

## Research Article

# Retrospective Analysis of Factors Impairing Glycemic Control in Type 2 Diabetics on Intensive Insulin Therapy with HbA1c Levels of 10% or Above (Single-Center Experience)

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### Abstract

**Objectives:** In this study, we aimed to investigate the effects of factors related to lifestyle, treatment compliance, and eating habits on blood glucose regulation in patients diagnosed with Type 2 DM (Diabetes Mellitus) with HbA1c 10% and above who are receiving intensive insulin therapy.

**Methods:** The study sample consisted of 100 diabetic patients with inadequate glycemic control who applied to our clinic between January 2015 and December 2016. A questionnaire developed by the researchers was used in the study. The patients' sociodemographic and anthropometric characteristics, eating habits, compliance with insulin treatment, physical activity, and dental health data were documented.

**Results:** Of the patients included in our study, 75% were female and 25% were male, the average age was 60, the average HbA1c was 12.3%, and the average Body Mass Index was 31.7 kg/m<sup>2</sup>. While 88% of our patients stated that they had three main meals a day, 12% stated that they skipped at least one main meal, and 64% had irregular eating habits. Forty percent of our patients skipped insulin doses at least 1–2 times a week, and there was a statistically significant relationship between the frequency of insulin dose skipping and HbA1c subgroups ( $p=0.014$ ). Sixty-seven percent of our patients did not exercise daily.

**Conclusion:** Although education level, eating habits, exercise, and dental health are among the variables affecting glycemic control in diabetic patients, the most critical factor affecting glycemic control in our study group was a lack of compliance with insulin injection.

**Keywords:** Diabetes, Diet, HbA1c, Exercise, Insulin

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Diabetes Mellitus (DM) is a syndrome that occurs due to absolute or relative insufficiency of pancreatic insulin secretion or insulin resistance developed against insulin action in peripheral tissues, characterized by hyperglycemia causing multisystem involvement and acute metabolic and chronic degenerative complications.<sup>[1]</sup> It has become one of the biggest health problems of our day, with its increasing rates reaching epidemic proportions and its complications

leading to severe mortality and morbidity. Considering the linear relationship between microvascular complications and HbA1c levels in patients with type 2 DM, it is recommended that HbA1c be kept below 7%.<sup>[2]</sup> When patients receiving frequent insulin therapy were examined, glycemic control was not at the desired level in the long term. Our study aimed to examine the patient-related reasons for failure to achieve glycemic control despite multidisciplinary treatment options

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such as developments in diabetes treatment, new treatment options, diabetes education programs, and nutrition education. This article was produced from the specialization thesis of Dr. S.Y., which was completed in the Department of Internal Medicine at Şişli Hamidiye Etfal Training and Research Hospital under the supervision of Prof. Dr. Y.A.

## Methods

### Patients and Laboratory Evaluation

A total of 100 patients, aged between 30 and 75, diagnosed with Type 2 DM, receiving intensive insulin therapy, with HbA1c levels of 10% and above, who were able to communicate, had the cognitive ability to answer questions and were willing to participate in the study, were included in our study after obtaining their informed consent. Patients diagnosed with gestational diabetes, secondary diabetes, Type 1 DM, Latent autoimmune diabetes in adults (LADA), Maturity-onset diabetes of the young (MODY), those with a history of malignancy, those with chronic liver disease or kidney disease, those using pancreatotoxic drugs or corticosteroids that may impair glucose tolerance, and those with Cushing syndrome/disease were excluded from the study. The patients' sociodemographic and anthropometric characteristics, eating habits, compliance with insulin treatment, physical activities, and dental health data were documented. A questionnaire developed by the researchers was used in the study. In order to conduct the study, written permission was obtained from the relevant institution management (S.B. Şişli Hamidiye Etfal Training and Research Hospital Ethics Committee dated 14.11.2017, decision number 895). HbA1c was studied using the HPLC (High-Performance Liquid Chromatography) method on the Adams HA-8180V device. The research was conducted in accordance with the Helsinki Declaration Principles. Scientific and universal principles were followed in the study.

### Statistical Analysis

The study data were analyzed using the SPSS 22 package program. Data were summarized as numbers and percentages. The chi-square test was used to determine the relationship between categorical variables. Z test was used to determine which groups the relationship originated from in tables larger than 2x2 that were found significant due to the relationship test. The statistical significance level was taken as  $p < 0.05$ .

## Results

When 100 patients included in the study were examined, 75% of our patients were female, 25% were male, the average age was 60, the average HbA1c was 12.3%, and the average BMI (Body Mass Index) was 31.7 kg/m<sup>2</sup>.

### Educational Status

Thirty-five percent (n=35) of the patients were illiterate, 49% (n=49) were primary school graduates, 8% (n=8) were secondary school graduates, 5% (n=5) were high school graduates, and 3% (n=3) were university graduates.

