Original Article

Cost- Effectiveness of Breast Cancer Screening in Shiraz, Iran

Abstract

Background: Breast cancer is the most common cancer in the world, which accounts for 21.4% of all kinds of cancers for women in Iran. However, the treatment of breast cancer is costly and given that the budget devoted to the healthcare sector is limited, the present study aimed to investigate the cost-effectiveness of breast cancer screening for women, who referred to breast clinic located in Shahid Motahari clinic affiliated to Shiraz University of Medical Sciences, Shiraz city, Iran in 2017-2018. **Methods:** This study is a cross-sectional study analyzing the cost-effectiveness of breast cancer screening versus no screening. The study was conducted on 3500 women, who referred to the breast clinic in Motahari clinic, at 2017–2018 in Shiraz, Iran. The patients were identified and direct costs, which were correlated to cancer breast screening, were calculated based on the patients' records with public tariff per person. Tree age pro 2011 used to analyze cost effectiveness. **Results:** Based on the results obtained, the expected cost of screening and no screening were 7556 $ppp and 7840 $ppp, respectively. Given their difference in effectiveness (16%), screening was dominant (less costly and more effective) compared to no screening. Tornado diagram showed that the results had the maximum sensitivity to the increase in screening cost. **Conclusions:** In general, according to the results obtained from the current study, the screening was more cost effective compared with no screening.

Keywords: *Breast cancer, cancer of breast, cost-effectiveness analysis, diagnostic screening programs, screening*

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Introduction

Breast cancer is the most common malignancy in women and the leading cause of death in the world with approximately 508,000 death in 2011.[1-5]

In Iran, the average age of the breast cancer among Iranian ladies is 10 years lower than western countries considering one out of 4 women with breast cancer in Iran would be in the advanced-stage cancer due to the late diagnosis.[6-12] A study of cost effectiveness of breast cancer screening in the National Breast and Cervical Cancer and claimed breast cancer screening improves Quality Adjusted Life of Years (QALYs) and was cost-effective among the target population of low-income, 3 uninsured women aged 40–64 years.[13]

In another study was shown that the mammography screening in Iranian women in the first round saved International $ 37,350 per QALY and screening program was cost-effective in 53% of the cases, they also claimed according to cost per QALY in the second and third rounds of screening, evaluation of other screening strategies would be useful to identify more cost-effective program.[14] In united states results showed breast cancer screening lead to reduce breast cancer deaths by 26% for every 1,000 women screened, and increase life expectancy by 1.4 months, decrease the number of women diagnosed with late-stage cancer, increasing 5-year survival rates and finally save money due to diagnosis at an early stage which is less expensive to treat comparing to late stages.[15]

Results of another study indicated that compared with no screening, the risk-based breast cancer screening program is cost effective in low- and middle-income countries.[16]

In this study we investigated the cost effectiveness of screening in women who referred to the referral breast cancer clinic of Southern Iran utilizing clinical examination, mammography, sonography, and finally biopsy and pathological tests.

Methods

Population

This study was a cost-effectiveness analysis performed on all 3,500 referred women to

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the Motahhari referral clinic, Shiraz, Iran for breast cancer during 2017–2018.

Inclusion criteria included those over the age of 20, survivors of breast cancer who had a complete medical record, women who had a diagnosed breast cancer mass were excluded from the study.

Measurement

The researchers used patients' medical records to collect demographic information, medical history including: Type of surgery, chemotherapy, radiotherapy, and medications currently used and finally in the last part, follow up data including: Number of visits and type of diagnostic tests such as mammography, blood tests, breast ultrasound, MRI, breast biopsy and X-ray. The cost data recorded in each relevant part. In this study, the direct medical costs were measured from a service provider's perspective.

To calculate treatment costs, patients categorized by cancer stages based on American Joint Committee on Cancer (AJCC) classification and the costs of medication and services received at each stage of the disease and the direct costs of screening breast cancer were calculated for each patient, based on the governmental tariff in 2017.

Total costs of screening program and treatment and diagnosis calculated per patient in the public sector.

To measure the effectiveness, case detection or diagnosis, recurrence, and metastasis indices were used to see if this indicator was able to make diagnostic tests effective in early detection of metastasis or recurrence or not.

