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RESEARCH ARTICLE

The effect of intuitive eating and conscious eating on glycemic control in individuals with type 2 diabetes: A Cross-sectional Study

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KEYWORDS

Diabetes Mellitus, Type 2;

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Intuitive Eating.

The effect of intuitive eating and conscious eating on glycemic control in individuals with type 2 diabetes: A Cross-sectional Study

ABSTRACT

Introduction: Eating behavior models such as intuitive eating (IE) and mindful eating (ME) have recently gained importance in a role in providing glycemic control. In this study, we aimed to evaluate the effect of intuitive eating and mindful eating on the dietary treatment of type 2 diabetes mellitus (T2DM) and to investigate their relationship with glycemic control and obesity.

Methodology: A total of 153 patients who were diagnosed with T2DM within at least one year and aged between 19 and 64 years were included. Descriptive characteristics of the patients were questioned using face-to-face interviews and anthropometric measurements The Intuitive Eating Scale 2 (IES-2) was used to evaluate intuitive eating behaviors and the Mindful Eating Questionnaire (MEQ) was used to assess mindful eating behaviors.

Results: The total IES-2 score was higher in patients with T2DM who had inadequate glycemic control ($p<0.05$), and a one-point increase in the IES-2 increased the probability of HbA1c level above 7% by 25.2% ($p<0.05$). There was a moderate negative correlation between the total MEQ score and body weight, BMI, waist circumference, and waist-to-height ratio in the patients with adequate glycemic control ($r=-0.526$, $r=-0.537$, $r=-0.506$, $r=-0.510$, respectively; $p<0.05$). There was a weak negative correlation between the total IES-2 score and BMI and between the total MEQ score and waist-to-height ratio, triglyceride, and very low-density lipoprotein cholesterol in the patients with inadequate glycemic control ($r=-0.225$, $r=-0.224$, $r=-0.114$, $r=-0.178$, respectively; $p<0.05$).

Conclusions: This study results suggest that intuitive eating adversely affects glycemic control in patients with T2DM and mindful eating is positively associated with body weight control, although it has no direct effect on glycemic control.

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El efecto de la alimentación intuitiva y consciente sobre el control glucémico en personas con diabetes tipo 2: Un estudio transversal

PALABRAS CLAVE

Diabetes Mellitus Tipo 2;

Hemoglobina Glucada;

Obesidad;

Alimentación Intuitiva.

RESUMEN

Introducción: Los modelos de comportamiento alimentario como la alimentación intuitiva (IE) y la alimentación consciente (ME) han cobrado importancia recientemente por su papel en el control glucémico. En este estudio, nuestro objetivo fue evaluar el efecto de la alimentación intuitiva y la alimentación consciente en el tratamiento dietético de la diabetes *mellitus* tipo 2 (DM2) e investigar su relación con el control glucémico y la obesidad.

Metodología: Se incluyeron un total de 153 pacientes diagnosticados de DM2 en al menos un año y con edades comprendidas entre 19 y 64 años. Las características descriptivas de los pacientes fueron obtenidas mediante entrevistas cara a cara y medidas antropométricas. Se utilizó la Escala de alimentación intuitiva 2 (IES-2) para evaluar los comportamientos alimentarios intuitivos y el Cuestionario de alimentación consciente (MEQ) para evaluar los comportamientos alimentarios conscientes.

Resultados: La puntuación total del IES-2 fue mayor en pacientes con DM2 que tenían un control glucémico inadecuado ($p<0,05$), y un aumento de un punto en el IES-2 aumentó la probabilidad de que el nivel de HbA1c estuviera por encima del 7% en un 25,2% ($p<0,05$). Hubo una correlación negativa moderada entre la puntuación total del MEQ y el peso corporal, el IMC, la circunferencia de la cintura y la relación cintura-talla en los pacientes con control glucémico adecuado ($r=-0.526$, $r=-0.537$, $r=-0.506$, $r=-0.510$, respectivamente; $p<0.05$). Hubo una débil correlación negativa entre la puntuación total del IES-2 y el IMC y entre la puntuación total del MEQ y el índice cintura-talla, triglicéridos y colesterol unido a lipoproteínas de muy baja densidad en los pacientes con control glucémico inadecuado ($r=-0.225$, $r=-0.224$, $r=-0.114$, $r=-0.178$, respectivamente; $p<0.05$).

