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Cost of diabetes mellitus and related macrovascular complications in Turkiye

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ABSTRACT

OBJECTIVE: This study aimed to identify the costs and resources used for diabetes mellitus (DM) and macrovascular complications in Turkiye.

METHODS: The "Cost of Illness" method and a bottom-up costing approach were used in this study. We used e-Nabiz to identify patients with DM and collected their data from 2016 to 2020. We also examined macrovascular complications such as acute coronary syndrome, unstable angina, coronary artery disease, cerebrovascular events, transient ischemic attacks, carotid artery syndrome, intracranial hemorrhage, diabetic foot, heart failure, atrial fibrillation, and peripheral vascular disease using relevant ICD codes. No sampling was done; costs were calculated based on the entire population. When calculating per patient costs, all outpatient/inpatient, medication, intervention, and laboratory/screening tests were considered.

RESULTS: Between 2016 and 2020, the e-Nabiz database recorded 7,656,700 people diagnosed with diabetes, a prevalence of 10.4%. The total 2020 cost for treating diabetes was $4,526,212,569 (31,276,128,849 TL), with an average patient cost of $591.145. The health-care expense for 991,945 people diagnosed with major vascular complications due to diabetes was $1,013,004,565.0 (6,999,861,544.16 TL) in 2020, with a per patient average cost also of $591.145 (4048.81 TL). Breakdown of the total cost is 44% for healthcare, 34% for medication, 12% for insulin, 6% for oral antidiabetic drugs, and 1% for testing supplies. Women have a complication rate of 11.2%, while men have a higher rate of 20.8%.

CONCLUSION: DM is both a significant disease burden and an important economic burden. The findings will be a guide the development of effective strategies and sound health policies.

Keywords: Cost of illnesses; diabetes mellitus; disease management; e-Nabiz; macrovascular complications.

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Diabetes mellitus (DM) is an important health problem that is increasing in pandemic proportions. DM is a chronic disease with significant morbidity and mortality [1–3]. Approximately 10.5% of the world population has DM. DM causes 12.2% of deaths worldwide [3]. In the past 30 years, the prevalence of DM has increased dramatically all over the world. The number of patients increased from 30 million in 1985 to 537 million in 2021. The International Diabetes Federation (IDF) predicts that 783 million people will have DM in 2045. This figure means that the prevalence of DM will increase by 46% from 2021 to 2045, making DM an epidemic-class disease. The IDF reports that half of people with DM are unaware that they have DM and that the disease is responsible for 4.2 million deaths each year, or in other words, one DM-related death occurs every 8 seconds [3].

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According to the 2012 data of the Social Security Institution (SSI), there are 5.2 million diabetic patients in Turkiye, with an average increase of 17% over the years [4]. When the total health expenditures made by SSI in 2012 were analyzed, it was reported that diabetes has a large proportion in health expenditures with 23% [4]. At the same time, diabetes, which is defined as an important economic burden, was reported by Malhan et al. [5] showing that the T2D cost burden was between 11.4 billion and 12.9 billion TL from the perspective of the payer institution as of 2010. Approximately 12% of this amount is related to diabetes drugs, 15% to non-diabetes drugs, and 73% to complication screening and treatment. In addition, according to a report of SSI on diabetes, the total cost of type 1 and type 2 diabetes to the Turkish health system was approximately 10 billion TL in 2012, accounting for approximately 23% of the total health expenditure of SSI [4].

Since complications cause an important disease and economic burden, this study aimed to determine the costs and resource utilization of macrovascular complications related to DM in 2020.

MATERIALS AND METHODS

In 2015, e-Nabiz Personal Health System established by the Health Ministry started to store the health data of citizens living in Turkiye [6]. To identify patients with DM within the system, a disease phenotyping was created and according to this phenotyping, retrospective data for 2016–2020 were collected. Then, complications were categorized within themselves and the annual cost of each macrovascular complication for 2020 was calculated per patient. The incidence of complications according to age, gender, and provinces was determined. The method used to calculate the costs in the study is the "Cost of Illnesses" method. Among the direct, indirect, and intangible costs, which are the components of the method, only direct costs were focused and calculations were made from the perspective of the payer. Direct costs include laboratories, imaging services, outpatient and clinical services, medicines, and medical devices/materials. After all resource utilization was determined, per patient costs were determined on the basis of each complication and the total cost of macrovascular complications was determined using a bottom-up cost approach [7].

