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Impact of Obesity on Metabolic Control in Type 2 Diabetes: Five-Year Trends of Turkish Nationwide Survey of Glycemic and Other Metabolic Parameters of Patients with Diabetes (TEMD Obesity Study, 2017–2022)

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Keywords
Obesity · Type 2 diabetes · Hemoglobin A1c · Hypertension · Dyslipidemia

Abstract
Introduction: Türkiye has the highest obesity prevalence in Europe. Obesity not only causes type 2 diabetes mellitus (T2DM) but also impairs glycemic control in patients with T2DM. There is insufficient information about the demographic and clinical differences between individuals with T2DM who are living with or without obesity. The second TEMD survey across Türkiye investigated the latest overweight and obesity prevalence in patients with T2DM. The present study evaluated the 5-year changes in the prevalence, factors associated with an obesity diagnosis, and the association between obesity and metabolic control. ***Methods:*** Patients under follow-up in tertiary units specialized for diabetes care were consecutively enrolled. The sociodemographic, anthropometric, and clinical variables were recorded. Metabolic targets were defined as hemoglobin A1c <7%, home arterial blood pressure <135/85 mm Hg, or low-density lipoprotein cholesterol <100 mg/dL or <70 mg/dL

The members of the TEMD Study Group can be found in the online supplementary material (https://doi.org/10.1159/000547136).

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or <55 mg/dL according to the risk factors or complications of patients. Metabolic target attainment rates were investigated across normal-weight, overweight, and obesity body mass index (BMI) classes. ***Results:*** The TEMD Obesity Study enrolled 4,935 patients with T2DM (age 58.9 ± 10.1 years; women 59.8%). The prevalence of overweight and obesity was 33.4% and 55.1%, respectively. Obesity was more frequent in women with T2DM than men (66.2% vs. 38.1%; $p \leq 0.001$). From 2017 to 2022, the obesity rate decreased from 59.0% to 55.1%, while the overweight rate increased from 31.0% to 33.4%. As BMI class increased, the achievement of three metabolic targets decreased while the incidence of microvascular complications rose. Significant associations were found between obesity and sociodemographic characteristics (age, sex, education level) and lifestyle measures (diet, exercise, smoking) in multivariable logistic regression analysis. ***Conclusion:*** The TEMD Obesity study showed a decrease in obesity rates among patients with T2DM between 2017 and 2022. Also, the findings suggest that obesity poses an important barrier to the achievement of metabolic goals.

Introduction

Obesity is a serious chronic disease that causes multiple comorbidities, including type 2 diabetes mellitus (T2DM). With a worldwide increasing trend, its prevalence is particularly higher among patients with T2DM [1–3]. There are multiple factors attributed to increased rates of obesity and overweight in patients with T2DM, such as sociodemographic characteristics, behavioral features, and the weight-gaining effects of certain medications [4]. Obesity is not only a causative factor for T2DM, but it also negatively impacts the metabolic control measures [5].

Türkiye has the highest obesity prevalence in Europe [6]. The First Turkish Nationwide Survey of glycemic and other Metabolic parameters of patients with Diabetes (TEMD) study revealed that the prevalence of overweight and obesity was 31.0% and 59.0% in patients with T2DM. Overweight and obesity were associated with poorer glycemic control, higher blood pressure (BP), and elevated cholesterol levels at the same cohort [5]. Since obesity is a major public health problem in Türkiye, the official health authority has an ongoing national anti-obesity program to increase awareness and provide a multidisciplinary treatment approach [7]. Updates on trends in the prevalence of overweight and obesity in patients with T2DM are essential to facilitate potential improvements in patient care at all levels. The burden of derangement of metabolic parameters associated with obesity and overweight in these patients is another point of interest. Therefore, the TEMD-2 survey investigated the 5-year changes in overweight and obesity prevalence and their association with metabolic control of parameters in patients with T2DM.

Methods

Patients and Basic Characteristics

The TEMD-2 survey was performed as a nationwide, multicenter project from October 2022 through January 2023. Thirty-six cities and 70 tertiary healthcare units specialized in diabetes care in all the statistical regions of Türkiye participated in the survey. Consecutive patients aged over 18 years and under follow-up in the same study center for at least 1 year were included. Pregnancy, lactation, psychiatric illness, and mental retardation were the exclusion criteria. The study was approved by the Central and Local Ethics Committee and conducted in accordance with the Declaration of Helsinki. All participants gave written informed consent before enrollment. The ClinicalTrials.gov registration number was NCT06347445.

Sociodemographic characteristics (age, sex, education, and monthly income), behavioral features (exercise, diet, smoking), duration of diabetes, macro- and microvascular complications, medications and physical examination findings were recorded using a standardized questionnaire. Receiving less than 8 years of formal education was defined as a low education level. Patients were classified into three categories of monthly income: low, moderate and high. Regular exercise was defined as physical activity lasting longer than 30 min and performed more than 2 days a week.