### Diabetes Education

While 2% (n=2) of our patients did not have diabetes education, 98% (n=98) of our patients had previously received diabetes education in our hospital.

### HbA1c Levels

While the HbA1c value was between 10-11% in 34% (n=34) of our patients, it was between 11.1-12% in 27% (n=27) of our patients, it was between 12.1-14% in 30% (n=30) of our patients, and it was above 14% in 9% (n=9) of our patients.

### Body Mass Index Distribution

Fifteen percent (n=15) of our patients were 18.5-24.9 kg/m<sup>2</sup>, 28% (n=28) were 25-29.9 kg/m<sup>2</sup>, 47% (n=47) were 30-39.9 kg/m<sup>2</sup>, 10% (n=10) were 40 kg/m<sup>2</sup> and above.

### Insulin Usage and Frequency of Skipping Doses

While 60% (n=60) of our patients never skipped their insulin, 22% (n=22) skipped their insulin 1-2 times a week, 9% (n=9) skipped their insulin 3-4 times a week, and 9% (n=9) skipped their insulin 7-8 times a week. 85% (n=85) of our patients were doing their insulin, and 15% (n=15) had their insulin done by a relative.

### Nutrition

Eighty-eight percent (n=88) of our patients stated that they had three main meals a day, while 12% (n=12) did not. 67% (n=67) of our patients had snacks, while 33% (n=33) did not. 51% (n=51) of the patients stated that they never skipped a meal, 33% (n=33) skipped meals 1-2 times a week, 4% (n=4) skipped meals 3-4 times a week, and 12% (n=12) skipped meals 5-7 times a week. 64% (n=64) of our patients had irregular eating habits.

### Dental Health

Thirty-five percent (n=35) of our patients had total dentures, 16% (n=16) had partial dentures, 32% (n=32) had more than 50% of their teeth missing, and only 17% (n=17) had healthy teeth.

### Exercise

Sixty-seven percent (n=67) of the patients do not exercise, and 33% (n=33) exercise at least half an hour daily. Fifty-three percent (n=53) of the patients had orthopedic knee problems.

The gender, age distribution, education status, diabetes education status, age of diabetes onset, diabetes duration, dental health data, and body mass index distributions of our patients according to HbA1c are shown in Table 1. Although not statistically significant, more than 50% of patients in all HbA1c groups were over 50 years of age.

**Table 1.** Age, gender distribution, education status, diabetes education status, age of diabetes onset, diabetes duration, dental health data, and body mass index distributions of our patients according to HbA1c.

	HbA1C			p
	10-12% n (%)	Above 12% n (%)	Total n (%)	
Age				
30-40	0 (0)	2 (5.1)	2 (2)	0.344
41-50	13 (21.3)	9 (23.1)	22 (22)	
51-60	29 (47.5)	19 (48.7)	48 (48)	
61-70	14 (23)	8 (20.5)	22 (22)	
71+	5 (8.2)	1 (2.6)	6 (6)	
Gender				
Female	44 (72.1)	31 (79.5)	75 (75)	0.407
Male	17 (27.9)	8 (20.5)	25 (25)	
Educational Status				
Illiterate	26 (42.6)	9 (23.1)	35 (35)	0.320
Primary school	25 (41)	24 (61.5)	49 (49)	
Middle school	5 (8.2)	3 (7.7)	8 (8)	
High school	3 (4.9)	2 (5.1)	5 (5)	
University	2 (3.3)	1 (2.6)	3 (3)	
Diabetes Education Status				
No	1 (1.6)	1 (2.6)	2 (2)	0.747
Yes	60 (98.4)	38 (97.4)	98 (98)	
Age Of Diabetes Onset				
20-30	7 (11.5)	5 (12.8)	12 (12)	0.364
31-40	19 (31.1)	19 (48.7)	38 (38)	
41-50	23 (37.7)	9 (23.1)	32 (32)	
51-60	8 (13.1)	5 (12.8)	13 (13)	
61-70	4 (6.6)	1 (2.6)	5 (5)	
Diabetes Duration				
0-10 years	23 (37.7)	14 (35.9)	37 (37)	0.855
11 years and above	38 (62.3)	25 (64.1)	63 (63)	
Body Mass Index				
18,5-24,9 kg/m <sup>2</sup>	5 (8.2)	10 (25.6)	15 (15)	0.089
25-29,9 kg/m <sup>2</sup>	17 (27.9)	11 (28.2)	28 (28)	
30-39,9 kg/m <sup>2</sup>	33 (54.1)	14 (35.9)	47 (47)	
40 kg/m <sup>2</sup> and above	6 (9.8)	4 (10.3)	10 (10)	
Dental Health Data				
Total dentures	24 (39.3)	11 (28.2)	35 (35)	0.516
Partial dentures	10 (16.4)	6 (15.4)	16 (16)	
Healthy	8 (13.1)	9 (23.1)	17 (17)	
No teeth	19 (31.1)	13 (33.3)	32 (32)	

\*Ki-Kare & Z.