This study was to accurately identify newly diagnosed DM patients who are in the e-Nabiz system between 2016 and 2020 and who are within the specified acceptance criteria;

Highlight key points

- The number of people diagnosed with DM with the phenotype determined for 2020 using the e-Nabiz database is 7,656,700. The 5-year prevalence for 2016–2020 is 10.4%. The total cost of DM for 2020 is $4,526,212.57 (31,276,128.849 TL) (Table 1) and the average cost per patient is $591.145 (4 084.81 TL) ($1=6.91 TL as the average of 2020).
- In the data accessed through e-Nabiz, there were 991,465 people who developed macrovascular complications between 2016 and 2020 and 1,608,234 complications were detected (one patient may have more than one complication). The average cost per patient with macrovascular complications is $1,086.7 (7 509.11 TL) per year.
- The total health expenditure of 991,945 people diagnosed with macrovascular complications due to DM from the perspective of SSI for 2020 is $1,013,004,565.002 (6,999,861,544.16 TL) and the average cost per patient is $591,144 (4084.81 TL).
- Of the total cost, outpatient and inpatient health-care costs constitute 44%, medication 34%, insulin 12% (Dipeptidyl peptidase-4 inhibitors, SU, Thiazolidinedione, and cotransporter Type 2 inhibitors, OAD 6%), and strip/needle 1%.
- The diabetic foot is the most costly complication because of the lateness of the intervention of this complication. Diabetic treatment centres should be increased and they should be established in the regions in need.
- Diabetes nurses should be trained. Service planning should be reconsidered in regions with high incidence of diabetic foot complications.

1 ICD10 Diagnosis Code: E11.x or E08.x or E09.x or E13.x or E14.x

and

Those with at least one of the following

2 HbA1c ≥6,5 (SUT CODE: L102820 (Former code: 901460)/L102830 (Former code: 901450)/ L102840)

or

3 Fasting Blood glucose ≥126 mg/dL (7.0 mmol/L) (SUT CODE: L102890 (Former Code: 901500)

or

4 OGTT 2nd h≥200 mg/dL (SUT CODE: L113280 (Former Code: 901520)

or

5 Diabetes medication use (those with at least two prescriptions for ATC: A10A or A10B)

and

6 ICD10 Code: NOT O24.4 or O24.9 or Z86.32 or O99.81

Table 1. Annual cost of diabetes mellitus (TL)-2020

	n	Total cost ($)	Average cost per patient ($)
Diabetes mellitus total cost in 2020	7,656,700	4,526,212,568.58	591.145

A query was made as follows. Then, acute coronary syndrome, unstable angina pectoris, angina pectoris, coronary artery disease, cerebrovascular event, transient ischemic attack, carotid artery syndrome, intracranial hemorrhage, diabetic foot, heart failure, arterial fibrillation, and peripheral vascular disease with the relevant ICD codes under macrovascular complications were extracted from the e-Nabiz system. Our 2020 population is 83,614,362 and after the data cleaning, the relevant data were studied on 73,945,186 people. In other words, this rate shows e-Nabiz coverage of 88.4%. For this study, we got approval from the Ministry of Health on 5th January 2023 with the number of E-95741342-708.01-206385672. Due to reaching real-world data, Ethics Committee approval is no longer needed as real-world data are available. Since the data were collected retrospectively, it was not possible to have the consent form filled.

RESULTS

Cost of DM in Turkiye

The number of people diagnosed with DM with the phenotype determined for 2020 using the e-Nabiz database is 7,656,700. The 5-year prevalence for 2016–2020 is 10.4%. The total cost of DM for 2020 is $4,526,212.57 (31,276,128.849 TL) (Table 1) and the average cost per patient is $591.145 (4 084.81 TL) ($1=6.91 TL as the average of 2020).

Outpatient treatments accounted for 14% of the total cost, laboratory and imaging for 7%, inpatient treatments for 24%, drugs for 50%, and medical devices/materials for 4%. When the drugs with the largest cost item were analyzed, it was found that biguanide ranked first among oral antidiabetics (OAD) (39%), followed by Biguanide+DPP (11.6%) and Biguanide+Sulfonylurea (SU) (8%) (Fig. 1).

When we look at the distribution of insulins, it is observed that 37.3% Basal+Fast, 30.5% Basal, and 22.1% Premix are in the first place. Insulins constitute 27% of the total drug cost, OAD 19%, and the cost related to other complications 54% of the total drug cost (Fig. 2).

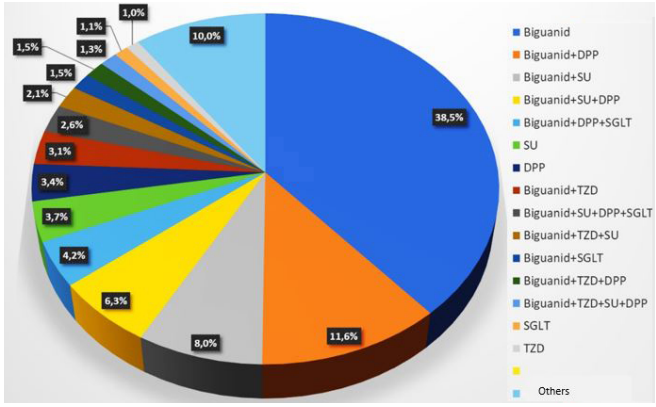

Figure 1. OAD distribution.

