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Socioeconomic and clinical determinants of the cost of illness in breast cancer: an analytical study

Usman Ali Khan [a], Hafiz Zahid Mahmood [b,*], Muhammad Omer Rana [c], Khalid Masood Gondal [d], Imran Hameed Khaliq [e], Seerat Fatima Aslam [f]

[a] Program Director, Punjab Family Planning Program, Health & Population Department, Punjab, Pakistan
[b] Department of Economics, COMSATS University Islamabad, Lahore Campus, Pakistan
[c] Lahore Medical & Dental College, Pakistan
[d] Vice Chancellor, Fatima Jinnah Medical University, Pakistan
[e] Department of Public Health, University of Health Sciences, Pakistan
[f] The University of Lahore, Pakistan

* Correspondence: hzmahmood@hotmail.com

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Abstract

Breast cancer poses a significant economic burden on affected households, especially in low- and middle-income countries where healthcare services rely mainly on out-of-pocket expenditures. This analytical study determined the associations between the socioeconomic and clinical characteristics of breast cancer patients and different elements of the cost of illness (COI). The study included 200 women with breast cancer receiving healthcare services at two public tertiary care hospitals in Lahore, Pakistan. Demographic, clinical, and household cost data were collected from patients through face-to-face interviews using a pretested questionnaire. COI was categorized into direct medical, direct nonmedical, indirect nonmedical, and overall costs according to the World Health Organization framework. Our study results highlighted that the mean age of the patients was 43.87 ± 9.67 years; most were married (84.5%), were housewives (73.0%), and had stage III breast cancer (54.0%). Direct medical costs differed significantly according to patient education, the education level of the husband, and monthly household income (all, $p < 0.05$). Direct nonmedical costs differed significantly by patient age, location, and marital status, whereas indirect nonmedical costs differed by patient age and prediagnosis occupation (all, $p < 0.05$). The overall COI was significantly associated with patient age, level of education, level of education of the husband, and monthly household income (all, $p = 0.05$). Multivariable analysis showed that the level of education of the husband ($p = 0.022$), location ($p = 0.022$), self-employment ($p = 0.011$), employment status ($p = 0.049$), stage II breast cancer ($p = 0.013$), and family history of breast cancer ($p = 0.047$) were independently associated with the overall cost of disease. The study concluded that the household economic burden of patients with breast cancer varies according to their socioeconomic and clinical characteristics, with multiple factors affecting individual cost elements and the overall cost of disease treatment.

Keywords

Breast neoplasms; Health care costs; Cost of illness; Noncommunicable diseases; Demography; Socioeconomic factors; Developing countries

1. Introduction

Breast cancer is the most frequently diagnosed cancer among all types of cancers in women and is a leading cause of cancer death globally [1]. In 2022, an estimated 2.29 million new breast cancer cases were recorded worldwide. In the recent past, Africa has recorded the highest mortality-to-incidence ratio among all continents, at 0.51, reflecting

limited access to early detection and treatment compared with higher-income regions worldwide. On the basis of the available data, projections highlight that the number of global breast cancer cases could exceed 6 million by the year 2050, with the steepest increase expected in Asia, where the number of cases may increase to approximately 2 million, followed by Africa, where the number of cases may reach 1.1 million, indicating regions with the greatest future burden of disease, a zone that is even least equipped to absorb it [2].

Within the Asian continent, Pakistan has the highest burden of breast cancer in the region [3]. National data from the country show that breast cancer accounted for 34,066 new cases, and in recent years, it has been both the most frequently diagnosed as well as the primary cause of cancer death among Pakistani women [4]. Lifetime risk estimates for Pakistan reveal that one in every nine women in the country will develop breast cancer at some point in her life, and the age-standardized incidence rate in the country, approximately 110 per 100,000 women, is significantly higher than that in neighboring countries of the region. Hospital-based data from Karachi revealed that the number of diagnosed cases nearly doubled between the years 2004–2005 and 2014–2015, with projections showing a further increase in cases in the years 2024–2025 [5]. Studies from two major cities in Pakistan, Lahore and Faisalabad, have reported an increasing incidence of disease, with the majority of women presenting with disease at stage III or later and the majority of patients diagnosed at forty years of age [6]. Pakistan still lacks a nationwide, completely functional cancer registry, which makes it difficult to track the true prevalence of the disease in the country and plan future healthcare delivery services accordingly [7].

