RESEARCH NOTE

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The economic burden of prostate cancer in Iran: a cross-sectional cost-of-illness study

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Abstract

Objective This study aims to assess the economic burden of prostate cancer in Iran by analyzing direct medical costs, direct non-medical costs, and indirect costs. We conducted a cross-sectional cost-of-illness study in Khorramabad, located in western Iran, during 2023, using a prevalence-based, bottom-up approach. Data were collected from 285 prostate cancer patients using questionnaires, interviews, and patient records.

Results Our study estimated the economic burden of prostate cancer at $744,990. Direct medical costs accounted for 63.50% of this, totaling $153,330, with therapy being the largest component. Direct non-medical costs were $62,130, and indirect costs from productivity losses were $209,760. The calculated overall cost per patient was $2,614.88. Extrapolating from the 2021 Global Burden of Disease data, which reported approximately 83,000 prostate cancer patients in Iran, the national economic burden is estimated at $217,034,040. This substantial burden highlights the need for improved insurance coverage and early detection. The findings suggest that policymakers and healthcare providers in Iran should develop standardized cost analysis methods and enhance financial protection to alleviate economic strain and improve healthcare outcomes and sustainability.

Keywords Economic burden, Prostate cancer, Iran, Healthcare costs, Health policy

Introduction

Prostate cancer ranks as the second most prevalent cancer among men worldwide, with approximately 1.4 million new cases diagnosed in 2020. This disease significantly contributes to the overall cancer burden in men [1, 2]. The incidence of prostate cancer has exhibited a concerning upward trend, particularly in high-income regions such as Europe and North America. This increase can be attributed to factors such as population aging and the widespread adoption of prostate-specific antigen (PSA) screening [3]. However, mortality rates associated with prostate cancer follow a more intricate pattern. While high-income countries have witnessed a decline in mortality rates, low- and middle-income countries (LMICs) continue to grapple with higher mortality rates

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due to limited access to early diagnostic and treatment services [4, 5].

In Iran, prostate cancer stands as the third most common cancer among men, with an estimated 8,937 new cases reported in 2020 [6]. Projections indicate that the prevalence of prostate cancer in Iran will escalate significantly by 2040, posing substantial challenges to the healthcare system [6]. This rise can be attributed to demographic shifts, including population aging, urbanization, and changes in lifestyle and dietary patterns. Consequently, there is an urgent need to comprehensively understand the economic impact of prostate cancer on the Iranian healthcare system [7].

The economic burden of prostate cancer encompasses both direct costs (such as diagnosis, treatment, and follow-up care) and indirect costs (including lost productivity and income) [8]. Studies conducted across various regions consistently highlight the substantial financial strain that prostate cancer imposes on healthcare systems and patients alike [9]. For instance, in the United States, the annual costs associated with managing prostate cancer were estimated at $11.85 billion in 2010, making it one of the costliest cancers to treat. Similarly, in Europe, annual healthcare costs related to prostate cancer reach €8.5 billion [10].

This study aims to fill the gap in understanding the economic burden of prostate cancer in Iran, driven by unique socio-economic and healthcare challenges. The mixed public-private healthcare system in Iran exhibits significant disparities in access to care, with high out-of-pocket expenses exacerbating the financial strain on families [9]. Rapid urbanization and lifestyle changes have led to an increased incidence of non-communicable diseases, including cancer. By analyzing direct medical costs, indirect costs, and the broader societal impact, this research provides essential insights for policymakers and healthcare providers to develop effective strategies for managing prostate cancer and mitigating its financial repercussions.

Main text
Methods
Study Design and Data Collection
We conducted a cross-sectional cost-of-illness study to assess the economic burden of prostate cancer in Khorramabad, western Iran, in 2023. Utilizing a prevalence-based, bottom-up approach from a societal perspective, we included all prostate cancer patients who visited or were hospitalized at Rahimi Hospital during the year [11]. Out of 338 identified patients, 53 were excluded due to lack of access, inaccurate diagnostic data, and mortality, leaving 285 patients for the final analysis. The study was approved by the relevant ethics committee, and informed consent was obtained from all participants. A subset

of patients could not be reached or contacted despite repeated attempts, resulting in incomplete data collection. Some patients had incomplete or inaccurate diagnostic records, affecting the reliability of cost estimates. Additionally, some patients had passed away before data collection could be completed, necessitating their exclusion. This introduces potential bias, as the remaining cohort may not fully represent the broader population of prostate cancer patients in Khorramabad. The exclusion of these patients could impact the generalizability of the cost estimates. Future research with more comprehensive data collection and a larger sample size is recommended to mitigate these biases and provide a more accurate assessment of the economic burden of prostate cancer.

Cost estimation approach
Data were collected through questionnaires, interviews, and a review of patient documents to estimate costs, categorized into three domains: direct medical costs (DMC), direct non-medical costs (DNMC), and indirect costs.

