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Article

Economic Burden of Obesity in Hungary: Estimation about Obesity Related Public Health Care Expenditures and Out of Pocket Payments in 2019 and 2022

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Abstract: *Background.* Obesity is an important threat to national and global public health in terms of prevalence and economic burden due to the obesity-related complications (ORCs) and morbidities. *Aim* of this study is to calculate the obesity related public expenditures in Hungary, to estimate the expenses and contribution of patients in 2019 (before) and in 2022 (after) the covid-pandemic. *Method.* The National Health Insurance Fund is the only health-care financing agency in a single-payer social-insurance system in Hungary, managing all of the public payments. Expenditures related to the patients with obesity and more frequent co-morbidities were requested from the national database. Financing of the inpatient (hospital) and the outpatient (secondary or ambulatory care) providers, reimbursement for prescription of medicines and healing aids were collected. Lower and upper thresholds were estimated, representing the prevalence of the respective morbidities among obese persons. The upper values were used in the final estimation, because many of other obesity related morbidities and treatments were not included in the calculation. *Results.* Obesity-related morbidities represent 10-12 % of all cases in the public health care system. National public health care expenses could be about 144 Billion HUF (444 Million EUR) for 2019 and 133 Billion HUF (393 Million EUR). These sums represent 7-11% of the national spending for health care provision, without sick leave expenditures. The co-payment of patients was estimated 34 Billion HUF (104 Million EUR) and 43 Billion HUF (109 Million EUR), respectively. Public expenditures and co-payments related to diabetes Type2, and hypertension were the highest. The public and individual expenditures together represents 0.3-0.4% of the Hungarian GDP. This study presents whole national database which is appropriate for reliable calculation. Reducing of high expenses could be possible by weight maintenance, preferable as early prevention, and weight reduction among persons living with obesity at individual level. Beside these, more efforts are needed in the education and public health policy. To calculate the cost of obesity, to improve homogeneity and comparability an international consensus is required on standardized methods.

Keywords: co-payment; health care expenditures; Hungary; obesity

Obesity represents an important threat to national and global public health in terms of prevalence, incidence and economic burden [1]. Over the past four decades, the worldwide prevalence of obesity has almost tripled [2]. It was estimated in 2014, more than 2.1 billion people, nearly 30% of the global population, were overweight or obese and 5% of the deaths worldwide were attributable to obesity. If this trend continues, almost half of the world's adult population will be overweight or obese by 2030 [3].

The United States of America has one of the highest rates of obesity in the world, with over 40% of adults were estimated to have obesity in 2017–2018 [4]. The prevalence of obesity in Europe is almost so high and increasing over time. In 2019, 52.7% of the adult EU members was overweight

defined as a body mass index (BMI) of ≥ 25 kg/m², of which 16.3% could be classified as obese (BMI ≥ 30 kg/m²)[5].

Compared with people without obesity, people living with obesity have an increased risk of morbidity and excess mortality as well, because of the co-morbidities associated with obesity. Obesity is linked to more than 250 genetic variants and a wide array of clinical conditions, including diseases of the circulatory, endocrine, digestive, neurological, dermatological, musculoskeletal, respiratory, and genitourinary systems, infectious, and malignant diseases, more frequent injuries [1].

Many of previous studies found that obesity induces higher healthcare costs due to treatment of obesity-related diseases and complications. Different methods are used to calculate the real economic burden. Cost-of-illness (COI) is the method most commonly used to estimate the economic costs which are divided into three components: direct, indirect, and intangible costs. The *direct* medical costs are associated with treating obesity itself and the medical costs for treating those diseases for which excess body weight are a risk factor. Hospital care, physician outpatient visits, nursing home, hospice, rehabilitation, specialist and other health professional care, diagnostic tests, prescription drugs, and other medical supplies belong to this group. *Indirect* costs include the value of the time lost from employment or other productive activities, costs of personal contribution of the family members and friends. *Intangible* costs are those associated with the pain and suffering from obesity itself, and from those diseases for which obesity is a contributing factor. Because of the difficulty of assigning a monetary value to physical or emotional suffering, this component has not been usually included in the total costs of obesity. The COI method has been used to derive two sets of estimates related to the economic costs of obesity: the *prevalence based* and *incidence based* costs estimates [6–11].