Conclusiones: Los resultados de este estudio sugieren que la alimentación intuitiva afecta negativamente el control glucémico en pacientes con DM2 y la alimentación consciente se asocia positivamente con el control del peso corporal, aunque no tiene un efecto directo sobre el control glucémico.

KEY MESSAGES

1. Since strong food cravings and emotional overeating can impair adherence to dietary recommendations, increasing awareness of patients with T2DM about managing physiological and cognitive processes related to eating may provide additional contribution to the management of T2DM.
2. It should not be forgotten that the idea that glycemic control can only be achieved with IE and ME in T2DM patients may lead to poor glycemic control.

CITATION

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INTRODUCTION

About 422 million individuals worldwide suffer from diabetes, and 1.5 million deaths are attributed to diabetes each year[1]. A healthy diet is one of the cornerstones of diabetes management. However, deciding what to eat is the most challenging part of the treatment plan for these individuals[2].

Intuitive eating (IE) is a dietary behavior associated with psychological well-being, characterized by eating in response to physiological hunger and satiety cues rather than external conditions and emotional factors[3,4]. The Intuitive Eating Scale 2 (IES-2) is a validated tool which measures the degree of adherence to IE behaviors and attitudes[5]. It was originally developed against the failures of classical diets or energy-restricted diets in weight control of individuals and their negative effects on the body. The basic principles are to respond to innate hunger and satiety signals without restriction in the types of food consumed[6]. No restrictions on the types of food an individual can eat are set, unless there are no certain health problems such as diabetes or food allergies, as it is thought that the body can instinctively choose a variety of foods that provide nutritional balance[6]. In some studies, on intuitive eating in individuals with type 2 diabetes, it has been reported that intuitive eating may reduce the risk of inadequate glycemic control, while in some studies it is reported that it will have a positive effect on glycemic control by reducing body weight[7–9].

Mindful eating (ME) is the state of being aware of the effect of eating on thoughts, feelings, bodily sensations, and behaviors. Given the various physiological and cognitive processes associated with eating such as memory, attention, and metabolic state, a wide variety of different practices can be defined as ME[10]. Most diets follow eating guidelines (i.e., what to eat, how much to eat, and what not to eat) aiming at specific outcomes such as weight loss, good glycemic control, and improved glycated hemoglobin (HbA1c). All diets have the potential for success or failure based on body weight results. Individuals may be aware of that their body weight results depend on their calorie intake and energy expenditure, and they may understand that it is related to their behavior; however, it is difficult to maintain behavior change without seeing results on body weight[11]. In a study evaluating the eating awareness of individuals with type 2 diabetes, 81% of individuals with T2DM were found to be slightly overweight and obese, while the incidence of eating disorders in these individuals was changed to be between 7.5% and 9%[12]. Kes *et al*. In a study conducted by 2021 using the MEQ scale, it was found that higher scale scores were associated with decreased BMI values and a lower risk of developing T2DM[13].

Mindful eating seems to be an effective approach for body weight control and glycemic control in individuals with type 2 diabetes mellitus (T2DM) with promising outcomes. In the present study, we aimed to evaluate the effect of IE and ME on the dietary treatment of T2DM and to investigate their relationship with glycemic control and obesity.

METHODOLOGY

This single-center, analytical cross-sectional study was conducted at the Department of Nutrition and Dietetics of a tertiary care center between March 2022 and April 2022. A total of 153 adult patients aged between 19 and 64 years with T2DM who were referred from the Mersin City Training and Research Hospital, Department of Endocrinology and Metabolic Disorders of our center and were diagnosed with T2DM within at least one year were included. Exclusion criteria were as follows: having type 1 diabetes, pregnancy and lactation, malignancies, previous history of bariatric surgery, hypothyroidism, Stage 4-5 chronic renal failure, receiving dialysis, having an eating disorder, psychological disorders, and non-communicable neurological disease.

The study power analysis and sample size calculation were performed using the G*Power 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). With an alpha (α)=0.05, power (1-β)=0.95, and medium effect size (d)=0.50, the study power was calculated as 100% with a sample size of 150. A written informed consent was obtained from each participant. The study was approved by the institutional Toros University Scientific Research and Publication Ethics Committee with Approval No: 113 and Date: 10/12/2021 and Ministry of Health of the Republic of Turkey Approval No: 2 and Date: 09/03/2022. The study was conducted following the principles of the Declaration of Helsinki.

