*	**0.001**	0.309

*Comparison between all groups, p1; Group 1 versus Group2, p2; Group 1 versus Group 3, p3; Group 1 versus Group 4, p4; Group 2 versus Group 3, p5; Group 2 versus Group 4, p6; Group 3 versus Group 4. Bold *P* values indicate statistical significance. *P* values in italic show *P* values close to statistical significance.
IQR = inter-quantile range.

Table 3

Comparison between Group A and Group B

	Group A (Group 1 + 2) (n = 75)	Group B (Group 3 + 4) (n = 120)	*P*
Age, median (IQR), yr	52 (15)	56 (16)	.220
Gender, n (%)			.200
Female	28 (37.3)	56 (46.7)	
Male	47 (62.7)	64 (53.3)	
BMI, mean ± SD	30.2 ± 0.5	29.6 ± 0.4	.306
C peptide, median (IQR)	2.5 (1.5)	2.3 (1.9)	.112
Mindful Eating total score, median (IQR)	3.4 (0.7)	3.5 (0.7)	.187
Baseline HbA1c, median (IQR)	12.2 (3.3)	11.7 (2.6)	**.05**
3rd mo HbA1c, median (IQR)	7.1 (1.6)	8.9 (2.3)	**<.001**
HbA1c difference, median (IQR)	5.5 (3.2)	3.0 (2.9)	**<.001**
Education, n (%)			*.07*
Less than sixth grade	39 (52.0)	78 (65.0)	
sixth grade or higher	36 (48.0)	42 (35.0)	
Beck depression score > 9 n (%)	33 (44.0)	82 (68.3)	**.001**
Physical activity, n (%)			.452
GPPAQ inactive	39 (52.0)	69 (57.5)	
3rd mo HbA1c >7%, n (%)	39 (52.0)	107 (89.2)	**<.001**
No			

Bold *P* values indicate statistical significance. *P* values in italic show *P* values close to statistical significance. Group A: patients who had good metabolic control before (either had no diabetes or had previous HbA1c levels ≤7). Group B: patients who had poor metabolic control for at least a couple of yr before enrollment ("persistently poorly controlled").

BMI = body mass index, calculated as weight (in kilograms) divided by height (in square meters), GPPAQ = General Practice Physical Activity Questionaire, IQR = inter-quantile range.

inadequately controlled type 2 diabetes, particularly those with an HbA1c of 10% or more who had a history of variable glycemic control, i.e., who were newly diagnosed, whose glycemic control had recently worsened, or who had a history of poor glycemic control. The glycemic history of the patients had a notable impact on HbA1c levels at 3 months. Patients in groups 1 to 4 exhibited median HbA1c values of 6.7%, 7.4%, 8.5%, and 9.3%, respectively, suggesting that past glycemic control patterns can indicate future diabetes treatment success.

Throughout the study, a significant reduction in HbA1c levels was achieved with 3 months of intensive treatment. The most noteworthy decrease in HbA1c levels was observed in patients with newly diagnosed type 2 diabetes and in patients whose glycemic control had deteriorated within the past year, although they had previously been well-controlled. While the rate of those achieving HbA1c levels of 7% or less was nearly 50% in these 2 groups, successful control was achieved in only 1 in 10 patients with persistently high HbA1c levels. When the 4 groups were analyzed separately, 60% of newly diagnosed patients achieved an HbA1c level of 7% or less within the first 3 months, whereas this rate was only 6% in those who had an HbA1c level of 10 or more from the start.

Due to the short duration of the study, success rates for achieving a 20% reduction in HbA1c were also examined to assess another effect of intensive treatment on glycemia. A success rate of up to 97% was achieved in newly diagnosed individuals with type 2 diabetes, while this rate was only half in the group whose HbA1c levels were persistently 10% or above.