The *total* medical cost of each obesity-related diseases used in studies are based on the attributable risk approach is obtained from few published studies rather than being estimated directly by the authors of those studies [12].

Based on the prevalence data in Canada in 2004, overall 45% of hypertension, 39% of type II diabetes, 35% of gallbladder disease, 23% of coronary artery diseases (CAD), 19% of osteoarthritis, 11% of stroke, 22% of endometrial cancer, 12% of postmenopausal breast cancer, and 10% of colon cancer could be attributed to obesity [7]. Obesity is reported to be one of the strongest lifestyle-related factors for developing type II diabetes with relative risk (RR) 17 by women and 23 by men, is associated with hypertension with RR ranging from 2.2 to 5.7, can lead to coronary disease (RR=1.4) and is also associated with an increased risk of both ischemic and haemorrhagic stroke. People with obesity have a predisposition to cholelithiasis (RR=1.9) and to osteoarthritis in weight-bearing joints such as knee (RR= 6) and hip (RR=4) [10,12].

As obesity is a growing problem in most countries, Hungary being no exception. In 2015 the overall prevalence rate of overweight and obesity among adult men was 40% and 32%, respectively, while both overweight and obesity occurred in 32% of women. In 1988 obesity was registered by only 12% of men and by 18% of women [13]. National public health care expenditures in 2013 were evaluated in our previous study, focusing to the expenditures of diabetes and hypertension only [14].

The Hungarian National Health Insurance Fund (NHIF-Hungarian acronym: NEAK) is the only health-care financing agency in a single-payer social-insurance system, managed by the government. All the public inpatient (hospitals) and outpatient (secondary/specialist) health care providers have to report their activities on monthly basis to the NHIF.

Hospital services (inpatient care) are financed through the implementation of a system similar to the American *Diagnosis Related Groups* (DRG). The diagnoses as a reason for hospitalisation are recorded and reported. The main diagnosis serves as a basement for financing, modified with registered co-morbidities, duration of the treatment and other factors. In the outpatient care, a German *fee-for-service* point system is used for financing.

Prescribed drugs are partially reimbursed by NHIF. Its ratio depends from the type of morbidities (almost 100% for cancer patients, less for insulin's) and 25-75% for other medications, except over-the counter (OTC) products. Medications dedicated for only obesity treatment did not get any reimbursement, even surgical (metabolic, bariatric) procedures.

In the Hungarian health care system the *International Classification of Diseases* (ICD-10) codes are still used [15].

All public health care provision and reimbursement for medication are related to the social security number.

The **aim** of this study is to calculate the obesity related public expenditures in Hungary, to estimate the expenses and contribution of patients and to make a comprehensive evaluation about the financial data of the last year before the pandemic (2019) and the last available year 2022, after the post-pandemic recovery of the health care system.

Method

Expenditures. Based on the Hungarian version of ICD-10 codes and diagnoses, public payments and expenditures related to the patients whose leading morbidity was coded accordingly were searched in the NHIF-database: *obesity* (E 66-68) and morbidities with the closest pathological relation to obesity, like *diabetes* (E 10,11), *hypothyreosis* (E 78), *hypertension* (E 10-15), *cardiac failure* and *ischemic heart disease* (I 21-25), *stroke* (I 63-64), *osteoarthritis* of major joints: *gonarthrosis* and *coxarthrosis* (M 16,17), *gallbladder diseases* (K 80). Some malignant diseases were also selected; cancers of the *colon* (C 18), *sigmae* (C19), *rectum* (C 20), *breast* (C 50), *cervix* (C 53), *corpus uteri* (C 54), *ovarium* (C 56) and *prostate* (C 61). Financing for *dialysis* is also included in calculation. NHIF-reimbursement for prescription of medicines and healing aids (syringes, blood-sugar strips and devices, crutches, corselets, laces etc.) for the above listed therapeutic indications were collected and presented as well.

Data of those medications are also presented when the patient’s financial contribution is covered by the state (*free health services*), mainly due to the socio-economic status of patients, having no regular income or low pension or are handicapped.