The height and weight were measured with underwear according to a standard protocol. To determine body mass index (BMI), weight (kilograms) was divided by the square of height (meters). The definitions for BMI classes were normal weight, 18.5–24.9 kg/m^2; overweight, 25–29.9 kg/m^2; class I obesity, 30–34.9 kg/m^2; class II obesity, 35–39.9 kg/m^2, class III obesity, ≥40 kg/m^2. Arterial blood pressure (ABP) was obtained using automatic BP monitors (Omron M2, HEM-7121-E). After at least 5 min of rest in an upright sitting position, three measurements were taken, and their average was recorded. Patients were also requested to take ABP measurements at home twice a day for 1 week, and the mean of these measurements was recorded as home ABP. Hypertension was defined as home ABP recordings higher than 135/85 mm Hg or currently using antihypertensive treatment. For patients who were unable to track their BP at home, the average office BP >140/90 mm Hg in two different visits was defined as hypertension.

Laboratory Measurements

Venous blood samples were taken after 8–12 h of fasting. Laboratory analyses were performed at each study site. Total cholesterol, triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and creatinine levels were determined using an auto-analyzer with commercially available assay kits. The Friedewald formula [8] was used to calculate low-density lipoprotein cholesterol (LDL-C) levels if TG was less than 400 mg/dL. A cation exchange high-performance liquid chromatography method was used to determine hemoglobin A1c (HbA1c) levels. The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula was used to calculate the estimated glomerular filtration rate (eGFR).

Definitions

Macrovascular complications were defined as follows: history of coronary artery disease (prior myocardial infarction or coronary revascularization or ≥50% stenosis on coronary angiography or other imaging of coronary arteries), hemorrhagic or ischemic stroke, cerebrovascular revascularization procedure (e.g., carotid endarterectomy and/or stent), peripheral artery disease (previous limb angioplasty, stenting, bypass surgery, history of limb or foot amputation due to circulatory insufficiency, angiographic evidence of significant peripheral artery stenosis, or physician reported ankle-brachial index of <0.9).

The presence of retinopathy was self-reported. Nephropathy was defined as eGFR <60 mL/min/1.73 m^2 (CKD-EPIcr) or urine albumin to creatinine ratio (UACR) ≥30 mg/g. Neuropathy was defined as the presence of symptoms and physical examination findings associated with bilateral distal symmetrical neuropathy or other autonomous neuropathies related to diabetes mellitus.

Metabolic Targets

Treatment targets were HbA1c <7%, home ABP <135/85 mm Hg, and LDL-C <100 mg/dL, <70 mg/dL, or <55 mg/dL, according to the risk factors or complications of patients [9–11].

Statistical Analysis

Statistical analyses were performed using the SPSS Statistics for Windows version 25.0 (SPSS Inc. 111 Chicago, IL, USA). Continuous variables are displayed as mean (standard deviation). Categorical variables are displayed as a number (%). The normality of distribution was assessed using the Kolmogorov-Smirnov test. The ANOVA test or Kruskal-Wallis test was used to test the differences between the three independent groups. Pearson chi-square test was used to compare categorical variables, and the Student's *t* test or the Mann-Whitney U test was used to compare continuous variables. Multivariable logistic regression analysis was implemented to evaluate the factors associated with obesity status. Hosmer and Lemeshow test and Likelihood-ratio test were used to assess the final model fitting. Statistical significance was defined as 2-sided p value ≤0.05.

Results

Clinical and Sociodemographic Characteristics

The survey included 4,935 patients with T2DM (mean age: 58.9 ± 10.1 years, women: 59.8%). The mean BMI was 30.7 ± 8.1 kg/m^2 (Table 1). Only 11.4% (n = 564) of patients were normal-weight, while 33.4% were overweight and 55.1% were classified as having obesity (shown in Fig. 1a). The prevalence of class I, II, and III obesity were 28.9%, 15.9%, and 10.3%, respectively (shown in Fig. 1b).

Patients with obesity were younger than the normal-weight and overweight patients (p < 0.001 for both). Patients with class II and III obesity were also younger than those with class I obesity (p = 0.002). Diabetes duration was similar across BMI classes. The education level was significantly higher in patients with normal weight than those with overweight and obesity (p < 0.001 for both). The education level was also significantly higher in overweight patients than in those with obesity (p < 0.001). Patients with obesity had the lowest monthly income when compared with the normal-weight and overweight patients (p < 0.001 for both) (Table 1).