Failure to intensify medications when indicated in patients with poorly controlled T2DM is referred to as clinical inertia and is a contributing cause of poor control of T2DM, but this phenomenon cannot be solely attributed to it in our study. All of these participants already had poor glucose control and were therefore treated similarly, but there were significant differences in success rates. Also, there is a notable increase in both oral antidiabetics and insulin usage rates. Even after excluding newly diagnosed patients, insulin use increased twofold.

Two separate studies emphasized the importance of meeting glycemic objectives early in treatment. Kim and colleagues stated that the time it took to achieve the target HbA1c was connected to the long-term stability of glycemic control; the sooner, the better.[13] In the study by Schwab et al, they found that early therapy modifications resulted in better near-term glycemic control.[14] These data are consistent with our findings. In our study, the patients whose diabetes was previously well-controlled, reached better glycemic profiles than the patients whose diabetes was previously poorly controlled diabetes. The earlier the glycemic control is adjusted, the higher the chances of meeting glycemic goals.

If the desired HbA1c target cannot be achieved through adherence to dietary restrictions, lifestyle changes, and metformin therapy alone, alternative oral or injectable treatments such as Glukagon like peptide-1 analogues and sodium-glucose co-transporter 2 inhibitors can be considered. These newer agents have been found to provide renal protection while simultaneously lowering cardiovascular risks and minimizing the incidence of hypoglycemia. Due to their diverse yet complementary mechanisms for reducing HbA1c levels, these novel therapies hold great promise in managing type 2 diabetes resistant to traditional treatment approaches.[15] By the 3rd month, over 50% of the participants were taking sodium-glucose cotransporter 2 inhibitors. In Turkey, exenatide—the only covered GLP analogues—is covered by health insurance for people with a BMI of 35 or greater, as well as those who are not using basal-bolus or mixed insulin. However, this access is limited because a prescription from an endocrinologist is required. While this is a limitation, it applies equally to all groups studied. Notably, d'Alessio et al's research indicated that over the 24-week period, no dissimilarities observed in HbA1c reduction rates between glargine and liraglutide in individuals with HbA1c levels ranging from 7.5% to 12%.[16] Though these 2 medication types may have distinct long-term effects, short-term glycemic outcomes appear comparable.

The study also aimed to compare the clinical characteristics of patients with T2DM who had achieved good glycemic control versus those who had not. The results showed that patients with persistent poor glycemic control had a higher prevalence of depression at baseline than patients with a good glycemic control history. While the study found differences in depression rates at baseline, interestingly, there was no significant effect of HbA1c reduction on depression scores. It is important to consider the possibility of reverse causality in these groups. It is plausible that the presence of depression may be linked to high levels of HbA1C, and conversely, poor diabetes control could potentially contribute to the development of depression.

In addition, patients with HbA1c levels below 7% at month 3 in the persistently poorly controlled group had better basal C-peptide levels than patients with levels above 7% (which could indicate either better pancreatic reserve or higher insulin resistance). The study did not find any significant impact on changes in HbA1c in relation to the participants' educational level or physical activity. No significant influence was observed in terms of food awareness.

In some of the studies on poorly controlled diabetes, age below 35 years was associated with poor control, whereas in others, age below 50 years was associated with poor control.[17] In our study, the participants' median age was 54 years, and no significant age difference existed between those who responded well to treatment and those who did not.

It was observed that in the groups that did or did not achieve a 20% reduction, those that did were more likely to be male and to have higher initial A1c levels. In a study conducted by

Table 4

Comparison of groups based on HbA1c levels below or above 7%.

