RESEARCH ARTICLE

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Pathways to Care, Out- of- Pocket Expenditure, and Associated Factors Among Breast Cancer Patients in Kerala, India: A Hospital-Based Cross- Sectional Study

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Abstract

Background: Breast cancer, the most common cancer among women in India, poses a significant public health challenge. However, data on pathways to care and out-of-pocket expenditure (OOPE) among breast cancer patients are limited in India. Kerala, despite its high literacy rates and excellent healthcare access, continues to experience significant delays in cancer care, making it an important setting for this study. Therefore, we aimed to study the pathways to care, estimate OOPE, and identify factors associated with OOPE among breast cancer patients in the Indian state of Kerala. **Methods:** We conducted a hospital-based cross-sectional study among 216 breast cancer patients (mean age: 57 years) from one private and one public tertiary cancer care centre (TCCC) in Kerala. A structured interview schedule was used to collect socio-demographic, clinical, and expenditure-related data. Descriptive statistics, Mann–Whitney U tests, and median regression analysis were performed. The duration of the study was from October 2024 to May 2025. **Results:** Most participants were diagnosed at early stages (n=152, 70.4%), and 42.5% (n=92) had health insurance coverage. In the study, 168 (77.8%: 95% CI: 71.6–83.1%) participants followed indirect pathways, initially consulting traditional healers (25, 11.57%) or other healthcare providers (143, 66.20%) before reaching TCCCs. OOPE was significantly higher among patients treated in private TCCCs compared to those in public TCCCs (median INR 2,26,395 vs 1,93,290; p = 0.015). Residence ≥82 km from the centre (coefficient:28470; p=0.044), treatment at private TCCC (coefficient:50010; p=0.001) and indirect pathway to TCCC (coefficient:46180; p=0.015) were significantly associated with higher OOPE. **Conclusion:** The majority of breast cancer patients in Kerala accessed tertiary care through indirect pathways, with substantially higher out-of-pocket expenditure (OOPE) among those treated in private centres. Targeted policy interventions, such as strengthening primary care linkages and improving referral coordination, are essential to reduce delays in care pathways and alleviate the financial burden on breast cancer patients.

Keywords: Breast cancer- pathways to care- out-of-pocket expenditure- Catastrophic health expenditure

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Introduction

Cancers account for 16.8 % mortality globally [1]. In the year 2022, 2.3 million women had a breast cancer diagnosis and 6.7 million died from the disease worldwide [2]. In India as per medical certification of cause of death, cancer was the fifth leading cause of mortality in the year 2018 [3]. According to GLOBOCAN, India came in third place, behind the United States of America and China, with a projected burden of 2.08 million cases by 2040, a 57.5% increase from 2020 [4]. Breast cancer is the most common malignancy among women, with an anticipated 178,361 new cases and 90,408 fatalities in 2020 or 13.5% of all female cancer deaths [5]. The population-based incidence rates of breast cancer in women of various ages (per 100,000) are 32.8% in those aged 25–49, 27.9% in those aged 50–69, and 23.4% in those aged 70 and above [6].

In India, breast cancer accounts for more than 28% of all clinically diagnosed cancers, with an economic burden projected to increase from USD 10.2 billion in 2025 to USD 13.95 billion by 2030 [6]. Breast cancer-related catastrophic health expenditure in India can account for anywhere between 30% and 70% of yearly household income, particularly for those without insurance [7]. Breast cancer is the topmost cancer among women in Kerala, the most advanced state in epidemiologic and demographic transition in India [8]. Despite the existence of health programs, research in Kerala indicates that households are

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forced into debt as a result of financial hardship brought on by cancer treatment, with out-of-pocket expenditure (OOPE) experienced by more than 70% of patients [9]. In spite of improvements in treatment methods, women with breast cancer are at danger for death due to a lack of access to current facilities and a failure to diagnose the illness in its early stage [10]. The course of the disease and the expense of therapy are greatly impacted by delays at several points in the care pathway (detection, diagnosis, referral, and treatment). Prolonged or fragmented pathways in breast cancer are linked to late stage diagnosis and high OOPE [11].

The initial healthcare for cancer in India is predominantly provided by the private sector, which accounts for 71% of care [12], which are mostly composed of individual providers who are both formal (qualified) and informal (non-qualified). When impoverished and disadvantaged people seek medical care, they usually turn to informal providers and other alternative medical systems. The financial situation of the household is negatively impacted by breast cancer treatment as they frequently turn to pawning jewellery, selling possessions, taking out high-interest loans, and borrowing from social networks. Furthermore, patients and their companions experience daily salary loss and paid leave tiredness [13]. Kerala represents a critical study setting as it combines high literacy, widespread healthcare access, and a strong public health system, yet continues to report persistent delays in cancer diagnosis and treatment, highlighting gaps between system capacity and real-world care delivery [14]. However, the existing literature lacks a comprehensive examination of the care routes and financial burden for breast cancer patients in India. Kerala has limited state-specific data, despite having a high human development index and a growing cancer rate. Therefore, we aimed to study the pathways to care, estimate OOPE, and identify factors associated with OOPE among breast cancer patients attending tertiary cancer care centres in the Indian state of Kerala.

