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

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Abstract

Background Breast cancer is a significant global health challenge, affecting millions annually and imposing a considerable burden on healthcare systems and economies worldwide. This cross-sectional study aims to determine the economic impact of breast cancer in Lorestan Province, western Iran.

Methods A retrospective cost-of-illness analysis utilizing a cross-sectional design was performed from November 2023 to July 2024. Data were collected using patient medical records and telephonic interviews. Costs were categorized into direct medical costs, direct non-medical costs, and indirect costs. A bottom-up approach was employed for cost calculation from a societal viewpoint, with a prevalence-based analysis.

Results The study analyzed 525 patients with an average age of 42.74 ± 11.75 years. The total economic burden of breast cancer was estimated at $5,394,409.13, with a mean of $10,275.07 per patient. Direct medical costs comprised 70.2% of the total expenses, primarily attributed to hospitalization, chemotherapy, and laboratory tests. Direct non-medical costs, including accommodation and transportation for patients and their companions, accounted for 12.5%. Indirect costs, largely stemming from productivity losses due to morbidity and mortality, represented 17.3% of the total burden.

Conclusion Breast cancer imposes a substantial economic burden on patients and their families in Lorestan Province. Enhancing health insurance coverage, providing government subsidies for treatment, and improving healthcare infrastructure to offer advanced diagnostic and treatment options locally are critical steps to alleviate this burden. Early detection and prevention programs can facilitate earlier diagnosis and reduce treatment costs. Comprehensive policies addressing both medical and non-medical expenses are necessary to improve patients' quality of life and lessen the financial challenges associated with breast cancer in Iran.

Keywords Breast cancer, Economic burden, Cost of illness, Health policy, Cross-sectional study, Iran

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Background

Breast cancer represents a significant global health challenge, affecting millions annually and imposing a considerable burden on healthcare systems and economies worldwide [1]. As the most common cancer among Iranian women, it not only causes profound emotional and physical distress for patients and their families but also imposes a considerable economic burden on the nation's healthcare system [2]. This disease, transcending geographical boundaries, stands as a critical global health issue with its extensive prevalence and life-altering impact, ranking as the second most common cancer globally [3].

Data from the Institute for Health Metrics and Evaluation (IHME) indicate that breast cancer mortality in Iran increased from 3.26 (95% CI: 2.79–3.75) per 100,000 population in 1990 to 9.57 (95% CI: 8.63–10.59) in 2021. Similarly, its incidence rose from 11.35 (95% CI: 9.50–13.52) per 100,000 population in 1990 to 58.70 (95% CI: 52.60–65.72) in 2021 [4]. These statistics underscore the growing public health challenge posed by breast cancer in Iran and its increasing significance in national healthcare priorities.

Breast cancer's economic burden includes substantial direct healthcare costs—encompassing diagnosis, treatment, and palliative care—as well as indirect costs, such as productivity losses due to morbidity and mortality [5]. The rising expenses of advanced, often imported treatments place significant financial strain on both households and the national healthcare system [6]. Moreover, indirect costs related to workforce productivity losses, caregiving responsibilities, and income reductions contribute to the nation's diminished economic output [7]. These factors highlight the need for targeted interventions to address the growing incidence, mortality rates, and economic pressures associated with breast cancer [8]. Efforts to mitigate these impacts require improved healthcare access, government support for treatment expenses, and initiatives promoting early detection and awareness [9].The growing incidence and mortality rates of breast cancer, coupled with its escalating economic burden, emphasize the urgency of addressing this issue [10]. Comprehensive efforts are needed to alleviate its impact, which include improved access to healthcare, government support for treatment expenses, and initiatives to promote early detection and awareness [11]. Furthermore, addressing this public health concern requires robust data and localized studies that reflect the specific circumstances and challenges faced in different regions of Iran [7].

Despite the considerable global and national implications of breast cancer, there is a notable lack of localized economic studies within Iran, particularly in its western regions. This manuscript seeks to bridge this gap by delivering an in-depth, region-specific evaluation of breast cancer's economic impact in Lorestan province. By focusing on the societal perspective, this study provides critical insights into the direct and indirect costs associated with breast cancer, which are essential for resource distribution, treatment access, and advancing prevention programs. These findings aim to guide policymakers in designing targeted interventions that can mitigate the economic and social consequences of breast cancer in Iran.

Methods

Design and population

This study employed a cross-sectional design to perform a partial economic evaluation and cost-of-illness (COI) analysis [12]. The COI approach was utilized to estimate the economic burden of breast cancer, capturing both direct costs (healthcare and non-healthcare expenses) and indirect costs (productivity losses due to morbidity and mortality) [13].

The study population comprised all breast cancer patients in Lorestan province, western Iran. The sampling framework relied on the registration system of breast cancer patients maintained by the Lorestan University Medical of Sciences, Vice Treatment, which includes records from public and private healthcare providers in the region. Eligible participants were those residing in Lorestan province until the study's conclusion, who consented to partake, and who underwent continuous treatment as either outpatients or inpatients. To ensure representativeness of the sample, efforts were made to include patients from diverse demographics and stages of disease. Recruitment was carried out through stratified sampling, with proportional allocation to ensure that patients from both urban and rural areas were represented.

