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Research Article

Estimating the Economic Burden of Type 2 Diabetes Among the Elderly in Tehran Province

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Abstract

Background: The prevalence of non-communicable diseases such as diabetes tends to rise with age, peaking among the elderly population.
Objectives: This study aimed to estimate the economic burden of type 2 diabetes mellitus (T2DM) among the elderly in Tehran province.
Methods: This research employs a descriptive-analytical approach, focusing on T2DM patients who attended the specialized diabetes clinic of Tehran province in 2019. A total of 1256 cases were included in the study. Data collection involved reviewing hospital records and accessing information from the accounting department. Data analysis was conducted using Excel software.
Results: The economic burden of T2DM amounted to 432,471,301,510 Rials. Among this, 230,841,323,930 Rials (53.3%) were attributed to the costs of diagnosis and treatment, while 180,365,897,580 Rials (41.7%) were associated with treating disease complications. Additionally, 9,043,200,000 Rials (2%) accounted for non-medical direct costs (NMDC), and 12,220,880 Rials (0.3%) were attributed to NMDC due to complications.
Conclusions: Given the substantial financial burden incurred by elderly T2DM patients and the constraints on healthcare resources, it is imperative to prioritize preventive and therapeutic measures for this demographic. Comprehensive efforts are needed to mitigate the costs and consequences of this disease within the healthcare system.
Keywords: Economic Burden; Diabetes; Elderly

1. Background

One of the most significant challenges confronting healthcare systems worldwide in the 21st century is the escalating burden of chronic diseases. According to reports from the World Health Organization, 60% of all causes of death and 43% of the global disease burden are attributable to non-communicable diseases. Low and middle-income countries (LMICs) bear the brunt of this burden, accounting for 79% of deaths and 85% of the disease burden (1). Mortality rates from these diseases, along with the costs of healthcare interventions, have increasingly impacted societies. There is a global consensus that chronic diseases are a primary driver of healthcare expenditure. When considering the impact of chronic diseases on the global and national economy, both direct and indirect costs need to be taken into account (2).

The prevalence of non-communicable diseases such as diabetes rises with age and peaks among the elderly (3, 4). Globally, the total number of individuals with diabetes was 366 million in 2011, and it is projected to reach 552 million by 2030. The majority of people with diabetes reside in LMICs, which are expected to experience the greatest increase in diabetes cases over the next 19 years (5). Diabetes is recognized as the most prevalent metabolic disorder and a leading cause of morbidity and mortality. In the United States, diabetes is an underlying factor in 12% of new cases of blindness, one-third of new cases of end-stage kidney disease, and almost half of non-traumatic lower limb amputations. Additionally, diabetic patients

face a double risk of death from heart disease or stroke compared to non-diabetic individuals. The treatment of diabetes and its complications entails substantial expenses for patients and the healthcare system. Furthermore, the decrease in income due to productivity loss, disability, and premature death attributable to diabetes results in significant societal losses, imposing high costs on society. This issue is particularly significant in the case of type 2 diabetes, which accounts for 90-95% of all diabetes cases (6, 7). The average prevalence of diabetes among Iranians was 7.9% in 2010, with considerable variations observed across different provinces, ranging from 1.3% to 14.5% (5). Iran's demographic structure reveals that more than 45% of the population (over 34 million people) are now aged over 30 and are at risk of developing diabetes (8). According to studies, approximately 22% of Iran's elderly population suffer from diabetes (9).

The total cost or economic burden associated with diseases is typically divided into direct and indirect costs. Policy makers often concentrate on direct costs, as they are utilized in economic evaluations of various interventions to make decisions regarding the allocation of healthcare resources. Indirect costs, on the other hand, have received less attention, as most national guidelines for economic evaluations of healthcare interventions deem them insignificant for healthcare budgeting decisions. In estimating indirect costs, lost productivity has traditionally been measured in terms of days of absenteeism, lost work hours, and job turnover. However, mounting evidence suggests that workplace absenteeism, reflecting reduced productivity while on the job, may constitute a major source of lost productivity and warrants accurate measurement.