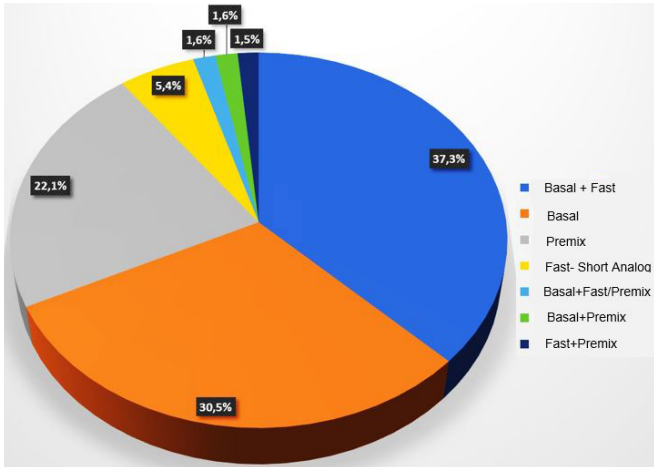

Figure 2. Insulin distribution.

The 5-year incidence of macrovascular complications between 2016 and 2020 was calculated. Among patients with DM, 991 495 people, that is, 12.95%, have macrovascular complications. Cardiovascular (CV) complications are 10.95%, cerebrovascular complications 0.81%, and peripheral vascular complications 1.40% (Table 2).

Table 2. 5-year incidence of macrovascular complications (2016–2020)

	Available			Developing After 2016			Total	
	n	Frequency (%)	%	n	Frequency (%)	%	n	Frequency (%)
Macrovascular complications	**778,191**	**10.16**	**79**	**213304**	**2.79**	**22**	**991495**	**12.95**
Cardiovascular complications	**678,792**	**8.87**	**81**	**159247**	**2.08**	**19**	**838039**	**10.95**
Acute coronary syndrome	15,209	0.20	55	12654	0.17	45	27863	0.36
Unstable angina pectoris	1503	0.02	60	995	0.01	40	2498	0.03
Angina pectoris	474,158	6.19	81	112599	1.47	19	586757	7.66
Coronary artery disease	580,315	7.58	82	128819	1.68	18	709134	9.26
Heart failure	64,012	0.84	78	17896	0.23	22	81908	1.07
Atrial fibrillation	25,537	0.33	85	4499	0.06	15	30036	0.39
Cerebrovascular complications	**47,055**	**0.62**	**76**	**14512**	**0.19**	**24**	**61567**	**0.81**
Ischemic cerebrovascular disease	34,922	0.46	78	10106	0.13	22	45028	0.59
Transient ischemic attack	11,121	0.15	76	3588	0.05	24	14709	0.19
Carotid artery syndrome	64	0.001	63	37	0.000	37	101	0.001
Intracranial hemorrhages	1234	0.02	57	917	0.01	43	2151	0.03
Peripheral vascular complications	**62,754**	**0.82**	**59**	**44246**	**0.58**	**41**	**107000**	**1.40**
Diabetic foot	40,853	0.53	82	8812	0.12	18	49665	0.65
Peripheral vascular diseases	22,549	0.30	39	35836	0.47	61	58385	0.76

Table 3. Cost of macrovascular complications related to diabetes mellitus

	Cost ($)	Distribution (%)
Costs		
Health service	446,189,076.99	44
Medicine	335,955,033.10	34
Medical supplies	42,441,320.48	3
OAD	59,139,000.72	6
Insulin	118,594,37.59	12
Strip/needle tip	10,685,761.18	1
Total cost	1,013,004,565.00	100

OAD: (DPP: Dipeptidyl peptidase-4 inhibitors; SU: Sulfonylurea; TZD: Thiazolidinedione; SGLT: Co-transporter type 2 inhibitors).

Table 4. Cost per patient for a single occurrence of macrovascular complications

	Total cost ($)	Cost per patient ($)
Acute coronary syndrome	4,732,927.39	349.18
Angina pectoris	4,025,372.32	276.81
Heart failure	24,707,890.38	471.43
Atrial fibrillation	9,580,426.40	444.74
Ischemic cerebrovascular disease	9,580,426.40	444.74
Transient ischemic attack	4,075,459.79	376.93
Carotid artery syndrome	28,881.67	344.49
Intracranial hemorrhages	555,849.14	337.70
Diabetic foot	33,545,448.58	855.14

The proportion of male patients with DM who developed macrovascular complications was 41.1% and 58.9% in women. The mean age of the patients was 59.3 years, 59.27 years for women, and 59.41 years for men. In patients with DM who developed macrovascular complications, the average of the population with HbA1c level above 6.5 for 2020 is 43.4%, and this rate is 49.6% in men and 39.5% in women. While the proportion of cases with uncontrolled diabetes rate was 26.5% in Isparta province, the highest rate was determined in Batman with 66.5% (Table 1). The average HbA1c of all patients with diabetes was 7.6% (Fig. 3).