Materials and Methods

Study design

This study was a hospital- based cross- sectional study.

Study setting

The study setting included two tertiary cancer care centres (TCCC) in Kerala: Amrita Institute of Medical Sciences (AIMS), Kochi in the Southern part of Kerala is a not-for-profit organization established in 1998, that has a comprehensive cancer center that offers advanced diagnosis & treatment for all types of cancers, including solid tumors, hematological malignancies, pediatric cancers, and palliative care. The Malabar Cancer Centre (MCC), Kannur in the Northern part of Kerala, is an autonomous institution under the state government's Health and Family Welfare Department. It was established in 2001 to provide comprehensive cancer care and develop as a research and training centre of international standards.

Study population

Female patients diagnosed with breast cancer at any stage, aged 18 years and above, who had completed at least one cycle of treatment, provided informed consent and could produce billing data were included in the study. The cases were selected from the Outpatient Departments (OPDs) of Radiation Oncology, Medical Oncology and Surgical Oncology of the hospitals. A total of 241 patients were approached, of whom two refused to provide consent to participate and 23 did not have billing data.

Study duration

The study duration was from October 2024 to May 2025. The data collection period was from December 15, 2024 to February 15, 2025.

Sample size

The sample size was estimated based on a study from Northeast India, where 15% of patients initially sought cancer care from non-tertiary centres, assuming the prevalence of indirect pathway as 15% [12] with 5% absolute precision and a 95% confidence level. The calculated sample size was 196, which, after accounting for a10% non-response rate, resulted in a final sample size of 216. This calculation was performed using Open Epi Version 3.0.

Sampling technique

On an average, 20-25 breast cancer patients visit the OPDs of both TCCCs. The daily token lists from both TCCCs were reviewed, and patients were selected using simple random sampling. Eligible patients were identified from the waiting area of the OPDs. A maximum of 10 patients were recruited each day, and only those who met inclusion criteria and provided consent were included. If a patient did not meet the inclusion criteria, the next patient on the token list was considered for inclusion. Wherever possible, cross- verification with hospital records were done to mitigate the recall bias. Face-to-face interviews were conducted with patients to collect the data. Each interview took approximately 30–40 minutes to complete.

Study tools

A self-administered structured interview schedule was used which was developed based on a review of literature, feasibility considerations and suitability to the local context and was validated by subject experts. It consisted of three sections: (i) socio-demographic and clinical characteristics, capturing essential information on participant's background, (ii) pathways adopted by the patients to reach the TCCC, designed to map the sequence of healthcare facilities and providers consulted; and (iii) out- of- pocket expenditure incurred by the patients during the course of seeking care.

Ethical consideration and procedure of data collection

The study protocol was reviewed and approved by the Institute ethics committee of Amrita School of Medicine, Kochi and Malabar Cancer Centre, Kannur. A written informed consent was obtained from the patients.

Study variables

The independent variables included age, education, occupation, family income, family size, distance to healthcare facility, religion, marital status, place of residence, comorbidities, health insurance coverage, family history of breast cancer, coping mechanisms, type of healthcare facility 1st visited, diagnostic visit, diagnostic test, place of surgery, chemotherapy and radiotherapy. The outcome variable included pathways to care (patient visits from symptom recognition to the time of data collection) and out- of- pocket expenditure (expenditure incurred during healthcare visits). In this study, direct pathway is defined as the patient proceeding from symptom onset directly to the TCCC for diagnosis or treatment and, indirect pathway is defined as the patient consulting one or more other providers or facilities before reaching the TCCC for diagnosis or treatment which included Ayurveda, Yoga & Naturopathy, Unani, Sidda, Homeopathy (AYUSH) healthcare providers, private clinics, or general practitioners and other primary-level facilities before reaching the tertiary cancer care centre.

Statistical analysis

Data were collected and entered in Epicollect5 app analysed using STATA version 14. Categorical variables, such as socio-demographic characteristics, and type of healthcare facility used, were summarized using frequencies and percentages. Continuous variables were presented as median and inter- quartile ranges (IQR). Chi square test was applied to identify factors associated with direct and indirect pathways to care. Mann- Whitney U test was applied to compare difference in OOPE between the TCCCs. Median regression analysis was performed to identify the factors associated with high out- of- pocket expenditure. Variables with a p- value of less than 0.2 in the bivariate analysis were included in the quantile regression analysis. A p- value less than 0.05 was considered statistically significant.