Descriptive characteristics of the patients were questioned using face-to-face interviews including age, sex, marital status, education status, age at the time of diagnosis, treatment duration, and medications used. Anthropometric measurements including body weight, height, body mass index (BMI) waist circumference (WC), and hip circumference (HC) were done. The Intuitive Eating Scale 2 (IES-2) was used to evaluate IE behaviors[14] and the Mindful Eating Questionnaire (MEQ) was used to assess ME behaviors[15]. Data including biochemical parameters such as fasting blood glucose (FBG), HbA1c, fasting insulin, total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very low-density lipoprotein cholesterol (VLDL-C) were retrieved from the patient files.

Glycemic Control. The glycemic control status of individuals with type 2 diabetes participating in the study was evaluated using the HbA1c levels obtained from the individuals' medical records. It was categorized as adequate glycemic control when HbA1c levels ≤7% and insufficient glycemic control when HbA1c >7%[2].

Anthropometric measurements. The body weight, height, WC, and HC were measured by a researcher during face-to-face interviews[16]. The BMI values (body weight (kg) / height (m^2)) were calculated from body weight and height measurements and classified according to the World Health Organization (WHO) as follows: BMI <18.5 kg/m^2 underweight, 18.5-24.9 kg/m^2 normal, 25.0-29.9 kg/m^2 overweight, and ≥30.0 kg/m^2 obese[17]. The WC measurements were classified according to the WHO classification as follows: men, <94 cm low risk, 94-101 cm high risk, and ≥102 cm very high risk; women, <80 cm low risk, 80-87 cm high risk, and ≥88 cm very high risk[18]. The HC and waist-to-hip ratio (WHR) were also measured and classified according to the WHO classification (>0.90 for men and >0.85 for women)[18]. The waist-to-height ratio (WHtR) was calculated as waist measurement divided by height measurement as described by Ashwell *et al.*[19] as follows: <0.5 low risk, 0.5-0.6 high risk, and ≥0.6 very high risk).

IES-2. The IES-2 is a 21-item scale which is used to evaluate IE behaviors. It was developed by Tylka and Kroon Van Diest in 20135 and its validity and reliability studies were carried out by Baş *et al.*[14] in the Turkish population. It uses a 5-point Likert-type scale from 1=strongly disagree to 5=strongly agree. It consists of four domains of IE: unconditional permission to eat (UPE), eating for physical rather than emotional reasons (EPR), reliance on hunger and satiety cues (RHSC), and body-food choice congruence (B-FCC). The total scores are calculated by dividing the four domains and total score by the total number of items in the relevant area. Higher scores indicate a higher tendency to IE behavior[14].

MEQ. The MEQ is a reliable tool for the assessment of ME behavior of individuals. It was developed by Framson *et al.*[20] and its validity and reliability studies were carried out by Köse *et al.*[15] in the Turkish population. It consists of 30 items and seven subscales (i.e., disinhibition-mindless eating, emotional eating, eating control, mindfulness, eating discipline, conscious nutrition, and interference). It uses a 5-point Likert-type scale from 1=None to 5=Always. The total scores are calculated by dividing the seven subscales and total score by the total number of items in the relevant area. Higher scores indicate more mindful attitudes toward eating[15].

Statistical Analysis. Statistical analysis was performed using the SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were presented in mean ± standard deviation (SD), median (min-max) or interquartile range (IQR) or number and frequency, where applicable. The normality of distribution of variables was checked using the Shapiro-Wilk test. The Levene test was used to determine the homogeneity of variance. Independent samples T-test was used to compare normally distributed variables between the two groups, while the Pearson correlation analysis was used to determine the relationship between variables. The Mann-Whitney U test was used to compare non-normally distributed variables and the Spearman correlation analysis was performed to analyze the relationship between variables. The Chi-square test was used to compare continuous variables with the Yates and Fisher correction tests. Binary logistic regression analysis was used to identify the factors affecting the HbA1c groups. First, FBG, diabetes management plan, treatment duration, age at the time of diagnosis, and IES-2 total score were included in the regression model. Next, a final logistic regression model (reduced model) was created using the log-likelihood-based backward elimination (backward-LR) method, eliminating non-significant factors. The alpha (α) values of IES-2 and MEQ were calculated as 0.767 and 0.715, respectively. A p value of <0.05 was considered statistically significant.