The average prevalence of patients with DM who developed macrovascular complications was 13.8%, the highest rate was 16.7% in Tunceli and the lowest rate was 10.9% in Mugla. The province with the lowest rate of macrovas-

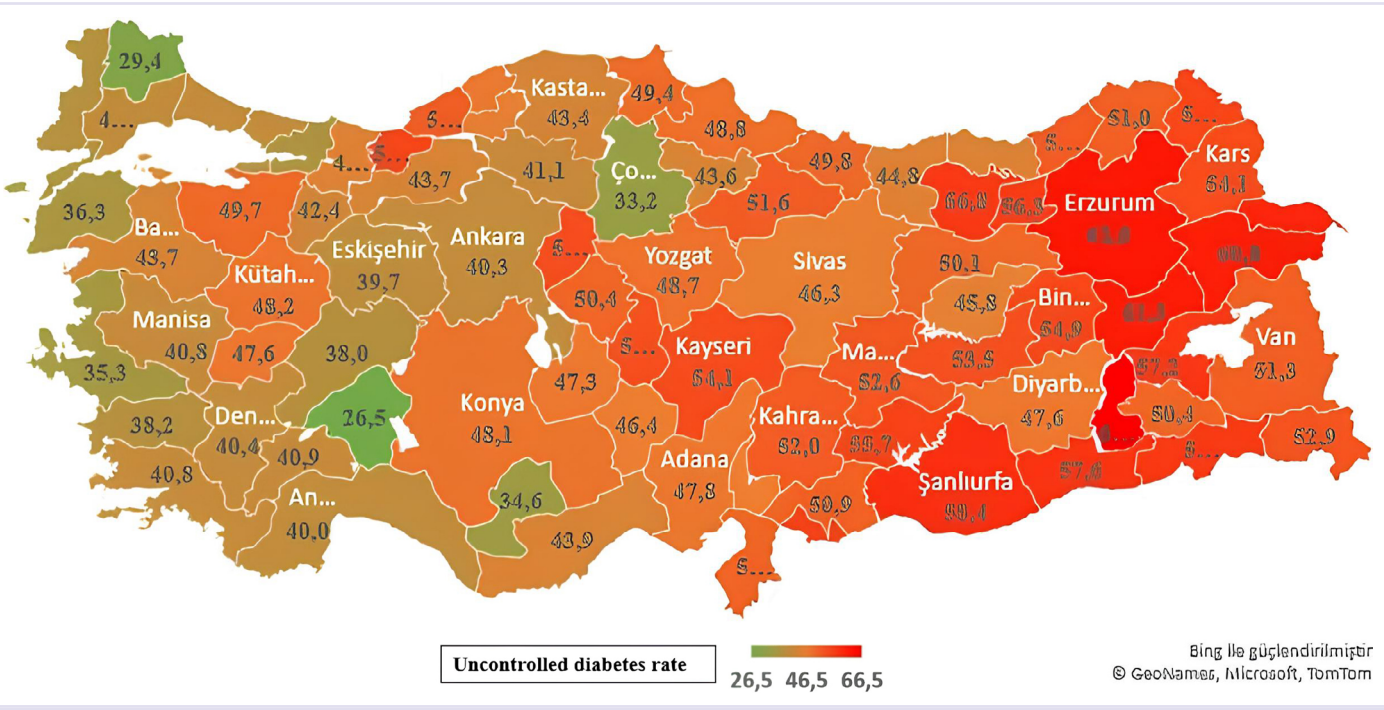

FIGURE 3. HbA1c average by province.