Despite numerous efforts, accessing a subset of patients with complete information remains challenging. Additionally, some patients had incomplete or inaccurate diagnostic records, affecting the reliability of the cost estimates. Furthermore, some patients passed away before data collection could be completed. We adopted a bottom-up approach for cost calculation from a societal viewpoint and conducted a prevalence-based analysis to estimate breast cancer costs during the designated timeframe. Given that breast cancer mainly affects women, this study concentrated on female patients who have been diagnosed with the disease. This economic evaluation was conducted from November 2023 to July 2024. All costs for 2023 were initially reported using the average exchange rate provided by the Central Bank of Iran (1 USD = 430,000 Rials). However, for better cross-country comparability, costs were also converted using the Purchasing Power Parity (PPP) exchange rate for 2023.

Data collection

Data was gathered using a specially designed form, informed by oncology and health economics experts. This form included sections on demographic details, direct medical costs, direct non-medical costs, indirect costs, and out-of-pocket expenses. Demographic data such as age, marital status, educational attainment, insurance status, and disease stage were collected via patient medical records and telephonic interviews with patients or their caregivers.

Costs

1. Direct Medical Costs (TDMC): These encompassed expenses for consultations with physicians and oncologists, emergency department visits, chemotherapy sessions, surgical procedures, laboratory analyses, ultrasonography, MRI and CT scans, echocardiography sessions, radiotherapy treatments, medications, physiotherapy sessions, hormone therapy courses, lymphedema management treatments, psychological services and hospital admissions. The pricing was based on tariffs determined by the Ministry of Health and Medical Education (MOHME).
2. Direct Non-Medical Costs (DNMC): These included transportation expenses, accommodation fees, telephone and internet costs and meal costs for both patients and their companions. The figures were derived through interviews with patients and their relatives.
3. Indirect Costs: These were calculated based on productivity losses due to work absenteeism and premature mortality affecting both patients and caregivers. The losses were quantified using the average wage data for 2023 from the Iranian Statistics Center by applying the human capital approach with the minimum wage for that year.

Stage-specific cost analysis

The costs associated with different stages of breast cancer were calculated by stratifying the sample into four stages based on clinical diagnostic records. For each stage, the average costs for direct medical, direct non-medical, and indirect categories were calculated and aggregated to determine stage-specific totals.

Calculation of economic burden of breast cancer

The economic burden for all breast cancer patients was calculated using the following formula [14], which incorporates the estimated average direct and indirect costs for each patient and the prevalence rate of breast cancer in the country:

Economic burden = Total cost (Direct Medical Cost + Direct Non-medical Cost + Indirect Cost) × Number of breast cancer patients.

This study reports annual costs for 2023 and includes 525 breast cancer patients in Khorramabad. The reliance on a single year's exchange rate may limit comparability with studies conducted in other years. To address this, sensitivity analyses were performed with varying exchange rate scenarios to assess robustness.

Sensitivity analysis

To comprehensively evaluate the economic burden of breast cancer in western Iran, we conducted a sensitivity analysis on the direct medical costs, non-direct medical costs, and indirect costs. This analysis was performed to assess the robustness of our findings under varying economic conditions and assumptions.

Specifically, we explored two different discount rates, 0% and 5%, to reflect different time value of money scenarios:

1. 0% discount rate: This rate assumes no discounting over time, providing a baseline scenario where future costs are treated equally to present costs. This scenario helps in understanding the immediate, unadjusted economic burden of breast cancer.
2. 5% discount rate: This rate is commonly used in health economic evaluations and reflects the opportunity cost of capital, where future costs are discounted to present value. This discount rate accounts for the time preference of money, recognizing that costs incurred in the future are less significant than those incurred in the present.

By comparing these two scenarios, we aimed to capture a range of possible outcomes and enhance the credibility and reliability of our economic burden estimates. The tornado diagram was employed to visually depict the sensitivity of our cost estimates to the chosen discount rates, highlighting the parameters with the greatest influence on the overall economic burden.

Catastrophic Health expenditure (CHE) index calculation

To assess the financial burden of breast cancer care, the Catastrophic Health Expenditure (CHE) index was calculated. CHE was defined as the proportion of households whose out-of-pocket (OOP) healthcare costs exceeded 40% of their capacity to pay (CTP). The capacity to pay was estimated as the household's annual income after meeting subsistence needs (basic living expenses). The following formula was used to calculate the CHE indicator:

$$\text{CHE Indicator} = \frac{OOP\,Costs}{CTP} \times 100$$

Statistical analysis

Data were analyzed using R software Version 4.4.1. Descriptive statistics summarized demographic characteristics and cost data.