The estimated direct cost of diabetes in 2019 was $760 billion, projected to rise to $825 billion by 2030 and $845 billion by 2045. There is considerable variation in the annual costs of diabetes treatment, with the United States having the highest estimated cost at $294.6 billion, followed by China and Brazil at $109.0 billion and $52.3 billion, respectively. The age group with the highest annual health costs related to diabetes is 60 - 69 years, with $177.7 billion, followed by 50 - 59 years and 70 - 79 years, with $173.0 billion and $171.5 billion (10). Diabetes-related medical costs per person vary widely, ranging from $23 in Somalia (a low-income country) to $11,144 in Norway. In LMICs, this cost has been reported to range from $56 in Pakistan to $801 in Tuvalu (8).

2. Objectives

Given the constraints on available resources to meet healthcare needs, strategic planning for resource allocation becomes essential. Over the past three decades, numerous cost-of-illness studies have been conducted, offering valuable insights into the societal impact of various diseases. Understanding the economic burden of a disease is crucial for informing policy decisions related to healthcare prioritization, prevention, and treatment. This study aims to provide guidance to healthcare experts and policymakers in Tehran province by estimating the economic burden of diabetes among the elderly population in 2019. The findings of this study can serve as a framework and inform decision-making processes for stakeholders involved in the healthcare sector, including insurance organizations and private hospitals.

3. Methods

3.1. Study Type, Statistical Population, and Sampling

The research population for this study comprises all elderly individuals diagnosed with diabetes in Tehran province in 2019. Their medical records were utilized to estimate the total cost associated with the disease. The sample for the study consisted of hospital records from all patients with type 2 diabetes mellitus (T2DM) who sought treatment at diabetes clinics in hospitals affiliated with medical universities in Tehran province, including Iran, Tehran, Shahid Beheshti, and Welfare Sciences universities, during the year 2019.

3.2. Study Implementation

Two main approaches are commonly employed to calculate the economic burden of a disease: the incidence-based approach (IBA) and the prevalence-based approach (PBA). The IBA considers new cases of the disease within a specific period, whereas the PBA estimates the economic burden associated with existing cases during a certain period. The PBA, which accounts for total annual healthcare costs, is particularly suitable for chronic diseases requiring long-term treatment. In this study, the societal approach was adopted to estimate the costs related to diabetes. However, since the study focuses on the elderly population (aged 65 and over), only direct medical cost (DMC) and non-medical direct costs (NMDC) were estimated, while indirect costs, such as those associated with lost productivity, were not included in the analysis.

3.3. Data Collection

In this research, all types of DMC were calculated using the data available in patients' records. These costs encompass the expenses associated with diagnosing and managing diabetes, as well as the costs of treating complications and comorbidities resulting from diabetes, such as cataracts, blindness, limb amputations, leg ulcers, etc. Subsequently, the average cost per patient was determined. Another component of the costs incurred by diabetes is NMDC, which include expenses related to travel, food, and accommodation during the treatment process. NMDC was assessed based on data obtained from questionnaires administered to each patient. Data collection was completed through questionnaires and interviews

with patients.

3.4. Data Analysis

The collected data were entered into Excel software for analysis. Patients and their families were assured that their information would remain confidential and would be used solely for the purpose of this research.

4. Results

The results indicated that a total of 1256 patients with diagnosis codes E14.0-E14.9 were hospitalized in various departments, with 1230 cases classified as general hospitalizations and 26 cases categorized as global hospitalizations. Among the hospitalized patients, 49% were male and 51% were female. The average length of stay (ALoS) was calculated to be 6.7 days (Table 1).

Table 1. Characteristics of Diabetes Patients in Hospitals

Variables	Values a
Sex	
Male	615 (49)
Female	641 (51)
Education	
Illiterate	102 (8)
Elementary	263 (21)
Middle	389 (31)
Diploma	256 (20)
Associate	158 (12.5)
Bachelor's degree	67 (6)
Masters' degree and higher	21 (1.5)
Marital status	
Single	27 (2)
Married	1208 (96)
Widow	21 (2)
Employment status	
Employed	205 (16)
Housewife	352 (28)
Retired	685 (55)
Others	14 (1)
Family history of diabetes	
Yes	867 (69)
No	389 (31)
Type of hospital	
Private	268 (21.3)
General	988 (78.7)

[a] Values are expressed as No. (%).

Furthermore, Table 2 presents the cost of diagnosis and treatment in elderly patients with type 2 diabetes mellitus (T2DM). The total cost of diagnosis and treatment among the patients amounted to 230 841 323 930 rials, with the majority (58%) attributed to other services (e.g., operating room, anesthesia, consultation) and the lowest percentage allocated to nursing services (1%).