RESULTS

Sociodemographic characteristics and biochemical test results of the patients according to the HbA1c groups are shown in Table 1. The majority of the patients with inadequate glycemic control were male (n=77, 59.2%) and were on oral antidiabetic medications alone (n=64, 49.2%). In these patients, age at the time of diagnosis, treatment duration, and FBG levels were significantly higher than those with adequate glycemic control (p<0.05). In addition, a statistically significant correlation was observed between inadequate glycemic control and WC of women and WHR of both men and women (p<0.05).

The IES-2 and total MEQ scores and subscale scores according to the HbA1c groups revealed that only IES-2 total scores were significantly higher in the patients with inadequate glycemic control (p<0.05) (Table 2).

The correlations between anthropometric and biochemical test results of the patients according to the HbA1c groups and IE and ME behavior are shown in Table 3. There was a moderate negative correlation between the total MEQ score and body weight, BMI, WC, and WHtR in the patients with adequate glycemic control (r=-0.526, r=-0.537, r=-0.506, r=-0.510, respectively; p<0.05).

Table 1. Sociodemographic characteristics and biochemical test results of the patients according to the HbA1c levels.

	HbA1c		Test statistics	p
	≤7 % (n=23)	>7 % (n=130)		
Age, year (median)	69.6	78.3	U=1323	0.381
Sex, n (%)				
Male	15(65.2)	77(59.2)	Fisher X^2=0.292	0.650
Female	8(34.8)	53(40.8)		
Age at the time of diagnosis, month (median)	57.1	80.5	U=1036	**0.019**
Treatment duration, month (median)	58.7	80.3	U=1072	**0.030**
Treatment plan, n (%)				
Insulin	2(8.7)	21(16.2)	Fisher X^2=8.962	**0.009**
OAD	19(82.6)	64(49.2)		
Insulin + OAD	2(8.7)	45(34.6)		
BMI (kg/m²) (mean±SD)	33.9±8.9	31.3±6.1	T=1.714	0.089
Classification (kg/m²), n (%)				
Underweight (<18.5)	1(4.3	2(1.5)	Fisher X^2=4.084	0.230
Normal (18.5-24.9)	4(17.4)	18(13.8)		
Overweight (25.0-29.9)	3(13.0)	39(30.0)		
Obese (≥30.0)	15(65.2)	71(54.6)		
Waist circumference (cm) (male) (mean±SD)	108.3±12.9	106.8±13.5	T=0.429	0.673
Classification (cm), n (%)				
Low risk (<94)	2(13.3)	12(15.6)	Fisher X^2=0.368	0.902
High risk (94-101)	1(6.7)	10(13.0)		
Very high risk (≥102)	12(80.0)	55(71.4)		
Waist circumference (cm) (female) (mean±SD)	98.3±12.3	108.3±12.3	T=-1.536	0.163
Classification (cm), n (%)				
Low risk (<80)	1(12.5)	-	Fisher X^2=10.552	**0.006**
High risk (80-87)	2(25.0)	1(1.9)		
Very high risk (≥88)	5(62.5)	52(98.1)		
WHR (male) (mean±SD)	0.8±0.1	0.9±0.1	T=-3.784	**<0.001**
Classification (cm), n (%)				
Low risk (0.90)	11(73.3)	20(26.0)	Fisher X^2=10.573	**<0.001**
High risk (≥0.90)	4(26.7)	57(74.0)		

	HbA1c		Test statistics	p
	≤7 % (n=23)	>7 % (n=130)		
WHR (female) (mean±SD)	0.9±0.0	1.0±0.0	T=-1.607	0.146
Classification, n (%)				
Low risk (0.85)	2(25.0)	-		**0.015**
High risk (≥0.85)	6(75.0)	53(100)		
WHtR (mean±SD)	0.7±0.1	0.7±0.0	T=-0.432	0.626
Classification, n (%)				
Low risk (<0.5)	16(69.6)	96(85.7)	Fisher X^2=3.506	0.181
High risk (0-5-0.6)	5(21.7)	32(24.6)		
Very high risk (≥0.6)	2(8.7)	2(1.5)		
Biochemical test results (median)				
FBG (mg/dL)	18.9	87.3	U=157	**<0.001**
TG (mg/dL)	64.7	79.2	U=1213	0.150
TC (mg/dL)	78.9	76.7	U=1451	0.824
LDL-C (mg/dL)	79.2	69.4	U=1168	0.292
HDL-C (mg/dL)	92.4	74.3	U=1140	0.070
VLDL-C (mg/dL)	67.6	78.7	U=1278	0.269