Results

Demographic characteristics

Table 1 presents the demographic characteristics of the study participants. The age distribution of the participants showed that the majority were aged 40–49 years (43.62%), followed by those aged 50–59 years (20.76%). Participants aged 20–29 years accounted for 11.81%, 30–39 years for 15.62%, and those over 60 years for 8.19%. The marital status distribution of participants revealed that the majority were married (80.57%), while 12.76% were widowed. A smaller proportion of participants were divorced (3.43%) or single (3.24%). Employment status shows a large proportion of unemployed patients (85.52%) compared to employed individuals (14.48%). Most participants resided in urban areas (76.38%), with 23.62% from rural areas. The distribution of cancer stages showed that 38.86% of patients were in stage 1, followed by 36.38% in stage 2, 15.81% in stage 3, and 8.95% in stage 4. These figures provide insight into the severity of cancer stages among the sample population.

Table 1 Demographic characteristics of patients

Variables	Number	Percent
Age		
20–29	62	11.81
30–39	82	15.62
40–49	229	43.62
50–59	109	20.76
> 60	43	8.19
Employment status		
Employment	76	14.48
Unemployment	449	85.52
Marital status		
Married	423	80.57
Single	17	3.24
Divorced	18	3.43
Widow	67	12.76
Residential location		
Urban	401	76.38
Rural	124	23.62
Education status		
Illiterate	148	28.19
Under diploma	167	31.81
Diploma	140	26.67
Higher than diploma	70	13.33
Insurance status		
Rural	109	20.76
Social Security	223	42.48
Armed forces	46	8.67
Iran health	104	19.81
No	6	1.14
Others	37	7.05
Supplemental insurance		
Yes	351	66.86
No	174	33.14
Stage of cancer		
1	204	38.86
2	191	36.38
3	83	15.81
4	47	8.95
Outcome (Survival)		
Survived	465	88.62
Deceased	60	11.38

Figure 1 presents a detailed breakdown of the various costs associated with breast cancer patients.

Direct medical costs

Table 2 summarizes the direct medical costs for cancer treatment. Chemotherapy costs were highest in stage 4 patients (mean of 1,428.84), with stage 1 patients incurring lower costs (mean of 612.37). Chemotherapy accounted for the largest proportion of direct medical costs across all stages, comprising 12.90% of the total. Other major costs included hospitalization, which represented 32.17% of direct medical costs, and radiotherapy, which made up 7.23% of total costs. It is worth noting the variability of costs across stages (e.g., hospitalization costs were higher for more advanced stages, with stage 4 patients incurring the highest mean costs of 3,017.41).

Direct non-medical costs

Direct non-medical costs, which include transportation (33.76%) and accommodation (36.65%), were also substantial. The mean transportation cost for stage 4 patients was 917.15, reflecting the increased travel burden for patients in later stages. Similarly, accommodation costs were highest for stage 4 patients, averaging 958.13.

Indirect costs

Indirect costs related to the absence of patients' families from work and the patients' own absence from work due to illness were also significant. The mean absence cost for family members ranged from 184.62 (stage 1) to 328.62 (stage 4), with patients' absence from work costing between 318.52 (stage 1) and 483.17 (stage 4). These costs were highest for patients in the more advanced stages of cancer.

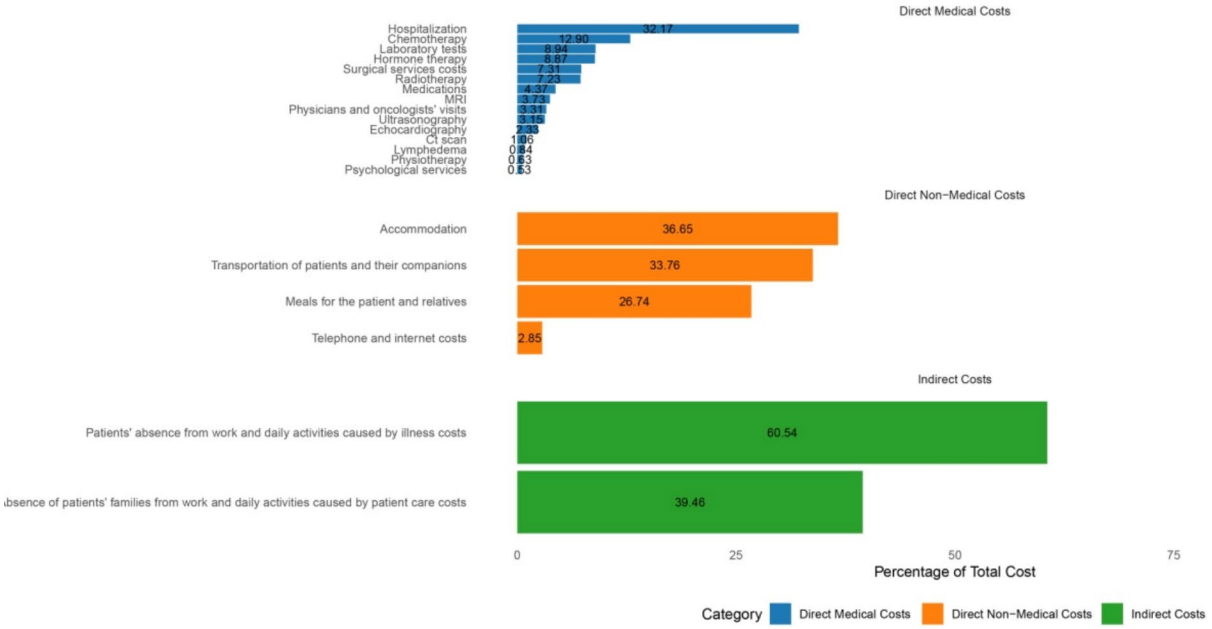

Fig. 1 The costs and percentages for items related to direct medical, direct non-medical, and indirect costs are detailed