Patients in higher BMI classes reported less frequent regular exercise and lower rates of smoking (p < 0.001 for both). Only 4.9% of the participants were following a diet prescribed for obesity and/or diabetes mellitus in the last year. On the other hand, significantly more patients with obesity (6.1%) reported following an obesity/diabetes mellitus diet compared to those in the normal-weight and overweight groups (p = 0.002) (Table 1).

Comorbidities, Complications, and Metabolic Control of Patients

Of the participants, 25.6% and 51.4% had macrovascular and microvascular complications, respectively. No significant difference was observed in the rates of

Table 1. Clinical and demographical characteristics of patients with T2DM having overweight and obesity in TEMD Obesity Study, 2017–2022

	Total patients, *n* = 4,935	Normal, *n* = 564 (11.4%)	Overweight, *n* = 1,654 (33.4%)	Obesity, *n* = 2,717 (55.1%)	*p* value
Age, years	58.9±10.1	60.0±11.3	59.6±9.9	58.3±9.9	<**0.001**[b,c]
Sex, women, *n* (%)	2,952 (59.8)	217 (38.5)	776 (46.9)	1,959 (72.1)	<**0.001**[a,b,c]
BMI, kg/m^2	30.7±8.1	23.7±1.8	27.7±2.3	34.6±6.5	<**0.001**[a,b,c]
Education (>8 years), *n* (%)	1,675 (35.3)	287 (53.2)	676 (42.7)	712 (27.1)	<**0.001**[a,b,c]
Monthly income, *n* (%)					
Low	3,235 (68.2)	334 (62.2)	1,028 (65.1)	1,873 (71.2)	
Average	1,259 (26.5)	169 (31.5)	464 (29.4)	626 (23.8)	<**0.001**[b,c]
High	252 (5.3)	34 (6.3)	87 (5.5)	131 (5.0)	
Diabetes duration, years	13.1±8.1	13.1±8.4	13.0±8.1	13.1±8.1	0.927
Diet, *n* (%)	244 (4.9)	21 (3.8)	62 (3.9)	161 (6.1)	**0.002**[b,c]
Exercise, *n* (%)	2,070 (41.9)	327 (58.0)	801 (48.4)	942 (34.7)	<**0.001**[a,b,c]
Smoking, *n* (%)	1,035 (21.0)	167 (29.6)	389 (23.5)	479 (17.6)	<**0.001**[a,b,c]
Home BP (systolic), mm Hg	124.8±13.6	121.4±12.7	124.0±13.1	126.1±14.0	<**0.001**[a,b,c]
Home BP (diastolic), mm Hg	77.0±9.0	75.4±8.3	76.0±8.8	77.9±9.2	<**0.001**[b,c]
Macrovascular complications, *n* (%)	1,264 (25.6)	142 (25.2)	447 (27.0)	675 (24.8)	0.268
Coronary artery disease	1,059 (22.4)	116 (21.3)	381 (23.8)	562 (21.7)	0.224
Peripheral artery disease	237 (5.0)	27 (4.9)	77 (4.9)	133 (5.1)	0.945
Cerebrovascular disease	176 (3.6)	22 (3.9)	50 (3.0)	104 (3.9)	0.326
Microvascular complications, *n* (%)	2,535 (51.4)	268 (47.5)	811 (49.0)	1,456 (53.6)	**0.002**[b,c]
Retinopathy	839 (19.2)	87 (17.4)	264 (17.9)	488 (20.4)	0.091
Neuropathy	1,430 (31.4)	146 (28.0)	436 (28.1)	848 (34.1)	<**0.001**[b,c]
Nephropathy	1,454 (29.5)	153 (27.1)	481 (29.1)	820 (30.2)	0.322
Laboratory					
HbA1c, %	7.9±1.9	8.0±2.2	7.9±1.9	7.9±1.9	0.328
Total cholesterol, mg/dL	188.5±54.0	182.5±45.9	187.7±57.8	190.2±53.0	**0.006**[b]
HDL-C, mg/dL	48.0±13.6	51.1±15.7	47.6±13.7	47.5±13.1	<**0.001**[a,b]
LDL-C, mg/dL	109.5±41.1	107.7±51.0	108.9±39.5	110.2±38.6	0.314
TG, mg/dL	178.4±130.8	152.5±125.4	172.2±130.4	187.4±131.2	<**0.001**[a,b,c]
eGFR, mL/min/1.73 m^2	85.7±27.5	89.3±28.7	85.9±26.1	84.8±28.1	**0.002**[a,b]
Treatment, *n* (%)					
Insulin	2,021 (41.0)	223 (39.5)	655 (39.6)	1,143 (42.1)	0.221
GLP-1 RA	363 (7.4)	0	24 (1.5)	339 (12.5)	<**0.001**[a,b,c]
Oral antidiabetic	4,191 (84.9)	461 (81.7)	1,423 (86.0)	2,307 (84.7)	**0.048**[a]
SGLT2-inh	1,698 (34.4)	164 (29.1)	586 (35.4)	948 (34.9)	**0.017**[a,b]
Anti-hypertensive medications	2,513 (50.9)	242 (42.9)	813 (49.2)	1,458 (53.7)	<**0.001**[a,b,c]
Statin	1,824 (37.0)	202 (35.8)	636 (38.5)	986 (36.3)	0.298