	Group A (group 1 + 2) (n = 75)			Group B (group 3 + 4) (n = 120)		
	HbA1c ≤7% (n = 36)	HbA1c > 7% (n = 39)	p	HbA1c ≤7% (n = 13)	HbA1c > 7% (n = 105)	*P*
Age, median (IQR), yr	52 (15)	53 (16)	0.378	61 (15)	54 (15)	.167
Gender, n (%)			0.244			.969
Female	11 (30.6)	17 (43.6)		6 (46.2)	50 (46.7)	
Male	25 (69.4)	22 (56.4)		7 (53.8)	57 (53.3)	
Education, n (%)			0.739			.735
Less than sixth grade sixth grade or higher	18 (50.0)	21 (3.8)		9 (69.2)	69 (64.5)	
	18 (50.0)	18 (46.2)		4 (30.8)	38 (35.5)	
BMI, mean ± SD	29.7 ± 0.8	30.6 ± 0.8	0.265	30.3 ± 1.0	29.5 ± 0.5	.485
C peptide, median (IQR)	2.6 (1.4)	2.4 (1.8)	0.463	4.5 (3.9)	2.2 (1.7)	**.01**
Mindful eating total score, median (IQR)	3.4 (0.8)	3.3 (0.7)	0.614	3.5 (1.0)	3.4 (0.7)	.802
Initial HbA1c, median (IQR)	12.4 (3.7)	11.7 (2.4)	0.113	11.8 (4.4)	11.7 (2.6)	.790
Decrease in HbA1c (%), mean ± SD	51.6 (11.2)	33.0 (15.0)	**<0.001**	47.2 (17.6)	24.1 (18.9)	**<.001**
Beck depression score > 9			0.696			.234
n (%)	15 (41.7)	18 (46.2)		7 (53.8)	75 (70.1)	
Physical activity, n (%)			0.897			.365
GPPAQ inactive	19 (52.8)	20 (51.3)		9 (69.2)	60 (56.1)	

Bold *P* values indicate statistical significance. Group A: patients who had good metabolic control before (either had no diabetes or had previous HbA1c levels ≤7). Group B: patients who had poor metabolic control for at least a couple of yr before enrollment ("persistently poorly controlled").

BMI = body mass index, calculated as weight (in kilograms) divided by height (in square meters), GPPAQ = General Practice Physical Activity Questionaire, IQR = inter-quantile range.

Table 5

Comparison of 2 groups formed based on the difference in HbA1c levels after 3 mo, patients were divided into 2 groups: those with a difference of <20% and those with a difference of more than 20%.

	Group A (1 + 2)				Group B (3 + 4)			
	Total (n = 75)	HbA1c difference ≥20% (n = 69)	HbA1c difference < 20% (n = 6)	p	Total (n = 120)	HbA1c difference ≥20% (n = 74)	HbA1c difference < 20% (n = 46)	*P*
Age, median (IQR), yr	52 (15)	53 (15)	48 (15)	0.159	56 (16)	56 (16)	55 (16)	.721
Gender, n (%)				0.135				*.08*
Female	28 (37.3)	24 (34.8)	4 (66.7)		56 (46.7)	30 (40.5)	26 (56.5)	
Male	47 (62.7)	45 (65.2)	2 (33.3)		64 (53.3)	44 (59.5)	20 (43.5)	
Education, n (%)				0.419				.408
Less than sixth grade sixth grade or higher	39 (52.0)	37 (53.6)	2 (33.3)		78 (65.0)	46 (62.2)	32 (69.6)	
	36 (48.0)	32 (46.4)	4 (66.7)		42 (35.0)	28 (37.8)	14 (30.4)	
BMI, mean ± SD	30.2 ± 0.5	30.2 (7.8)	29.4 ± 1.3	0.968	29.6 ± 0.4	28.8 ± 0.5	30.5 ± 0.9)	**.03**
C peptide, median (IQR)	2.5 (1.5)	2.5 (1.6)	3.1 (1.0)	0.489	2.3 (1.9)	2.4 (2.0)	2.2 (1.5)	.928
Mindful eating total score, median (IQR)	3.4 (0.7)	3.4 (0.8)	3.1 (0.5)	0.172	3.5 (0.7)	3.5 (0.8)	3.4 (0.5)	.856
Initial HbA1c, median (IQR)	12.2 (3.3)	12.3 (3.5)	11.6 (2.2)	**0.04**	11.7 (2.6)	12.3 (2.7)	10.9 (1.9)	**.001**
Decrease in HbA1c (%), mean ± SD	44.1 (19.1)	44.9 (16.7)	6.0 (4.9)	**<0.001**	26.0 (21.6)	30.7 (10.5)	10.6 (10.9)	**<.001**
Beck depression score > 9				*0.08*				.326
n (%)	33 (44.0)	28 (40.6)	5 (83.3)		82 (68.3)	53 (71.6)	29 (63.0)	
Physical activity, n (%)				0.419				.556
GPPAQ inactive	39 (52.0)	37 (53.6)	2 (33.3)		69 (57.5)	41 (55.4)	28 (60.9)	