Results

Mean (SD) ages of the study participants were 57.14 (7.80) years in AIMS and 57.54(9.93) in MCC. Table 1 presents the socio-demographic characteristics of patients. Among the 216 breast cancer patients studied, half of them were aged 58 years and above. Majority were Hindus, currently married, residing in rural areas, living in a family of size less than 4, had a graduate degree or higher and were in non-professional employment, while half of the patients resided within 82 km from the TCCCs. More than half of the patients had a household monthly income of ≥ INR 80,000.

Table 2 presents the clinical and financial characteristics of the participants. Only16.7% of the participants reported any family history of breast cancer, while the majority were diagnosed at either Stage I or II. Among the patients, multiple histopathological types were recorded with invasive ductal carcinoma being the most common in the public TCCC and ductal carcinoma-in-situ being the most common in private TCCC. Only one case of mammary Paget's disease was recorded, that being in private TCCC, while metastatic breast cancer was least observed in public TCCC. Almost all the patients underwent surgery in both the centres, while proportions of participants who have undergone radiotherapy and chemotherapy was lower in private TCCC compared to public TCCC. Health insurance coverage was limited, with fewer than half of the participants being insured.

Among the 216 participants, 48 (22.2%, 95% CI 16.9-28.4%) followed direct pathways by seeking care directly from private or public TCCs. The remaining 168 (77.8%, 95% CI 71.6-83.1%) followed indirect pathways, initially consulting traditional healers (25, 11.57%) or other healthcare providers (143, 66.20%) before reaching tertiary care centres (Figure 1).

Table 3 summarises the median out-of-pocket expenditures. Overall, the total median OOPE was higher in the private TCCs (INR 226395; IQR 144447-323590)

Table 1. Socio-Demographic and Pathway Related Characteristics of Breast Cancer Patients Seeking Care from Public and Private Tertiary Cancer Care Centres in Kerala (N=216).

Variables	Public (n=108) n (%)	Private (n=108) n (%)	Total n (%)
Age (in years)			
< 58	51 (47.2)	57 (52.8)	108 (50.0)
≥ 58	57 (52.8)	51 (47.2)	108 (50.0)
Religion			
Hindu	53 (49.1)	72 (66.6)	125 (57.9)
Muslim	30 (27.8)	23 (21.3)	53 (24.5)
Christian	25 (23.1)	13 (12.1)	38 (17.6)
Educational qualification			
Below graduate	49 (45.4)	30 (27.8)	79 (36.6)
Graduate & above	59 (54.6)	78 (72.2)	137 (63.4)
Occupation			
Professionals	7 (6.5)	8 (7.4)	15 (7.0)
Semi-professional	24 (22.2)	28 (25.9)	52 (24.1)
Others	77 (71.3)	72 (66.7)	149 (68.9)
Household Monthly Income (in INR)			
< 80,000	64 (59.3)	36 (33.3)	100 (46.3)
≥ 80,000	44 (40.7)	72 (66.7)	116 (53.7)
Household size			
≤4	89 (82.4)	74 (68.5)	163 (75.5)
>4	19 (17.6)	34 (31.5)	53 (24.5)
Marital status			
Currently married	86 (79.6)	88 (81.5)	174 (80.6)
Others	22 (20.4)	20 (18.5)	42 (19.4)
Area of residence			
Urban	13 (12.0)	73 (67.6)	86 (39.8)
Rural	95 (88.0)	35 (32.4)	130 (60.2)
Distance to centre (in km)			
< 82	59 (54.6)	68 (63.0)	127 (58.8)
≥ 82	49 (45.4)	40 (37.0)	89 (41.2)
Pathways to care			
Indirect pathway	105 (97.2)	63 (58.3)	168 (77.8)
Direct pathway	3 (2.8)	45 (41.7)	48 (22.2)