In this study we used annual average rate of US dollars based on purchasing power parity (PPP) at 2018 (equivalent to 14535.9 Rials per dollars for conversion) provided by the World Bank.[17]

Statistical Analysis

For descriptive analysis of data, Excel 2007 software was used TREEAGE PRO 2011 software was also used to perform economic analyzes such as cost-effectiveness chart analysis, calculation of incremental cost-effectiveness index, drawing Tornado chart and to perform sensitivity analysis. According to the study time horizon, which is one-year (second half 2017 and first half 2018) no discount rate was applied. The incremental cost-effectiveness ratio (ICER) was calculated using the following equation in which cost A is screening cost, cost B is treatment and diagnosis cost, outcome A is the number of cases detected or diagnosed and outcome B is the number of cases with recurrence and metastasis indices:

$$ICEAR = \frac{Cost\ A - Cost\ B}{Outcome\ A - Outcome\ B}$$

The ICER was calculated by dividing the cost difference by the effective difference. If the ICER result is negative; In this case, one of the programs is dominant compared to the other program, and if ICER is positive, then to decision making, ICER should be compared with the threshold. To increase the robustness of the results, At last, in order to assess and increase the accuracy of the work and because of the inherent uncertainties of the data and power of analysis, one-way sensitivity analysis was used.

Results

Based on the data shown in Table 1, in 3444 cases studied with the average age of 42 ± 4 years, the average age of healthy women and those suffering from the breast cancer were 40 ± 8 and 50 ± 6, respectively. The most cases of these two groups were in the age group of 40–49. Also, among the cases studied, 75% were married women, 33% were women with more than three children and 70% and 25% were women with breast feeding and abortion history.

In studied cases, the women with government jobs had the most contribution (75%) in comparison with the others. The menopause age was estimated to be about 47 years and 24% of the women had a history of breast cancer at least at one of their family members or relatives and 7% of them in the closet members of their family. The patients aged 40-49 years had the maximum frequency (35%) and those in 20-30 had the minimum.

All of the screening costs for women, who referred to the breast clinic, are shown in Table 2. Direct expenses of screening for each case based on public and private tariffs were estimated 43.6 $PPP and 145.6 $PPP, respectively. Among the offered services, the number and the cost of prescribed sonography is the highest, and then mammography, biopsy, pathology, MRI, and chest X-ray, respectively.

Based on Figure 1, the studied cases in both screening and non-screening groups were divided into two secondary branches, namely HAVE CANCER and NO CANCER. Below each branch is the status of the subgroup and below that the probability of each subgroup is obtained by dividing the number of subgroups by the total number of individuals in each subgroup (0.2 and 0.8 are the probability of breast cancer and non-breast cancer, respectively. In addition, 0.8 and 0.2 are the probability of positive and negative tests among involved patients and 0.03 and 0.97 are the probability of positive and negative tests among healthy people, respectively), which was obtained by dividing the number of individuals in each subgroup by the total number of them in each group.

The results of cost-effectiveness analysis indicated in Table 3. Based on this table, the expected costs for breast cancer screening and no-screening were 7556 $ppp and 7840 $ppp, respectively, and given their difference in effectiveness (16%), screening was dominant (less costly and more effective) compared to no screening.

Table 1: Demographic status of patients referring to Breast clinic, Motahari Clinic in 2017-2018