Total costs

The total economic burden of breast cancer in this study was $5,394,409.13, with a mean cost of $10,275.07 per patient. Figure 2 highlights the contributions of direct medical costs, direct non-medical costs, and indirect costs to this economic burden.

The total costs, combining direct and indirect costs, varied by cancer stage, with stage 4 patients incurring the highest total costs (mean of 13,880.08). This total includes both direct medical and non-medical costs, as well as indirect costs. In contrast, stage 1 patients had the lowest total costs, with a mean of 6,418.87. This finding underscores the financial burden associated with more advanced cancer stages, as well as the growing economic strain as patients' conditions worsen. Figure 3 depicts the costs of breast cancer patients in this study categorized by the stage of the disease.

Sensitivity analysis

By applying discount rates of 0% and 5%, the range of changes in direct medical costs, non-direct medical costs, indirect costs, and economic burden can be observed in Fig. 4. The sensitivity analysis conducted on the economic burden of breast cancer in western Iran revealed notable differences in cost estimates under varying discount rates. For direct medical costs, at a 0% discount rate, the confidence interval for direct medical costs ranged from 3,115,944 to 5,075,944. This scenario represents the immediate and unadjusted costs, reflecting the full economic burden without considering the time value of money. When applying a 5% discount rate, the confidence interval for direct medical costs decreased slightly to a range of 2,920,899 to 4,880,899. This reduction demonstrates the effect of discounting future costs, highlighting the present value of these expenses. For non-direct medical costs, the confidence interval for non-direct medical costs at a 0% discount rate was between 757,862 and 1,149,862. These costs include expenses such as transportation and accommodation for treatment. Under a 5% discount rate, the interval decreased to 712,440 to 1,104,440, indicating a similar discounting effect as seen with direct medical costs. For indirect costs, representing lost productivity and other economic losses, ranged from 246,603.4 to 442,603.4 at a 0% discount rate. With a 5% discount rate, the confidence interval for indirect costs narrowed to 230,193.8 to 426,193.8, again reflecting the discounted present value of future costs. For economic burden of breast cancer, encompassing all cost categories was estimated to be between 4,218,409 and 6,570,409 at a 0% discount rate. At a 5% discount rate, this range reduced to 3,961,533 to 6,313,533, underscoring the significant impact of discounting on the overall economic burden. The comparison between these two scenarios highlights the sensitivity of cost estimates to the chosen discount rates. The tornado diagram visually depicted this sensitivity, identifying the parameters with the greatest influence on the economic burden. The results indicate that discounting future costs can substantially alter the estimated economic burden, with a lower discount rate reflecting higher immediate costs and a higher discount rate showing reduced present value of future costs. Analysis demonstrates that the economic burden of breast cancer in western Iran is sensitive to the discount rate applied. The 0% discount rate scenario

Table 2 Average annual direct medical, direct non-medical and indirect costs

Type of costs	The mean of costs by stage				Total mean	Percent of cost in type of costs	Percent of total costs
	1 (204 patients)	2 (191 patients)	3 (83 patients)	4 (47 patients)			
Direct medical costs							
Chemotherapy	612.37	943.16	1041.85	1428.84	1006.56	12.90	**75.93**
CT scan	58.42	62.13	90.18	118.93	82.42	1.06	
Echocardiography	90.18	153.39	212.72	272.39	182.17	2.33	
Hormone therapy	0	682.65	893.16	1193.27	692.27	8.87	
Hospitalization	1934.21	2336.37	2751.28	3017.41	2509.82	32.17	
Laboratory tests	512.53	629.86	786.18	862.19	697.69	8.94	
Lymphedema	0	55.19	82.18	124.35	65.43	0.84	
Medications	262.08	294.18	328.93	478.23	340.86	4.37	
MRI	162.03	212.89	327.16	462.15	291.06	3.73	
Physicians and oncologists' visits	201.63	231.70	280.51	319.18	258.26	3.31	
Physiotherapy	13.62	35.81	63.11	83.72	49.07	0.63	
Psychological services	25.61	36.82	43.19	58.26	40.97	0.53	
Radiotherapy	381.27	524.65	619.57	729.82	563.83	7.23	
Surgical services costs	417.83	531.42	619.11	712.18	570.14	7.31	
Ultrasonography	119.84	185.92	285.28	392.51	245.89	3.15	
Total Direct medical costs	**4942.90**	**7108.27**	**8637.46**	**10518.56**	**7801.80**	**100**	
Direct non-medical costs							
Accommodation	396.19	494.17	815.12	958.13	665.90	36.65	**17.68**
Meals for the patient and relatives	318.62	484.93	527.05	612.61	485.80	26.74	
Telephone and internet costs	43.18	49.27	53.19	61.84	51.87	2.85	
Transportation of patients and their companions	215.74	536.92	783.41	917.15	613.31	33.76	
Total Direct non-medical costs	**973.73**	**1565.29**	**2178.77**	**2549.73**	**1816.88**	**100**	
Indirect costs							
Absence of patients' families from work and daily activities caused by patient care costs	184.62	237.05	285.71	328.62	259.00	39.46	**6.39**
Patients' absence from work and daily activities caused by illness costs	318.52	361.39	426.47	483.17	397.39	60.54	
Total Indirect costs	**503.14**	**598.44**	**712.18**	**811.79**	**656.39**	**100**	
Total cost	**6418.87**	**9272.00**	**11528.41**	**13880.08**	**10275.07**		

