RESEARCH ARTICLE

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Assessment of Total Delays and Their Associated Factors among Breast, Cervical, and Head and Neck Cancers in Northwestern India: A Cross-Sectional Study

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Abstract

Background: Timely diagnosis and treatment are critical for improving cancer survival; however, significant delays persist across the cancer care continuum, particularly in resource-constrained settings like India. This study aimed to analyze the extent and patterns of delays among patients with breast, cervical, and head and neck cancers in northwestern India. **Methods:** This exploratory cross-sectional study included all histopathologically confirmed cases of the three cancer types who initiated radiotherapy at the Radiotherapy Department of Government Medical College, Amritsar, during December 1, 2023, to November 30, 2024. Data on sociodemographic profiles, clinical details, and treatment timelines were collected through interviews and medical records. Delays were categorized as appraisal, help-seeking, diagnostic, pre-treatment, system, and total delays. Analysis was conducted at the descriptive, bivariate, and multivariable levels. Median delays and interquartile ranges were calculated for each cancer type. Differences in delay intervals between cancer groups were assessed using the Kruskal–Wallis H test, and differences between two-category variables were assessed using the Mann–Whitney U test. Associations between categorical variables and the presence of prolonged total delay (≥120 days) were examined using the chi-square test or Fisher's exact test, as appropriate. Correlation between total delay and number of medical contacts was evaluated using Spearman's rank correlation coefficient. Finally, multivariable binary logistic regression was performed to identify independent predictors of prolonged total delay, and adjusted odds ratios with 95% confidence intervals were reported. A p-value of <0.05 was considered statistically significant. **Results:** Among the 119 patients included in the study (45 breast, 28 cervical, and 46 head and neck cancers), breast cancer patients experienced the longest total delay (median: 282 days), followed by cervical (median: 199 days) and head and neck cancers (median: 190 days). System delay was the primary contributor across all three cancer types, driven largely by diagnostic delays. Appraisal delay was longest for breast cancer (median 155.5 days), help-seeking delay was longest for head and neck cancer (median 65 days), and pre-treatment delay was also longest for breast cancer (median 51.5 days). Variations in delays were observed across sociodemographic factors, but none reached statistical significance. **Conclusion:** This study highlights the need for a targeted, cancer-specific approach to address delays, with a focus on strengthening diagnostic services and improving system efficiency within the healthcare infrastructure. Implementing multi-pronged strategies for early detection, timely care, and prevention is crucial in reducing the cancer burden in this high-risk region.

Keywords: Breast cancer- Cancer delays- Cervical cancer- Head-and-neck cancer- North India

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Introduction

Cancer continues to be a leading cause of morbidity and mortality worldwide, with the burden rising significantly in low- and middle-income countries (LMICs) [1]. Timely diagnosis and treatment are critical in improving survival outcomes, yet delays across the cancer care continuum remain a major challenge. These delays can occur at multiple stages i.e., beginning with patients' recognition of symptoms (appraisal delay), their decision to seek medical attention (help-seeking delay), the diagnostic process within the health system (diagnostic delay), and initiation of definitive treatment (pretreatment delay). Collectively, these factors contribute to substantial "system delays," which are often longer in resource-constrained settings [2]. In India, where breast, cervical, and head and neck cancers account for the majority of cancer cases, such delays are particularly concerning [3]. Breast cancer is now the most common cancer among Indian women, while cervical cancer continues to be a leading cause of cancer-

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related mortality despite the availability of screening and preventive measures [3]. Head and neck cancers, closely linked with tobacco use, represent a major proportion of cancers among men in the country [4]. Delays in diagnosis and initiation of treatment for these cancers not only compromise prognosis but also increase treatment complexity and financial burden, thereby worsening patients' quality of life [5-9].

Existing literature suggests that diagnostic delay is often the most significant contributor to total delay, reflecting systemic gaps in health infrastructure, availability of specialists, and referral pathways [10]. Studies from India have shown that factors such as socioeconomic status, education, rural–urban residence, health-seeking behavior, and number of medical contacts can influence delays at different stages [7]. However, the relative contribution of each type of delay and its variation across cancer types remain underexplored in the Indian setting, particularly in regions with high cancer burden such as North-Western India.