Bold *P* values indicate statistical significance. *P* values in italic show *P* values close to statistical significance. Group A: patients who had good metabolic control before (either had no diabetes or had previous HbA1c levels ≤7). Group B: patients who had poor metabolic control for at least a couple of yr before enrollment ("persistently poorly controlled").

BMI = body mass index, calculated as weight (in kilograms) divided by height (in square meters), GPPAQ = General Practice Physical Activity Questionaire, IQR = inter-quantile range.

Walraven and colleagues, subgroups of patients diagnosed with T2DM were identified based on their individual HbA1c trajectories.[18] In contrast to our study, patients who displayed less favorable glycemic control were found to have higher baseline HbA1c levels than those who exhibited more favorable outcomes. However, in the study by Murphy and colleagues, interventions targeting individuals with higher baseline HbA1c levels were found to have the greatest effect, similar to our findings.[19] Also, in our study, it was observed that participants who failed to achieve a 20% reduction in the persistently poor control group had a higher BMI.

Persistently inadequately managed diabetes poses a significant clinical dilemma due to the complexity of addressing the factors contributing to poor diabetes control. Patient adherence to therapy is another factor that should be considered. A systematic review reported that the nonattendance rate varied between studies from 10% to 30%, depending on the study.[20] It is worth noting that more than 20% of participants in our study were lost to follow-up, possibly due to poor adherence to therapy. This finding is significant as these patients exhibit a greater number of risk factors and complications compared with patients with better glycemic control.

Table 6

Comparison of patients with a decrease in HbA1c of <20% or more at the end of the 3rd mo.

	HbA1c difference ≥20% (n = 143)	HbA1c difference < 20% (n = 52)	*P*
Age, median (IQR), yr	54 (15)	54 (17)	.804
Gender, n (%)			**.01**
Female	54 (37.8)	30 (57.7)	
Male	89 (62.2)	22 (42.3)	
Education, n (%)			.355
Less than sixth grade	83 (58.0)	34 (65.4)	
Sixth grade or higher	60 (42.0)	18 (34.6)	
BMI, mean ± SD	29.5 ± 0.4	30.7 ± 0.8	*.09*
C peptide, median (IQR)	2.4 (1.9)	2.4 (1.2)	.629
Mindful eating total score, median (IQR)	3.4 (0.7)	3.4 (0.6)	.813
Initial HbA1c, median (IQR)	12.3 (2.9)	10.9 (1.9)	**<.001**
Beck depression score > 9			.272
n (%)	81 (56.6)	34 (65.4)	
Physical activity, n (%)			.696
GPPAQ inactive	78 (54.5)	30 (57.7)	

Bold *P* values indicate statistical significance. *P* values in italic show *P* values close to statistical significance. Group A: patients who had good metabolic control before (either had no diabetes or had previous HbA1c levels ≤7). Group B: patients who had poor metabolic control for at least a couple of yr before enrollment ("persistently poorly controlled").

BMI = body mass index, calculated as weight (in kilograms) divided by height (in square meters), GPPAQ = General Practice Physical Activity Questionaire, IQR = inter-quantile range.

Although this study employed a pragmatic approach to managing patients with poorly controlled diabetes, there were some limitations. The study had a short follow-up period, and the patients' medication adherence and compliance were not assessed. In addition, lifestyle changes were not assessed, and Glukagon like peptide-1 analogues prescription issues resulted in a low preference rate for the medication. Despite these limitations, the study had some strengths, such as easy access to medications because all the participants had insurance, and the frequent follow-up and invitation of patients for appointments. However, about one-fifth of the patients were lost to follow-up despite being actively called and invited for visits, which highlights the challenges of managing diabetes and the need to address patient perceptions and attitudes toward the disease.

