

The Impact of Obesity-Related Complications on Healthcare Costs – Outcomes of a Pharmacoeconomic Weight Loss Model

Esra Safak Yilmaz¹, Simten Malhan², Batu Gurser³, Dilek Gogas Yavuz⁴

¹Novo Nordisk, Patient Access and Public Affairs Department, Istanbul, Istanbul, Turkey; ²Baskent University, Department of Healthcare Management, Ankara, Turkey; ³Novo Nordisk, Medical & Scientific Affairs Department, Istanbul, Turkey; ⁴Department of Endocrinology & Metabolism, Marmara University Medical Faculty, Istanbul, Turkey

Correspondence: Esra Safak Yilmaz, Novo Nordisk, Patient Access and Public Affairs Department, Etiler, Nispetiye Cd. Akmerkez Is Kuleleri E3 Blok, Istanbul, 34335, Turkey, Tel +90 534 501 8205, Email EYIZ@novonordisk.com

Purpose: According to the World Health Organization European Regional Obesity Report, Turkey has the highest rate of overweight and obesity in Europe. This study used a weight loss pharmacoeconomic model to assess the influence of obesity on public health by examining its effects on private health institutions and its financial costs.

Patients and Methods: A micro-costing approach was used to estimate the direct healthcare costs of 10 obesity-related comorbidities from the perspective of private healthcare providers in Turkey. A survey was conducted on a representative sample of physicians in Turkey to determine resource utilization rates for comorbidities in expenditures. The unit costs of each cost item were analyzed for type A, B, and C private hospitals. Costs in the different categories were obtained by multiplying the unit costs by the health resource utilization rate.

Results: When the obesity-related complications were stratified according to weight loss rate, 5%, 10%, and 20%, a higher cost reduction was observed in the 40–49, 50–59, and 60–69 age groups. It should be noted that this decrease in healthcare expenditure was detected in the older age groups (40 to 69) and not in individuals between 20 and 39 years. Another analysis of the weight loss rate revealed that the decrease was highest in Type 2 Diabetes Mellitus costs. A health expenditure that costs 1 unit in a C-segment institution increases 1.44-fold in B-segment and 3-fold in A-segment hospitals. The effects of weight loss on reducing the cost of obesity-related complications indicated that the highest cost reduction was on T2DM, dyslipidemia, and CKD, respectively. Obesity-related complications constituted 28.87% of total costs in Segment A hospitals, 29.13% in Segment B hospitals, and 28.54% in Segment C hospitals.

Conclusion: The current pharmacoeconomic model indicated that complications were the major cost drivers in obesity. Weight loss dramatically reduced healthcare expenditures in obese patients, and T2DM was the leading cause in all age groups.

Keywords: weight loss, obesity, complication, healthcare resource utilization, pharmacoeconomic model

Introduction

Obesity pandemic emerges all over the globe outrageously, not only in adults but also in children and adolescents, regardless of socioeconomic status. It is perceived as a significant health problem that pressures healthcare utilization and costs at every level.¹ The report of the World Health Organisation (WHO) declared that 1 billion people will suffer from obesity in 2030 worldwide, with one out of every five women and one out of every seven men.² According to the World Obesity Federation (WOF) forecast, 1.9 billion people will suffer from obesity by 2035, one out of every four individuals.³ Childhood obesity is expected to increase by 100%, and lastly, the economic burden of obesity in the world will be 4.32 trillion dollars in the next decade.⁴

The World Health Organisation European Regional Obesity Report (2022) emphasized that Turkey had been ranked as the first country to have an overweight and obesity rate among all European countries. The mean rate of being overweight was 66.8%, while it was 58.7% in Europe. Regarding statistics on obesity, the mean rate was 32.1% in

Turkey and 23.3% in Europe. Regarding gender, the demographics were 64% males and 69.3% overweight individuals in Turkey, higher than the European average of 62.9% males and 54.3% females. The obesity rate was elaborated as 24.4% males and 39.2% women, higher than the European average of 21.8% males and 24.5% females.²

The aforementioned data and the current increase in obesity rate require urgent measures nationwide. The occurrence of comorbidities during obesity is another obstacle to disease management, healthcare utilization, and costs. Obesity, metabolic syndrome, and insulin resistance facilitate inflammation, leading to hypertension, diabetes, cardiac diseases, stroke, respiratory problems, depression, and even various cancers.⁵ Within the scope of this research, we aimed to elucidate the decisive utilization of the “Weight Loss Tool” to model the clinical and economic impacts of selected comorbidities in a specified population and period in private hospitals within nationally adjusted data. This pharmacoeconomic tool aims to assist clinicians and decision-makers in calculating the risks of obesity-related complications over the next ten years. In this study, the impact of obesity on public health was evaluated from the perspective of private health institutions and assessed in terms of financial burden.

Materials and Methods

The “Weight Loss Tool” pharmacoeconomic model was utilized to determine the annual costs of obesity and its ten significant complications from the perspective of private healthcare providers in Turkey. Those obesity-related comorbidities included type 2 diabetes mellitus (T2DM), heart failure, angina, hypertension, atrial fibrillation, hyperlipidemia, sleep apnea, osteoarthritis, asthma, and chronic kidney disease. They were benchmarked from the study of Haase CL et al (2021) on the effect of weight loss on obesity-related outcomes.⁶

A micro-costing approach was used to estimate the direct healthcare costs of 10 obesity-related comorbidities. A survey was conducted among a representative sample of physicians in Turkey to determine healthcare resource utilization rates for comorbidities in the identified cost categories (adverse events, complications, medical devices, diagnostic tests, inpatient procedures, imaging tests, outpatient visits, and drug treatment costs).⁵

CompuGroup Medical (CGM) provided the unit costs of each cost item and obtained them separately for A, B, and C-type private hospitals. Costs in the different categories were obtained by multiplying the unit costs by the health resource utilization rate. The total cost per patient per year of all comorbidities was estimated by summing all cost items in each cost category.