Macroeconomic data. The relevant official governmental websites were the sources of data regarding the Hungarian State Budget and Gross Domestic Product [16–18], actual exchange rate between Hungarian currency (HUF) and Euro [19] and the national health care expenditures [20].

All of the data represent the whole fiscal years of 2019 and 2022.

Calculation. Among direct medical costs, 100% of the expenses were considered when *obesity* was coded as leading diagnoses. In many of relevant papers (medical textbooks, treatment guidelines and other scientific reports) numeric relations were mentioned between obesity and its co-morbidities [7,8,10,12]. The lowest and the highest obesity-prevalence among the accounted morbidities were used in our calculations and were indicated in the tables.

Statistics. Descriptive statistics were presented. All data we worked with were available in single aggregated form; therefore no statistics could be executed to test the differences between years and morbidities.

Ethics. According to the Hungarian legislations, only studies involving intervention or biological material require ethical approval. The current study collected mass of anonymous registered data of public websites only; therefore no ethical approval was necessary.

Results

The health care services provided by the Hungarian public financed inpatient and outpatient institutions are presented in the Table 1. Obesity-related morbidities used our calculation represent 10-12 % of all cases.

Table 1. The total number of patients and their cases treated in the Hungarian hospitals and outpatient’s clinics in 2019 and 2022, the number of involved patients in our calculation and the number of the Hungarian population [17].

Year	2019		2022	
Number	cases	patients	cases	patients
Inpatients	2 430 621	1 505 659	2 016 726	1 246 676

Outpatients	62 450 204	6 728 025	53 420 573	6 261 632
Calculated*				
Inpatients	278 212	140 519	248 821	118 226
Outpatients	6 567 327	1 531 180	5 569 668	1 371 628
Population	9 772 756		9 689 010	

* without dialyses and gallbladder diseases.

The number of in - and outpatients and their cases in 2019 and 2022 according to their main diagnoses are presented in the Table 2. Less patients were served in the year before the pandemic.

Table 2. The number of patients and their cases served in hospitals and outpatient’s clinics in 2019 and 2022 are presented according to the main diagnoses and ICD codes of provision.

		Outpatient				Hospital			
		2019		2022		2019		2022	
Morbidities	ICD code	cas e	patien t	cas e	patien t	cas e	patien t	cas e	patien t
Obesity	E66,67	48 291	22 834	52 750	23 863	179	178	165	163
Diabetes	E10,11	1 368 220	442 819	1 197 250	417 499	18 701	16 474	11 926	10 813
Cardio-vascular	I10-25	2 167 165	943 497	1 719 223	800 234	39 498	34 218	35 838	31 762
Stroke	I63,64	178 178	83 621	142 314	69 029	41 751	35 723	29 031	26 459
Osteo-arthritis	M16,17	1 515 553	313 493	1 217 015	263 246	24 131	22 412	19 446	18 097
Cancers	C18,19,20,50,53,54,56,61	1 289 921	170 435	1 241 116	160 685	153 722	38 299	152 415	36 561
Total		6 567 327	1 531 180	5 569 668	1 371 628	278 212	140 519	248 821	118 226

The total public health care expenditures are presented for 2019 in the Table 3, and for 2022 in the Table 4. The upper and lower percentages of expected prevalence rate of named morbidities among people living with obesity are used for calculation in both years.

Table 3. Total expenditures of NHIF in 2019 for in- and outpatient services, for drug reimbursement and healing aids, including free health services in Million HUF and EUR (actual exchange rate [19]). Spending related to obesity linked co-morbidities were estimated, using the lower and upper level of calculation.