The cost of breast cancer to patients and their families extends well beyond the clinical care of disease [8]. The healthcare delivery system of Pakistan is usually based on out-of-pocket payments, with public spending on healthcare remaining low and healthcare insurance coverage being minimal for most households in the country [9]. Another study reported that a patient in Pakistan on average spends 1093.13 USD on the treatment of breast cancer [10]. In low- and middle-income countries (LMICs), cancer patients and their caregivers are estimated to spend as much as 42% of their annual household income on out-of-pocket costs related to the treatment of disease, compared with approximately 16% in high-income countries [11]. These costs usually push households to borrow money, sale assets, or reduce spending on food and education, and in some stances, they also lead to delay or discontinuation in treatment, which worsens survival outcomes and deepens household poverty [12].

Although the clinical burden of breast cancer in Pakistan is well documented, far less is known about how the financial burden on households varies according to patients' demographic and clinical profiles or which specific factors lead a household into a higher-cost category of morbidity. Without this concrete evidence, it is difficult for healthcare service policy makers in the country to determine which patients are most financially vulnerable and to design targeted support, such as subsidized treatment programs, transport assistance, or income-protection schemes, for those who need it most. Therefore, this study examined the differences in demographic and clinical characteristics of breast cancer patients across different household cost categories of breast cancer morbidity. This study also identified factors associated with the overall cost burden of breast cancer morbidity.

2. Methods

2.1. Study design

This analytical study was conducted between August and December 2015.

2.2. Ethical considerations

The study was approved by the Institutional Review Board (IRB) of King Edward Medical University/Mayo Hospital Lahore (No. 348/RC/KEMU).

2.3. Study setting

The study was conducted in the second-most populous city of Pakistan, which has a population of 11,126,285 people [13]. The data were collected from two major public tertiary care hospitals providing complete breast cancer care: Mayo Hospital and Jinnah Hospital. The patients were recruited from the oncology, surgery, chemotherapy, and radiotherapy departments.

2.4. Patient recruitment

One physician and one researcher identified 200 patients who met selection criteria. Before data collection, patients were informed about the study purpose, IRB approval, the benefits and risks of the study as well as provisions to uphold confidentiality. All the patients then provided written informed consent.

Our study included females aged 18 years or older with clinically diagnosed primary malignant breast cancer who had been under treatment for at least 3 months but not more than 2 years and who were able to communicate English, Urdu, Saraiki, or Punjabi [14,15]. Those who were not able to provide informed consent were excluded from the study.

2.5. Sample size and sampling technique

A purposive sampling technique was used to identify 200 breast cancer patients. During the study period, 115 (57.5%) patients were selected from Mayo Hospital, and 85 (42.5%) were selected from Jinnah Hospital.

2.6. Questionnaire development

The multidisciplinary team of authors developed a questionnaire that was further pretested with 10 breast cancer patients receiving cancer care at one of the study sites, i.e., Jinnah Hospital to assess question presentation, ease of understanding, acceptability, as well as facial validity. The study instrument needed few modifications prior to the collection of data.

2.7. Baseline characteristics

Eleven survey questions were used to assess baseline characteristics of the breast cancer patients. They were asked about their age, marital status (unmarried, married, widowed, separated), education level (number of years at school), education level (if married), geographical location (urban, rural), monthly household income, household size, number of children, employment status of the prediagnosis of breast cancer (house lady, employed, self-employed), stage of breast cancer, and family history of breast cancer.

The income was later converted into United States dollars (US$) using the average exchange rate of 2015, when US$ 1 was equal to PKR 102.77.

2.8. The overall cost of illness (COI)

The survey also collected information concerning COI borne by the families of breast cancer patients. Three cost categories were calculated by following the framework

suggested by the WHO [16,17,18]. Each of the cost categories had various elements, as defined below:

- Direct medical costs included payments for diagnostic procedures, treatment, follow-up appointments with clinicians, spending on prescriptions, hospital inpatient expenses as well as outpatient expenses etc.
- Direct nonmedical costs were the costs borne by the patients and families during the diagnosis period and throughout treatment. These costs were not directly related to medical care but represent nontreatment-related out-of-pocket expenses, such as travel from home to health facilities and vice versa, as well as lodging and food expenses, etc.
- Indirect nonmedical costs were related to losses in income owing to morbidity in terms of time off work and decreased income of patients and patient attendants. In addition, this cost category included expenses incurred on additional educational services (for example, tuition services) to children, paid home help taken, and any other cost incurred due to breast cancer morbidity.