Data are expressed as mean ± standard deviation. BP, blood pressure; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; eGFR, estimated glomerular filtration rate; GLP-1 RA, glucagon-like peptide-1 receptor agonists; SGLT2-inh, sodium-glucose cotransporter-2 inhibitors. Post hoc analyses: [a]normal vs. overweight, [b]normal vs. obesity, [c]overweight vs. obesity.

macrovascular complications across BMI classes. The rate of microvascular complications was higher in patients with obesity than in normal-weight and overweight patients ($p = 0.002$ for both). Patients with normal weight had significantly higher eGFR compared to those who were overweight or had obesity ($p = 0.002$ for both).

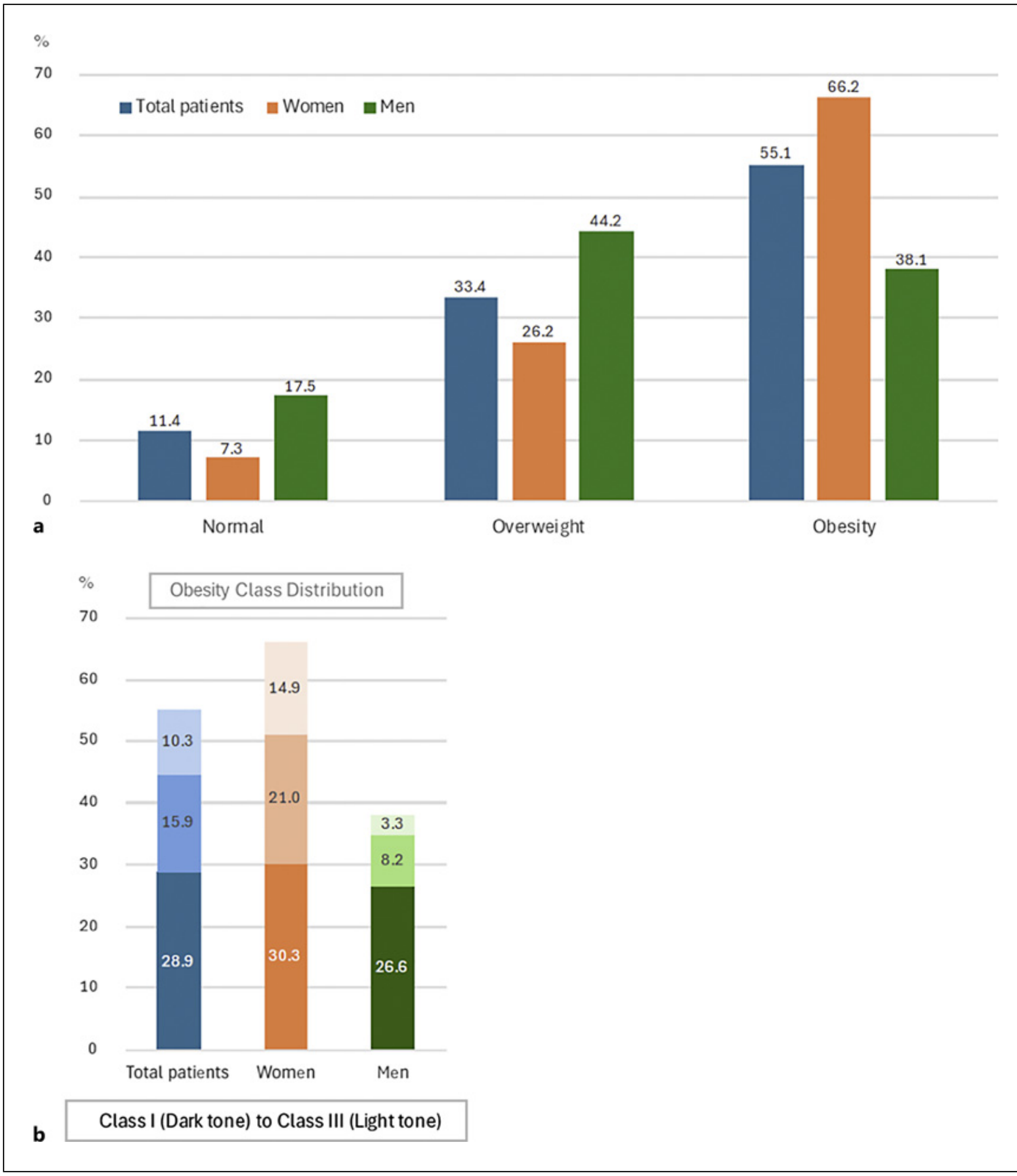

Fig. 1. a The distribution of BMI categories in patients with T2DM ($p < 0.001$ for all). **b** The frequency of obesity classes in women and men with obesity.