2019. Million HUF ICD	Outpatient	Hospital	Medication	Healing aid	Free services	Total: M [HUF] Σ	%	lower	%	upper
E 66-68	130	11	12	1	1	155	100	155	100	155
E 10	696	1 105	13 528	4 769	111	20 365	20	4 073	30	6 110
E 11	2 312	1 126	35 499	2 250	785	42 044	40	16 818	80	33 636
E 78			11 149	8	317	11 474	30	3 442	60	6 884
I 10-15	5 910	678	31 678	39	1 515	39 820	40	15 928	60	23 892
I 21-25	1533	22 096	3 720	8	217	27 574	40	11 030	60	16 544
I 63,64	588	7 560	540	282	114	9 084	40	3 634	60	5 450
K 80	370	6 689	76	2	12	7 149	20	1 430	60	4 289
C	4 055	36 497	24 579	2 012	47	67 190	10	6 719	30	20 157
M 16,17	3 157	15 517	679	*1 446	*443	21 242	40	8 497	80	16 994
Dialyses		25 471					20	5 094	40	10 188
Total: Million HUF								76 820		144 299
Million EUR								236.11		443.52

Table 4. Total expenditures of NHIF in 2022 for in - and outpatient services, for drug reimbursement and healing aids, including free health services in Million HUF and EUR (actual exchange rate [19]). Spending related to obesity linked co-morbidities were estimated, using the lower and upper level of calculation.

2022 Million HUF ICD	Outpatient	Hospital	medications	Healing aid	Free services	Total: Million [HUF] Σ	%	lower	%	upper
E 66-68	140	15	12		65	232	100	232	100	232
E 10	595	815	12 201	6 811	97	20 519	20	4 104	30	6 156
E 11	2 248	689	47 769	2 150	1 110	53 966	40	21 586	80	43 173
E 78			13 324	2	297	13 623	30	4 087	60	8 174
I 10-15	5 275	732	31 838	15	1 355	39 215	40	15 686	60	23 529
I 21-25	1 123	19 348	3 517	3	183	24 174	40	9 670	60	14 504
I 63,64	535	5 341	504	263	111	8 001	40	3 200	60	4 801

K 80	334	5 529	105	2		5 980	20	1 196	60	3 588
C	5 599	37 001	33 595	2 054	51	78 300	10	7 830	30	23 490
M 16,17	2 871	13 688	616	*1 574	226	18 975	40	7 590	80	15 180
Dialyses							20	5 444	40	10 888
Total: Million HUF								80 625		153 715
Million EUR								206.03		392.83

Although the public payments were higher in 2022 than in 2019, due to the deteriorated exchange rates the amounts were lower in EUR. Majorities of payments were related to diabetes Type2, hypertension and malignancies in both years. Cardiovascular and rheumatoid morbidities represented also a significant ratio.

The NHIF contributes to the price of most of the available medications with reimbursement. The copayment of patients to drugs and healing aids are presented on the Table 5 for the year of 2019, and on the Table 6 for 2022.

Table 5. The financial contribution (co-payment) of patients for medications (drugs), healing aids in 2019.

2019. Million [HUF] ICD	Medications	Healing aid *	Total	%	lower	%	upper
E 66-68	11	0,2	11	100	11	100	11
E 10	638	935	1 573	20	315	30	472
E 11	11 937	508	12 445	40	4 978	80	9 956
E 78	4 260	2	4 262	30	1 279	60	2 557
I 10-15	30 487	9	30 496	40	12 198	60	18 298
I 21-25	1 858	2	1 860	40	744	60	1 116
I 63,64	509	47	5 56	40	222	60	334
K 80		0,5		20		60	
C	433	182	615	10	62	30	185
M 16,17	898	348*	1 246	40	498	80	997
Total Million HUF					20 307		33 926
Total Million EUR					62.42		104.28

* including bath and spa services.

Table 6. The financial contribution (co-payment) of patients for medications (drugs), healing aids in 2022. (Data of drugs registered for anti-obesity medications are available only for 2022.).

2022 Million [HUF] ICD	Medications	anti-obesity medications	Healing aid	Total	%	lower	%	upper
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E 66-68	8	3 018	492	3 518	100	3 518	100	3 518
E 10	624		12	636	20	127	30	191
E 11	17 398		1 005	18 403	40	7361	80	14 722
E 78	4 115			4 115	30	1 235	60	2469
I 10-15	32 157		3	32 160	40	12 864	60	19 296
I 21-25	1 779		1	1 780	40	712	60	1068
I 63,64	481		35	514	40	206	60	308
K 80			0,4		20		60	
C	466		160	626	10	63	30	188
M 16,17	798		274*	1 072	40	429	80	858
Total				Million HUF		26 515		42 618
Total				Million EUR		67.76		108.91

* including bath and spa services.