Table 2. Cost of Diagnosis and Treatment in Included Patients

Diagnosis and Treatment Costs	Cost a	Per Capita Cost
Medicine	36 934 611 829 (16)	29 406 538
Bed	25 392 545 632 (11)	20 216 995
Laboratory diagnostic services	18 467 305 914 (8)	14 703 269
Other diagnostic services	13 850 479 436 (6)	11 027 452
Nursing services	2 308 413 239 (1)	1 837 909
Other services (operating room, anesthesia, etc.)	133 887 967 879 (58)	106 598 701
The total cost of diagnosis and treatment	230 841 323 930	183 790 863

[a] Values are expressed as No. (%).

Table 3 illustrates the direct costs associated with complications resulting from T2DM in the elderly. According to Table 3, the direct costs of complications totaled 180 365 897 580 Rials. The highest costs were associated with cardiovascular diseases (18.56%) and wound treatment (15.9%), while hyperlipidemia accounted for the lowest percentage (6.9%). Additionally, other complications, including skin complications, neurological disorders (neuropathy), bacterial and fungal infections, respiratory issues, digestive symptoms, etc., collectively represented 18.6% of the total cost of treating complications.

Table 3. Direct Costs of Complications of T2DM in the Elderly

Type of Complication	Costs, Rials a	Standard Deviation
Cataract	13 707 808 216 (7.6)	1 096 624 657
Cardiovascular diseases	13 707 808 216 (18.56)	2 678 072 847
Kidney disease	14 068 540 011 (7.8)	1 125 483 201
Hyperlipidemia	12 445 246 933 (6.9)	995 619 755
Blood pressure	15 222 881 756 (8.44)	1 217,830 540
Blindness	13 707 808 216 (7.6)	1 096 624 657
Wound	28 678 177 715 (15.9)	2 294 254 217
Amputation	15 511 467 192 (8.6)	1 240 917 375
Other	33 548 056 950 (18.6)	2 683 844 556
Total cost	180 365 897 580	14 429 271 806

[a] Values are expressed as No. (%).

Table 4 outlines the NMDC of T2DM in the elderly.

Table 4. Non-medical Direct Costs of T2DM in the Elderly

Cost item	Cost a	Mean ± Standard Deviation
Travel	1 821 200 000 (20)	1 450 000 ± 182 120 000
accommodation	4 584 400 000 (50)	3 650 000 ± 522 621 600
Nutrition	2 637 600 000 (30)	2 100 000 ± 342 888 000
Total NMDC	9 043 200 000	2 400 000

a Values are expressed as No. (%).

As observed, the total NMDC incurred in treating the disease amount to 9 043 200 000 Rials, with the majority attributed to accommodation expenses (50%). Table 5 presents the NMDC of T2DM complications in the elderly.

Table 5. NMDC of T2DM Complications

Cost Item	Cost	Mean ± Standard Deviation
Travel	4 622 080 000 (38)	3 680 000 ± 462 208 000
Accommodation	3 265 600 000 (27)	2 600 000 ± 372 278 400
Nutrition	4 333 200 000 (35)	3 450 000 ± 563 316 000
Total NMDC due to complications	12 220 880 000	3 243 333

According to Table 5, the total NMDC associated with disease complications is 12 220,880,000 Rials, with the majority of costs attributed to nutrition.

Table 6 illustrates the economic burden of T2DM in the elderly. It can be noted that the economic burden of this disease amounts to 432 471 301 510 Rials. Among this, 53.3% is related to the costs of diagnosis and treatment, 41.7% is associated with treating the complications of the disease, 2% accounts for the direct non-treatment costs, and 3% represents NMDC of complications.

Table 6. The Economic Burden of T2DM in the Elderly

Type of Costs	Cost a	Percentage
Cost of diagnosis and treatment	230 841 323 930 (53.3)	53.3
Cost of treating complications of the disease	180 365 897 580 (41.7)	41.7
NMDCD	9 043 200 000 (2)	2
NMDC of complications	12 220 880 000 (3)	3
Total cost of illness	432 471 301 510	100

a Values are expressed as No. (%).

5. Discussion

This study aimed to assess the economic burden of T2DM among the elderly in Tehran province in 2019. According to the study findings, the total cost of diagnosis and treatment amounts to 230 841 323 930 Rials. Of this, the majority (58%) is attributed to operating room services, anesthesia, counseling, etc., while nursing services represent the lowest proportion (1%). Additionally, the total NMDC for treating the disease is 9 043 200 000 Rials, primarily driven by accommodation expenses (50%). Moreover, the total NMDC associated with disease complications is 12 220 880 000 Rials, with nutrition costs being the highest.