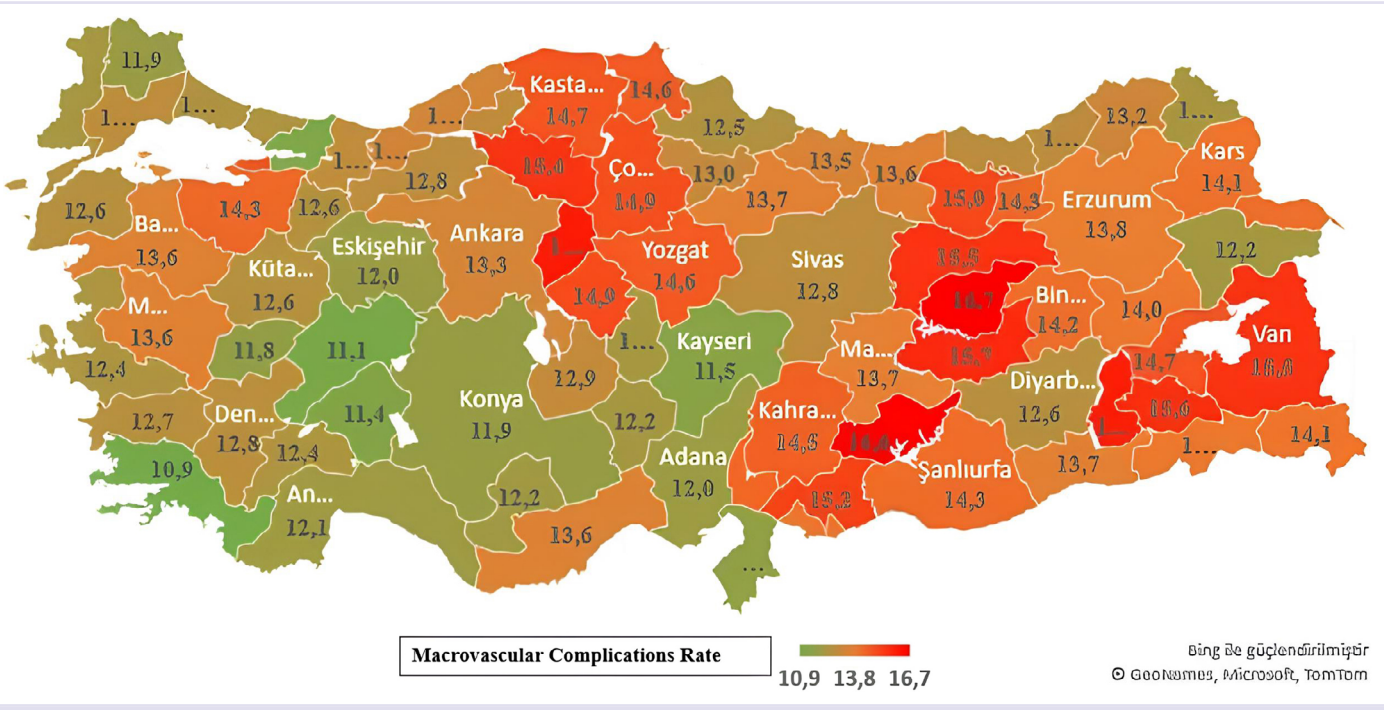

FIGURE 4. Incidence of macrovascular complications by province.

cular complications in males was Mugla with 15.7% and the highest rate was Adiyaman with 23%. In females, the province with the lowest incidence was Mugla with 6.7% and the highest was Batman with 12.7% (Fig. 4).

Within the 5-year prevalence, the lowest province with the incidence of CV complications was Kocaeli with 9% and the highest province was Adiyaman with 14.9%. In women, the lowest rate was in Mugla with 5.4% and

TABLE 5. Cost per patient in case of dual occurrence of macrovascular complications

	Total cost ($)	Cost per patient ($)
Unstable angina and angina pectoris	426,623.74	296.55
Acute coronary syndrome and heart failure	78,176.78	387.87
Acute coronary syndrome and diabetic foot	136,565.14	986.08
Acute coronary syndrome and peripheral vascular disease	108,393.31	1,213.60
Acute coronary syndrome and heart failure	78,176.78	387.87
Angina pectoris and diabetic foot	104,403.44	1,150.54
Angina pectoris and heart failure	75,735.90	533.76
Angina pectoris and peripheral vascular disease	104,773.89	1,044.10
Atrial fibrillation and diabetic foot	195,672.78	1,169.45
Atrial fibrillation and peripheral vascular disease	180,090.71	871.95
Coronary artery disease and peripheral vascular disease	1,053,734.38	890.68

the highest rate was in Adiyaman with 11.2%. The prevalence of DM-related cerebrovascular disease is 0.8%, 1% in males and 0.7% in females. The provinces with the lowest incidence are Van with 0.3% and Manisa with 1.5%. In males, the lowest prevalence was found in Ardahan with 0.3% and the highest in Manisa with 1.8%. In females, the lowest was Hakkari with 0.2% and the highest was Manisa with 3.5%. The incidence of DM-related peripheral vascular complications was 1.6%, the lowest was in Hakkari with 1% and the highest was in Kastamonu, Sinop with 2.2%. The lowest incidence rate of peripheral vascular complications in men was in Rize with 1.4% and the highest in Sinop with 3.2%. In females, the lowest rate was 0.7% in Hakkari and 1.9% in Sakarya.

Cost of Macrovascular Complications Related to DM

The total health expenditure of 991,945 people diagnosed with macrovascular complications due to DM from the perspective of SSI for 2020 is $1,013,004,565.002 (6,999,861,544.16 TL) and the average cost per patient is $591.14 (4084.81 TL). Of the total cost, outpatient and inpatient health-care costs constitute 44%, medication 34%, insulin 12% (Dipeptidyl peptidase-4 inhibitors, SU, Thiazolidinedione, and cotransporter Type 2 inhibitors), OAD 6%, and strip/needle 1% (Table 3).