Systolic and diastolic BP levels were significantly higher across increasing BMI classes ($p < 0.001$ for all). The frequency of antihypertensive drug intake was higher in patients with obesity when compared to those with normal-weight and overweight patients ($p < 0.001$ for all).

The mean HbA1c level was similar across the three BMI classes. Patients in the upper BMI classes were more frequently on glucagon-like peptide-1 receptor agonist (GLP-1 RA) and sodium-glucose cotransporter-2 (SGLT-2) inhibitor compared with the normal-weight class ($p < 0.001$ for both). The overall rate of insulin use was 41%, with no significant difference across the three BMI classes.

The mean TG level was higher, and high-density lipoprotein cholesterol level was lower in patients with obesity than in patients with normal weight and overweight ($p < 0.001$ for both). The mean LDL-C level and

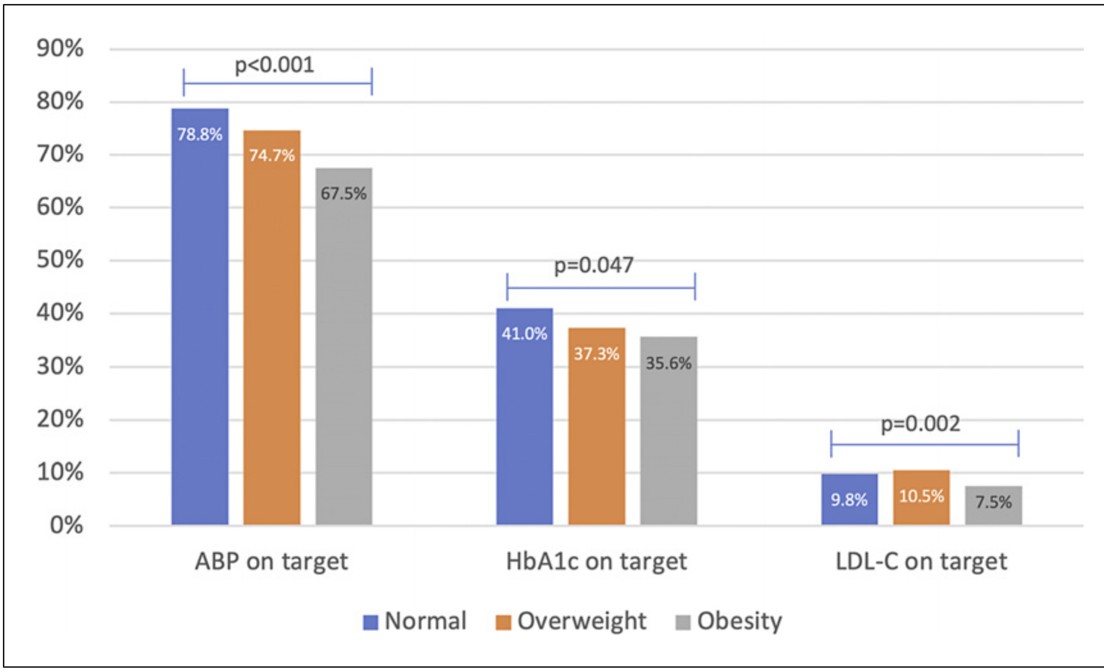

Fig. 2. The effect of overweight and obesity on the metabolic target attainment rates in patients with T2DM. ABP, ambulatory blood pressure; LDL-C, low-density lipoprotein cholesterol; HbA1c, hemoglobin A1c.

the rate of statin users were similar among the three BMI classes (Table 1). Significantly lower ABP ($p < 0.001$), HbA1c ($p < 0.047$), and LDL-C ($p = 0.002$) target attainment rates were observed in patients with obesity compared to those with overweight or normal weight (shown in Fig. 2).

Obesity Rates between Women and Men

The mean BMI (33.4 ± 7.0 kg/m^2) and the rate of obesity (66.2%) were significantly higher in women than in men (29.2 ± 4.8 kg/m^2 and 38.1%, respectively) ($p \leq 0.001$ for both). Only 7.3% of women and 17.5% of men were normal weight ($p \leq 0.001$) (shown in Fig. 1a). More women were in class I (30.3% vs. 26.6%), class II (21.0% vs. 8.2%), and class III (14.9% vs. 3.3%) obesity than men ($p < 0.001$ for all) (shown in Fig. 1b). The proportion of patients with higher education levels (>8 years) was significantly lower in women with obesity than men (18.7% vs. 48.8%, respectively) ($p < 0.001$).