Accessibility to health services and support, such as medications, consultations with physicians and nurses, and guidance from dietitians are crucial for patients with diabetes. However, these resources may not be sufficient to regulate diabetes in those with a history of poor glycemic control. Simply intensifying the monitoring of diabetic patients may not be enough. In order to close the gap and improve outcomes for people with diabetes, it is vital to address psychosocial factors and other non-pharmacological aspects that may influence lifestyle, especially in groups with long-standing poor control. This approach should involve interventions such as meditation, improving sleep patterns, cultivating social support networks, and providing psychological support.[21–24] Recognizing the need for these interventions is crucial in effectively managing diabetes.

These findings can inform the development of tailored interventions to improve glycemic control and reduce the burden of diabetes in affected populations.

12. Conclusion

In patients with type 2 diabetes with an HbA1c of 10% or more, previous individual glycemic trends provide valuable information about the possibility of achieving diabetes control. Patients with newly diagnosed type 2 diabetes are more likely to perceive good glycemic control. When patients have "persistently poorly controlled" diabetes, simply relying on more intensive monitoring and frequent hospital visits is unlikely to achieve the desired glycemic control. A more comprehensive approach is needed that considers psychosocial factors and non-pharmacological aspects of lifestyle such as meditation, sleep patterns, social support, and psychological assistance. It is essential to recognize the importance of these interventions as necessary in order to address this gap and improve outcomes for people with diabetes.

Acknowledgments

We want to thank Dr Necati Çıtak for his help in statistics.

Author contributions

Conceptualization: Ayşe Naciye Erbakan, Aytekin Oğuz.
Data curation: Ayşe Naciye Erbakan, Müzeyyen Arslan Bahadır, Fatoş Nimet Kaya, Büşra Güleç, Miraç Vural Keskinler, Özge Faydalıel.
Formal analysis: Ayşe Naciye Erbakan.
Investigation: Ayşe Naciye Erbakan, Müzeyyen Arslan Bahadır, Miraç Vural Keskinler, Özge Faydalıel, Banu Mesçi.
Methodology: Ayşe Naciye Erbakan, Aytekin Oğuz.
Project administration: Ayşe Naciye Erbakan, Müzeyyen Arslan Bahadır, Fatoş Nimet Kaya.
Supervision: Ayşe Naciye Erbakan, Müzeyyen Arslan Bahadır, Fatoş Nimet Kaya, Banu Mesçi, Aytekin Oğuz.
Validation: Büşra Güleç.
Writing – original draft: Ayşe Naciye Erbakan.
Writing – review & editing: Ayşe Naciye Erbakan, Aytekin Oğuz.

References

[1] Sun H, Saeedi P, Karuranga S, et al. IDF Diabetes Atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
[2] Davies MJ, Aroda VR, Collins BS, et al. Management of hyperglycemia in type 2 diabetes, 2022 a consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care. 2022;45:2753–86.
[3] Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000;321:405–12.
[4] Fang M, Wang D, Coresh J, et al. Trends in diabetes treatment and control in US adults, 1999–2018. N Engl J Med. 2021;384:2219–28.
[5] Crowley MJ, Tarkington PE, Bosworth HB, et al. Effect of a comprehensive telehealth intervention vs telemonitoring and care coordination in patients with persistently poor type 2 diabetes control: a randomized clinical trial. JAMA Intern Med. 2022;182:943–52.
[6] Masood MQ, Singh K, Kondal D, et al. Factors affecting achievement of glycemic targets among type 2 diabetes patients in South Asia: analysis of the CARRS trial. Diabetes Res Clin Pract. 2021;171:108555.
[7] Dixon JB, Zimmet P, Alberti KG, et al. International Diabetes Federation Taskforce on Epidemiology and Prevention Bariatric surgery: an IDF statement for obese type 2 diabetes. Surg Obes Relat Dis. 2011;7:433–47.
[8] Walker RJ, Williams JS, Egede LE. Influence of race, ethnicity and social determinants of health on diabetes outcomes. Am J Med Sci. 2016;351:366–73.
[9] Azami G, Soh KL, Sazlina S-G, et al. The effect of depression on poor glycemic control in adults with type 2 diabetes: the mediating roles of self-efficacy and self-management behaviors. Int. J. Diabetes Metab. 2020;25:80–9.
[10] Gizem K, Tayfur M, Birincioğlu I, et al. Adaptation study of the mindful eating questiıonnare (MEQ) into Turkish. J Cognitive-Behavioral Psychother Res. 2018;5:125–34.
[11] Hisli N. Beck depresyon envanterinin universite ogrencileri icin gecerliligi, guvenilirligi (A reliability and validity study of beck depression inventory in a university student sample). J Psychol. 1989;7:3–13.