The cost categories in our micro-costing exercise were based on a systematic development process of previously established studies^{7,8} (Figure 1). Each item’s cost within each category was calculated separately (Box 1). The quantification of cost categories is denoted in Table 1. The costs were expressed in EUROS (€), and the foreign exchange rate was 1 Euro = 25.9 Turkish Liras (TRY). A Turkish steering committee comprising local academic physicians and a panel of independent industry experts drove local validation of all cost categories (Box 2).

Private hospitals are divided into five categories according to the quality of their services, patient rights, and employee safety. The score consists of an evaluation according to statistics such as the square meters of hospital closed area per bed, the number of operating room rooms, the number of nurses per bed, and the number of beds. Three different hospital types were considered when calculating the costs of obesity and its complications. The share of A-type hospitals on private health insurance (PHI) coverage is 75%, B-type hospitals 23%, and C-type hospitals 2%. The main difference between these hospital segmentations can be elaborated on in terms of pricing. According to their pricing strategies, health expenditure that costs 1 unit in a C-segment institution increases 1.44-fold in B-segment and 3-fold in A-segment hospitals.

The weight-loss tool is a pharmacoeconomic model that analyses the economic impact of obesity and obesity-related complications. The model could be adjusted to designate the public and private health costs within specific risk categories.

Results

Obesity-related complications vary according to the private hospital segment. The annual cost of ORCs was 49.181 Euros in C-segment hospitals, 57.817 Euros in B-segment hospitals, and 97.244 Euros in A-segment private hospitals. Hypertension was the lowest-cost complication, with an annual expenditure of 1.325 Euros in C-segment hospitals, 1.544

A

Treatment pathways, including screening, diagnosis, medications, and complications, were identified via a systematic literature review of clinical guidelines. Keywords relating to each ORC and 'guidelines' or 'systematic review' were used to identify relevant PubMed and Google Scholar references and determine the healthcare cost parameters pertinent to each ORC

**B**

The following cost categories were included in the analysis: diagnostic tests per patient, scheduled outpatient visits per patient/ year, treatments received (plus dose, frequency, and duration), consumables and devices per patient/ year, monitoring tests per patient/ year, treatment-related adverse events and complications per patient/ year (which included inpatient hospitalization, outpatient visits, intensive care unit (ICU) care, emergency room (ER) visits and inpatient procedures per patient/ year.

**C**

Cost categories were consolidated in a standardized template and administered via interviewer-assisted online surveys to clinicians, and 70 experienced specialists were asked to provide healthcare resource utilization (HCRU) estimates. An independent third party recruited clinicians; hence, they were required to work in their current specialist role for at least three years and care for at least ten relevant patients monthly. Potential participants were screened to ensure they met the inclusion criteria and were selected from various geographic regions. Out-of-pocket costs were excluded from the calculations. Where required, targeted secondary research was also conducted to validate the cost data.

Figure 1 (A and B) Identification of cost categories (C) Quantification of cost categories of the model.

Euros in B-segment hospitals, and 2.418 Euros in A-segment private hospitals. On the contrary, chronic kidney disease (CKD) had the highest cost, with an annual expenditure of 12.510 Euros in C-segment hospitals, 14.815 Euros in B-segment hospitals, and 24.174 Euros in A-segment private hospitals (Table 2) (Figure 2). While chronic kidney disease, heart failure (HF), and T2DM were the highest costly three complications, hypertension, asthma, and atrial fibrillation were the least costly ORCs.

Box 1 Cost Calculation Formulas of the Weight Loss Model

The annual cost per patient per cost item was calculated as:

Annual cost per cost item = Percentage (%) of patients utilizing the healthcare resource x Number of healthcare resource units utilised per year x Unit cost

The annual cost for each drug per patient was calculated as:

Annual cost for each drug treatment = Average consumption per day x 30 days x 12 months x Unit cost of treatment x Percentage (%) of patients receiving treatment.

Following the calculation of unit costs for each ORC, the total annual cost per patient per cost category was determined by summing all cost items. Finally, the total annual cost per patient per ORC was calculated by summing all cost categories. Cost data are presented as mean values in Euros or as a percentage of total costs.

Table 1 Specialties Who Contributed Healthcare Resource Utilization Estimates to the Micro-Costing Analysis

Obesity-Related Complications	Specialties	Number of Physicians
Type 2 Diabetes	Endocrinologists	10
	Internal Medicine	10
Asthma	Pulmonologists	10
Sleep apnoea	Otolaryngologists	10
Osteoarthritis	Orthopaedists	5
Chronic Kidney Disease	Nephrologists	10
Angina	Cardiologists	15
Atrial fibrillation		
Hyperlipidaemia		
Heart failure		
Hypertension		

Box 2 Data Validation Procedure for Local Adaptation

Aggregated annual cost estimates were shared with the Turkish expert steering committee for final validation. The local expert steering committee comprised one senior academician and a panel of independent industry experts. The steering committee also validated cost drivers and unit cost estimates. Where necessary, a targeted literature review was conducted to corroborate cost data.