1. Direct Medical Costs (DMC): These included diagnostic services, laboratory and pathology tests, inpatient and outpatient care, rehabilitation, medical devices, physician visits, therapies, and consultations. Costs were based on tariffs from the Ministry of Health and Medical Education (MOHME) and gathered retrospectively via patient and specialist interviews, and examination of healthcare records and financial documents. Each cost was calculated individually, considering both patient files and specialist input.
2. Direct Non-Medical Costs (DNMC): These encompassed transportation, accommodation, and food costs. Estimates were derived from interviews with patients and their families.
3. Indirect Costs: These were based on productivity losses from absenteeism and presenteeism, calculated using monthly income data from questionnaires and direct inquiries. This included work and daily activity absences by patients and their caregivers, with costs estimated using average salary data for 2023 from Iranian Statistics.

This approach ensured comprehensive cost analysis by integrating multiple data sources and cost categories.

In this study, all reported costs are annual and specific to a cohort of 285 prostate cancer patients from Rahimi Hospital in Khorramabad for the year 2023. These costs do not represent lifetime costs or the total economic burden for Iran but reflect the financial impact on this specific group. The findings are not immediately applicable to a broader national context, and future research should include multiple centers and regions for a comprehensive

national estimate. Extrapolation to national costs should be done cautiously, and additional analyses are recommended. The study employed a one-way sensitivity analysis, varying the prevalence rate of prostate cancer in Iran to calculate the disease population and economic burden, assuming constant cost components per patient. To facilitate international comparisons, all costs were converted into US dollars using the exchange rate of 420,000 Iranian Rials per US dollar in 2023. The collected data underwent rigorous analysis using R software version 4.3.2.

Results

The mean age of the patients was 71.53 years, with a standard deviation of 16.18 years. Demographic characteristics are detailed in Table 1. The highest percentage of patients fell within the 60 to 69 age group, comprising 39.64%, followed by the 70 to 79 age group at 29.82%. Among the patients, 67.36% were employed, while 18.24% were unemployed. Additionally, 88.07% of the patients were married. Regarding insurance status, 3.88% of patients had no insurance, and 4.57% had a family history of prostate cancer. The calculated costs are categorized as follows (see Table 2A): The direct medical cost amounts to $473,100, with the bulk of this being attributed to therapy costs. The direct non-medical cost is

$62,130, largely driven by accommodation costs. The indirect costs reach $209,760, primarily due to patients being absent from work and their usual daily activities. The calculated overall cost per patient was $2,614.88.

$$Overall \; \cos t \; per \; patient$$
$$= \frac{Total \; economic \; burden}{Total \; number \; of \; patients}$$
$$= \frac{744990}{285} = 2614.88$$

Figure 1 represents the total costs across all three categories. The economic burden of prostate cancer in this study amounted to $744,990. Direct medical costs accounted for 63.50% of the total costs, indirect costs for 8.33%, and non-medical costs for 28.17%. Based on the disease stage, the economic burden was calculated as follows: $138,377 for patients in stage 1, $189,623 for patients in stage 2, $314,194 for patients in stage 3, and $102,796 for patients in stage 4. The detailed table breaking down costs by cancer stage is provided in Table 2B. Based on the number of patients in each stage, the total cost per patient was calculated as follows: $4,463.77 for stage 1, $1,841 for stage 2, $2,513.55 for stage 3, and $3,953.65 for stage 4.

Table 1 Demographic characteristics of the patients

Variable	Number	Percent	Variable	Number	Percent
Age			**Family History of Prostate Cancer**		
< 50	9	3.15	Yes	13	95.43
50–59	41	14.38	No	272	4.57
60–69	113	39.64	**Smoking Status**		
70–79	85	29.82	Never smoked	37	13
≥ 80	37	13.01	Former smoker	158	55.43
Geographic Location			Current smoker	90	31.57
Urban	233	81.75	**Treatment Modalities**		
Rural	52	18.25	Surgery	24	8.42
Employment status			Radiation therapy	106	37.19
Employed	192	67.36	Chemotherapy	89	31.22
Unemployed	52	18.24	Immunotherapy	29	10.17
Retired	41	14.40	Hormone therapy	24	8.42
Level of education			Cryotherapy	13	4.58
Illiterate	29	10.17	**Treatment**		
Under diploma	17	5.98	Stage I	31	10.87
Diploma	82	28.77	Stage II	103	36.14
Upper diploma	157	55.08	Stage III	125	43.85
Marital Status			Stage IV	26	9.14
Single	16	5.62			
Married	251	88.07			
Divorced	18	6.31			
Insurance Status					
Uninsured	11	3.88			
Public health insurance	89	31.22			
Social security	135	47.36			
Other	50	17.54			