Finally, the overall COI was derived by summing the totals of the three cost categories in PKR and later converted into US$.

2.9. Data collection

The principal investigator (PI) is multilingual; he or she conducted face-to-face interviews in a private room and answered any of the participants' questions. On average, the interviews lasted between 30 and 40 minutes in respondent's desired language.

2.10. Data analysis

The data thus collected were entered into Microsoft Excel and analyzed using SPSS 25.0 (IBM SPSS Inc., Chicago, IL, USA). Descriptive statistics were used as the primary analytical approach. The Shapiro–Wilk test was rendered to assess data normality. Based on this, the Mann-Whitney U test and Kruskal–Wallis H test, along with post hoc analysis, were applied to assess differences between two groups of variables (i.e., marital status, patient location, and family history of breast cancer) across cost categories. These tests were also used to evaluate differences among more than two groups of sociodemographic and clinical attributes (i.e., patient age, patient education, spouse's education, monthly household income, stages of breast cancer, etc.) across cost categories. Post hoc analysis compared all pairwise group differences with adjusted *p* values to control the overall the Type I error rate at 5%.

We also employed a multiple regression model in order to predict the values of an outcome variable (i.e., COI) from different predictor variables (i.e., socioeconomic and medical characteristics).

3. Results

The average age of the breast cancer patients was 43.87 ± 9.67 years, and their average number of years of education at school was 4.64 ± 5.23 (Table 1). Most of the patients were married (84.50%), and on average, their spouses had 7.51 ± 5.08 years of education at school. The median number of people living in a house was 7 (interquartile range [IQR], 5), and the median number of children in each family was 4 (IQR, 2). The median monthly household income was PKR 16,000 (IQR, PKR 19,750). Among the 200 breast cancer patients, the majority had stage III (108) cancer, followed by stage IV (56) and stage II (36) cancer. Moreover, 40 (20%) patients had a family history of breast cancer.

Table 1. Demographic/clinical characteristics of the respondents.

Variable		Frequency (%)	Mean ± SD	Median (IQR)
Patients' age (years)		-	43.87 ± 9.67	45.00 (14.00)
Patients' education (years)		-	4.64 ± 5.23	2.00 (10.00)
Husbands' education (years)		-	7.51 ± 5.08	8.00 (7.00)
Household size (in number)		-	7.93 ± 3.74	7.00 (5.00)
Number of children of the patient		-	3.83 ± 1.85	4.00 (2.00)
Monthly households' income (US$)		-	23,552.34 ± 20,548.43	16,000.00 (19,750.00)
Marital status	Unmarried	3 (1.50)	-	-
	Married	169 (84.50)	-	-
	Widowed	25 (12.50)	-	-
	Separated	3 (1.50)	-	-
Patient geographical location	Urban	95 (47.50)	-	-
	Rural	105 (52.50)	-	-
Employment Status (prediagnosis of breast cancer)	Employed	35 (17.50)	-	-
	Self-Employed	19 (9.50)	-	-
	House lady	146 (73.00)	-	-
Stage of breast cancer	Stage II	36 (18.00)	-	-
	Stage III	108 (54.00)	-	-
	Stage IV	56 (28.00)	-	-
Breast cancer family history		40 (20.00)	-	-

Table 2 delineates that direct medical costs varied significantly among breast cancer patients with different levels of education ($p = 0.001$). The median direct medical costs were lower among patients with no formal education (US$ 717.60) and high school or below (US$ 813.14) than among those with a college degree or above (US$ 2,113.42). These differences were statistically significant ($p = 0.001$), as corroborated by post hoc analysis using adjusted p values (not depicted in the table). Similarly, direct medical costs varied significantly among patients whose spouses had different levels of education ($p = 0.001$). Post hoc analysis showed that direct medical costs were significantly lower ($p = 0.001$) among patients whose spouses had no formal education (US$ 563.21) and who had completed high school or less (US$ 784.56) than among those whose spouses had completed a college degree or above (US$ 1,717.11). Furthermore, direct medical costs were significantly lower ($p = 0.001$) among patients whose monthly household income was ≤ PKR 15,000 (US$ 531.69) than among all the other income groups, i.e., 15,001 to 25,000 (US$ 892.19), 25,000 to 40,000 (US$ 903.89), and ≥ 40,001 (US$ 1,488.81).