The cost items have been arranged from the highest to the lowest value in all three segments of private hospitals. Obesity-related complications constituted 28.87% of total costs in Segment A hospitals, 29.13% in Segment B hospitals, and 28.54% in Segment C hospitals. The second highest cost item was inpatient procedures, constituting 21.46% of total costs in Segment A hospitals, 17.94% in Segment B hospitals, and 18.23% in Segment C hospitals. The third highest cost item was adverse events, which constituted 17.61% of total costs in Segment A hospitals, 17.77% in Segment B hospitals, and 17.41% in Segment C hospitals. These were followed by monitoring tests as they accounted for 11.20% of total costs in Segment A hospitals, 11.30% in Segment B hospitals, and 11.07% in Segment C hospitals. Outpatient visits were the fifth highest cost, generating 9.55% of total costs in Segment A hospitals, 9.64% in Segment B hospitals, and 9.44% in Segment C hospitals.

Treatment costs and consumable/device costs were the least expensive cost items. Treatment accounted for 3.01% of total costs in Segment A hospitals, 5.06% in Segment B hospitals, and 5.95% in Segment C hospitals, where consumable/device costs were 1.17% of total costs in Segment A hospitals, 1.97% in Segment B hospitals, and 2.31% in Segment C hospitals (Figure 2).

When the obesity-related complications were stratified according to weight loss rate, 5%, 10%, and 20%, a higher cost reduction was observed in the 40–49, 50–59, and 60–69 age groups. It should be noted that this decrease in healthcare expenditure was detected in older age groups (40 to 69) and not in individuals between 20 and 39 years (Table 3).

Another analysis of the weight loss rate revealed that the decrease was highest in Type 2 Diabetes Mellitus costs. The effects of weight loss on reducing the cost of obesity-related complications indicated that the highest cost reduction was on T2DM, dyslipidemia, and CKD, respectively. When all cost reduction items were collected, T2DM accounted for

Table 2 Obesity-Related Costs in Segment A, Segment B, and Segment C Hospitals (The Demographics Data Has Been Calculated According to the Age Distribution of Individuals With Obesity in Turkish Statistical Institute Health Survey Data)

		Atrial Fibrillation	Angina	Asthma	CKD	Heart Failure	Hyperlipidaemia	Hypertension	Osteoarthritis	Sleep Apnea	T2 Diabetes	Total
Type A Hospital	Adverse events	10.268	3.181	8.037	174.459	112.288	4.750	11.698	8.106	26.149	84.582	443.518
	Complications	15.328	30.815	7.325	299.101	76.896	93.447	8.685	15.346	51.148	129.009	727.100
	Consumables/ devices	10.251	0	242	3.528	0	0	3.422	2.833	3.808	5.350	29.434
	Diagnostic tests	17.542	24.517	10.889	27.632	30.736	16.082	7.841	4.810	37.407	2.083	179.541
	Inpatient procedures	24.082	107.891	0	7.195	159.215	988	0	142.996	63.700	34.547	540.613
	Monitoring tests	25.628	28.636	10.397	67.749	51.139	21.134	13.624	6.135	50.395	7.285	282.122
	Outpatient visits	25.692	21.513	25.438	28.083	34.780	25.240	14.754	15.771	19.769	29.505	240.544
	Treatment	12.757	10.260	12.678	18.365	8.172	2.555	2.605	2.766	0	5.582	75.738
	Total	141.549	226.812	75.005	626.113	473.226	164.196	62.628	198.762	252.375	297.943	2.518.609
Type B Hospital	Adverse events	6.161	1.909	4.822	104.676	67.373	2.850	7.019	4.864	15.689	50.749	266.111
	Complications	9.197	18.489	4.395	179.461	46.137	56.068	5.211	9.208	30.689	77.405	436.260
	Consumables/ devices	10.251	0	242	3.528	0	0	3.422	2.833	3.808	5.350	29.434
	Diagnostic tests	10.525	14.710	6.534	16.579	18.442	9.649	4.705	2.886	22.444	1.250	107.724
	Inpatient procedures	12.041	52.989	0	3.597	79.607	494	0	71.347	31.700	16.812	268.587
	Monitoring tests	15.377	17.181	6.238	40.649	30.684	12.680	8.174	3.681	30.237	4.371	169.273
	Outpatient visits	15.415	12.908	15.263	16.850	20.868	15.144	8.852	9.463	11.861	17.703	144.326
	Treatment	12.757	10.260	12.678	18.365	8.172	2.555	2.605	2.766	0	5.582	75.738
	Total	91.724	128.446	50.171	383.706	271.283	99.440	39.988	107.046	146.428	179.223	1.497.454
Type C Hospital	Adverse events	5.134	1.590	4.018	87.230	56.144	2.375	5.849	4.053	13.074	42.291	221.759
	Complications	7.664	15.408	3.662	149.551	38.448	46.723	4.342	7.673	25.574	64.504	363.550
	Consumables/ devices	10.251	0	242	3.528	0	0	3.422	2.833	3.808	5.350	29.434
	Diagnostic tests	8.771	12.258	5.445	13.816	15.368	8.041	3.921	2.405	18.703	1.042	89.770
	Inpatient procedures	10.526	44.157	0	3.597	72.144	412	0	59.456	26.416	15.483	232.192
	Monitoring tests	12.814	14.318	5.198	33.874	25.570	10.567	6.812	3.067	25.198	3.643	141.061
	Outpatient visits	12.846	10.756	12.719	14.042	17.390	12.620	7.377	7.886	9.884	14.753	120.272
	Treatment	12.757	10.260	12.678	18.365	8.172	2.555	2.605	2.766	0	5.582	75.738
	Total	80.763	108.748	43.963	324.003	233.235	83.293	34.327	90.138	122.658	152.647	1.273.776