Factors Associated with Obesity in Patients with T2DM

Multivariable logistic regression analysis showed that older age (OR = 0.98, 95% CI: 0.97–0.98, $p < 0.001$), higher education level (OR = 0.61, 95% CI: 0.53–0.71, $p < 0.001$), smoking (OR = 0.69, 95% CI: 0.59–0.81, $p < 0.001$), regular exercise (OR = 0.57, 95% CI: 0.50–0.65, $p < 0.001$), following a diet plan (OR = 0.62, 95% CI: 0.45–0.85, $p = 0.003$) were independently associated with a lower probability of obesity, whereas female sex (OR = 2.29, 95% CI: 1.99–2.63, $p < 0.001$), hypertension (OR = 1.81, 95% CI: 1.58–2.09, $p < 0.001$), past diagnosis of microvascular complications (OR = 1.15, 95% CI: 1.01–1.31, $p = 0.047$), and taking GLP-1 RA treatment (OR = 10.20, 95% CI: 6.72–15.4, $p < 0.001$) were associated with a higher probability of obesity (shown in Fig. 3).

Five-Year Trends in the BMI Classes and Metabolic Targets

Compared with the 2017 survey [5], TEMD-2 showed a lower obesity rate (59.0% vs. 55.1%) and a higher overweight (31.0% vs. 33.4%) rate in patients with T2DM ($p < 0.001$ for both) (shown in Fig. 4). Obesity rate was found lower than the previous survey in both women and men. Metabolic target attainment rates were similarly influenced by increasing BMI classes across both studies.

Discussion

The TEMD-2 Obesity Study revealed that almost 9 out of 10 patients with T2DM were overweight or had obesity. The results were marginally below the numbers obtained