Table 2 shows the distribution of insulin dose skipping, main meal skipping, snack skipping, presence of orthopedic knee problems, and exercise status according to HbA1c. There is a statistically significant relationship between insulin dose skipping frequency and HbA1c. The rate of skipping doses 3-4 times a week is higher in those with HbA1c above 12% than in those with HbA1c below 12% (p=0.014).

## Discussion

DM is one of the most critical health problems of our time, with its complications leading to severe morbidity and mortality. In our study, it was observed that the most important reason for this situation in patients with poor glycemic control despite receiving intensive insulin therapy was skipping insulin doses.

When we examined the data of our patients diagnosed with Type 2 DM with inadequate glycemic control, such as age, gender, education level, skipping meals, skipping insulin injections, and dental health, we found that age may also be an important factor in diabetes regulation. In the study conducted by Khattab et al. on Type 2 DM patients, they divided the patients into three groups according to their age: <50 years, 50-59 years, and 60 years and above, and found that diabetes regulation was worse in the 60 years and above group (3). In our study, 75% of our patients with HbA1c levels of 10% and above were over the age of 50. When we divided our patients into subgroups according to HbA1c, we found that an average of 70% of our patients in each subgroup were over the age of 50, although this was not statistically significant. On the other hand, in an epidemiological study conducted by McBrien K. et al. on 169,890 patients diagnosed with Type 1 or Type 2 DM with HbA1c levels of 10% and above, a strong correlation was found between young patients aged 18-39 and poorly controlled diabetes, compared to patients aged 75 and above.<sup>[4]</sup> Polonsky W. et al. conducted another study supporting the study by McBrien et al.<sup>[5]</sup> In these studies, it was observed that the rates of achieving adequate glycemic control (HbA1c <7%) were lower in young patients compared to older age groups, which was attributed to poor treatment compliance in young individuals. In addition to these two studies, several studies by EL-Kebbi I. et al., Nichols G. et al., and Rothenbacher D. et al. support the conclusion that younger patients have worse glycemic control.<sup>[6-8]</sup> Unlike many other studies, our study found similar results to the study by Khattab M. et al.

Regular exercise habits, an essential treatment approach in diabetes control, were found to be quite low in the patients in our study group. It was determined that 67% of our patients did not exercise regularly and only moved

**Table 2.** Distribution of insulin dose skipping, main meal skipping, snack skipping, presence of orthopedic knee problems and exercise status according to HbA1c.

	HBA1C			p
	10-12% n (%)	Above 12% n (%)	Total n (%)	
Frequency of Skipping Insulin Doses				
No skipping doses	40 (65.6) <sup>a</sup>	20 (51.3) <sup>a</sup>	60 (60)	0,014
Skipping doses 1-2 times a week	16 (26.2) <sup>a</sup>	6 (15.4) <sup>a</sup>	22 (22)	
Skipping doses 3-4 times a week	2 (3.3) <sup>a</sup>	7 (17.9) <sup>b</sup>	9 (9)	
Skipping doses 5-7 times a week	3 (4.9) <sup>a</sup>	6 (15.4) <sup>a</sup>	9 (9)	
Who Makes Insulin?				
Patient	49 (80.3)	36 (92.3)	85 (85)	0,102
Relative	12 (19.7)	3 (7.7)	15 (15)	
Three Main Meals A Day				
No	7 (11.5)	5 (12.8)	12 (12)	0,840
Yes	54 (88.5)	34 (87.2)	88 (88)	
Three Snacks A Day				
No	21 (34.4)	12 (30.8)	33 (33)	0,704
Yes	40 (65.6)	27 (69.2)	67 (67)	
Frequency of Skipping Main Meals				
No skipping meals	33 (54.1)	18 (46.2)	51 (51)	0,744
Skipping meals 1-2 days a week	18 (29.5)	15 (38.5)	33 (33)	
Skipping meals 3-4 days a week	2 (3.3)	2 (5.1)	4 (4)	
Skipping meals 5-7 days a week	8 (13.1)	4 (10.3)	12 (12)	
Irregular Eating Habit				
No	21 (34.4)	15 (38.5)	36 (36)	0,682
Yes	40 (65.6)	24 (61.5)	64 (64)	
Orthopedic Knee Problem				
No	30 (49.2)	17 (43.6)	47 (47)	0,585
Yes	31 (50.8)	22 (56.4)	53 (53)	
Daily Exercise Status				
No exercise	38 (62.3)	29 (74.4)	67 (67)	0,375
Half an hour of exercise a day	22 (36.1)	10 (25.6)	32 (32)	
Exercise for an hour a day	1 (1.6)	0 (0)	1 (1)	