Lagasnrie et al. concluded that the total cost of treating diabetes in the elderly was 19 billion euros, with 10 billion euros allocated to diabetes care. Of this, €2.3 billion accounted for direct costs, while €7.7 billion were attributed to additional indirect reimbursed costs related to diabetes. Antidiabetic drugs accounted for approximately €1.1 billion, constituting the total diabetes-specific costs, aligning with the findings of the present study. Weinberger's study revealed that approximately 5.16 billion dollars are spent annually on the treatment of elderly individuals with diabetes, with nearly 80% attributed to hospitalization costs (11). According to Eshwari et al.'s study, hospitalization costs have increased sixfold (12), imposing significant burdens on patients and the health system. Similarly, results reported by Mata-Cases et al. indicated that 62% of diabetes costs are related to medical direct costs (MDC) (13). Acharya et al. from India also identified hospitalization as a major determinant of costs associated with T2DM (14). Based on Amon and Aikins's study, the total monthly cost of T2DM management is estimated at 9980.62 US dollars, with direct health care management accounting for about 94% of this total cost, and medical costs representing approximately 83% of the direct cost, primarily due to medication expenses (15). It can be concluded that a significant portion of diabetes management costs comprises medical direct costs. Therefore, there is a need to raise awareness about the availability of affordable and quality services in public health centers compared to private ones. Additionally, facilitating access to quality drugs within the healthcare system can significantly reduce medication expenses.

The direct costs of complications arising from T2DM in the elderly amount to 180,365,897,580. Among these complications, cardiovascular complications account for the highest cost (18.56%), followed by wound treatment (15.9%), with hyperlipidemia representing the lowest cost (6.9%). Various studies have examined the costs associated with T2DM. According to this research, the economic burden of T2DM in the United States exceeds 20 billion dollars, with cardiovascular disorders accounting for 3849 million dollars, visual disorders for 387 million dollars, neuropathy for 240 million dollars, nephropathy for 104 million dollars, and skin wounds for 145 million dollars (16). The distribution of complication costs is largely consistent with the findings of the present study. In recent years, there has been an increase in the indirect costs of diabetes due to the rising number of disabled individuals in America. However, simultaneously, hospitalization costs for diabetic patients have decreased by 26%, attributed to the expansion of outpatient care and surgical services, resulting in fewer cases and shorter hospital stays. Among the direct costs, those related to diabetes complications hold significant importance. In a study by O'Brien et al., cardiovascular complications of diabetes account for the most substantial economic losses. When considering the costs associated with blood pressure and lipid control, the total costs for all T2DM patients in the country reach a significant annual figure (17), consistent with our study findings. Additionally, Amini's study in Isfahan province revealed that 21.26% of diabetes-related costs are attributed to tests and routine care, 4.12% to blood sugar control, 0.7% to education costs, and 73.92% to diabetes complications (both chronic and acute) (18).

According to Eshwari's study, the most common complication of diabetes was high blood pressure (84.3 - 496/588), followed by peripheral neuropathy (188, 31.9%), cardiovascular issues (178, 31.2%), elevated blood lipids (163, 27.7%), and cataracts (12). However, these findings do not align with the results of the present study, possibly because their study population included individuals from various age groups, whereas only the elderly were examined in our study. Another notable finding from their study was that the presence of co-morbidities (complications) significantly increased treatment costs for T2DM patients, doubling them compared to patients without any co-morbidities. Factors such as medication costs and the type of healthcare facility providing diabetes-related care were identified as primary drivers of increased costs among T2DM patients with complications (12).

Additionally, another study focusing on adults with type 2 diabetes reported that the most common complications, along with their highest average total costs, were non-proliferative retinopathy (40.3%) and kidney disease (averaging $28 076 USD), respectively (19). These findings differ somewhat from the results of our study. Caro et al. indicated in their research that cardiovascular disease comprises the largest component of the cost of T2DM complications, representing 85% of cumulative complication costs within the first five years of the disease. The average cost of complications per patient was estimated at $47 240 USD, with nephropathy accounting for 21%, neuropathy 17%, and retinopathy 10% of T2DM complication costs (20). These findings are in line with our study results.