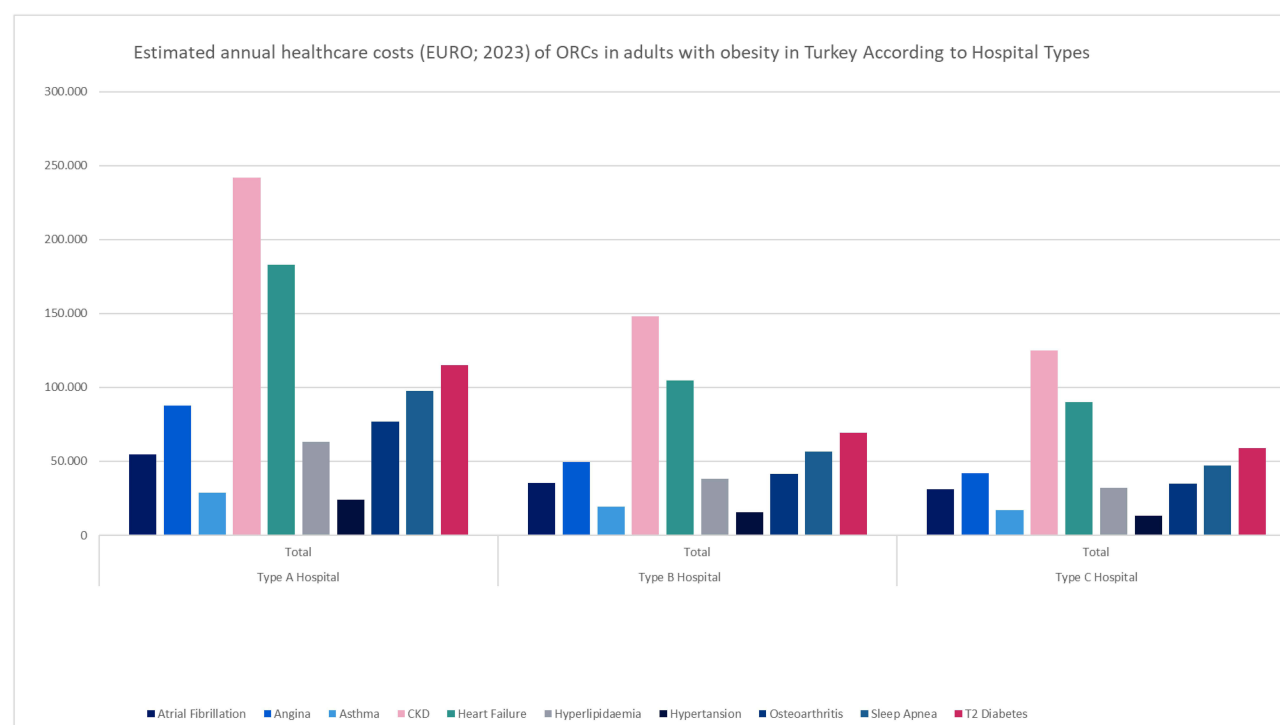


Figure 2 Estimated annual healthcare costs (TRY; 2023) of ORCs in adults with obesity in Turkey According to Hospital Types.

38.54% of the total cost reduction observed with 20% weight loss, 37.6% with 10% weight loss, and 37.15% with 5% weight loss in the 60–69 age group in Segment A hospitals. When the same analysis was performed on the 50–59 age group, T2DM constituted 40.57% of the total cost reduction with 20% weight loss, 41.66% with 10% weight loss, and 41.97% with 5% weight loss. When this calculation was made between the 40–49 age group, 42.66% of the total cost reduction was observed with 20% weight loss, 44.42% with 10% weight loss, and 45.87% with 5% weight loss in T2DM. It has been observed that as patients get younger, T2DM accounts for a larger portion of the costs of all obesity-related complications. In the 30–39 age group, T2DM accounted for 43.57% of the total cost reduction observed with 20% weight loss, 45.25% of the total cost reduction observed with 10% weight loss, and 45.96% of the total cost reduction observed with 5% weight loss. In the youngest patient group (20–29 age group), these rates were 45.57% with 20% weight loss, 46.86% with 10% weight loss, and 47.36% with 5% weight loss. Although the hospital segment has changed, the outcomes were comparable. Regarding the outcomes of our pharmacoeconomic model, when the obesity-related complications were stratified according to weight loss rate, 5%, 10%, and 20%, a higher cost reduction was observed in the 40–49, 50–59, and 60–69 age groups. The effects of weight loss on reducing the cost of obesity-related complications indicated that the highest cost reduction was on T2DM. When all cost reduction items were collected, T2DM accounted for 38.54% of the total cost reduction observed with 20% weight loss, 37.6% with 10% weight loss, and 37.15% with 5% weight loss in the 60–69 age group in Segment A hospitals. When the same analysis was performed on the 50–59 age group, T2DM constituted 40.57% of the total cost reduction with 20% weight loss, 41.66% with 10% weight loss, and 41.97% with 5% weight loss. When this calculation was made between the 40–49 age group, 42.66% of the total cost reduction was observed with 20% weight loss, 44.42% with 10% weight loss, and 45.87% with 5% weight loss in T2DM. It has been observed that as patients get younger, T2DM accounts for a larger portion of the costs of all obesity-related complications. In the 30–39 age group, T2DM accounted for 43.57% of the total cost reduction observed with 20% weight loss, 45.25% of the total cost reduction observed with 10% weight loss, and 45.96% of the total cost reduction observed with 5% weight loss. In the youngest patient group (20–29 age group), these rates were 45.57% with 20% weight loss, 46.86% with 10% weight loss, and 47.36% with 5% weight loss.