***T-test;** Mann-Whitney **U;** Fisher Chi-square.

BMI: Body mass index; **DM:** Diabetes mellitus; **FBG:** Fasting blood glucose; **HbA1c:** Glycohemoglobin; **HDL-C:** High-density lipoprotein cholesterol; **LDL-C:** Low-density lipoprotein cholesterol; **OAD:** Oral antidiabetic; **TC:** Total cholesterol; **TG:** Triglyceride; **VLDL-C:** Very low-density lipoprotein cholesterol; **WHR:** Waist-to-hip ratio; **WHtR:** Waist-to-height ratio.

There was a weak negative correlation between the total IES-2 score and BMI and between the total MEQ score and WHtR, TG, and VLDL-C in the patients with inadequate glycemic control (r=-0.225, r=-0.224, r=-0.114, r=-0.178, respectively; p<0.05).

The coefficients of independent variables included in the full and reduced logistic regression analysis are shown in Table 4. In the full model, only FBG was a significant independent variable (p<0.05). In the reduced model, treatment duration was excluded and FBG, age at the time of diagnosis, and IES-2 scores were found to have a statistically significant effect on HbA1c (p<0.05). In the reduced model using odds ratios, a one-unit increase in FBG, a one-year increase in the age at the time of diagnosis, and a one-point increase in the IES-2 score increased the probability of HbA1c levels above 7% by 9.9%, 13.2%, and 25.2%, respectively.

DISCUSSION

In the present study, we investigated the effect of IE and ME on the dietary treatment of T2DM and examined their relationship with glycemic control and obesity. Our study results showed that IE adversely affected glycemic control in patients with T2DM, while ME did not have a direct effect on HbA1c, although it was positively correlated with body weight control.

The American Diabetes Association (ADA) recommends an HbA1c of ≤7% for the treatment of adults with T2DM2. To achieve this goal, it is recommended to support body weight loss and reduce energy intake in T2DM adults who are mildly overweight or have obesity. In addition, the ADA recommends that a variety of eating patterns (i.e., combinations of different foods or food groups) can

Table 2. Intuitive eating and mindful eating of patients according to HbA1c levels.

	HbA1c		Test statistics	p
	≤7%	>7%		
IES-2				
UPE	3.3±1.1	3.7±1.0	T=-1.660	0.107
EPR	3.4±1.0	3.7±1.1	T=-1.884	0.070
RHSC	3.4±1.5	3.4±1.3	T=-1.251	0.220
B-FCC	3.2±0.7	3.5±0.6	T=-0.054	0.957
Total score	2.8±0.9	3.2±0.9	T=-2.329	**0.027**
MEQ				
Disinhibition	3.3±1.0	3.6±0.9	T=-1.235	0.227
Emotional eating	4.0±1.1	4.2±0.8	T=-1.094	0.276
Eating control	3.9±1.0	3.7±1.0	T=0.763	0.451
Mindfulness	3.5±0.5	3.5±0.5	T=-0.185	0.855
Eating discipline	3.1±0.9	2.8±0.9	T=1.731	0.094
Conscious nutrition	2.9±0.6	3.0±0.6	T=-1.059	0.297
Interference	4.0±0.9	3.9±0.9	T=0.237	0.814
Total score	3.5±0.6	3.5±0.4	T=-0.324	0.746

*T-test;

HbA1c: Glycohemoglobin; **IES-2:** Intuitive eating scale 2; **MEQ:** Mindful eating questionnaire; **UPE:** Unconditional permission to eat; **EPR:** Eating for physical rather than emotional reasons; **RHSC:** Reliance on hunger and satiety cues; **B-FCC:** Body-food choice congruence.

be applied for the management of T2DM, considering individual preferences such as tradition, culture, religion, health beliefs and goals, economics and metabolic goals while choosing an eating pattern over the other[2].