Against this background, the present study was undertaken to analyse the extent and patterns of delays among patients with breast, cervical, and head and neck cancers. By disaggregating total delay into appraisal, help-seeking, diagnostic, and pretreatment delays, and by examining associated sociodemographic and clinical factors, this study aims to provide insights into critical points of intervention. Understanding these patterns is essential for designing targeted strategies to minimize delays, improve early diagnosis, and enhance cancer care outcomes in high-burden settings.

Materials and Methods

This exploratory cross-sectional study was conducted in the Department of Community Medicine in collaboration with the Department of radiotherapy at Government Medical college Amritsar, Punjab, India.

Sample size and sampling technique

Total enumeration sampling was employed, including all histopathologically confirmed cases of breast, cervical, or head and neck cancer who met inclusion criteria and initiated radiotherapy treatment at a tertiary cancer centre during the study period (December 1, 2023, to November 30, 2024).

Inclusion criteria

All histopathologically confirmed cases of breast cancer, cervical cancer and Head & Neck cancer aged > 18 yrs both male and female gender irrespective of disease stage undergoing treatment at Radiotherapy Department were labelled as cases.

Exclusion criteria

* Who failed to give an informed consent
* Cases that were seriously ill
* Those who reported at radiotherapy department before or after the start /end of the study period

Data collection tool

Data were collected using a semi-structured questionnaire through one-to-one interviews conducted with the study participants. After obtaining written informed consent and explaining study objectives, socio-demographic profiles and clinical details were recorded. Treatment timelines including dates of symptom detection, healthcare consultation, diagnosis, and treatment initiation were extracted from patient records where available, or obtained from participant recall when records were unavailable. To minimise recall bias, treatment and diagnostic dates were primarily obtained from medical records. Patient recall was used only for early symptom and first consultation timelines when documentary evidence was unavailable. During interviews, timelines were reconstructed using probing questions and reference to key personal or calendar events, and were cross-verified with available prescriptions, investigation reports, and referral documents wherever possible. Information regarding delays at various levels and contributing factors was collected systematically for each participant.

Ethical consideration

Ethical approval for this study was obtained from one institutional ethics committee, namely the Institutional Ethics Committee of Government Medical College, Amritsar, prior to commencement of the study.

Definition of Delays

Delays along the cancer care pathway were operationally defined using six sequential time intervals. Appraisal delay was defined as the time from first symptom detection to the patient's decision to seek medical consultation. Help-seeking delay referred to the interval between the decision to consult and the first contact with a healthcare provider. Diagnostic delay was defined as the time from first healthcare consultation to histopathological confirmation of cancer. Pre-treatment delay represented the interval from confirmed diagnosis to initiation of definitive treatment. System delay was defined as the time from first medical contact to start of treatment, thereby capturing delays within the healthcare system. Total delay was calculated as the overall time from initial symptom detection to initiation of treatment.

Potential contributors to delay were further grouped into patient-related factors, healthcare provider/system-related factors, and disease-related factors in accordance with the conceptual framework proposed by Walter et al [10].

Statistical analysis

Data were compiled using Microsoft Excel and analyzed using SPSS v25. Total delay was calculated by determining the time interval from symptom detection to treatment initiation for each participant. Based on the defined threshold, patients were categorized into two groups: those with total delay ≥120 days (presence of delay) and those with total delay <120 days (absence of delay). A cut-off of 120 days was used to define prolonged total delay, as previous studies have shown that delays of four months or more are clinically meaningful and

associated with advanced stage at presentation and poorer outcomes in cancer patients [11]. The proportion of patients experiencing total delay was calculated by dividing the number of patients with delay by the total number of patients in each cancer type.