Direct nonmedical costs varied significantly among patients by age ($p = 0.014$). Post hoc analysis accentuated that this difference was statistically significant ($p = 0.020$) between the age groups of 40 to 49 years (U$ 291.91) and ≥ 50 years (US$ 163.96). Direct nonmedical costs also differed significantly ($p = 0.001$) between breast cancer patients in urban areas (US$ 108.98) and those in rural areas (US$ 350.29). Additionally, compared with unmarried, widowed or separated patients (US$ 155.68), married patients had high direct nonmedical costs (US$ 256.39), and the results were statistically significant ($p = 0.004$). Table 2 further shows that indirect nonmedical costs were significantly affected by patient age ($p = 0.002$). The results of the post hoc test corroborated the significant differences between the age groups < 40 years and ≥ 50 years ($p = 0.002$). Moreover, the indirect nonmedical costs were strongly affected by the patient's occupation immediately before her breast cancer diagnosis ($p = 0.001$). It was learnt by the post hoc analysis that

the indirect nonmedical costs reported by self-employed and employed patients were significantly greater than those reported by home lady patients ($p = 0.001$).

Finally, Table 2 presents the differences in the overall COI borne by breast cancer patients by varying socioeconomic and medical gradients. The COI was significantly affected by patient age ($p = 0.047$), but the post hoc analysis revealed that none of the values fell below our criterion of $p < 0.05$. Although the comparisons between < 40 years and ≥ 50 years were fairly close ($p = 0.063$), it might be useful to understand the significant differences between the two age groups. COI was also strongly influenced by patient education ($p = 0.001$), patients' spouses' education ($p = 0.001$), and monthly household income ($p = 0.001$). Besides, the post hoc analysis corroborated that patients who belonged to low-income families, i.e., those whose PKR was ≤15,000, had a lower COI that was significantly different only from that of patients who belonged to high-income families, i.e., those whose PKR was ≥ 40,001 ($p = 0.001$).

Table 2. Differences in the cost of illness of breast cancer morbidity by patient demographic/medical characteristics (N = 200).

Demographic Characteristics	n	DMC in US$ Median (IQR)	*p* Value	DNMC in US$ Median (IQR)	*p* Value	INMC in US$ Median (IQR)	*p* Value	COI in US$ Median (IQR)	*p* Value
Patient age (years)									
< 40	65	878.15 (943.07)		239.37 (310.10)		102.17 (536.14)		1524.30 (1461.30)	
40–49	67	857.32 (1380.17)	0.144	291.91 (428.13)	0.014 *	100.71 (245.20)	0.002 *	1404.93 (1634.98)	0.047 *
≥ 50	68	669.75 (1057.77)		163.96 (300.67)		0.00 (153.25)		1055.86 (1633.26)	
Locality of patient									
Rural	105	740.31 (824.14)	0.054	350.29 (337.35)	0.001 *	93.41 (244.23)	0.295	1356.14 (1138.03)	0.632
Urban	95	878.15 (1746.45)		108.98 (270.02)		43.79 (350.29)		1409.19 (2677.63)	
Marital status									
Married	169	802.05 (1209.60)	0.063	256.39 (342.51)	0.004 *	72.98 (238.39)	0.112	1404.93 (1554.81)	0.106
Unmarried/widowed/separated	31	506.58 (671.08)		136.22 (189.74)		210.17 (674.64)		972.65 (1358.91)	
Patient education									
No formal education	100	717.60 (1052.46)		288.02 (431.78)		87.57 (252.50)		1388.16 (1697.68)	
High School or less	73	813.14 (998.87)	0.001 *	209.20 (302.13)	0.521	29.19 (223.80)	0.865	1238.36 (1275.78)	0.001 *
College graduate or greater	27	2113.42 (3558.40)		155.68 (360.02)		58.38 (278.29)		2764.40 (3235.06)	
Patient's husband education									
No formal education	44	563.21 (608.89)		238.88 (435.92)		87.57 (332.05)		1139.35 (1056.39)	
High School or less	86	784.56 (1020.21)	0.001 *	288.02 (316.23)	0.367	71.52 (216.01)	0.361	1389.89 (1468.54)	0.001 *
College graduate or greater	44	1717.11 (2605.72)		177.43 (349.07)		28.22 (226.23)		2157.40 (2995.40)	
Patient occupation before breast cancer diagnosis									
Self-employed	19	798.91 (1259.49)		241.31 (406.73)		245.20 (739.50)		1924.21 (2308.92)	
Employed	35	773.12 (1072.72)	0.522	196.55 (288.99)	0.372	554.63 (843.13)	0.001 *	1795.79 (1345.55)	0.064
House lady	146	776.27 (1065.64)		233.53 (354.91)		17.51 (128.93)		1234.17 (1359.63)	
Monthly household income (PKR)									
≤ 15,000	96	531.69 (747.91)		259.56 (285.10)		91.22 (291.91)		1127.62 (1268.47)	
15,001 to 25,000	42	892.19 (1161.56)	0.001 *	183.90 (508.46)	0.475	35.68 (138.66)	0.329	1359.43 (1534.44)	0.001 *
25,001 to 40 ,000	33	903.89 (1476.26)		108.98 (405.75)		145.95 (491.38)		1544.74 (2029.45)	
≥ 40,001	29	1488.81 (2064.71)		195.58 (337.64)		50.60 (221.85)		2102.50 (2557.33)	
Stages of breast cancer									
Stage II	36	826.95 (1294.18)	0.329	196.07 (267.34)	0.375	9.73 (153.25)	0.191	1234.17 (1493.82)	0.251
Stage III	108	717.60 (979.13)		206.77 (370.97)		77.84 (288.99)		1276.26 (1523.33)	