Table 3 Distribution of Obesity-Related Complication Costs According to Age Stratification in Segment A – B & C Hospitals (The Demographics Data Has Been Calculated According to the Age Distribution of Individuals With Obesity in Turkish Statistical Institute Health Survey Data)

Segment A Hospital											
Age Group	Weight Loss Rate	Asthma	Atrial fibrillation	CKD	Dyslipidaemia	Heart Failure	Hypertension	Osteoarthritis	Sleep Apnea	T2D	Unstable Angina / MI
20–29	5%	164.277	10.183	140.506	546.920	25.634	451.642	42.439	562.304	1.749.156	390
	10%	324.621	15.578	253.378	1.134.076	29.703	901.920	90.177	1.001.067	3.307.377	520
	20%	626.885	17.404	384.373	2.393.047	7.866	1.777.705	188.671	1.585.504	5.844.865	325
30–39	5%	410.647	61.630	731.966	3.191.494	147.678	2.069.594	469.978	2.085.781	7.804.959	7.328
	10%	810.064	97.994	1.303.081	6.644.039	177.511	4.142.865	979.036	3.716.120	14.778.285	9.115
	20%	1.568.706	111.547	1.974.358	14.057.776	77.195	8.192.772	2.045.942	5.919.739	26.216.653	6.971
40–49	5%	5.290	239.096	1.875.536	6.830.893	542.344	3.806.808	1.760.782	3.093.387	15.411.051	33.631
	10%	1.045.846	390.618	3.343.586	14.245.029	696.336	7.640.904	3.683.806	5.510.600	29.256.481	44.234
	20%	2.025.565	461.752	5.101.130	30.271.690	389.215	15.189.516	7.797.427	8.846.952	52.163.428	42.743
50–59	5%	522.562	679.789	4.724.468	8.033.669	1.281.033	3.772.636	3.103.954	2.848.124	18.104.279	68.032
	10%	1.032.331	1.112.312	8.331.766	16.779.452	1.706.666	7.585.500	6.491.612	5.087.398	34.429.391	96.434
	20%	2.009.432	1.329.310	12.808.003	35.850.511	1.050.301	15.133.508	13.802.748	8.204.617	61.645.058	97.660
60–69	5%	356.551	1.237.505	7.756.540	4.753.941	2.316.901	2.293.974	2.713.886	1.434.782	13.552.900	65.703
	10%	701.885	2.041.382	13.780.666	9.953.714	3.076.329	4.619.015	5.677.020	2.567.210	25.791.055	91.868
	20%	1.360.347	2.429.471	21.130.318	21.347.556	1.888.257	9.248.412	12.062.044	4.114.351	46.203.595	88.380
Segment B Hospital											
Age Group	Weight Loss Rate	Asthma	Atrial fibrillation	CKD	Dyslipidaemia	Heart failure	Hypertension	Osteoarthritis	Sleep apnea	T2D	Unstable angina / MI
20–29	5%	109.885	6.598	86.108	331.224	16.367	258.917	22.856	326.249	1.052.172	221
	10%	217.140	10.095	155.279	686.817	17.028	575.876	48.566	580.819	1.989.490	295
	20%	419.325	11.278	235.558	1.449.271	4.510	1.135.065	101.611	919.910	3.515.869	184
30–39	5%	274.683	39.936	448.576	1.932.825	84.661	1.321.436	253.113	1.210.170	4.694.926	4.151

(Continued)

Table 3 (Continued).