Using these proportions, the burden of total delay was assessed across breast cancer, cervical cancer, and head & neck cancer categories. Comparisons between cancer types were performed using appropriate statistical tests, with statistical significance set at $p<0.05$. The three cancer sites were compared to examine differences in patient and health-system related delays across common high-burden cancers with distinct symptom profiles and diagnostic pathways. Breast cancer is typically symptom-detected, cervical cancer often presents with gynecological symptoms or screening findings, and head and neck cancers may present with nonspecific complaints requiring specialist referral. To account for these differences, delay components were calculated separately for each cancer type and compared using non-parametric methods. The aim was to evaluate variations in care pathways and system responsiveness rather than to equate biological behaviour across cancers.

A multivariable binary logistic regression model was fitted to identify independent predictors of total delay (≥120 days). Variables with clinical and epidemiological relevance including age group, gender, education, place of residence, socioeconomic status, cancer type, receipt of symptomatic treatment, and number of medical contacts were entered into the model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were estimated. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test, and statistical significance was set at $p < 0.05$.

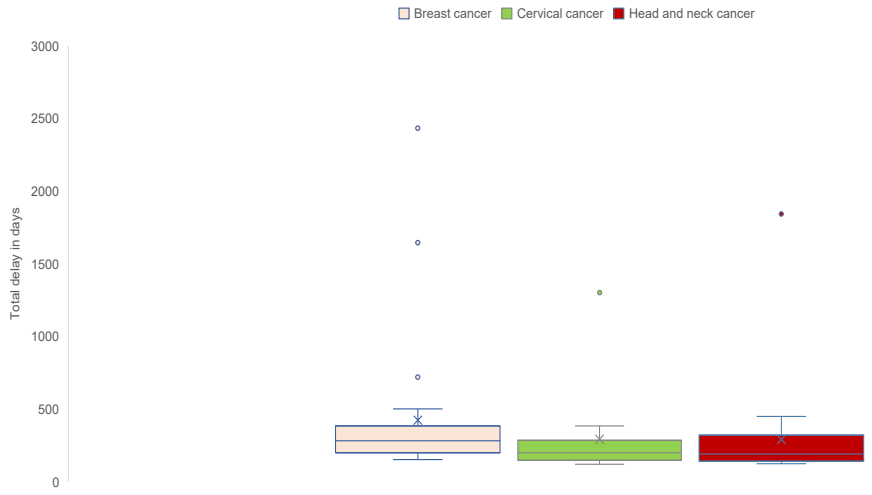
Results

A total of 119 patients were included in the study, comprising 45 (37.8%) breast cancer, 28 (23.5%) cervical cancer, and 46 (38.7%) head and neck cancer cases. The study population included both males and females across a wide age range, with the majority of participants belonging to middle and older age groups. Most patients were married and a substantial proportion had low educational attainment and belonged to lower socioeconomic strata. Both urban and rural residents were represented, with a slight predominance of rural participants. Many patients reported multiple healthcare contacts prior to diagnosis, and a considerable proportion had received some form of symptomatic treatment before definitive cancer diagnosis.

Breast cancer patients experienced the longest appraisal delay (median: 155.5 days), while cervical cancer patients had the shortest (median: 53.5 days). For help-seeking delay, head & neck cancer patients showed the highest median (median: 65 days) compared to breast (median: 30 days) and cervical cancer (median: 31 days). Diagnostic delay was of similar magnitude across the three cancer types, with median values of 124 days for breast cancer, 53 days for cervical cancer, and 51 days for head and neck cancer, and the difference was not statistically significant on Kruskal–Wallis testing. Pre-treatment delays were longest in breast cancer (median: 51.5 days) and shortest in head and neck cancer (38 days). System delays varied considerably, with cervical cancer showing the highest median (182 days) and breast cancer the lowest (21.5 days).

Comparison of delay components across the three cancer types was undertaken to identify which stages of the care pathway contributed most to overall delay in each cancer and to highlight potential targets for cancer-specific interventions. Using the Kruskal–Wallis H test, significant differences were observed between cancer types for appraisal delay ($p=0.002$) and system delay ($p=0.021$), indicating variation in early symptom appraisal and health-system related intervals. In contrast, diagnostic, help-seeking, and pre-treatment delays were broadly similar across cancers ($p>0.05$) (Table 1). These findings suggest that while certain delay stages are cancer-specific, others reflect common system-level constraints.