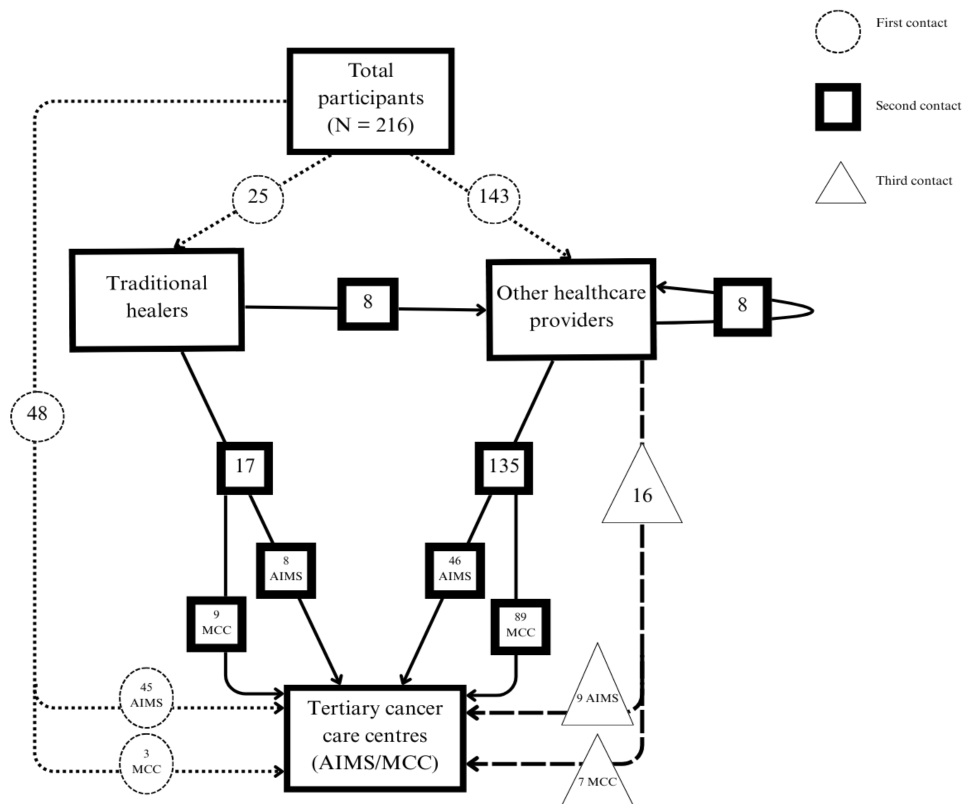

Figure 1. Figure Depicting Pathways to Care among Breast Cancer Patients Seeking Care from Public and Private Tertiary Cancer Care Centres in Kerala (N=216).

Table 2. Clinical and Financial Characteristics of Breast Cancer Patients Seeking Care from Tertiary Cancer Centres in Kerala (N=216)

Variables	Public n (%)	Private n (%)	Total n (%)
Presence of any comorbidity	28 (25.9)	40 (37.0)	68 (31.5)
Family history of breast cancer	18 (16.7)	18 (16.7)	36 (16.7)
Stage of diagnosis of breast cancer			
Early – Stages I and II	77 (71.3)	75 (69.4)	152 (70.4)
Advanced – Stages III and IV	31 (28.7)	33 (30.6)	64 (29.6)
Type of breast cancer			
Ductal carcinoma in-situ	18 (16.7)	40 (37.0)	58 (26.9)
Invasive ductal carcinoma	56 (51.9)	3 (2.8)	59 (27.3)
Lobular carcinoma in-situ	23 (21.3)	19 (17.6)	42 (19.4)
Invasive lobular carcinoma	9 (8.3)	25 (23.1)	34 (15.7)
Mammary Paget's disease	0 (0.0)	1 (0.9)	1 (0.5)
Metastatic breast cancer	2 (1.8)	20 (18.6)	22 (10.2)
Experienced symptom			
Lump	79 (73.1)	98 (90.7)	177 (81.9)
Pain	5 (4.6)	2 (1.9)	7 (3.3)
Nipple discharge	18 (16.7)	4 (3.7)	22 (10.2)
Skin changes	6 (5.6)	4 (3.7)	10 (4.6)
Treatment received*			
Surgery	108 (100)	106 (98.2)	214 (99.1)
Chemotherapy	68 (63.0)	60 (55.6)	128 (59.3)
Radiotherapy	100 (92.6)	39 (36.1)	139 (64.4)
Health Insurance coverage	46 (42.6)	46 (42.6)	92 (42.6)

Table 2. Continued

Variables	Public n (%)	Private n (%)	Total n (%)
Financing mechanisms			
Savings only	46 (42.6)	40 (37.0)	86 (39.8)
Savings plus borrowing money	6 (5.6)	14 (13.0)	20 (9.3)
Savings plus insurance	28 (25.9)	38 (35.2)	66 (30.6)
Savings plus loans	1 (0.9)	2 (1.9)	3 (1.4)
Savings plus selling assets	10 (9.3)	3 (2.8)	13 (6.0)
Savings plus two others	17 (15.7)	11 (10.2)	28 (13.0)

*Percentages do not add to 100 since more than one treatment is possible

compared to the public TCCCs. Private TCCC incurred higher expenditures on surgery, chemotherapy and radiotherapy, however, medicine charges were higher in the public TCCCs. Chemotherapy charges in private centre were more than double those in public centre (Median INR 138,500 vs. 58,900) reflecting substantially higher out-of-pocket expenditure for patients treated in private TCCCs.