[12] Noğay AEK, Mehmet O. Birinci basamak için fiziksel aktivite anketinin Türkçe uyarlamasının geçerlilik ve güvenilirliği (English Translation). Konuralp Med J. 2019;11:1–8.
[13] Kim KJ, Choi J, Bae JH, et al. Time to reach target glycosylated hemoglobin is associated with long-term durable glycemic control and risk of diabetic complications in patients with newly diagnosed type 2 diabetes mellitus: a 6-year observational study (Diabetes Metab J 2021;45:368–78). Diabetes Metab J. 2021;45:617–8.
[14] Schwab P, Saundankar V, Bouchard J, et al. Early treatment revisions by addition or switch for type 2 diabetes: impact on glycemic control, diabetic complications, and healthcare costs. BMJ Open Diabetes Res Care. 2016;4:e000099.
[15] Kroopnick JM, Davis SN. The role of recent pharmacotherapeutic options on the management of treatment resistant type 2 diabetes. Expert Opin Pharmacother. 2022;23:1259–71.
[16] D'Alessio D, Häring HU, Charbonnel B, et al. Comparison of insulin glargine and liraglutide added to oral agents in patients with poorly controlled type 2 diabetes. Diabetes Obes Metab. 2015;17:170–8.
[17] Gomes MB, Tang F, Chen H, et al. Socioeconomic factors associated with glycemic measurement and poor HbA1c control in people with type 2 diabetes: the global discover study. Front Endocrinol (Lausanne). 2022;13:831676.
[18] Walraven I, Mast MR, Hoekstra T, et al. Distinct HbA1c trajectories in a type 2 diabetes cohort. Acta Diabetol. 2015;52:267–75.
[19] Murphy ME, Byrne M, Galvin R, et al. Improving risk factor management for patients with poorly controlled type 2 diabetes: a systematic review of healthcare interventions in primary care and community settings. BMJ Open. 2017;7:e015135.
[20] Brewster S, Bartholomew J, Holt R, et al. Non-attendance at diabetes outpatient appointments: a systematic review. Diabet Med. 2020;37:1427–42.
[21] Tuudah E, Foye U, Donetto S, et al. Non-pharmacological integrated interventions for adults targeting type 2 diabetes and mental health comorbidity: a mixed-methods systematic review. Int J Integr Care. 2022;22:27.
[22] Wang X, He L, Zhu K, et al. An integrated model to evaluate the impact of social support on improving self-management of type 2 diabetes mellitus. BMC Med Inform Decis Mak. 2019;19:1–12.
[23] Liu M, Ahmed WL, Zhuo L, et al. Association of sleep patterns with type 2 diabetes mellitus: a cross-sectional study based on latent class analysis. Int J Environ Res Public Health. 2022;20:393.
[24] Heo S, Kang J, Umeakunne E, et al. Effects of meditation intervention on self-management in adult patients with type 2 diabetes: a systematic literature review and meta-analysis. J Cardiovasc Nurs. 2023;38:10–1097.