Demographic Characteristics	n	DMC in US$ Median (IQR)	*p* Value	DNMC in US$ Median (IQR)	*p* Value	INMC in US$ Median (IQR)	*p* Value	COI in US$ Median (IQR)	*p* Value
Stage IV	56	739.34 (1248.91)		262.23 (331.32)		92.44 (430.57)		1763.45 (1684.11)	
Family history of breast cancer									
Positive family history	40	909.42 (1632.40)	0.517	183.90 (309.42)	0.226	61.79 (336.64)	0.968	1333.92 (1544.79)	0.732
No family history	160	761.19 (1044.97)		233.53 (345.18)		82.71 (279.75)		1374.21 (1446.06)	

[*] Significance level = *p* value < 0.05. [**] DMC = Direct medical costs; DNMC = Direct nonmedical cost; INMC = Indirect nonmedical cost; and COI = Cost of illness. [***] In 2015, the average value of the official exchange rate was US$ 1 = PKR 102.77.

Table 3 shows positive relationships between outcome variable and most of the dependent variables, except for patient age, patient location and monthly household income, whose values were negative. Table 3 also indicates that a one-year increase in education caused an approximately 0.277-fold increase in the total COI. As per the observation and result of the regression analysis, patients' spouse education positively affect the COI. A negative relationship between the locality of the patient and the COI was identified, indicating that patients located in urban areas contributed less to the total COI than those living in rural areas did. The COI was high among breast cancer patients who were self-employed and employed by 0.279 and 0.206, respectively, compared with that of the house lady. More patients with stage II cancer than with stage III cancer were diagnosed with stage II cancer, with an increase in the overall COI of 0.228. The results further showed that patients with a positive family history tend to increase the COI by 0.171.

Table 3. Multiple linear regression for the cost of illness of breast cancer morbidity.

Independent Variables		Standardized Coefficients (B)	*p* Value
Patient age		-0.111	0.318
Patient education		0.003	0.977
Patient husband's education		0.277	0.022 [****]
Locality of patient		-0.250	0.022 [****]
Patient occupation (base: house lady)	Patient occupation as self-employed	0.279	0.011 [****]
	Patient occupation as employed	0.206	0.049 [****]
Monthly household income		-0.002	0.987
Stages of breast cancer (base: Stage III)	Breast cancer stage II	0.276	0.013 [****]
	Breast cancer stage IV	0.036	0.735
Family history of breast cancer		0.215	0.047 [****]

[*] Dependent Variable: Patient's overall cost of illness (US$). [**] F = 3.530. [***] R^2 = 0.342. [****] Sig = 0.001.