The co-payment of patients for anti-hypertensive medications was the highest, followed by the anti-diabetic drugs.

The financial expenditures allocated from the Hungarian National Budget for the National Health Insurance Fund are presented in the Table 7.

Table 7. The payments of the Health Insurance Fund for sickness leave and for health care services. Obesity related expenditures in percentage of cost of total health care provision using the lower and upper level of our calculations.

Year [Million]	2019	HUF	EUR	2022 HUF	EUR
total spending	2 540		7	3 739	9
	766		818	800	565
from these sum					
sickness leave payments	132		409	192	491
	905			148	
health care provision	1 340 690			2 203	5635
				179	
Amount and percentage of calculation					
lower	76 820	5.73%	236	80 625	3.66%
upper	144 299	10.76%	444	153 715	6.98%

The obesity related public expenditures and co-payment of patients are compared with the Hungarian national GDP in Table 8. According to the calculations, these amounts represented 0.23-0.37 % of the whole national GDP in 2019 and 0.16-0.3% in 2022.

Table 8. Hungarian official national GDP in 2019 and in 2022 in Millions of HUF, EUR and USD [16] compared to our lower and upper level of estimations.

			estimation	estimation
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Fiscal year	Sum		lower	%	upper	%
2019	GDP [Million HUF]	47 674 187				
	Million EUR 146 532					
	Million USD 164 026.1					
	public expenditures		76 820		144 299	
	co-payment		20 307		33 926	
	Σ		97 127	0.203	178 225	0.37
2022	GDP [Million HUF]	65 951 746				
	Million EUR 168 532.3					
	Million USD 176 757.5					
	public expenditures		80 625		153 715	
	co-payment		26 515		42 618	
	Σ		107 140	0.162	196 333	0.298

Discussion

Main Findings

This study presents the whole national database which is appropriate for reliable calculation.

Our findings confirm that obesity and its complications result in significant financial burden for the public healthcare system and for individual living with obesity. According to the estimation, public health care expenses could be about 144 Billion HUF (444 Million EUR) for 2019 and 133 Billion HUF (393 Million EUR) for 2022. The highest public expenditures were related to Diabetes Type2, hypertension and malignancies. The co-payment was the highest among patients with diabetes and hypertension.

These sums represented 7-11% of the national spending for health care provision, without sick leave expenditures. The co-payment of patients was 34 Billion HUF (104 Million EUR) and 43 Billion HUF (109 Million EUR), respectively. The sum of the public and individual expenditures represents 0.3-0.4% of the Hungarian GDP.

The most important argument why our upper percentage could be more realistic is the other morbidities where obesity is also an issue were not involved in our calculations. Hepatocellular cancer is the fourth most common malignancy on a worldwide basis, generating high expenditures, and fatty liver and liver transplantations. Urolithiasis often combined with obesity, mental and other gastrointestinal diseases, and illnesses of the respiratory tract, psychological support and services of dieticians, lipid-lowering medications, and expensive bariatric (metabolic) surgical procedures should also be considered. Patients often undergo imaging procedures (ultrasound, X-ray, CT, MRI) generating higher expenditures as well. We do not have data about payment of patients for private health care providers and over the counter (OTC) products bought by persons living with obesity. Majority of obesity related diseases are responsible for sickness leave. There are no exact data, because diagnosis is not linked to the payment

Comparison to Previous Research

There are many published papers dealing with the obesity-related expenditures, and numerous factors that explain the divergence of cost estimates between studies, including the selection of an appropriate cost model. It is essential to producing accurate and consistent estimates for a longer period for each involved person.

The reviewed papers below showed that obesity is responsible for a large fraction of costs, both for health care systems and for society. Heterogeneity is a major limitation among the cost of illness (COI) literature in general and the cost of obesity (COO) literature in particular, which hinders a conclusive comparison of the different studies, different methods and their data. A *micro-costing* analysis from the public payer perspective was conducted to estimate direct healthcare costs associated with ten obesity-related co-morbidities (ORCs) in Czech Republic, Greece, Hungary, and Romania. Chronic kidney disease and cardiovascular diseases were the costliest ORCs across all countries, where annual cost burden per ORC exceeded 1,500 USD per patient per year. In general, costs were driven by the tertiary care resources allocated to address treatment-related adverse events, disease complications, and associated inpatient procedures [21]. A similar micro-costing approach was used in Turkey to estimate direct healthcare costs associated with ten ORCs [22].