Moreover, Hidayat et al.'s study revealed that among the 18.9 million individuals included who had access to secondary and tertiary care, 812 204 (4%) were diagnosed with T2DM, with 57% of them experiencing complications. The most prevalent complication was cardiovascular disease (24%). The total DMCs amounted to US$576 million,

with 56% attributed to hospitalization, 38% to specialist visits, 4% to non-diabetic drugs, and 2% to antihyperglycemic drugs. Approximately 74% of total costs were related to patient management. Individuals with complications incurred twice the costs compared to those without complications (21).

Javanbakht et al.'s study also highlighted that the costs of complications of T2DM (48.9%) and medications (23.8%) were the primary components of DMCs. The majority of medical costs attributed to diabetes complications were related to cardiovascular diseases (42.3% of total complication costs), nephropathy (23%), and eye complications (14%) (22), findings which align with our study results. The economic burden of diabetes among the elderly in Tehran province amounted to 432 471 301 510 Rials, with 53.3% attributed to diagnosis and treatment costs, 41.7% to complication treatment costs, 2% to NMDC, and 3% to NMDC caused by complications.

Peters et al. demonstrated that the total economic burden of diabetes in the Netherlands reached €6.8 billion in 2016. This indicates a substantial economic burden, expected to escalate in the future due to demographic and lifestyle changes. They also noted that indirect costs, such as welfare payments, constitute a significant portion of the total economic burden of diabetes (23). Sadeghi MA's study showed that the total economic costs per T2DM patient amounted to 7 743 329.6 Rials, with a total cost of 37 942 315 040 Rials for all T2DM patients. MDC accounted for 10.5% of total costs, while indirect costs comprised 89.5%, which were 8.5 times higher than direct costs (2). Our study did not examine indirect costs due to the age group, thus not aligning completely with these findings.

Furthermore, other studies have also indicated that MDC constitute a significant portion of the total healthcare costs for T2DM patients (24, 25). The American Diabetes Association reported a doubling of diabetes-related costs among patients over 60 years old (26). Al-Maskari et al.'s study suggested higher diabetes-related costs among men (27), possibly due to increased productivity loss, correlating with indirect costs. Bayazidi's study demonstrated that MDC include costs related to medications, tests, visits, and treatment of complications. For each diabetic person, according to the life expectancy of each person and also the pattern of risk factors of the person during five years, as well as the history of diabetes and complications related to it, as well as other demographic factors of the person, for common care, the cost of treatment is 747,183,646 Rials. Complications are 791,766,538 Rials and diabetes treatment costs are 957,416,107 Rials (28). The ratio of costs between disease treatment and complication treatment in Bayazidi's study aligns with our findings.

According to the results obtained, it appears that significant measures are necessary to alleviate the costs associated with diabetes. Therefore, it is recommended that the healthcare system of the country focus on the following aspects:

(1) Comprehensive and practical education for diabetic patients regarding the disease process, complications, and the importance of blood sugar control and overall care to enhance blood sugar management and consequently reduce complications.

(2) Extensive public education initiatives to increase awareness of diabetes and expand screening coverage for individuals at risk, facilitating early diagnosis through integration into the national healthcare delivery system.

(3) Expansion of home-based healthcare coverage for diabetic patients to decrease hospitalization costs, coupled with providing access to home blood sugar monitoring devices to enhance patient awareness and control.

(4) Provision of comprehensive care facilities and broader insurance coverage for the prompt diagnosis and treatment of diabetes complications, thereby slowing complication progression and reducing associated costs.

This study, the first of its kind in the country, investigated the economic burden of a prevalent chronic disease and related conditions. However, the research had limitations, notably the exclusion of unidentified cases.

In conclusion, the findings underscore the significance of disease-related factors such as treatment duration, presence of complications, utilization of private healthcare services, combined treatment approaches, and hospitalization as key predictors of costs. Moreover, the study highlights the high DMC associated with managing T2DM in Tehran province, emphasizing the importance of early diagnosis, timely treatment, and optimal disease management to mitigate costly complications.

Authors' Contribution:

S.B. F and S.GH. had the original idea for this work. A.R. and R.J. designed the study. S.B. F and R.J. and S. GH collected data; and R. J and S.GH performed analysis; and N. GH and E.S wrote the manuscript. All authors critically revised the draft of the manuscript and approved its final version.

Conflict of Interests:

There is no competing interest to declare.

Ethical Approval:

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