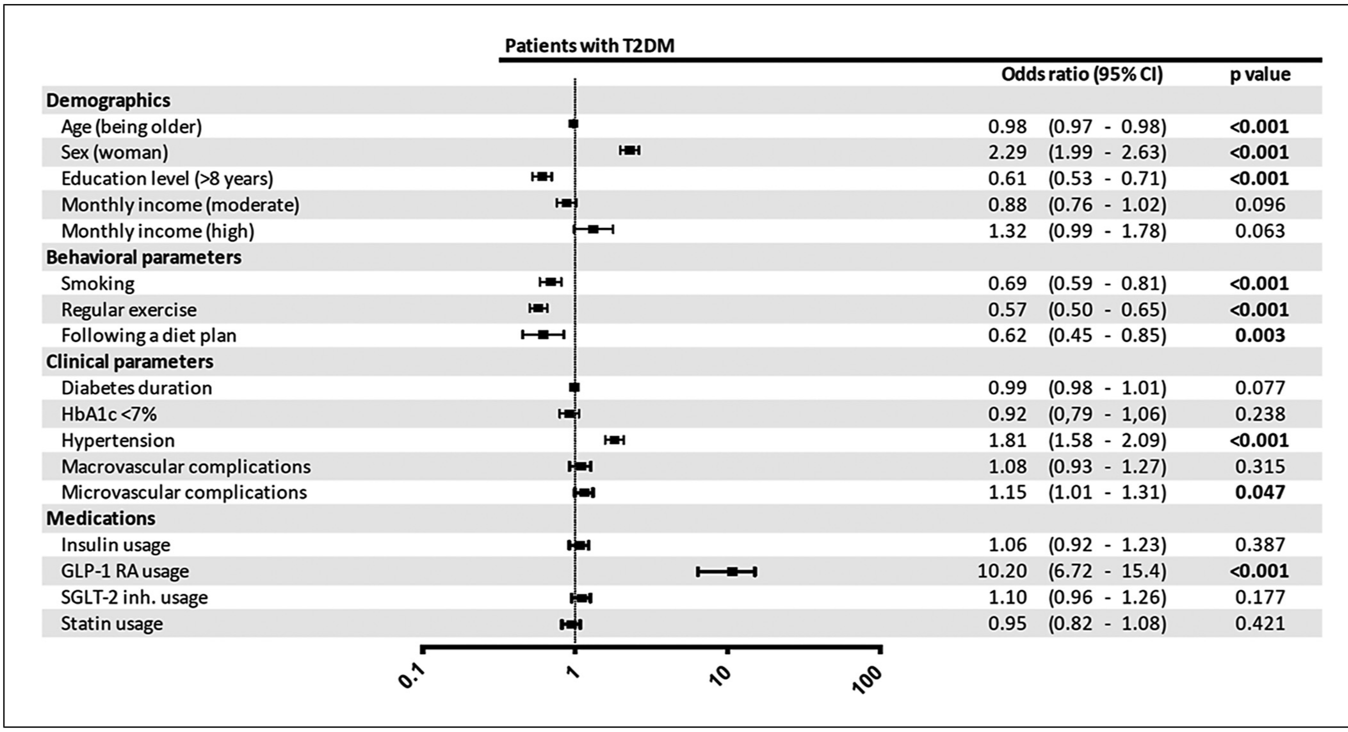

Fig. 3. The independent variables associated with obesity in patients with T2DM. CI, confidence interval; HbA1c, hemoglobin A1c; GLP-1 RA, glucagon-like peptide-1 receptor agonists; SGLT2-inh, sodium-glucose cotransporter-2 inhibitors.

5 years ago. Additionally, metabolic target attainment rates were found to decline with increasing BMI classes.

About 16% of adults live with obesity worldwide, while the prevalence of overweight was reported as 43%, though the numbers vary according to the region [12]. Türkiye reports an extremely high prevalence of both obesity and T2DM [6]. The recent nationwide TURDEP-II study reported the prevalence of obesity and diabetes reached 35% and 16.5% in the general population [13]. Compared with the earlier TURDEP-I study, the increase in the prevalence of obesity was much higher in men than women (107% vs. 34%, respectively) in the past 12 years [13, 14]. The present study showed an overburden of obesity in patients with T2DM, which hampers disease management and prevention of complications. On the other hand, the increased prevalence of obesity in patients with T2DM than the general population is well-established [15]. As in the present study, the overall prevalence of overweight and obesity among T2DM patients was reported over 85% in the UK [16] and the USA [17]. Although there are geographical variations [18], more than 1 in 2 patients with T2DM worldwide have excess weight.

Many factors influence the obesity rates such as sociodemographic, and behavioral factors [6, 16, 18]. In the TEMD-2 Obesity Study, patients with obesity were younger than the patients in normal and overweight BMI categories. The prevalence of obesity appears to decrease in later ages, probably due to muscle loss, which is common in this age group, or caused by the fact that patients with obesity have a higher mortality rate in early ages compared to those with a lower BMI [16, 19, 20].

In the present study, the prevalence of obesity in women was significantly higher than in men (66.2% vs. 38.1%). The prevalence of obesity is higher among adult women than men, contrary to other health risks according to the WHO reports [6]. Women in regions less economically developed and have lower education levels are at greater risk of obesity [21]. Consistent with this, we observed that the patients in the higher BMI classes had lower education level and monthly income. Furthermore, the proportion of patients who had a low education level was higher in women with obesity than in men. The high obesity prevalence in this socioeconomically disadvantaged group may be associated with the lack of knowledge on a healthy lifestyle,

Fig. 4. Five years trends of obesity rates in patients with T2DM in TEMD Obesity Study, 2017–2022.

limited access to healthy food, lack of environmental conditions and time to exercise, and/or difficulty accessing healthcare.

The present study showed that smoking was less frequent in patients with overweight and obesity. Population-based studies show that smokers have lower BMI compared to non-smokers, which is attributed to the increased energy expenditure and appetite-suppressing effect of nicotine [22, 23]. On the other hand, smokers show a tendency to have abdominal obesity which elevates their risk for cardiometabolic diseases [24].

Lifestyle interventions that include regular exercise and diet are the cornerstones of obesity and T2DM management. In Look AHEAD trial long-term lifestyle intervention produced more than 5% weight loss in half of the patients at 8 years [25, 26]. In our study, the number of patients who adopted a diet plan was low in the entire study group but relatively higher in patients with obesity. In contrast, the percentage of patients doing regular exercise was lower in patients with obesity, probably due to their physical inabilities, compared to patients with overweight and normal weight. We observed that doing regular exercise and following a diet plan were associated with low BMI, in line with the literature [25, 26].

GLP-1 RAs and SGLT-2 inhibitors are associated with clinically meaningful weight loss [27]. They are also recommended as first-line treatment for patients with high atherosclerotic cardiovascular disease (ASCVD) risk or established ASCVD and/or to patients with diabetic nephropathy [28–30]. Nevertheless, patients have limited access to GLP-1 RAs according to the Turkish reimbursement rules. While approximately 1 in 3 patients in our study population were on an SGLT-2 inhibitor, only 7.4% of the sample was on a GLP-1 RAs. On the other hand, while the percentage of patients using SGLT-2 inhibitors and GLP-1 RAs was 1.7% and 5.9%, respectively, in the first TEMD survey [31], there was a significant increase in the use of SGLT-2 inhibitors in the second survey. Increased use of these agents in line with new guidelines might be responsible for the slight decrease in obesity prevalence in the current study.