Eating behavior models such as IE and ME have recently gained importance in body weight control and have been proposed to play a role in providing glycemic control[21]; therefore, these models have begun to be studied in patients with diabetes[7,22,23]. Previous studies have shown that the IES-2 total score and B-FCC subscale score are effective in providing better glycemic control in patients with T2DM[7]. A study including children and adolescents with type 1 diabetes reported that higher IES-2 total score and EPR subscale scores were associated with lower HbA1c[23]. In another study, the IES-2 total score and EPR subscale score positively affected HbA1c and FBG in gestational diabetes[22]. Unlike the aforementioned studies, we obtained controversial results in our study. The IES-2 total scores were significantly higher in the patients with inadequate glycemic control. In addition, a one-point increase in the IES-2 increased the probability of HbA1c level above 7% by 25.2%. Consistent with our findings, a study of African-American women with T2DM showed poor agreement of self-reported dietary practices with IE concepts[24]. Therefore, the difference in portion perception in some T2DM patients results in confusion in portion control. In the aforementioned study, patients with T2DM believed that larger-sized individuals needed much more energy and, therefore, they did not respect to the advice to eat less after being diagnosed with diabetes. It is thought that, in T2DM, the changes in brain responses to food stimuli are different from healthy individuals and the IE method may be misleading due to their strong cravings for food stimuli and changes in brain responses to emotional overeating[25]. We think that these results, which contradict the positive effect of the intuitive eating model on T2DM according to the literature, may be due to the fact that the number of individuals with poor glycemic control in the study was higher than those with good glycemic control.

Table 3. Correlation of intuitive eating and mindful eating with anthropometric and biochemical measurements.

	HbA1c							
	≤7 %				>7 %			
	IES-2		MEQ		IES-2		MEQ	
	r	p	r	p	r	p	r	p
Body weight (kg)	-0.328	0.127*	-0.526	**0.010***	0.117	0.184*	-0.120	0.173*
BMI (kg/m²)	-0.391	0.065*	-0.537	**0.008***	-0.225	**0.010***	-0.099	0.260*
WC (cm)	-0.257	0.236*	-0.506	**0.014***	-0.163	0.064*	-0.170	0.053*
WHR	0.275	0.203*	0.055	0.805*	0.156	0.076**	-0.061	0.493**
WHtR	-0.300	0.164*	-0.510	**0.013***	-0.130	0.141*	-0.224	**0.010***
FBG (mg/dL)	-0.149	0.498*	0.222	0.309*	0.021	0.810**	-0.058	0.513**
TG (mg/dL)	-0.266	0.219*	0.116	0.599*	0.089	0.313**	-0.114	**0.027****
TC (mg/dL)	-0.075	0.735*	0.112	0.610*	0.005	0.953**	-0.091	**0.305****
LDL-C (mg/dL)	0.113	0.608*	0.112	0.332*	-0.086	0.357**	-0.006	0.951**
HDL-C (mg/dL)	-0.316	0.634**	0.360	0.092**	0.042	0.637**	0.085	0.335**
VLDL-C (mg/dL)	-0.265	0.221*	0.117	0.594*	0.061	0.493**	-0.178	**0.043****

*Pearson; ** Spearman.

BMI: Body mass index; **FBG:** Fasting blood glucose; **HbA1c:** Glycohemoglobin; **HDL-C:** High-density lipoprotein cholesterol; **IES-2:** Intuitive eating scale 2; **LDL-C:** Low-density lipoprotein cholesterol; **VLDL-C:** Very low-density lipoprotein cholesterol; **MEQ:** Mindful eating questionnaire; **TG:** Triglyceride; **TC:** Total cholesterol; **WC:** Waist circumference; **WHR:** Waist-to-hip ratio; **WHtR:** Waist-to-height ratio.

Overeating can be overcome by improving attention, improving awareness of current events, and focusing on the food itself[26]. Mindful eating can facilitate body weight management by promoting healthier eating[27]. It is helpful for individuals to develop awareness of both internal and external stimuli for eating, stop eating automatically, and eat in response to natural physiological cues of hunger and satiety. It can also improve irregular eating and dietary habits[28]. However, in a systematic review, a limited number of evidence showed that IE and ME interventions affected energy intake or diet quality[29]. Furthermore, some studies on ME and T2DM have demonstrated that ME reduces HbA1c levels[30,31], while some others have not observed significant changes in HbA1c levels[32,33]. Our study results do not support the presence of an association between ME and HbA1c. We think that this may be due to the difference in the amount of food consumption of individuals with type 2 diabetes who participated in the study.