\*Ki-Kare & Z. <sup>a, b</sup>: different letters indicate significant difference (p<0.05).

indoors. In addition, 53% of our patients had an orthopedic knee problem that made it difficult or prevented them from walking. In the study conducted by Khattab M. et al., it was observed that patients who did not exercise had worse glycemic control.<sup>[3]</sup> In our study, although no statistically significant relationship was found between HbA1c subgroups and exercise status, the rate of those with orthopedic knee problems and the rate of those who did not exercise were found to be statistically significantly higher in individuals over 50 years of age (p=0.002, p=0.042, respectively). The decrease in exercise frequency and increase in orthopedic knee problems with age may contribute to the worsening of glycemic control in older people.

Although the female gender ratio was much higher than the male ratio in our patients with poor glycemic control included in our study, no statistically significant difference was detected in the HbA1c subgroups based on gender. In the study conducted by Oğuz et al. on 2358 patients, 93.9% of whom were Type 2 DM patients followed up in 44 different centers in Turkey, no significant relationship was found between diabetes regulation and gender.<sup>[9]</sup> In the study conducted by McBrien K. A. et al., when patients with HbA1c>10% were compared with patients with HbA1c in the range of 7-8%, the rate of male patients was significantly higher in the group with HbA1c>10%, and it was stated that male gender was correlated with poor glycemic control.<sup>[4]</sup> Similarly,

a study conducted in Oman showed that glycemic control was better in women.<sup>[10]</sup> In contrast, in another study consisting of 523 patients diagnosed with Type 2 DM, when the patient group with HbA1c 7% and above was compared with the patient group with HbA1c <7%, it was found that there were statistically significantly more female patients in the group with HbA1c 7% and above.<sup>[11]</sup> In the study conducted by Beshyah SA. et al., obesity was stated to be more common in female patients.<sup>[12]</sup> In our study, a statistically significant relationship was also found between gender and BMI, and the rate of those with a BMI of 18.5-24.9 was higher in men than in women ( $p=0.006$ ).

Raum E. et al.'s study, which evaluated treatment non-adherence and poor glycemic control in Type 2 DM patients, determined a correlation between increased body mass index, obesity, and inadequate glycemic control.<sup>[13]</sup> In light of all these data, it has been stated that although women have better treatment compliance, poor glycemic control is more common in women due to their higher body mass index and obesity rates compared to men.<sup>[11]</sup> Since the patients in our study are not a homogeneous patient group reflecting the whole society and our patient number is limited, we think this issue should be re-evaluated in a larger patient group with a more balanced gender distribution.

When we examined the relationship between diabetes regulation and education in our study, 35% of our patients were illiterate, 49% were primary school graduates, 8% were secondary school graduates, 5% were high school graduates, and 3% were university graduates. As can be seen, 84% of our patients with HbA1c 10% and above were illiterate or had primary school-level education. Although there was no statistically significant difference between the level of education and HbA1c subgroups, we can say that low level of education is associated with poor glycemic control. In the study conducted by Polonsky W. et al., it was stated that low education is one of the important factors contributing to poor treatment compliance and was associated with poor glycemic control.<sup>[5]</sup> In the study conducted by Sinorita H. et al., examining the effects of dietary compliance and education level on glycemic control in Type 2 DM patients consisting of 88 participants, they found that dietary compliance had a statistically significant effect on glycemic control. However, they could not find a significant relationship between education level and glycemic control.<sup>[14]</sup> As in our study, the study conducted by Sinorita H. et al. was also conducted in a single-center and small patient group and shows heterogeneity in other sociodemographic factors affecting diabetes regulation.

## Limitations of the Study

There are some limitations in our study. Since the patients included in our study were not a homogeneous patient group reflecting the entire society, the number of our patients was limited, and the gender distribution was not balanced, all factors could not be evaluated statistically. In addition, since it is a single-center study, it does not reflect the entire Turkish population.

## Conclusion

As a result, our study showed that factors such as sociodemographic status, lifestyle, exercise, treatment and diet compliance, and dental health may influence glycemic control in Type 2 DM patients with poor glycemic control who receive frequent insulin therapy. Basically, we observed that the most important factor affecting glycemic control in our study group was lack of compliance with insulin injection. Our study was single-center and consisted of limited participants, and this issue needs to be re-examined in a more extensive series.

## Disclosures

**Ethics Committee Approval:** This research complies with all relevant national regulations, institutional policies, and the principles of the Declaration of Helsinki, and Ethics Committee Approval was received from the Şişli Hamidiye Etfal Training and Research Hospital Ethics Committee dated 14.11.2017, with decision number 895.

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