We observed a significant difference in the proportion of patients reaching the metabolic targets in the three BMI classes. Similar to the results of the TEMD-1 Obesity Study [5], metabolic target attainment rates decreased with increasing BMI classes. Previous studies in different populations also showed low rates of HbA1c, ABP and LDL-C target achievements [16, 32, 33]. Considering that these risk factors can be improved by weight loss; prioritizing obesity treatment would be crucial. Increasing patients' access to GLP-1 RAs, which have high potency both in weight loss and glycemic control may be one of the essential steps of this strategy, as well as lifestyle interventions.

The proportion of patients on statin treatment did not differ between the three BMI classes in the current survey. Despite the global recommendations of statins for primary and secondary prevention of ASCVDs in patients with T2DM [10], the rate of statin use ranged between 35.8% and 38.5% in the total sample, indicating that most patients were either not adherent or not prescribed a statin drug. Furthermore, only a minority of patients reached the LDL cholesterol targets stratified by cardiovascular risk categories [10].

Several limitations of the current survey should be acknowledged. Patients with T2DM were recruited from tertiary centers specialized in diabetes treatment. While most patients with T2DM are treated at primary care facilities, individuals with multiple comorbidities and complex treatments may more frequently refer to these centers. Therefore, less complex patients might be underrepresented in the current survey. In addition, the study's cross-sectional design limits establishing a causal relationship between obesity and achieving the defined treatment goals. Large sample size, country-wide representation and prospective enrollment of participants were the main strengths of the current survey.

Conclusion

This survey showed that obesity is still a major and growing problem in patients with T2DM, especially in socio-economically disadvantaged groups. The results also show that patients with T2DM and obesity are less likely to attain individual metabolic targets. Consequently, the results also emphasize the need for comprehensive obesity management strategies in T2DM.

Acknowledgments

We express our gratitude to our colleague Seda Sancak Nurdan who had valuable contributions to the TEMD Obesity Study and recently passed away. The authors acknowledge all the physicians at each of the TEMD study centers participating in patient recruitment and characterization as the collaborators of the TEMD Study Group (see online suppl. material; for all online suppl. material, see https://doi.org/10.1159/000547136).

Statement of Ethics

The study was conducted in accordance with the Declaration of Helsinki. This study protocol was reviewed and approved by the Local and Central Ethics Committee (Ethics Committee of Gulhane Training and Research Hospital, Approval No.: 06.04.2022/2022-01). The ClinicalTrials.gov registration number was NCT06347445. All participants gave written informed consent before enrollment.

Conflict of Interest Statement

Sinem Kiyici engaged in advisory boards and lectures with Novo Nordisk, Trispera Pharma Solutions, Boehringer Ingelheim, AstraZeneca, Abbott, Novartis, and Sanofi and participated in clinical trial performed by Boehringer Ingelheim. Alper Sonmez participated in advisory board meetings performed by Novo Nordisk, Novartis, Eli Lilly, and Trispera. Cem Haymana participated in speakers' bureaus performed by Sanofi, Novartis, and Boehringer Ingelheim. Serpil Salman participated in speakers' bureaus and advisory boards conducted by AstraZeneca, Eli Lilly, Novo Nordisk, Abdi İbrahim, and Roche Diagnostics. Meral Mert participated in speakers' bureaus performed by Novo Nordisk, Boehringer Ingelheim, Sanofi, and Abdi İbrahim. Fahri Bayram participated in clinical studies and advisory board meetings conducted by Novo Nordisk, Eli Lilly, MSD, Meditronic, Trispera, Abbott, Sanovel, Sanofi, and Novartis. Volkan Demirhan Yumuk engaged in advisory boards and lectures with Novo Nordisk, Eli Lily, Rhythm, and Regeneron. Other authors declare that they have no conflict of interest.

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Author Contributions

A.S. was the principal investigator of the study and responsible for study design. S.K., I.D., A.S., C.H., M.M., I.N., I.T., and S.S., participated in data analyses, manuscript preparation, and the creation of tables and figures. V.D.Y., F.B., and I.S. were the senior advisors and made critical revisions to the manuscript. All authors have read and approved the final version of this manuscript. A.S., S.K., and I.D., are the guarantor of this work and, as such, have full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of data analysis. All authors confirm that they had full access to all data in the study and accept the responsibility for submitting it for publication.

Data Availability Statement

The data that analyzed in this study are not publicly accessible due to the privacy of research participants but are available from the corresponding author (S.K.) upon reasonable request. The authors confirm that the work they have submitted for publication is original and has not been published in any language or format, except as an abstract or preprint.

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