	10%	541.854	63.499	798.577	4.023.748	101.764	2.645.221	527.273	2.156.093	8.889.599	5.164
	20%	1.049.310	72.282	1.209.961	8.513.638	44.254	5.231.088	1.101.870	3.434.633	15.770.134	3.949
40–49	5%	3.538	154.933	1.149.400	4.136.909	310.915	2.430.648	948.293	1.794.783	9.270.228	19.052
	10%	699.568	253.118	2.049.076	8.627.041	399.195	4.878.720	1.983.965	3.197.250	17.598.685	25.059
	20%	1.354.904	299.213	3.126.165	18.333.070	223.129	9.698.511	4.199.412	5.133.002	31.377.928	24.214
50–59	5%	349.543	440.499	2.895.333	4.865.332	734.390	2.408.829	1.671.677	1.652.482	10.890.288	38.541
	10%	690.528	720.772	5.106.021	10.161.933	978.397	4.843.344	3.496.148	2.951.709	20.710.352	54.630
	20%	1.344.113	861.385	7.849.229	21.711.703	602.116	9.662.750	7.433.661	4.760.320	37.081.423	55.325
60–69	5%	238.498	801.897	4.753.501	2.879.071	1.328.232	1.464.703	1.461.601	832.461	8.152.492	37.222
	10%	469.492	1.322.804	8.445.313	6.028.145	1.763.597	2.949.242	3.057.438	1.489.496	15.514.124	52.044
	20%	909.939	1.574.284	12.949.458	12.928.457	1.082.499	5.905.114	6.496.181	2.387.147	27.792.903	50.068
Segment C Hospital											
Age Group	Weight Loss Rate	Asthma	Atrial fibrillation	CKD	Dyslipidaemia	Heart failure	Hypertension	Osteoarthritis	Sleep apnea	T2D	Unstable angina / MI
20–29	5%	96.289	5.810	72.710	277.440	14.050	222.607	19.246	273.288	896.156	187
	10%	190.271	8.889	131.119	575.292	14.640	494.351	40.895	486.533	1.694.489	250
	20%	367.439	9.930	198.907	1.213.940	3.877	974.377	85.561	770.579	2.994.536	156
30–39	5%	240.695	35.164	378.780	1.618.974	72.788	1.134.364	213.133	1.013.721	3.998.764	3.516
	10%	474.807	55.912	674.323	3.370.374	87.492	2.270.743	443.989	1.806.090	7.571.451	4.374
	20%	919.472	63.645	1.021.697	7.131.200	38.048	4.490.535	927.827	2.877.081	13.431.741	3.345
40–49	5%	3.100	136.421	970.559	3.465.161	267.312	2.086.548	798.508	1.503.432	7.895.640	16.137
	10%	613.006	222.875	1.730.250	7.226.189	343.212	4.188.051	1.670.591	2.678.234	14.989.156	21.224
	20%	1.187.253	263.462	2.639.749	15.356.160	191.838	8.325.516	3.536.102	4.299.751	26.725.215	20.509
50–59	5%	306.292	387.867	2.444.833	4.075.303	631.399	2.067.817	1.407.631	1.384.231	9.275.478	32.642
	10%	605.085	634.652	4.311.549	8.511.846	841.187	4.157.684	2.943.920	2.472.552	17.639.425	46.270
	20%	1.177.797	758.464	6.627.926	18.186.173	517.676	8.294.818	6.259.491	3.987.567	31.582.997	46.858
60–69	5%	208.987	706.083	4.013.879	2.411.569	1.141.961	1.257.349	1.230.736	697.326	6.943.642	31.525
	10%	411.399	1.164.751	7.131.263	5.049.299	1.516.271	2.531.725	2.574.506	1.247.703	13.213.692	44.079
	20%	797.346	1.386.182	10.934.585	10.829.144	930.690	5.069.141	5.470.089	1.999.636	23.671.776	42.406

Discussion

Apart from its known endocrine and metabolic effects, obesity continues to be investigated as a significant public health problem and emerges with a new complication every day. Many of the clinical and economic impacts of obesity are attributed to comorbidities related to increased mortality.⁹ Obesity increases the risk for over 230 medical conditions, including high blood pressure, heart disease, certain cancers, arthritis, lipid disorders, sleep apnea, and type 2 diabetes. A report by the World Health Organization indicated the effects of obesity on multiple organ systems.¹⁰ Furthermore, observational studies have reported that various conditions, including type 2 diabetes, sleep apnea, osteoarthritis, and cardiovascular disease, are strongly associated with higher BMI. People with obesity tend to have higher direct and indirect healthcare costs. Indirect costs include workers' compensation, disability costs, and costs of presenteeism and medical-related absenteeism. Better management of obesity can yield significant health and cost savings for the healthcare system.^{11–13}

According to the results of the “National Burden of Disease Study” conducted by Hacettepe University Population Studies Institute to determine the burden caused by diseases caused by obesity in Turkey, 57,143 people die every year due to diseases and comorbidities caused by obesity. Most of these deaths occur due to ischemic heart disease. On the other hand, the disease with the highest disability burden was determined to be Diabetes.¹⁴ Regarding the outcomes of the Weight Loss Tool, we have found that chronic kidney disease, heart failure, and T2DM were the top 3 costliest complications; hypertension, asthma, and atrial fibrillation were the least expensive ORCs. These results were also similar to the study of Yavuz et al (2023),⁷ where they investigated the ORCs in the public health system. Considering the three aforementioned studies, one can say that the cost items did not change within the last decade.^{7,14}

In a study conducted to determine the costs of obesity-related surgery in Turkey, obesity costs were divided into pre-surgical, surgical, and post-surgical phases. In the case of surgical treatment of obesity, the most cost is incurred during the surgery phase, while the least cost is seen after the surgery. The cost varies depending on the method used in the surgical treatment of obesity. While the cost for surgeries performed via laparoscopic banding was 3.974 dollars, it was 8.351 dollars for the laparoscopic gastrectomy method and 8.195 dollars for surgeries performed using the laparoscopic gastric bypass method.¹⁵ The Weight Loss Tool was designed to measure ORCs, and therefore, surgery was not included as a separate item; however, the tool indicated that inpatient procedures constituted 21.46% of total costs in Segment A hospitals, 17.94% in Segment B hospitals, and 18.23% in Segment C hospitals. At this stage, it should be emphasized that ORCs constituted 28.87% of total costs in Segment A hospitals, 29.13% in Segment B hospitals, and 28.54% in Segment C hospitals as the leading cost item.