presents a higher immediate economic burden, while the 5% discount rate scenario reflects a lower present value of future costs. These findings provide a nuanced understanding of the economic implications of breast cancer and underscore the importance of considering discount rates in health economic evaluations. To identify which costs are most sensitive to changes in the discount rate, we compared the relative decrease in confidence intervals for direct medical costs, non-direct medical costs, and indirect costs when moving from a 0% to a 5% discount rate. The relative changes were 6.26% for direct medical costs, 5.99% for non-direct medical costs, and 6.66% for indirect costs. From this comparison, indirect costs show the largest relative change (6.66%) when moving from a 0% to a 5% discount rate, indicating that indirect costs are most sensitive to changes in the discount rate. The results of our sensitivity analysis demonstrate that indirect costs, which include lost productivity and other economic losses, are the most affected by changes in the discount rate.

Catastrophic health expenditure (CHE) index

The annual out-of-pocket (OOP) cost was calculated at 4,416,280,100 IRR (10,275.07 USD at an exchange rate of 1 USD = 430,000 IRR), while the average annual household income was 1,560,000,000 IRR. The capacity to pay (CTP) is 40% of household income after accounting for basic needs, the CTP was estimated at 624,000,000 IRR annually.

$$\text{CHE Indicator} = \frac{4416280100}{624000000} \times 100 = 708.40\%,$$

This result demonstrates that the CHE indicator far exceeds the critical threshold of 40%, indicating that all households in the cohort (100%) would face catastrophic health expenditures under these conditions.

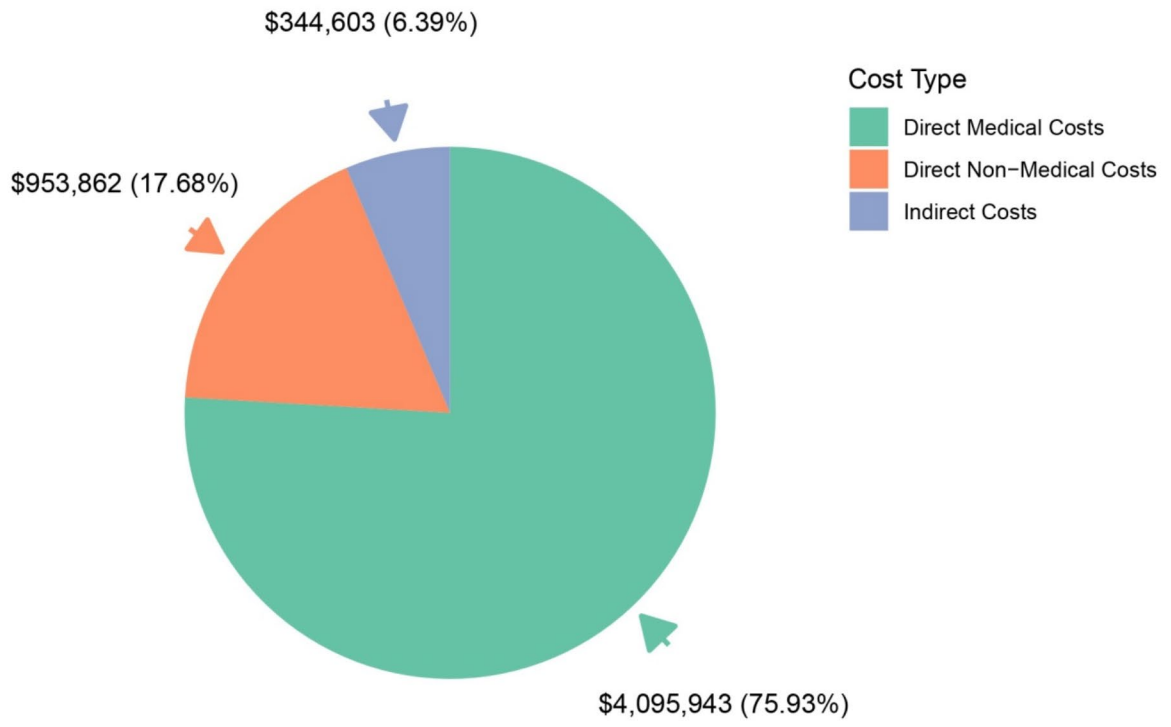

Fig. 2 Economic burden of breast cancer according to, non-direct medical costs and indirect costs