Sociodemographic and clinical factors associated with indirect pathway to tertiary cancer care among the study participants are shown in Table 4. Age group >=58 years (OR 1.92; p=0.050), rural residence (OR 16.01; p<0.001), lower monthly household income (OR 3.30; p=0.001), residence ≥82 km from the centre (OR 1.8; p<0.001), treatment at public tertiary cancer care centre (OR 2.5; p<0.001), having undergone chemotherapy (OR 2.25; p=0.013) and having undergone radiotherapy (OR

Table 3. Out-of-Pocket Expenditure Incurred by the Study Participants

Type of expenditure (INR)	Public (n=108) Median (IQR)	Private (n=108) Median (IQR)	Total (n=216) Median (IQR)
Direct medical expenditure			
Doctor consultation fees	1670 (1260-2030)	2050 (1790-2500)	1905 (1500-2250)
Registration fees (OP/IP)	250 (250-450)	450 (325-700)	355 (250-550)
Investigation charges	18400 (13850-22900)	20150 (16270-26740)	19020 (15500-24420)
Medicine charges	27750 (23100- 38500)	21050 (13850-25695)	25000 (18600-33500)
Hospital accommodation charges	3340 (3000-4650)	6500 (6000-7500)	6000 (3200-7000)
Surgery charges (*n=214)	35000 (28720-39225)	54800 (47850-64150)	43560 (32650-56400)
Chemotherapy charges (*n=128)	58900 (43500-73500)	138500 (96000-188500)	82800 (50000-136000)
Radiotherapy charges (*n=139)	48250 (42000-55250)	89000 (53000-116700)	51540 (42500-63000)
Direct non- medical expenditure			
Transport	5000 (2500-7500)	5000 (2500-10000)	5000 (2500-7500)
Meals en-route hospital	2500 (1250-2500)	2500 (2150-5000)	2500 (1250-2500)
Accommodation outside hospital	4000 (3500-5000)	9500 (4000-13500)	5000 (3500-10000)
Other costs	1375 (1000-2000)	2500 (2500-5000)	2500 (2000-4000)
Indirect Expenditure			
Loss of wages	5250 (5000-15000)	5000 (5000-6000)	5000 (5000-10000)
Care giver transport & meals	5000 (2500-10000)	2500 (2500-5000)	2500 (2500-7500)
Total direct medical expenditure	176260 (140385-206695)	204351.5 (128705-286445)	181340 (138720-231725)
Total direct non-medical expenditure	8750 (3750-13750)	10000 (6875-22000)	10000 (5000-16925)
Total direct expenditure	185965 (151175-215305)	221295 (142447-318735)	191600 (145760-251978)
Total indirect expenditure	7500 (2500-10000)	2500 (2500-5000)	3625 (2500-7750)
Total expenditure (direct + indirect)	193290 (154350-223160)	226395 (144447-323590)	202350 (150240-335450)

IQR, Interquartile range; *, Sample sizes reflect only those participants who received the respective treatments: surgery (n=214), chemotherapy (n=128), and radiotherapy (n=139)

5.47; p<0.001) were significantly associated with indirect pathway to care in bivariate analysis.

Median regression model was used to identify sociodemographic, clinical and financial factors associated with higher OOPE among the study participants as shown in Table 5. Residence ≥82 km from the centre (INR 219050; p=0.018), absence of family history of breast cancer (INR 207630; p=0.007), advanced stage at diagnosis (INR 227345; p=0.032), indirect pathway to care (INR 206805; p=0.040), treatment at private tertiary care centre (INR 226395; p=0.029), use of only private hospitals in the pathway (INR 221800; p=0.035) and treatment at private tertiary care centres following visits to public hospitals (INR282000; p=0.002) were significantly associated with higher OOPE. In the adjusted median regression model, three factors remained independently associated with higher OOPE - residence ≥82 km from the centre (coefficient:28470; p=0.044), treatment at private tertiary cancer care centre (coefficient:50010; p=0.001) and indirect pathway to tertiary cancer care (coefficient:46180; p=0.015). The model explained 14.82% of the variability in OOPE (pseudo-R^2 = 0.1482).

Discussion

The study provides the estimates of out-of-pocket expenditure for breast cancer treatment with regards to different pathways adopted by breast cancer patients in selected tertiary care centres in the Indian state of Kerala. We found significant variation in care pathways – while 22.2% of patients accessed tertiary care directly, the vast majority (77.8%) followed indirect referral pathways, often beginning with primary health centres, government secondary care hospitals, AYUSH providers or traditional healers, aligning with regional and national evidence. Ramalingam et al. had reported that 88.9% of patients accessed definitive care through indirect referrals. Factors such as misunderstanding symptoms, neglect, lack of awareness, misdiagnosis, financial constraints, and poor family support were highlighted as contributors to the indirect pathways which often delayed treatment initiation [15]. However in some urban areas with tertiary care centres, improved awareness campaigns, targeted screening and streamlined referral systems have been proposed to be gradually increasing use of direct pathways [16].