A study from Turkey revealed a concerning trend: as weight increased, so did the costs. The proportion of direct costs arising from obesity in the patient group who underwent surgery with the diagnosis of inguinal hernia, femoral hernia, umbilical hernia, and epigastric hernia was investigated. When total expenses were evaluated, it was determined that there was a 28.81% cost increase for the overweight patient group, 82.97% for the obese, and 210.08% for morbid obese compared to the normal-weight patient group. This significant cost increase for all expenditure types should raise a red flag about the economic impact of obesity. The increase in drug expenditures was 10.75% in the overweight category, 53.09% in obese patients, and 55.28% in morbid obese individuals. The increase in consumable item expenditures was 45.17% in the overweight category, 108.47% in obese patients, and 576.11% in morbid obese individuals. The increase in laboratory expenses was determined to be 77.42% in the overweight category, 1510.14% in obese patients, and 804.61% in morbid obese individuals. The increase in imaging expenditures was 743.75% in the obese category.¹⁶

In another study conducted to determine the cost of obesity in Turkey, the cost of obesity and obesity-related diseases was approximately 4.5 billion dollars in 2004, which increased to 13.5 billion dollars in 2012. Accordingly, there has been an approximately 3-fold increase in the cost of diseases resulting from obesity over the eight years. While the largest share of this cost is in ischemic heart disease, the smallest share is seen in uterine cancer in both periods. According to the “Health Technologies Assessment Report” the economic cost of obesity-related health problems in Turkey was 5 billion dollars in 2004, and it increased to 14 billion dollars in 2012.¹⁷

Weight loss is not just about reducing costs; it's about gaining health. The greater the weight loss, the greater the health benefits: a 3% decrease can lower blood sugar, a 5% decrease can reduce blood pressure, a 10% decrease can

lower the risk of sleep apnea, and a 15% decrease can lead to a significant reduction in cardiovascular events. A median 13% weight loss was associated with significant additional benefits for specific outcomes, notably T2D, CKD, hypertension, and dyslipidemia, compared with maintaining the corresponding stable lower BMI. Metabolic benefits may have conferred weight loss, contributing to additional benefits.^{18–20}

Nagi et al (2024)²¹ conducted a systematic review of 19 studies conducted using a prevalence-based approach using the Population Attributable Fraction (PAF) methodology. About half of the studies (53%) were conducted in high-income countries, while the others (47%) were conducted in middle-income countries. The economic burden of obesity ranged from a Purchasing power parity (PPP) of 15 million in Brazil to a PPP of 126 billion in the USA in 2022. Direct medical costs comprised 0.7% to 17.8% of the health system expenditure. Furthermore, the total costs of obesity ranged from 0.05% to 2.42% of the country's gross domestic product (GDP). Of the seven studies that estimated direct and indirect costs, indirect costs accounted for the most considerable portion of five studies.

The World Obesity Federation's prediction of a 4.3 trillion \$ cost by 2035 due to the escalating overweight and obesity crisis underscores the need for comprehensive strategies. These strategies should focus on direct healthcare costs and the indirect toll of lost employment, early retirement, and premature death. The individual, social, and economic cases for investing in obesity prevention and management today to reduce these future costs are evident.²² The OECD's estimates for the costs are, in turn, derived from the estimated association between high BMI and a range of 38 disease conditions calculated by the Global Burden of Disease Collaboration (GBD, 2017). These 38 conditions cover many of the significant comorbidities of obesity, including hypertension and cardiovascular disease, diabetes, liver and kidney disease, and several other NCDs. However, the list is by no means exhaustive in terms of additional comorbidities associated with high BMI, which are likely to have healthcare costs attached, such as mental health and neurological conditions, endocrine disorders, and respiratory conditions, amongst others, demonstrating the importance of a multi-faceted approach to addressing obesity.²³

As an example, Turkey currently grapples with the highest obesity prevalence among its European counterparts.^{3,24} Studies have estimated that obesity and its related comorbidities account for a substantial portion, approximately half, of the country's total government spending on healthcare.^{24–26} This case highlights the significant economic burden that obesity places on healthcare systems, making it a compelling case for investment in prevention and management.

Conclusion

According to the current pharmacoeconomic model, comorbidities were identified as the primary factors contributing to the costs associated with obesity. This study concluded that chronic kidney disease, heart failure, and T2DM were the highest costly three complications, while hypertension, asthma, and atrial fibrillation were the lowest. Weight loss decreased healthcare expenditures significantly in obese patients, and T2DM was the leading cause in all age groups.

Disclosure

The author(s) report no conflicts of interest in this work.

This paper's abstract was presented as a poster at the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) Conference 2024 with interim findings. The poster abstract was published in 'Poster Abstracts' in *Value in Health*, Volume 27, Issue 12, S98.

References

1. Zhang X, Ha S, Lau HC, Yu J. Excess body weight: novel insights into its roles in obesity comorbidities. *Semin Cancer Biol.* 2023;92:16–27. doi:10.1016/j.semcancer.2023.03.008
2. World Health Organisation. WHO European Regional Obesity Report. 2022.
3. Nutter S, Eggerichs LA, Nagpal TS, et al. Changing the global obesity narrative to recognize and reduce weight stigma: a position statement from the world obesity federation. *Obes Rev.* 2024;25(1):e13642. doi:10.1111/obr.13642
4. Leung AKC, Wong AHC, Hon KL. Childhood obesity: an updated review. *Curr Pediatr Rev.* 2024;20(1):2–26. doi:10.2174/1573396318666220801093225
5. Mahmoud M, Syn WK. Impact of obesity and metabolic syndrome on IBD outcomes. *Dig Dis Sci.* 2024;69(8):2741–2753. doi:10.1007/s10620-024-08504-8