The *base-case* analyses showed that total lifetime health care costs (for obese people aged 40 and BMI 35 kg/m²) ranged from €75,376 in Greece to €343,354 in the Netherlands, with life expectancies ranging from 37.9 years in Germany to 39.7 years in Spain. A one-unit decrease in BMI showed gains in life expectancy ranging from 0.65 to 0.68 year and changes in total health care costs varying from +€ 1,563 to + € 4,832 [23].

There is a great deal of variability in estimates of the lifetime medical care cost externality of obesity, partly due to a lack of transparency in the methodology behind these cost models [24].

A longitudinal electronic clinical data on a large representative sample of Italian population were analyzed to estimate the lifetime profile costs of different BMI classes. Research revealed that obese patients generate the highest cost differential throughout their lives compared to normal weight patients. Overweight individuals spend less than those with normal weight, primarily due to reduced expenditures beginning in early middle age [25].

The *English Longitudinal Study of Aging* provided data on BMI, mortality, and morbidities between 1998 and 2015, sampled from adults over 50 years of age. The study identified four trajectories: “stable overweight”, “elevated BMI”, “increasing BMI”, and “decreasing BMI”. No differences in mortality, cancer, or stroke risk were found between these trajectories. BMI trajectories were significantly associated with the risks of diabetes, asthma, arthritis, and heart problems. The results suggest that established BMI thresholds should not be used in isolation to identify health risks, particularly in older adults [26].

An international study analysed the socioeconomic status (SES) of patients. An inverse association was shown between excess weight and SES grade. For obesity, lower odds were found with medium or high SES [27]. Population and expected mortality rates by age, sex and deprivation were obtained from national data in the UK. Obesity has a significant impact on all-cause mortality rate and overall health care resource use, strongly linked to age, sex and local deprivation of the population. The expected increases in annual cost because of obesity, when considered over a lifetime, are being mitigated by the increased mortality of obese individuals [28].

There were some studies from the USA. Higher health care costs were associated with excess body weight across a broad range of ages and BMI levels, and are especially high for people with severe obesity. Among adults, obesity was associated with \$1,861 excess annual medical costs per person, accounting for \$172.74 billion of annual expenditures [29]. In a cohort study of a huge selected population found that ORCs are associated with high costs for healthcare systems. Of 28,583 included individuals, 12,686 had no ORCs, 7242 had one, 4180 had two and 4475 had three or more ORCs in the baseline year. Outpatient costs were the greatest contributor to baseline annual direct costs, irrespective of the number of ORCs. For specific ORCs, costs generally increased gradually over the follow-up; the largest percentage increases were observed for chronic kidney disease and type-2 diabetes [30].

Obesity was associated with 21 non-overlapping cardio-metabolic, digestive, respiratory, neurological, musculoskeletal, and infectious diseases. Compared with healthy weight, the confounder-adjusted HR for obesity was 2.83 for developing at least one obesity-related disease, 5.17 for two diseases, and 12.39 for complex multimorbidity [31].

Other obesity related costs for productivity losses are less explored. Previous studies have found obesity to be associated with absenteeism and unemployment [32].

In Hungary, in 2019 14% of the total number of working days was missed. It means 7.21% of the GDP, the greatest health losses are caused by non-communicable diseases like obesity, which can be prevented by a healthy lifestyle [33]. The best option for cost sparing seems the investment for the prevention and treatment of childhood and adolescent overweight and obesity as proved by a modelling study in China [34]. Childhood obesity is an important phase before becoming adult and also has financial consequences. During childhood, the direct medical expenditures were higher for males than for females, but, once reaching adulthood, the expenditures were higher for females [35]. New medications used for weight reduction and thereafter weight maintenance were compared with alternative traditional weight-maintenance program, which generated slightly fewer clinical benefits while generated substantial savings in lifetime health care spending [36].