Variables	No. of Patients (%)	No. of Healthy people (%)
Age groups		
≥29	16 (2.3)	535 (19.5)
30-39	79 (11.3)	837 (30.5)
40-49	246 (33.9)	812 (29.6)
50-59	187 (26.9)	398 (14.5)
60≥	172 (24.6)	162 (5.9)
Education Level		
Illiterate	129 (18.5)	197 (7.2)
Elementary	440 (62.9)	1004 (36.6)
Secondary	22 (3)	738 (26.9)
Post-graduate	109 (15.6)	805 (29.3)
Marital status		
Single	180 (25.7)	686 (25)
Married	520 (74.3)	2058 (75)
Job		
Housewife	128 (18.3)	598 (21.8)
Employee	539 (77)	2044 (74.5)
Free	33 (4.7)	102 (3.7)
OCP[1] usage history		
Yes	327 (46.8)	1190 (43.6)
No	373 (53.2)	1554 (56.6)
Number of children		
0	190 (27.1)	812 (29.6)
1-2	168 (24)	442 (16.1)
3-4	150 (21.5)	357 (13)
≤5	192 (27.4)	1133 (41.3)
Breast feeding history		
Yes	574 (82)	1879 (68.5)
No	126 (18)	865 (31.5)
Abortion history		
Yes	185 (26.4)	686 (25)
No	515 (73.6)	2058 (75)
Age of first pregnancy		
Mean	21.1±3	21.6±3
Menstrual age		
Mean	47.9±5	47±6
Family history of breast cancer		
No	525 (75.1)	2047 (74.6)
First degree	52 (7.42)	210 (7.6)
Second degree	123 (17.5)	487 (17.8)
History of smoking		
Yes	84 (12)	285 (10.4)
No	616 (88)	2459 (89.6)

[1]Oral contraceptive pill

Since in this study case detection was considered as an indicator of effectiveness, the calculated incremental cost effectiveness ratio indicated that screening reduced the expected cost by 201.80 $compared to no screening per unit increase. Based on the results, out of 3500 cases studied, 700 had breast cancer, of which 13% were under 40 and the rest were over 40.

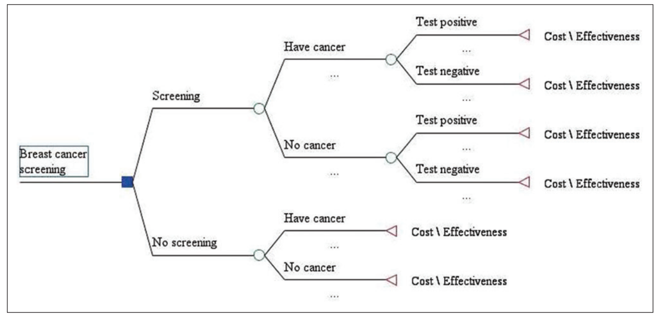

Figure 1: Decision tree results for breast cancer screening in comparison with non-screening

Figure 2 indicated the diagram of cost-effective analysis. The vertical and horizontal vectors represent the expected costs and effectiveness, and triangle and square symbols indicate no screening and screening, respectively. Also, the circle symbol indicates dominated option, and the positive symbol, representing the dominant option, has been placed on the square (screening) demonstrating that screening compared to no screening is the dominant option. Since economic evaluations are associated with uncertainty, it has been tried to test the consistency and generalizability of the results through one-way analysis of sensitivity. In one-way sensitivity analysis, each parameter increased by 20% and the Tornado diagram was drawn [Figure 3].

Based on the results obtained from the Tornado diagram, ICER (-1775$PPP) has the lowest and the highest sensitivity to the increase in the effectiveness and cost of screening, respectively [Figure 3].

According to Table 4, The highest number of malignant masses were found in women aged 40-49 years, followed by those of 50-59 years and then over 60 years. As the menopause age was estimated 47 in the present study, and most of the patients recognized, were at age 47, it seems that breast cancer screening will be cost-effective if it starts at the age of 40. Furthermore, according to the increasing growth of this disease in young women in Iran, it is recommended that screening of breast cancer begins for people over 35 years of age.

Discussion

Despite the enormous costs that breast cancer incurs on the health sector each year, little attention has been paid to preventive measures in this regard in Iran. It seems that the economic burden of this disease may lead to catastrophic health expenditure, especially in low-income families. Therefore, it is necessary to conduct studies on implementation of different methods for early diagnosis so that they may have favorable results in terms of effectiveness of treatment and cost-effectiveness.