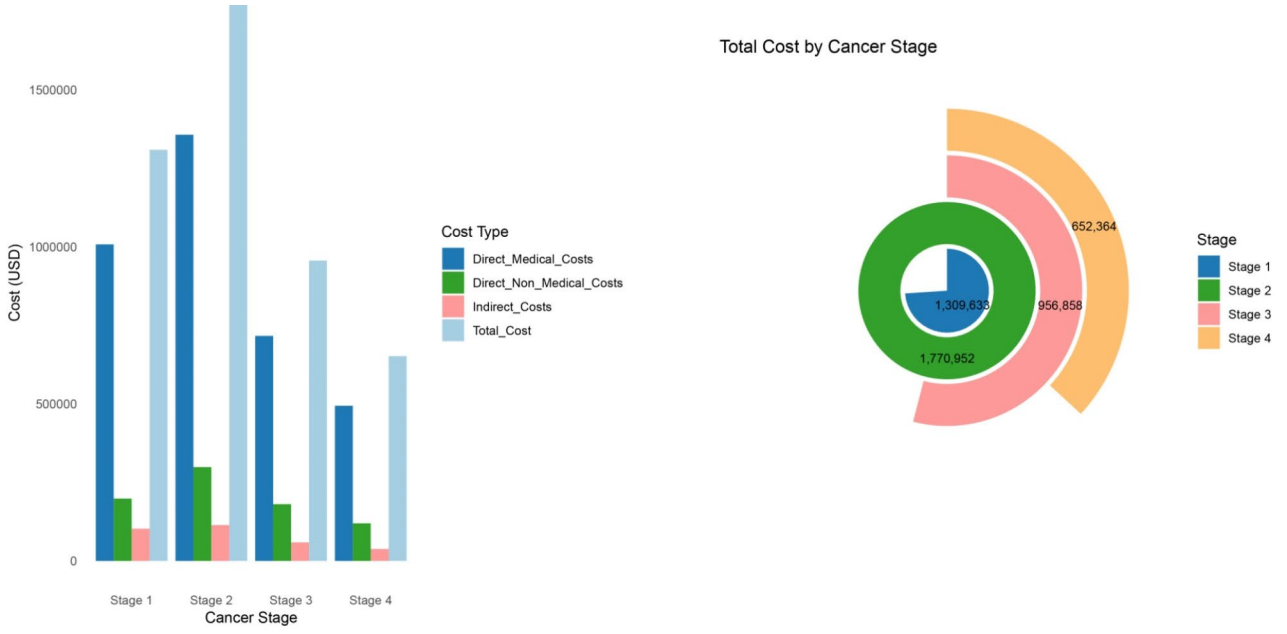

Fig. 3 Different costs calculated according to the stage of the disease

Discussion

The economic burden of breast cancer in this study was calculated at $5,394,409.13. This figure underscores the considerable strain placed on the healthcare system and individual households, particularly in the context of Iran's economic challenges. Patients with breast cancer often require multifaceted healthcare services, contributing to the substantial financial impact observed.

Our findings revealed that the majority of patients were aged between 40 and 60 years, consistent with studies from Ghana [15] and Iran [13, 16]. This age range often coincides with significant hormonal shifts, such as menopause, which may increase breast cancer risk [17].