Table 2 A: Breakdown of costs associated with prostate cancer, B: economic burden of prostate cancer by disease stage

A

Type of cost	Costs	Costs per US	Total Costs (USD) for 258 Patients	Total cost (%)
Direct medical costs	Diagnostic services costs	119	33,915	**63.50**
	Laboratory and pathology services costs	179	51,015	
	Inpatient costs	95	27,075	
	Rehabilitation costs	124	35,340	
	Outpatient costs	103	29,355	
	Medical devices costs	119	33,915	
	Physician visit costs	318	90,630	
	Therapy costs	538	153,330	
	Consultation and psychology services costs	65	18,525	
	Total		**473,100**	
Direct non-medical costs	Transportation costs	106	30,210	**8.33**
	Accommodation costs	60	17,100	
	Food costs	52	14,820	
	Total		**62,130**	
Indirect costs	Patients' absence from work and daily activities caused by illness costs	485	138,225	**28.17**
	Absence of patients' families from work and daily activities caused by patient care costs	251	71,535	
	Total		**209,760**	
Total costs	**744,990**			**100**

B

Stage	Number of patients	Direct medical costs	Direct non-medical costs	Indirect costs	Total costs
Stage I	31	96,011	10,173	32,193	138,377
Stage II	103	119,381	17,023	53,219	189,623
Stage III	125	186,403	26,182	101,609	314,194
Stage IV	26	71,305	8752	22,739	102,796
Total	**285**	**473,100**	**62,130**	**209,760**	**744,990**

Based on the sensitivity analysis, the range of costs is as follows: direct medical costs are between $425,790 and $520,410; direct non-medical costs range from $55,917 to $68,343; indirect costs vary from $188,784 to $230,736; and total costs are calculated to be between $670,491 and $819,489. Detailed costs for sensitivity analysis are provided in supplementary file 1.

To estimate the national economic burden of prostate cancer in Iran, we extrapolated our data using prevalence statistics from the 2021 Global Burden of Disease (GBD) (https://vizhub.healthdata.org/gbd-results/), which reported approximately 83,000 prostate cancer patients in the country. With a calculated cost per patient of $2,614.88, the estimated total economic burden for prostate cancer in Iran amounts to $217,034,040.

Discussion

The aggregate direct medical costs in our investigation amounted to $473,100, predominantly influenced by the costs of therapy. Similar studies in other in other countries and studies conducted in Iran, direct medical costs had the largest share of the economic burden of prostate cancer [6, 7, 9]. This discrepancy can be ascribed to variations in methodologies, treatment patterns, and cost conversion practices.

Our study discovered that indirect costs, primarily due to patients' absence from work, totaled $209,760, representing 28.17% of the total costs. This is in line with the findings from the US study by Gustavsen et al., where productivity losses were a significant component of the economic burden, although they observed that high-risk patients incurred greater costs over time due to disease progression [11].

Although patients with metastatic disease incur significant medical costs, the higher number of patients with
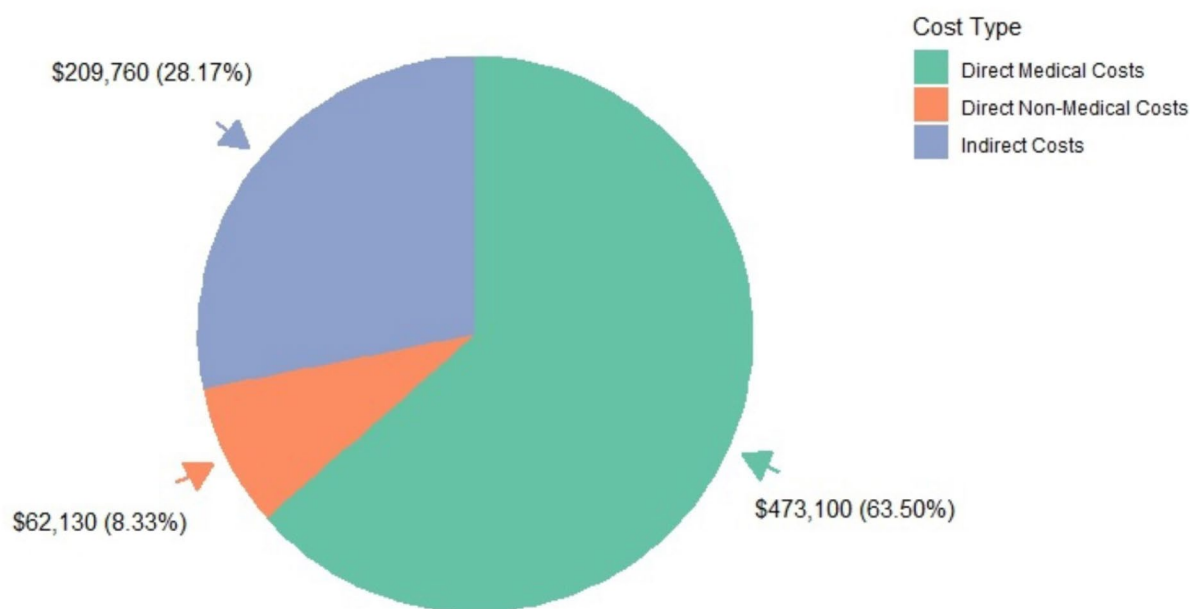
Fig. 1 Costs of prostate cancer by category. The plot shows that direct medical costs constitute 63.50% of the total costs, non-medical costs make up 28.17%, and indirect costs account for 8.33%