According to the findings of this study, out of the 5 individuals with an average age of 42 years, healthy individuals and those with breast cancer were 40 and 50,

Table 2: Screening costs of public and private tariffs referrals to Motahari Clinic, breast clinic in 2017-2018

	Number	Public tariffs ($/ppp) per unit	Private tariffs ($/ppp) per unit	Total cost in PPP
GPs' visits[1]	3444	2.62	8.74	9027.05
Specialist visit	7771	3.99	22.50	31007
Mammography	2029	14.8	48.84	30010
Sonography	3335	9.91	33.02	3318.68
Biopsy and pathology Patients	700	57.96	317.45	40573.89
Healthy People: Benign	59		10.59	3419.80
Sum	759		106.36	43993.69
Chest Radiography	27	3.16	10.59	85.44
M.R.I	96	31.92	106.36	3077.62
Total cost of screening 150240			501566	
Cost of screening: Per person 43.6			145.6	

[1]General practitioner

Table 3: Comparison of Cost-effectiveness of breast cancer screening versus non- screening in 2018-2018

Variables	Mean Expected Cost±SD (US$, PPP)	Expected effectiveness (true positive)	Cost difference	Effectiveness difference	Screening versus No screening
Screening	7556±34	0.16	-284	0.16	Dominant
No screening	7840±38	0			

Table 4: The average size of the mass based on the age range of the patients with breast cancer

Age range	20-29 (%)	30-39 (%)	40-49 (%)	50-59 (%)	≥60 (%)
≤2	1	6.6	22	18	15.4
2-5	0.2	3.8	9.8	8/8	0.7
5≥	0.4	1.2	3.4	1.6	0.6

respectively. In both groups, the maximum numbers were at the average age of 40-49 years, which 75% of them were married. Besides, among them, the highest frequency, namely 33% belonged to the women with three children, whom 70% and 25% of them had breastfeeding and abortion history, respectively. The menopause age was estimated to be about 47 years among women who referred.

Additionally, it should be mentioned that 24% of referred individuals had a history of breast cancer at least in a member of their family or their close relatives. Patients aged 40-49 and 20-30 years had the maximum (35%) and the minimum (2.3%) frequencies respectively, among the other patients.

Based on the results obtained from the study, the average of expected cost for screening in comparison with no screening was 7556 $ ppp and 7840 $ ppp, respectively, per patient at the final stage of the disease. Thus, the average annual cost of screening per patient is lower than non-screening option and treatment costs at the late stages of the disease.

In this study the average cost of each screened individual based on public and private tariffs was estimated to be 43.6 $PPP and 145.6 $PPP, respectively. Whereas, according to Davari *et al*., the average of direct medical costs in the case of non-screening option for a four-stage

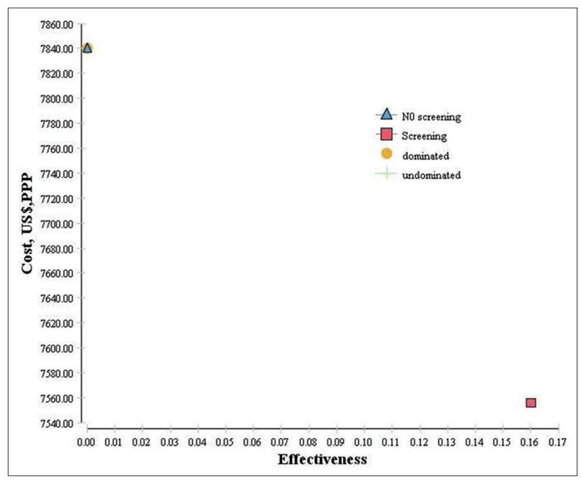

Figure 2: Cost-effectiveness analysis of breast cancer screening compared to non-screening

treatment period, were 4218.89, 4336.99, 5424.3, and 4451.71 $, respectively.[18] This decrease is attributed to the high pharmaceutical, surgical, and chemotherapy costs. Moreover, indirect costs such as low household income levels, travel costs, accommodation during post-hospitalization for the patients under treatment, the costs of treatment and the consequences of non-screening option, can be increased dramatically.