6. Haase CL, Lopes S, Olsen AH, Satylganova A, Schnecke V, McEwan P. Weight loss and risk reduction of obesity-related outcomes in 0.5 million people: evidence from a UK primary care database. *Int J Obes*. 2021;45(6):1249–1258. doi:10.1038/s41366-021-00788-4
7. Yavuz Gogas D, Akhtar O, Low K, et al. The economic impact of obesity in turkey: a micro-costing analysis. *Clinicoecon Outcomes Res*. 2024;16:123–132. doi:10.2147/CEOR.S446560
8. Alqahtani SA, Al-Omar HA, Alshehri A, et al. Obesity burden and impact of weight loss in Saudi Arabia: a modelling study. *Adv Ther*. 2023;40(3):1114–1128. doi:10.1007/s12325-022-02415-8
9. Kalra S, Verma M, Kapoor N. Obesity is a communicable disease. *J Pak Med Assoc*. 2024;74(4):820–821. doi:10.47391/JPMA.24-29
10. World Health Organisation. WHO Obesity and overweight factsheet. 2024 Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>. Accessed July 9, 2029.
11. Butalia S, Luu H, Guigue A, Martins KJB, Williamson T, Klarenbach SW. Health care cost of severe obesity and obesity-related comorbidities: a retrospective cohort study from Alberta, Canada. *Obes Res Clin Pract*. 2023;17(5):421–427. doi:10.1016/j.orcp.2023.09.006
12. Xue Y, Zou H, Ruan Z, et al. Pharmacoeconomic evaluation of anti-obesity drugs for chronic weight management: a systematic review of literature. *Front Endocrinol*. 2023;14:1254398. doi:10.3389/fendo.2023.1254398
13. Onyimadu O, Violato M, Astbury NM, et al. A systematic review of economic evaluations of interventions targeting childhood overweight and obesity. *Obes Rev*. 2023;24(9):e13597. doi:10.1111/obr.13597
14. Sandalcı U, Tuncer G. An evaluation of direct and indirect costs of obesity. 2020:29–44. Available from: <http://aksarayibid.aksaray.edu.tr/tr/download/article-file/1152210>. Accessed March 19, 2025.
15. Koçkaya G, Ergin G, Atikeler K, et al. Operational cost of obesity surgery for Turkey. 2013:1142–1143.
16. Kockaya G, Yenilmez FB, Ergin G, Atikeler K, Tatar M. Cost effectiveness and economic value of obesity surgery for Turkey (CEVOS-T. *Obesity Med*. 2016;1:33–37.
17. Yiğit A, Yiğit V. Economic burden of obesity-related comorbidities in Turkey. *Gumushane Univ J Health Sci*. 2019;8(3):223–230.
18. Ryan DH, Yockey SR. Weight Loss and Improvement in comorbidity: differences at 5%, 10%, 15%, and over. *Curr Obes Rep*. 2017;6(2):187–194. PMID: 28455679; PMCID: PMC5497590. doi:10.1007/s13679-017-0262-y
19. Hall KD, Kahan S. Maintenance of lost weight and long-term management of obesity. *Med Clin North Am*. 2018;102(1):183–197. PMID: 29156185; PMCID: PMC5764193. doi:10.1016/j.mcna.2017.08.012
20. Elmaleh-Sachs A, Schwartz JL, Bramante CT, Nicklas JM, Gudzone KA, Jay M. Obesity management in adults: a review. *JAMA*. 2023;330(20):2000–2015. doi:10.1001/jama.2023.19897
21. Nagi MA, Ahmed H, Rezaq MAA, et al. Economic costs of obesity: a systematic review. *Int J Obes Lond*. 2024;48(1):33–43. doi:10.1038/s41366-023-01398-y
22. World Obesity Federation, World Obesity Atlas. 2023, Available from: <https://www.worldobesity.org/news/economic-impact-of-overweight-and-obesity-to-surpass-4-trillion-by-2035>. Accessed July 9, 2024.
23. Dai H, Alsah TA, Chalhaf N, Riccò M, Bragazzi NL, Wu J. The global burden of disease attributable to high body mass index in 195 countries and territories, 1990–2017: an analysis of the global burden of disease study. *PLoS Med*. 2020;17(7):e1003198. PMID: 32722671; PMCID: PMC7386577. doi:10.1371/journal.pmed.1003198
24. Turkish Statistical Institute. Health expenditure Statistics, 2020 [Internet]. Turkish Statistical Institute. 2023 Available from: <https://data.tuik.gov.tr/Bulten/Index?p=37192&dil=2>. Accessed July 9, 2024.
25. World Health Organisation. WHO European Regional Obesity Report. 2022. Available from: <https://apps.who.int/iris/handle/10665/353747>. Accessed July 9, 2024.
26. Yigit A, Yigit V. Economic burden of obesity-related comorbidities in Turkey. *Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi*. 2019;8(3):223–230.

ClinicoEconomics and Outcomes Research

Publish your work in this journal

ClinicoEconomics and Outcomes Research is an international, peer-reviewed open-access journal focusing on Health Technology Assessment, Pharmacoeconomics and Outcomes Research in the areas of diagnosis, medical devices, and clinical, surgical and pharmacological intervention. The economic impact of health policy and health systems organization also constitute important areas of coverage. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/clinicoeconomics-and-outcomes-research-journal>

Dovepress
Taylor & Francis Group