Our study has found the following factors to be significantly associated with indirect pathway to breast cancer care - age ≥ 58 years, rural residence, lower household monthly income, longer distance to TCCC, treatment in public TCCC, and having to undergo chemotherapy and radiotherapy for treatment. Older patients are more likely to follow indirect care pathways, probably owing to lower health literacy, dependence on family members, and the propensity to first seek care from local or informal providers [15, 17]. The association of

Table 4. Factors Associated with Indirect Pathway to Care among the Study Participants: Results of Bivariate Analysis

Variable	Indirect pathway (n=168) (%)	Direct pathway (n=48) (%)	Unadjusted Odds Ratio	P value
Age group				
≥ 58	83.3	16.7	1.92	0.05
< 58	72.2	27.8	Ref	
Area of residence				
Rural	94.6	5.4	16.01	<0.001
Urban	52.3	47.7	Ref	
Family size				
≤4	82.6	17.4	1.46	0.374
>4	76.5	23.5	Ref	
Household monthly income				
< 80,000	88	12	3.3	0.001
≥ 80,000	69	31	Ref	
Educational qualification				
Below graduation	84.8	15.2	1.99	0.059
Graduate and above	73.7	26.3	Ref	
Marital status				
Others	83.3	16.7	1.54	0.335
Currently married	76.4	23.6	Ref	
Distance to centre				
≥ 82 kms	89.9	10.1	1.8	<0.001
< 82 kms	69.3	30.7	Ref	
Patients with any other comorbidities				
No	79.1	20.9	1.26	0.506
Yes	75	25	Ref	
Family History of breast cancer				
No	79.4	20.6	1.7	0.188
Yes	69.4	30.6	Ref	
Stage of breast cancer				
Advanced	82.8	17.2	1.55	0.248
Early	75.7	24.3	Ref	
Type of healthcare facility studied				
Govt	97.2	2.8	25	<0.001
Private	58.3	41.7	Ref	
Experienced financial distress				
Yes	81.5	18.5	1.38	0.383
No	76.2	23.8	Ref	
Chemotherapy done				
Yes	83.6	16.4	2.25	0.013
No	69.3	30.7	Ref	
Radiotherapy done				
Yes	88.5	11.5	5.47	<0.001
No	58.4	41.6	Ref	

rural residence with indirect care pathways could be due to reduced access to specialised care along with inadequate transportation and a preference for more proximal healthcare providers [12, 17]. In India, rural patients also encounter greater logistical challenges in navigating the conventional referral-based health care institutions. These barriers are amplified in cases of chronic conditions requiring multiple hospital visits, repetitive investigations and various treatment modalities [17–19]. Nonetheless, in some rural settings with robust government outreach, telemedicine, or well-developed public transportation, these disadvantages are attenuated, narrowing the gap with urban care-seeking patterns [20, 21]. Evidence from studies reveal that higher income often enables improved

Table 5. Sociodemographic, Clinical and Financial Factors associated with Out-of-Pocket Expenditure (OOPE) among the study participants– Results of Quantile (Median) regression analysis (N=216)

Variables	Median OOPE (IQR)	Unadjusted coefficient	p-value	Adjusted coefficient	p- value
Age group					
< 58	193400 (147963 - 243085)	Ref		Ref	
≥ 58	215480 (153760 - 266320)	22510	0.082	-2060	0.881
Educational qualification					
Graduate and above	193650 (149550-254920)	Ref			
Below graduation	214850 (153000 -260660)	21200	0.135		
household monthly income (in INR)					
< 80000	206805 (154350-256998)	10070	0.466		
≥ 80000	196052.5 (149095-263827)	Ref			
Area of residence					
Urban	194427.5 (145050-277450)	Ref			
Rural	204375 (158650-243110)	9445	0.517		
Distance to centre					
< 82	188300 (140750-243450)	Ref			Ref
≥ 82	219050 (174550-267653)	30750	0.018	28470	0.044
Patients with any other comorbidities					
Yes	211197.5 (154350 -273930)	15690	0.261		
No	196052.5 (148545-252128)	Ref			
Family History of breast cancer					
Yes	162025 (144244.5-214025)	Ref		Ref	
No	207630 (159020-260330)	45100	0.007	27690	0.127
Stage of breast cancer					
Early	191260 (145200-239600)	Ref		Ref	
Advanced	227345 (180290-323710)	36150	0.032	15480	0.303
Type of healthcare facility studied					
Govt	193290 (154350-223160)	Ref		Ref	
Private	226395 (144447-323590)	34290	0.029	50010	0.001
Pathway to tertiary cancer care					
Direct	169340 (110100-285250)	Ref		Ref	
Indirect	206805 (159555-255290)	32420	0.04	46180	0.015
Type of hospitals in the pathway of care					
Government only (n=42)	176185 (146635-221038)	Ref			
Private only (n=87)	221800 (130800-325550)	45190	0.035		
Government to private (n=15)	282000 (199660-327475)	105390	0.002		
Private to government (n=72)	197875 (163163-227468)	22390	0.309		
Insurance coverage					
Yes	205810 (156295-263735)	7820	0.561		
No	197875 (148125-254513)	Ref			