It has been well established that there is a strong relationship between T2DM development and abdominal obesity[34]. Obesity markers such as WHR and WHtR are better predictors than BMI for poor glycemic control[35]. In a study, Miller *et al.*[30] reported that ME and diabetes self-management education improved body weight loss and glycemic control. In addition, changes in body composition that develop with weight loss provide improvements in glycemic control markers and metabolic improvements. Therefore, blood glucose regulation control with individual nutrition programs and body composition monitoring in consultation with a dietician is recommended for individuals with diabetes[36–38]. In our study, the number of male and female patients with high WHR was significantly higher among those with inadequate glycemic control. On the other hand, there was a negative and significant correlation between ME and body weight, BMI, WC, and WHtR in patients with adequate glycemic control. These findings suggest that ME has positive effects on body weight control with improved glucose control. However, short-term appetite regulation with insulin, not blood glucose level in healthy individuals, has been shown to be impaired in overweight and obese individuals[39]. Therefore, it may be risky to conclude that only ME can be used reliably to reduce energy intake for patients with diabetes.

Table 4. Coefficient statistics for regression models.

Model	Coefficient	OR	95%CI		p
			Lower	Upper	
Full model	FBG	1.105	1.048	1.164	**<0.001**
	Treatment plan (Ref=Insulin+OAD)				
	Treatment plan (OAD)	6.401	0.211	193.997	0.286
	Treatment plan (Insulin)	0.420	0.059	2.998	0.387
	Treatment duration	0.827	0.512	1.336	0.438
	Age at the time of diagnosis	1.350	0.840	2.170	0.215
	IES-2 total	3.052	0.996	9.353	0.051
	Constant	0.000			**<0.001**
Reduced model	FBG	1.099	1.047	1.153	**<0.001**
	Treatment plan (Ref=Insulin+OAD)				
	Treatment plan (OAD)	5.518	0.202	150.376	0.311
	Treatment plan (Insulin)	0.351	0.048	2.564	0.302
	Age at the time of diagnosis	1.132	1.005	1.275	**0.041**
	IES-2 total	3.252	1.063	9.946	**0.039**
	Constant	0.000			**<0.001**

OR: Odds ratio; **CI:** Confidence interval; **FBG:** Fasting blood glucose; **OAD:** Oral antidiabetic; **IES-2:** Intuitive eating scale 2.

Dietary habits and diet therapy are one of the mainstays to achieve blood glucose targets in diabetes[2]. While IE is the main determinant for eating habits in response to physiological hunger and satiety cues, ME consists of making conscious food choices, being aware of physical and psychological hunger and satiety cues, and eating health[3,4,10]. In the present study, we investigated the effects of IE and ME on the glycemic control of patients with T2DM. The main limitation to this study is the relatively small sample size with good glycemic control, as the vast majority of the patients who were admitted to the Department of Nutrition and Dietetics had impaired glycemic control. Another limitation is the lack of food consumption records of individuals with type 2 diabetes who participated in the study.

CONCLUSIONS

In conclusion, T2DM is a preventable disease, and its associated complications can be prevented with healthy and regular dietary habits. Several aspects should be considered while evaluating HbA1c levels in these patients. Of note, living with diabetes for long years may result in fatigue or non-adherence to diet therapy. A strong craving for food, particularly emotional overeating, may impair adherence to dietary recommendations. Therefore, improving the awareness of patients with T2DM to manage the physiological and cognitive processes related to eating in diet therapy may provide additional contribution to the T2DM management. However, it should be kept in mind that the idea that glycemic control of T2DM patients can be achieved with only IE and ME may yield poor glycemic control. Although dietary habits are the leading factors affecting glucose control in T2DM, age at the time of diagnosis is also a prognostic factor. Further large-scale, prospective studies including age matched T2DM patients with good glycemic control are needed to elucidate the direct effects of IE and ME on T2DM.

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AUTHORS' CONTRIBUTIONS

M.M., Ö.Ö.A.: Idea, Study creation, design. M.M.: Data collection. Ö.Ö.A.: Analysis. M.M., Ö.Ö.A:. Literature review, writing. All authors read and approved the final manuscript.

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COMPETING INTERESTS

The authors declare that they have no potential conflict of interest regarding the investigation, authorship, and/or publication of this article.

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