Cost of Macrovascular Complications by Province

The cost of macrovascular complications was calculated on the basis of provinces and the highest cost belongs to Bitlis with $948.94 (6557.20 TL) per patient. It is followed by Siirt with $831.58 (5746.28 TL). According to the provinces, the highest outpatient cost of macrovascular complications due to DM was realized in Mus with $433.80 (2997.60 TL) and then in Bitlis with $424.63 (2934.20 TL). The lowest cost was $25.11 (173.55 TL) in the group with unknown province.

According to the provinces, the highest inpatient cost of macrovascular complications due to DM was $585.31 (3623.08 TL) in Bitlis and then $450.793 (3114.98 TL) in Siirt. The lowest cost was $70.13 (484.60 TL) in the group with unknown province.

When the costs of macrovascular complications across Turkiye are analyzed, the highest costs are found in provinces such as Mus, Agri, Bitlis, and Siirt. Rates of uncontrolled diabetes are also quite high in these regions: 61.3% in Mus, 60.8% in Agri, 57.2% in Bitlis, and 50.4% in Siirt. These high rates have a direct impact on cost data.

The highest cost of macrovascular complications in case of a single occurrence is diabetic foot, which is $855.14 (5,909.03 TL) per patient (Table 4).

Complications are associated with more than one comorbidity. The highest per patient cost is associated with the coexistence of acute coronary syndrome and peripheral vascular disease ($1213.59 (8385.95 TL)/patient). This was followed by atrial fibrillation and diabetic foot ($1169.45 (8080.90 TL)/patient) and angina pectoris and diabetic foot ($1150.53 (7950.22 TL)/patient) (Table 5).

In the presence of at least three complications, heart failure, cerebrovascular event, and peripheral vascular disease ($3879.16 (26,804.98 TL)/patient), followed by heart failure, cerebrovascular even and diabetic foot ($3395.76 (23,464.71 TL)/patient) and heart failure,

Table 6. Cost per patient in the presence of all three macrovascular complications

	Total cost ($)	Cost per patient ($)
Acute coronary, angina pectoris, and coronary disease cost	4,083,648.68	401.59
Acute coronary, angina pectoris, and coronary disease	2,476.03	1,091.70
Acute coronary syndrome, heart failure, and peripheral vascular disease	3,466.87	1,155.62
Angina pectoris, diabetic foot, and peripheral vascular disease	2,886.62	1,443.31
Angina pectoris, coronary artery, disease, and atrial fibrillation	83,872.54	885.51
Angina pectoris and coronary artery, disease and intracranial hemorrhage	76,076.45	551.49
Unstable angina, angina pectoris, and heart failure	11,019.42	802.47
Unstable angina, angina pectoris, and coronary artery	325,681.37	417.55
Unstable angina, angina pectoris, and diabetic foot	48,257.26	3,289.40
Cerebrovascular event, transient ischemic atacks, and peripheral vascular disease	2,193.49	548.37
Cerebrovascular event, transient ischemic attack, and diabetic foot	2,999.76	1,499.88
Heart failure, cerebrovascular event, and transient ischemic attack	2,437.61	1,218.81
Heart failure, cerebrovascular event, and peripheral vascular disease	15,516.63	3,879.16
Heart failure, cerebrovascular event, and diabetic foot	22,743.17	3,395.76
Heart failure, diabetic foot, and peripheral vascular disease	27,839.09	2,937.74
Heart failure, atrial fibrillation, and peripheral vascular disease	4,902.83	612.85
Heart failure, atrial fibrillation, and diabetic foot	9,847.61	1,188.98
Angina pectoris, coronary artery disease, and heart failure	4,749,532.77	655.82
Angina pectoris, coronary artery disease, and peripheral	1,588,078.06	645.90
Angina pectoris, coronary artery disease, and cerebrovascular event	1,847,633.97	540.36
Angina pectoris, coronary artery disease, and peripheral vascular disease	1,588,078.06	645.90
Angina pectoris, coronary artery disease, and cerebrovascular event	1,847,633.97	540.36
Angina pectoris, coronary artery disease, and transient ischemic attack	688,066.02	633.77
Angina pectoris, heart failure, and diabetic foot	12,813.69	2,462.58
Coronary artery disease, foot and peripheral vascular disease	6,868.29	851.41
Coronary artery disease, heart failure and diabetic foot	32,763.01	1,206.43
Coronary artery disease, heart insufficiency, and peripheral vascular disease	37,645.15	2,569.98

diabetic foot, and peripheral vascular disease ($2937.74 (20,299.78 TL)/patient) (Table 6).