The final regression model includes Age group, distance to tertiary care cancer centre, family history of breast cancer, stage of breast cancer at presentation, type of healthcare facility studied, and pathway type. (pseudo Rsquared=0.1482) Regression coefficients are interpreted as difference in median compared to the reference (Ref) category. Certain variables such as family monthly income, educational qualification, and area of residence were excluded from the final regression model due to lack of statistical significance in unadjusted analysis and evidence of multicollinearity with other predictors. These variables did not substantially improve model fit and were therefore removed to avoid over-adjustment

access to advanced and quality care, while patients from poorer households might be forced to utilise the available and affordable healthcare services even when inadequate [20, 22]. Greater distance from healthcare centre is a well-documented barrier, contributing to indirect pathways through challenges in transportation and accommodation especially in case of conditions requiring chronic care like cancer and absence of clear referral mechanisms [15, 20, 23]. Our study finding that patients from public TCCC having undertaken indirect pathways has been found to be consistent across studies reporting that most public tertiary cancer centres serve as the final destination for

patients who first visit other formal and informal care providers before reaching definitive care, especially when expenditure escalate or when advanced diagnostics or treatments are required [15, 24, 25]. This has been found to be significantly higher among poor socioeconomic groups [24]. Qualitative studies have reported this frequent switching of hospitals for advanced treatments such as chemotherapy and radiotherapy, to be driven by limited drug availability, equipment constraints, or gaps and delays in insurance enrolment at public centres due to the daycare nature of chemotherapy treatment [15, 17, 24, 26]. Despite high literacy in Kerala, health literacy around cancer care remains low, leading many to first visit nearby facilities and delaying timely access to TCCC. Patients often transition to private facilities for faster access, shorter waiting times, or perceived better quality, resulting in delays, fragmented pathways, higher expenditure, and logistic complexities in navigating the healthcare system [18, 20].

In our study, OOPE among breast cancer patients have been found to be higher – for direct medical expenditure, direct non-medical expenditure, total direct expenditure and total OOPE – for patients from private tertiary care centres, while indirect expenditure was found to be more among patients from public tertiary care cancer centres. Private TCCCs typically charge more for surgery, chemotherapy, and radiotherapy due to higher procedure charges, specialist fees, and sometimes greater use of advanced technologies [27]. This underscores the significant financial risk faced by patients opting for private care, even if perceived as more accessible. For instance, expenditure for surgery in private hospitals can range from INR150,000 to 450,000, chemotherapy from INR 100,000 to 400,000 per cycle, and radiotherapy from INR 200,000 to 500,000, with expenditure often exceeding INR two hundred thousand for comprehensive care in private settings [9, 20, 27, 28]. Among the direct expenditure, our study has reported that medicine charges are higher among patients from public TCCCs. Several analyses have pointed out similar evidence which could be attributed to supply-side constraints such as limited access to subsidized or generic drugs, multiple factors affecting government procurement, and frequent drug shortages, which may force either patients to purchase medicines from outside at market rates or hospitals to purchase the medicines locally to provide them at subsidised rates which may still be high for socioeconomically deprived patients [12, 16, 27, 28]. Other reasons which could potentially lead to the same result are higher waiting times leading to patients opting for medicine purchase from outside, use of paid wards and services in public hospitals by patients who can afford, along with reduced trust of the patients in the free or generic medicines provided in the public hospitals [20, 23].

In our study, the indirect pathway to care has been found to incur significantly higher OOPE than the direct pathway. Studies from tertiary Indian hospitals show that patients who navigate multi-step referral processes can spend nearly twice as much compared to those taking a direct route [12, 29]. This could be potentially be due to delayed treatment initiation, greater need for advanced care, increased transport and accommodation expenditure, along with cumulative consultation fees, repeated diagnostics and resulting complications in financial reimbursement through insurance. These factors combine to force patients into delayed access to definitive, cost-effective care [20 ,21, 23].