In this study, case detection was used as the effectiveness indicator. Given the greater efficacy of the screening option, it was proved to be a suitable option to prevent and encounter breast cancer. It is noteworthy that the results obtained from this study are in line with the results obtained from the study conducted by Pataky *et al*., which was carried out on cost effectiveness of breast cancer screening among women aged 40-49 years. Thus

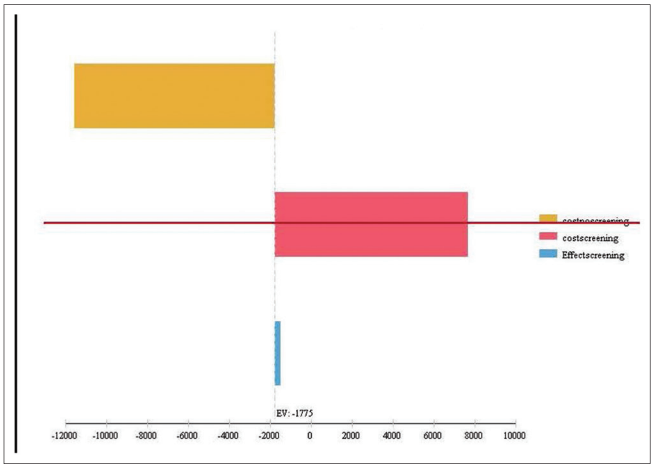

Figure 3: Tornado Diagram for One-Way Sensitivity Analysis. Based on this diagram, the ICER (-1775$PPP) has the lowest and the highest sensitivity to the

approved, screening women in the age group of 40–49 was more cost effective than screening women aged 70–74.[19] Sankatsing *et al*. (2015) evaluated the cost-effectiveness of breast cancer screening compared to non-screening in the Netherland. They concluded that the cost of producing an additional LYG compared to a less sensitive screening strategy was 5.329 € (biennial 74-48 versus current strategy), 2876 € (biennial 74-45 versus biennial 74-48), 10826 € (biennial 74-40 versus biennial 74-45), 18759 € (annual 40-49, biennial 74-50 versus biennial 74-40). Other strategies have been resulted in less desirable ICER. These findings show that the expansion of the screening programs is cost-effective in 40- to 49-year-old individuals in the Netherland, especially for the biennial strategies. Therefore, the present study confirms their findings.[20]

In another study, showed that the cost effectiveness of breast cancer screening versus non-screening has cost effectiveness. While screening can improve QALY among low-income women in the community who are not covered by insurance.[13]

In one study of cost effectiveness of breast cancer screening using mammography state that the epidemiological features of breast cancer in Korean, showed women differ from those reported in Western women, with the highest incidence of cancer. Korea occurs in women in their 40s. In her study, she emphasized the cost effectiveness of breast cancer screening over a period of time, and recommended that biennial screening be performed on women as young as 40 years old.[21] The results are in agreement with the findings of the present research.

There is also an agreement between the present results and those obtained from the recent studies based on the maximum incidence of breast cancer in women aged 40-49 years[8,9] after menopause.[22] Because the average age of the women with the breast cancer was 50, and the average age of menopause was 47, postmenopausal breast cancer screening seem to be crucial.

The impact of breast cancer appears to be more pronounced when the parents, especially the mother is affected, children's tranquility and the whole family well-being would be endangered. The issue would be more complicated when the mother of the family diagnosed with breast cancer is a source of family income, and she is unable to work and earn money and care for children for a while.

On the other hand, the estimated cost of this disease, as well as the age group at risk for breast cancer, shows how much it can affect a country's economy. Limitation of this study is not considering new risk factors for breast cancer, [23,24] indirect, and intangible costs were not calculated due to the extent and inability to accurately measure them. Based on the results of the study, the costs of non-screening treatment are very high compared to screening and early diagnosis of breast cancer.

Conclusions

According to the findings, the costs of breast cancer treatment are higher in the case of no screening compared to screening and early diagnosis. Therefore, it can be stated that due to the increased incidence of the disease at younger ages and due to the size of the malignant masses, indicating the delayed referral of patients, screening of patients over 40 years of age, especially in postmenopausal age and early diagnosis of primary stages of the disease can dramatically reduce mortality and morbidity as well as the economic and psychological burdens on the household. Finally, the results of this study seem to confirm the cost-effectiveness of annual screening in women over 40 years.

Admittedly, this study will provide essential information to health policy makers and other stakeholders. It is hoped that further studies on the disease and its costs will be carried out in the future, devoid of any shortcomings in this study.

Ethical approval

The Ethics Review Board of shiraz university of medical sciences, approved the present study with the following number: IR.SUMS.REC.1398.197.

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Conflicts of interest

There are no conflicts of interest.

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