The coexistence of four, five, or more complications is rare, but it does occur. The occurrence of multiple complications is associated with increasing costs.

DISCUSSION

DM is a chronic disease burden of increasing importance in Turkiye. DM is a disease with a high prevalence and high economic impact in the world and is considered a pandemic if not prevented. Diabetes-related expenditures reached 189 billion USD in the European region, which is 19.6% of global health expenditure. The European region has the highest per capita health expenditure and the cost per patient is 3086 USD [3].

In 2010, the total annual direct DM cost for the five countries of the European Union was €90 billion (€-EUR) and the indirect cost was €98.4 billion. The average annual DM cost per patient for each of these countries is €5432 in France, €5899 in Germany, €2756 in Italy, €1708 in Spain, and €4744 in the UK [7]. According to the IDF Atlas 2021, the direct health expenditure related to diabetes between the ages of 20 and 79 in Germany is 41.3 billion USD, 22.7 billion USD in France, 15.5 billion USD in Spain, 14.7 billion USD in Italy, and 23.4 billion USD in the United Kingdom [3].

The total cost of diagnosed DM patients in the United States of America (USA) in 2012 was 245 billion USD, of which 176 billion (72%) were direct medical costs and 69 billion (28%) were indirect costs. The average cost per DM patient per year is 13700 USD for the USA,

of which 7900 USD is attributable to diabetes. Of the direct medical costs, 43% are hospital costs, 18% are the costs of DM complications, and 12% are the costs of antidiabetic drugs and supplies [8]. In 2021, total direct health-related expenditures reached 379.5 billion USD, making it the country with the highest health expenditure on diabetes in the world. China ranks second with 165.3 billion USD. By 2030, if this rate of increase continues, it is thought that diabetes-related health expenditures globally will reach one trillion USD [3].

However, diabetes-related health expenditures in Turkiye reached 6.5 billion USD in 2010 [8]. According to the Direct Medical Cost Analysis of DM in Turkiye-2 (Diab-Cost-2) study on the cost of T2DM, the annual cost per capita was calculated as 498 USD on average for patients without any DM-related complications, but it was found that this figure increased significantly as the number of DM-related complications increased [9].

A 2009 study with data from more than 7000 patients estimated the cost of T2DM in diagnosed patients to be between 11.4 and 12.9 billion TL, corresponding to 1% of gross domestic product. CV complications accounted for the largest proportion of the total medical cost (range 24.3–32.6%), followed by the cost of renal complications (range 25.0–28.3%) and the cost of concomitant CV and anti-hypertensive medication (range 14.2–16.0%). The cost of anti-hyperglycemic drugs and monitoring costs were in the range of 10.9–12.3% and 4.4–5.0% of total costs, respectively. When DM causes complications, treatment and health-care costs can be more than 5 times higher than DM treatment alone [5].

It is known that the presence of complications increases costs. In the data accessed through e-Nabiz, there were 991,465 people who developed macrovascular complications between 2016 and 2020 and 1,608,234 complications were detected (one patient may have more than one complication). The average cost per patient with macrovascular complications is $1,086.7 (7 509.11 TL) per year. Complications cause serious negative health problems on the patient if they are not prevented and treated. In addition, while there is minimal resource utilization in case of precautions, the progression of the disease causes very high resource utilization, prolonged hospitalization, and even disability and early death. The most costly complication is CV diseases [10].

When the costs of macrovascular complications in Turkiye are analyzed, the highest costs are observed in provinces such as Mus, Agri, Bitlis, and Siirt. Rates of uncontrolled diabetes are also quite high in these regions. It was determined as 61.3% in Mus, 60.8% in Agri, 57.2% in Bitlis, and 50.4% in Siirt, respectively. These high rates have a direct impact on cost data. This situation shows that the diabetes follow-up of patients in these regions should be carried out more effectively by primary health-care services. Improvement of health services and regular follow-up of patients in these regions may contribute to reducing the rates of uncontrolled diabetes and thus reducing the costs related to macrovascular complications. Therefore, it is important to include primary health-care services in the performance criteria for patient follow-up and diabetes management and to improve the quality of these services to reduce costs and increase the chances of success in the fight against diabetes in these regions.

The highest cost in single complications was diabetic foot cost with $855.14 (5909,03 TL). According to the provinces, the highest macrovascular complication costs were found in Bitlis, Siirt, and Mus, respectively. The highest complication rate was observed in Batman, Agri, Siirt, and Sirnak provinces. Peripheral arterial disease and amputation are very common in diabetic foot patients. As time passes, the risk of being diagnosed with peripheral arterial disease increases in diabetic patients. The literature suggests that patients with diabetic foot ulcers should be made aware of peripheral arterial disease and necessary examinations should be performed regularly [11]. As a matter of fact, in this study, it was determined that the costs of patients with peripheral artery disease and diabetic foot were also high.