4. Discussion

Our study findings show that the economic burden of breast cancer is not uniformly distributed across patients but varies according to demographic, socioeconomic, and disease-related characteristics. Distinctive patterns were observed across individual components of cost, revealing that direct medical, direct nonmedical, and indirect costs are affected by different patient attributes. Furthermore, multivariable analysis identified several independent determinants of the overall COI, indicating that both sociodemographic factors and patients' clinical profiles contribute to the financial burden experienced by cancer-affected households.

The association of higher direct medical and overall costs of treatment with patient age or husband's education is consistent with reviews of financial toxicity reports concerning the influence of education, household income, employment, insurance, and treatment setting on economic strain, although the direction of the association may vary

across health systems depending on public subsidies, private-sector use, and insurance coverage [19,20,21,22]. The current study reported that patients from higher-income backgrounds have greater direct medical and overall costs, which does not imply lower hardship among poorer households; rather, they may underscore constrained spending, delayed care, incomplete treatment, or reliance on public-sector healthcare services among low-income families. Similar apprehension has been observed in LMICs, where lower expenditure may reflect unmet healthcare needs rather than protection from financial harm [23,24,25].

The higher direct nonmedical cost among rural patients with breast cancer is in line with the scientific literature showing that transport, food, lodging, and attendant costs contribute to a major share of the hidden cost of cancer care [26,27,28]. Patients residing in rural settings often have to make repeated visits to tertiary care hospitals, at times away from household responsibilities, and increase their dependence on attendants, making it difficult for patients to seek healthcare services. In China, India, Iran, and other LMICs, nonmedical and indirect costs contribute significantly to catastrophic expenditures among patients with breast cancer and other types of cancer from different socioeconomic backgrounds [11,26,27,28,29].

The findings of the current study, in which employed and self-employed women had higher indirect costs than housewives did, are supported by the breast cancer survivorship literature, which has correlated financial toxicity with work disruption, job retention problems, reduced income, and treatment-related loss of productivity among working patients [30,31,32,33]. The findings of the current study also highlight that indirect cost is not limited to the patient's own work; attendant time, child education support, paid domestic help, and household reorganization can also transfer disease burden to the family economy, which is relevant in settings where paid and unpaid female labor are both vital to household operations and functioning [34,35]. Furthermore, studies have reported that younger and middle-aged patients may face greater financial burdens because of work, childcare, debt, and family responsibilities [36,37,38]. However, older patients may spend less because of lower treatment intensity, dependency on family decision-making, or lower access to advanced care.

The findings of the study also highlighted stage II disease as a significant predictor of overall cost compared with stage III disease, whereas stage IV disease was not independently significant. The higher adjusted cost among stage II patients may reflect more active curative-intent pathways, surgery, chemotherapy, diagnostics, and follow-up for cancer treatment. On the other hand, the lower observed expenditure in advanced disease can be attributed to patients not being able to afford complete treatment and not seeking healthcare, being present late, or receiving mainly palliative care only. Recent studies on cancer-related out-of-pocket spending have reported that stage and treatment pathway affect cost, but this relationship is not always linear in low-resource settings [39,40].

The current study has several strengths, including but not limited to a detailed assessment of direct medical, direct nonmedical, indirect nonmedical, and overall costs of breast cancer by using a standardized cost-of-illness framework and an evaluation of both socioeconomic and clinical determinants through multivariable analysis in breast cancer patients recruited from two major public tertiary care hospitals. However, certain limitations should be acknowledged, including that the study design may cause inference, purposive sampling from two public hospitals in a single city may limit the generalizability of the findings, and cost estimates were based on patient-reported information, making them susceptible to recall bias.

5. Conclusions

This study concluded that the household cost burden of breast cancer in Pakistan is affected by both socioeconomic and clinical factors. Education, household income, occupation, place of residence, disease stage, and family history contributed to variations in economic burden, highlighting that the financial burden of disease treatment extends beyond treatment expenditures alone. Further multicenter prospective studies are needed to determine the long-term economic outcomes and impact of breast cancer among patients and to promulgate evidence-based policies for equitable cancer care in Pakistan.

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