As source of data, the single Hungarian healthcare financing fund was used in our study. Only some of the health care records of the citizens are stored here. In most of the countries different national databases are not connected. In Denmark, it is possible to retrieve information on, for instance, health, medication, and employment status and income level from national registries. This makes it possible to identify obese subjects and link them individually with information for calculating both direct and indirect costs [32].

Obesity is associated with a high economic burden, with an estimated 7.9% of US national medical expenditure devoted to treating obesity and related co-morbidities in adults in 2015 [30]. It is almost the similar to our calculation, despite the very different health care and insurance system of the countries.

Most of the studies investigated the economic burden of obesity, included costs associated with treating ORCs and some of them the costs-related loss of productivity and premature mortality. However, expenditures related to informal care, defined as unpaid care provided by people other than health care professionals, were not considered in any of the studies in the review [23].

The indirect costs were not calculated in our study and are the other reason, why the upper percentage of calculation could be more realistic. Without registered data, we could not calculate the cost of obese patients treated and hospitalized due to covid-infection [37].

Our estimation differed from the COI model used in Canada, because of the lower obesity incidence in 2004 [7]. This model was used in our previous study when data of 2013 were evaluated. The public spending was lower when expressed in HUF, but similar when given in EUR [14]. In the previous decade the HUF/EUR exchange ratio roughly deteriorated [19]. Because of the covid-restrictions in the access to the provision and perhaps due to the fear of the people, the number of patients was less in 2022. In January and February the financing from NHIF was independent from the number of patients, it was a "*basic-financing*" which was effective during the pandemic-years.

In Hungary after the covid-pandemic, the government realized the decade-long underpayment of physicians and after 2021 their salaries increased significantly. It explains the higher health care financing in 2022, compared to 2019. Hungarian state budget allocate much lower amount for health care financing than other European countries. In these years it was 6.3% and 7.4% of the national GDP [38].

There are huge differences between countries in terms of obesity related economic burden. In 2019, based on the direct and indirect costs it was estimated 0.8% of gross domestic product (GDP) in India, 1.4% in Thailand, 1.6% in South-Africa, 1.8% in Australia, 2% in Mexico and Spain while 2.4% in Saudi Arabia. These findings demonstrate that the economic impacts of obesity are substantial across countries, irrespective of economic or geographical context and will increase over time if current trends continue [39,40].

Moreover, international consensus is required on standardized methods to calculate the cost of obesity to improve homogeneity and comparability. This aspect should also be considered when including obesity-related diseases. There was considerable heterogeneity in methodological approaches, target populations, study time frames, and perspectives [1].

Strengths and Limitations

The strengths of this study are to present the whole national database, based on reliable facts.

Acceptable limitation is the prevalence rate used in the estimation. They were based on different sources and differences could be expected between populations, age, genders and ethnical groups as well.

Based on the coding system, financing were linked to the main reasons of hospitalizations, co-morbidities have less influence to the payment.

We could not separate the cost of men and women and differences between age-groups.

Without official data, we were unable to predict the expenses related to persons with obesity who were hospitalized during the pandemic.

In the Hungarian hospitals and ambulances registration of anthropometric parameters is not compulsory; therefore comparison of individuals categorized by their BMI is not possible. Only fiscal years were evaluated in our study instead of life-span or life-long expenditures. Available data of national GDP often deviated, even in governmental sources [16,18].

In the first 2 months of 2022 special financing rules were effective, due to the pandemic. NHIF payment was not related to the number of patients.

Conclusion

If trends of obesity in the recent decades continue in Hungary [13], much higher expenditures could be expected both at national and individual level.

Future studies are needed using similar methods for appropriate comparison.

Authors' Contributions: EA Text writing, collecting data of public services, literature search. PT Contribution in macroeconomic data collections, literature search. IR Study design, text writing, literature search and final editing.

Policy Implications: Our recent and many previous studies draw attention to the possibility of reducing public expenses at individual level by weight reduction or maintenance and to prefer the early prevention. Public education is needed already in the school and strongly point to the need for advocacy to increase awareness of the societal impacts of obesity, and national and global policy actions to address the systemic roots of obesity.

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