Diabetic foot and peripheral arterial disease prolong the duration of hospitalization. For this reason, a costly and exhausting treatment process awaits the patient. In accordance with the literature, our findings are similar. Among macrovascular complications, diabetic foot is the most costly complication. Amputation should be considered as a last resort to reduce the disease burden of peripheral arterial disease caused by diabetes, and early diagnosis should be emphasized [12]. Morbidity and mortality rates of peripheral artery disease are high. In this study, only direct costs were calculated, but indirect costs are estimated to be much higher. In addition, it requires permanent lifestyle changes, the life of the patients may be adversely affected by the increase in the duration of hospitalization and the need for care, and the risk of acute and chronic complications increases. Peripheral arterial disease, which negatively affects the functional capacity of individuals due to these characteristics, leaves the person in a difficult situation in fulfilling social and professional roles [11, 13]. This will increase the moral costs at an increasing rate.

According to the WHO estimates, long-term adherence to treatment in patients with chronic diseases, including T2DM, can be as low as 50% on average in developing countries. This leads to poor health outcomes and increased treatment costs [14]. To avoid wasting resources on this issue, these analyses should be continuously evaluated and evaluated in a self-renewable manner in the system.

Determining the costs of diabetes complications is necessary to see the change in costs caused by favorable outcomes of treatments. In addition, whether new health technologies are worth reimbursement should be evaluated in terms of cost and benefit. To make all these evaluations, it is necessary to determine the costs of complications.

It is stated that diabetes, together with smoking habit, hypertension and hyperlipidemia, is an independent risk factor for coronary heart disease. The incidence of CAD increases four-fold in women with diabetes and two-fold in men [15, 16]. This shows how important it is to eliminate risk factors. To eliminate risk factors, both primary cares should take an active role and physicians and patients who succeed in reducing risk factors (such as smoking cessation) should be rewarded.

Complications in T2DM can be prevented with good glycemic control and appropriate treatment of concomitant diseases such as hypertension and lipid disorders [17]. In T2DM, which is accepted as the gold standard in the clinic, with each 1% decrease in HbA1c levels, DM-related mortality can be reduced by 25% and all-cause mortality by 7%. A 1% decrease in HbA1c also provides a risk reduction of 18% in the prevalence of myocardial infarction (AMI), 16% in the development of heart failure (CHF), 43% in lower extremity amputations, 12% in the development of stroke, and 35% in microvascular complications. In addition, a 34% risk reduction in the development of microalbuminuria has been recorded with strict blood glucose control. The results of the UKPDS and some other epidemiological studies have shown that an HbA1c level of 7% and a systolic blood pressure below 130 mmHg reduce the risk of chronic complications [18]. In our results, the mean value of HbA1c was found to be 7.6 and it was determined that the mean value was much higher in regions where the frequency of macrovascular complications was high.

It is stated that these complications can be prevented by following the course of the disease well and increasing the health literacy and awareness of patients [19]. Studies on this subject should be initiated immediately in Turkiye.

The existing "Electronic Disease Management Platform" should be developed in line with the needs. For example, diabetic foot examination should be made compulsory and its visuals should be processed into the system and made measurable with performance. In our study, it was determined in which provinces diabetic foot complications are more common. In addition, it is reported in the literature that not only medical costs but also loss of labor force and moral costs are high. The number of diabetic foot centers should be increased and they should be established in the regions in need. Diabetes nurses should be trained. Service planning should be reconsidered in regions with a high incidence of diabetic foot complications.

Certain limitations should be acknowledged in this study. First, the research relies heavily on data from the e-Nabiz system, and the quality of this data is reliant on the accurate input and recording by health-care professionals and patients, which might introduce some biases or inaccuracies. Second, this study predominantly focuses on provinces with high rates of diabetes complications, which may not represent the overall situation across the country. It is also worth mentioning that indirect costs, such as the impact on patient's quality of life, were not calculated, potentially underestimating the true cost of diabetes complications. Furthermore, while the study has made significant observations and suggestions, these findings might be influenced by other uncontrolled variables not included in the study, such as socioeconomic factors, patient adherence to treatment, and various behavioral and lifestyle factors. Finally, as the study relies on existing literature for evidence and comparisons, it is constrained by the limitations of these previous studies as well.

Conclusion

With e-Nabiz, which is a very important development in Turkiye, it is possible to see the follow-up of patients in detail. There is a need for control mechanisms that will immediately alert the physician and the patient before complications develop.

To ensure patient compliance with treatment, measures should be taken to increase health awareness and literacy, patient education should be included in the performance and measurable criteria should be set. Physician training should be carried out continuously, patient follow-up training should be provided starting from family medicine to specialty branches. Critical points should be based on performance.

A patient-oriented, multi-perspective, and multi-disciplinary approach is required to control the disease rate and complication rate of DM.

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