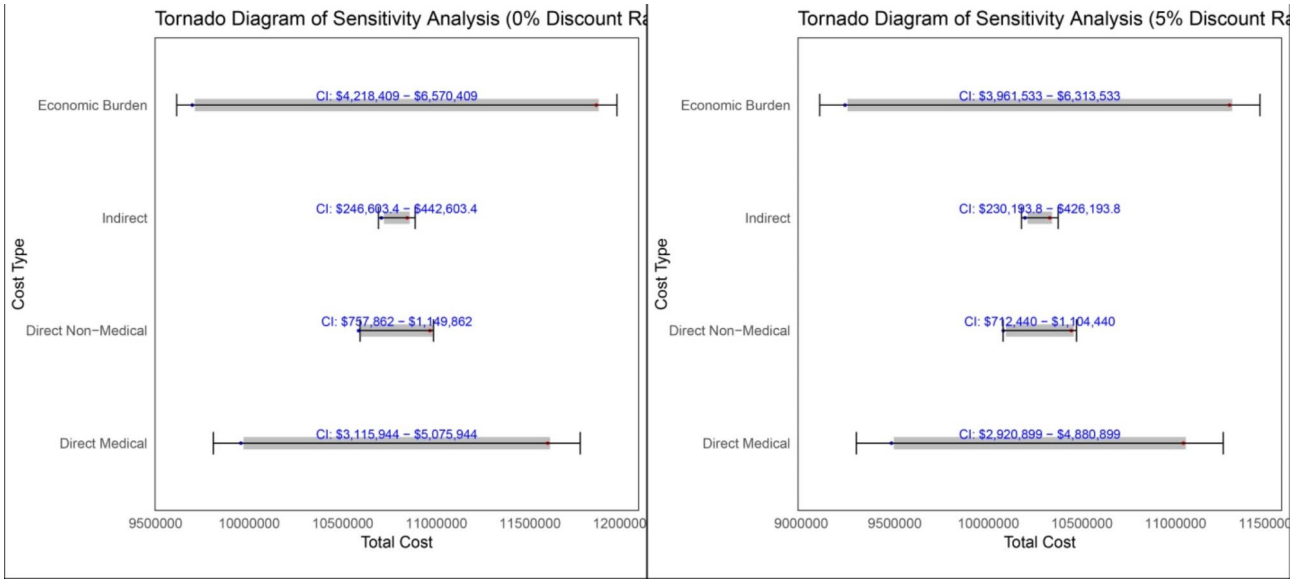

Fig. 4 Totnado diagram

Prolonged exposure to hormonal therapies, lifestyle factors, and environmental risks contribute to higher susceptibility during this phase. Hormone Replacement Therapy (HRT) use during menopause further exacerbates this risk [18]. Additionally, targeted breast cancer screening programs focusing on women aged 40 and above enhance diagnosis rates in this demographic [19, 20].

Our analysis showed a higher prevalence of breast cancer among women with lower educational attainment, echoing findings from studies in China [21] and Nigeria [22]. However, contrary to global trends, meta-analyses have indicated that women with higher education levels are at greater risk of developing breast cancer [23]. In Iran, lower education levels might contribute to limited health literacy, delayed medical consultation, and poor adherence to cancer screening programs [13, 16].

Lower education levels, as highlighted in our findings, were associated with a higher prevalence of breast cancer and greater economic burden. This association may partially be explained by the role of health literacy, which is often lower among individuals with limited education [24, 25]. Health literacy plays a critical role in the early detection of breast cancer, as individuals with higher health literacy are more likely to participate in regular screenings, recognize early symptoms, and seek timely medical care [26]. Additionally, inadequate health literacy can impact patients' ability to navigate healthcare systems, adhere to treatment regimens, and manage the disease effectively, thereby contributing to increased indirect costs such as productivity loss and caregiver burden [27]. Interventions aimed at improving health literacy, particularly in underserved populations, could mitigate these disparities by promoting early detection and better disease management, ultimately reducing both the prevalence and the economic burden of breast cancer [28].

Education level also correlates with socioeconomic status (SES). Lower SES may be associated with factors such as poor diet, inadequate healthcare access, and exposure to carcinogens, which could increase breast cancer risk [29]. Conversely, higher SES may facilitate early detection and better health outcomes due to greater access to screening and diagnostic services [30].

Direct medical costs constituted 70.2% of the total breast cancer-related expenses in our study. This aligns with similar findings from Spain [31], Saudi Arabia [32], and prior research in Iran [13, 33]. Breast cancer management typically involves multiple high-cost interventions, including surgery, chemotherapy, radiation therapy, and advanced imaging techniques [34]. These treatments are resource-intensive and represent significant expenditures for healthcare systems [35].

Hospitalization, chemotherapy, and laboratory tests were identified as the largest contributors to medical costs. Hospitalization costs encompass charges for inpatient care, medications, and associated diagnostic procedures [13, 16, 33]. Chemotherapy and laboratory testing—critical components of modern cancer care—account for a significant share of expenses due to advancements in personalized medicine and molecular diagnostics [36].

Indirect costs, including productivity losses and caregiving burdens, have been highlighted as significant yet underexplored contributors to the economic impact of breast cancer [37]. Caregivers, often family members, face financial strain, emotional stress, and disruption in

their professional lives [38]. Future studies should investigate the economic implications of caregiving, including the psychological toll and lost income of caregivers. Indirect costs related to productivity losses extend beyond the individual to the broader economy [24, 39].

For example, absenteeism and presenteeism among breast cancer patients and their caregivers can significantly affect national productivity [40, 41]. The cumulative impact on Gross Domestic Product (GDP) and workforce participation could be considerable, especially in labor-intensive sectors such as manufacturing and services [42]. Beyond direct productivity losses, the long-term effects on the labor market—such as early retirement, reduced work capacity, and shifts in workforce demographics—could further hinder economic growth [43]. Quantifying these indirect costs and evaluating their implications for national economic policies, including workforce development and social security programs, would offer critical insights for policymakers [44]. Such data could guide investment decisions in early cancer detection, treatment accessibility, and workforce reintegration programs, ultimately fostering both improved health outcomes and economic sustainability [45].

Accommodation for patients and their companions represented the most significant non-medical cost. Patients traveling from remote areas to urban centers such as Khorramabad incur additional expenses for lodging, highlighting disparities in healthcare accessibility. Previous studies in Iran and other countries [15, 46, 47] have identified similar challenges, emphasizing the need for affordable accommodations and travel subsidies for rural patients [16, 33, 48].