The study has found that among those patients who were residing >=82 kms from the tertiary care centre, the median OOPE is significantly higher. Large cohort and national studies consistently report that residence farther from tertiary centres dramatically increases OOPE due to higher transport, accommodation, and indirect expenditure [20, 23, 24]. One multicentric Indian report attributes over 23% of OOPE to travel and accommodation, disproportionately affecting those from distant rural settings leading to higher rates of treatment discontinuation [15].

The findings from the study that median OOPE is significantly higher in private tertiary care centres than public strongly aligns with the existing evidence. Ensuring the availability, accessibility, and affordability of essential drugs through the public health system is likely to reduce the cost in the public sector TCCC [30]. However, studies also point to the alarming consequences of exclusive private provision of healthcare especially in chronic conditions like cancer. Exclusive use of private care precludes access to government subsidies, insurance benefits, and cost-controlled generic medicines, further amplifying OOPE [12, 15, 23].

Among other factors, our study has also found that patients with no family history of breast cancer have incurred higher median OOPE than those with a family history, which could be due to reduced awareness and delayed recognition, resulting in more advanced disease, need for multimodal management and late-stage interventions [12, 20]. Patients with a positive family history are more likely to seek early screening, benefiting from less intensive and less costly treatment pathways [18, 25]. Patients who presented with advanced stage at diagnosis have also reported significantly higher OOPE than those with early stages, which could be due to longer treatment courses, additional diagnostics, greater likelihood of multimodal therapy (surgery, chemotherapy, radiotherapy), and increased medication requirements as evidenced in similar studies. Advanced-stage disease is a strong independent predictor of catastrophic health expenditure, as reported in major Indian cancer centres and national reports, patients presenting with more advanced stages typically undergo more complex diagnostic processes and multimodality treatment, which contributes to substantially higher OOPE and more fragmented care pathways [1, 12, 24, 27]. These findings together reiterate the need for improving early detection especially for those without a family history of breast cancer.

Along with increasing out-of-pocket expenditures, health financing in Kerala has evolved through a series of public financial protection initiatives, including Comprehensive Health Insurance Scheme (CHIS), Rashtriya Swasthya Bima Yojana (RSBY) which was later complemented by innovations such as CHIS-Plus for major chronic conditions and the Karunya Benevolent

Fund (KBF) for high-cost illnesses including cancer [31]. In 2018, the introduction of National health protection scheme (Ayushman Bharat - Pradhan Mantri Jan Arogya Yojna) led to the consolidation of these schemes into the Karunya Arogya Suraksha Padhathi (KASP), implemented through the State Health Agency [32]. Despite this strong policy architecture and Kerala's higher public spending on health, available evidence suggests only modest reductions in OOPE, with many households continuing to incur substantial costs. However, integration of improved screening modalities into primary care systems through newer initiatives by the Government of Kerala like "Anandam Arogyam" - which is aimed at increasing awareness and screening rates of three cancers namely breast, cervical and oral cancers - along with universal expansion of health insurance coverage could reap long lasting positive health benefits [33]. Situating the study within this policy framework helps explain how the existing health financing landscape shapes health expenditure and care-seeking patterns in the state [34].

One of the key strengths of this study is the inclusion of both public and private tertiary care institutions, which permits comparative perspective on care pathways and financial burden. By focusing on pathways to care and out-of-pocket expenditure, the study captures important nuances in patient choices in the management of chronic illnesses. Furthermore, the inclusion of two major tertiary cancer centres in Kerala enabled coverage of a wide geographical catchment within the state. However, the reliance on patient recall for expenditure and pathway details introduces the potential for recall bias. Future research should employ longitudinal or mixed-method approaches with larger samples across varying types of healthcare institutions to better capture evolving care pathways and their financial implications.

Author Contribution Statement

MSK, MM, JJO, KRT: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision. MSK, MM, JJO, GM, KP: Formal analysis, Data curation, Supervision, Writing - Review & Editing. MM, JJO, KRT: Supervision, Writing - Review & Editing. All authors contributed to finalise the manuscript.

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Approval

This study was part of the MPH dissertation of Dr. Manjima S Kumar. It was approved by the Institutional ethical committees of Amrita School of Medicine (ECASM-AIMS-2024-596) dated 13.12.2024 and of Malabar cancer centre (1617/IRB-IEC/13/MCC/29-01-2025/4) dated 07-02-2025. The final study report was submitted to Amrita Vishwa Vidyepeetham.

Availability of data

The dataset used for this study is available from the corresponding author upon reasonable request.

Conflicts of interest

The authors do not have any competing interests.

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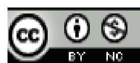

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