localized disease (approximately 91% compared to those with metastatic disease) results in a greater overall share of costs for patients with localized disease. This finding is consistent with studies conducted in Iran and other countries [6, 7, 12, 13]. Given that many of the services received at different stages, such as radiotherapy, hormone therapy, and chemotherapy, are expensive; this can explain why these patients incur the highest costs. This finding is consistent with studies conducted in other countries [13–16]. More severe stages of the disease can be very expensive for patients. Due to the higher costs and financial pressure on families, patients often reported having to use their savings, rely on family members, or borrow money to pay for their medical expenses [7, 17].

The substantial costs associated with prostate cancer, particularly in terms of direct medical expenses, highlight the necessity for financial support for patients. The findings from Eswatini by Ngcamphalala et al., [18] indicate that advanced cancer stages significantly augment healthcare costs, a trend also observed in our study. This suggests that early detection and treatment are pivotal in managing overall costs and enhancing patient outcomes.

This study highlights significant variation in stage-specific costs of prostate cancer treatment, with the highest cost per patient in stage 1 at $4,463.77 and the lowest in stage 2 at $1,841. These differences emphasize

the importance of early detection and tailored treatment strategies [16]. The higher cost in stage 1 likely reflects intensive initial treatments, while stage 2's lower cost suggests a more stable management period [10]. The estimated national economic burden of prostate cancer in Iran is approximately $217 million, underlining the need for effective public health initiatives. However, this estimate should be interpreted cautiously due to potential generalizability issues, as regional data may not fully represent the entire country.

Conclusion
Our study provides a comprehensive analysis of the economic burden of prostate cancer in Iran, highlighting critical areas for policy intervention and patient support. By refining cost classification methodologies, enhancing the generalizability of our findings, and ensuring clear and detailed reporting, our research aims to offer more reliable insights into the financial challenges faced by patients and the healthcare system. Addressing gaps in insurance coverage, emphasizing early detection and treatment, and improving healthcare infrastructure are essential strategies to alleviate the economic impact of prostate cancer on individuals and society. These findings can inform policymakers and healthcare providers in making evidence-based decisions to improve patient outcomes and financial protection.

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Limitations

Our study exhibits several limitations that warrant consideration. These include the potential for misreporting of costs and income, as well as the restricted generalizability of our findings due to the metropolitan focus of our patient cohort. Similar to the observations made by Alinezhad et al., [6] the bottom-up approach employed in our study, while valuable for obtaining direct patient information, may inadvertently lead to a higher likelihood of missing values. To address these limitations, future research endeavors should strive to incorporate a more diverse patient population and explore the utilization of top-down approaches to gather more comprehensive data. Since the data were collected from a single center, Rahimi Hospital, in one city, the results may not be representative of the entire country. The socioeconomic, demographic, and healthcare infrastructure variations across different regions of Iran could influence the economic burden of prostate cancer in ways that our study does not capture. To enhance the generalizability of future research, it is recommended that similar studies be conducted in multiple centers across diverse regions of Iran. This would provide a more comprehensive understanding of the economic burden of prostate cancer nationwide. Despite these limitations, we believe our study contributes valuable preliminary data that can serve as a foundation for broader analyses. Reporting the estimated economic burden for Iran as a whole, even with the acknowledged limitations, can still be beneficial for a wider audience, providing a useful starting point for policymakers and healthcare planners. while the national burden estimate offers valuable context, it should be interpreted with caution. The extrapolation is based on regional data that may not fully represent the entire Iranian population. Therefore, the estimated national burden might not be entirely accurate due to potential generalizability issues.

Abbreviations
LMICs   Low- and middle-income countries
DMC   Direct Medical Costs
MOHME   Ministry of Health and Medical Education
DNMC   Direct Non-Medical Costs

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-024-06913-6.

Supplementary Material 1: file 1. The sensitivity analysis.

Declarations

Ethics approval and consent to participate
The study was approved by Ethics Committee of the Iran University of Medical Sciences (IR.IUMS.REC.1402.698). All participants provided written informed consent to participate in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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