The findings on the CHE index highlight an economic challenge for households affected by breast cancer in Lorestan Province. With an annual OOP cost exceeding seven times the capacity to pay (708.40%), all households in the cohort face catastrophic financial burdens. This far surpasses the internationally recognized critical threshold of 40%, underscoring the profound inequities in healthcare affordability. Such a high CHE index reflects systemic gaps in health financing and emphasizes the urgent need for policy interventions, including enhanced health insurance schemes and government subsidies [49, 50]. Addressing this issue is essential to protect households from financial ruin and to ensure equitable access to cancer care services [51, 52].

Limitations

This study has several limitations. First, it relied on patient medical records and telephone interviews, which may result in incomplete or inaccurate data. While telephone interviews provided valuable insights, they may have introduced biases due to recall limitations or reporting inaccuracies. Steps to mitigate this included cross-checking with medical records and triangulating responses wherever feasible. Second, the findings are specific to Lorestan Province and may not generalize to other regions due to differences in healthcare infrastructure and cultural factors. This introduces potential bias, as the remaining cohort may not fully represent the broader population of breast cancer patients in Khorramabad. The exclusion of these patients could impact the generalizability of the cost estimates. Third, indirect costs such as productivity losses were estimated but require further exploration, particularly their macroeconomic implications. Intangible costs like pain and suffering, which significantly contribute to the overall burden, were not quantified. Additionally, measures to minimize bias included robust data verification procedures and triangulation of information from medical records, registry data, and caregiver interviews. Currency conversion challenges may also impact the accuracy of 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 breast cancer. By acknowledging these limitations, future studies can build on our findings to provide a more comprehensive understanding of the economic burden of breast cancer in diverse contexts.

Policy implications

The findings of this study have several policy implications for managing the economic burden of breast cancer in Iran:

1. **Enhancing health insurance coverage**: Expanding health insurance coverage is crucial to reduce out-of-pocket expenses, particularly for long-term treatments, rehabilitation, and caregiver-related costs. Comprehensive insurance policies should include provisions for indirect costs, such as income replacement for patients and caregivers.
2. **Government subsidies**: Implementing government subsidies for breast cancer treatments can significantly alleviate the financial strain on patients and their families. Subsidies should also extend to cover transportation, caregiving, and other indirect costs to ensure continuity of care.
3. **Improving healthcare infrastructure**: Strengthening healthcare infrastructure to provide advanced diagnostic and treatment options locally can minimize the indirect costs related to patient travel and accommodation. This can be especially impactful in rural and underserved areas.
4. **Promoting early detection and prevention**: Investing in early detection and prevention programs, including subsidized screenings and

targeted awareness campaigns, can reduce the incidence of late-stage cancer diagnoses. Early interventions can lead to cost savings in treatment and improve patient survival rates.

5. **Supporting patient and family care**: Establishing robust support mechanisms, such as financial aid, psychological counseling, and respite care for caregivers, can mitigate the socio-economic impact of caregiving burdens. Additionally, workplace policies promoting flexibility and job security for affected individuals can address workforce productivity losses.
6. **Addressing macroeconomic implications**: Policymakers should consider the broader macroeconomic impact of breast cancer, including absenteeism, presenteeism, and reduced workforce participation. Integrating these factors into national health and economic policies can strengthen the case for targeted investments in breast cancer management.

Conclusion

Breast cancer imposes a significant economic burden on patients and their families in Lorestan Province, Iran, driven by high direct medical expenses and substantial indirect costs. The study highlights the need for improved health insurance coverage, government subsidies, and enhanced healthcare infrastructure to address these financial challenges. Emphasizing early detection, prevention programs, and addressing socioeconomic disparities are critical for reducing costs and improving outcomes. Future research should explore regional cost variations and macroeconomic impacts to develop more effective strategies for managing the economic implications of breast cancer.

Abbreviations

IHME	Health Metrics and Evaluation
COI	Cost-of-Illness
TDMC	Direct Medical Costs
MOHME	Ministry of Health and Medical Education
DNMC	Direct Non-Medical Costs
CHE	Catastrophic Health Expenditure
OOP	Out-of-Pocket
CTP	Capacity to Pay
SES	Socioeconomic Status
GDP	Gross Domestic Product

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Author contributions

Conceptualization: BDT, MeB, SA, MSAR. Data curation: MaB, BDT, PH, SA, AB, MB, MS And SJE. Formal analysis: MaB, AR, MM and SA. Investigation: BDT, MB, SJE. Methodology: MaB, BDT. Project administration: MeB, AR, PH, SA. Supervision: MaB, AR. Validation: BDT, MaB. Writing – original draft: MaB, SA, AB, BDT. Writing – review & editing: SJE, AB, MaB, AR, BDT. The author(s) read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The ethics committee of the Lorestan University of Medical Sciences approved this study (approval code no. IR.LUMS.REC.1402.232).

Consent for publication

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Competing interests

The authors declare no competing interests.

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