(Figure 1) Maximum total delay (median=282; IQR=208-380) was observed among breast cancer cases. On the other hand, least delay was found among



(H=7.296; p= 0.026; df=2)

Figure 1. Site Wise Distribution of Cases According to Total Delay (in days) (N=119

Table 1. Site Wise Distribution of Cases According to Median Delay (in Days) for Types of Delay (N=119)

Site of cancer	Appraisal delay (Median;Range)	Help seeking delay (Median;Range)	Diagnostic delay (Median;Range)	Pre-treatment delay (Median;Range)	System delay (Median;Range)
Breast cancer(n=45)	155.5 (30-1492)	36 (30-112)	124 (31-1285)	51.5 (31-527)	44 (08-1703)
Cervical cancer(n=28)	53.5 (31-761)	31 (30-33)	53 (32-512)	49 (42-120)	182 (109-540)
Head and neck cancer(n=46)	72 (30-425)	65 (38-92)	51 (30-1796)	38 (31-149)	144 (97-1812)
H statistic (p value; df)	12.454 (0.002;2)	2.811 (0.245;2)	2.221 (0.329;2)	2.489 (0.288;2)	3.023 (0.221;2)

(# p<0.05 is considered statistically significant)

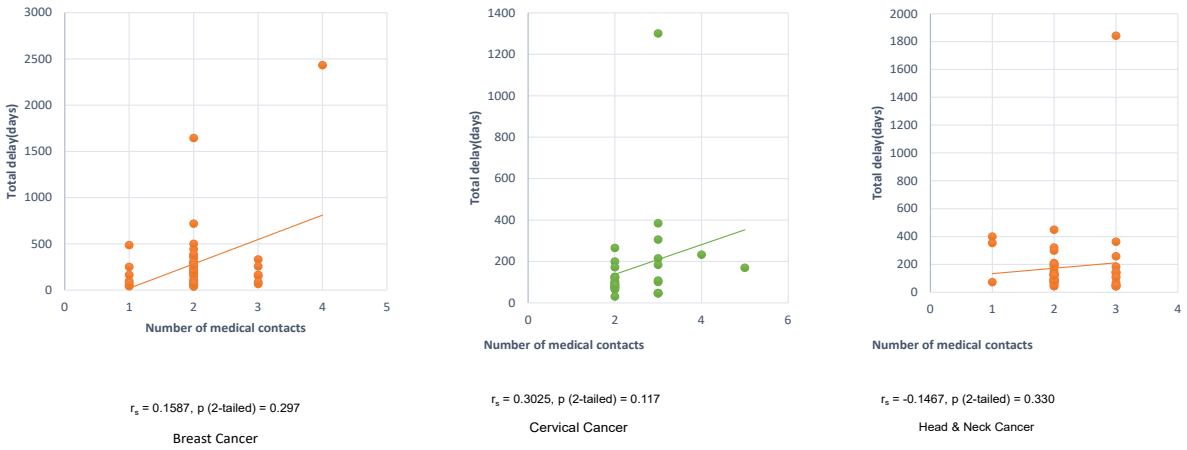


Figure 2. Correlation of Total Delay (in Days) with Number of Medical Contacts in Breast Cancer Cases (N=45), Cervical Cancer Cases (N=28) & Head and Neck Cancer Cases (N=46)

head and neck cancer cases where the median was 190 (IQR=142-310) days. The total delay in case of cervical cancer ranged between 169 to 265 days and the median delay was found to be 199 days. The variation of median delays between all the types of cancer was found to be statistically significant (p=0.026).

Breast cancer cases who had not received symptomatic treatment had the median total delay of 305.5 days (IQR=212-386) higher than the cases who had received symptomatic treatment [median=254.5 days; IQR=194-294].

Whereas, in cervical [median=199 days; IQR=147.5-285] and head and neck [median=190 days; IQR=141-321] cases who had received symptomatic treatment had higher median total delay when compared with cases who did not receive symptomatic treatment. The difference in head and neck cancer cases was found to be statistically significant (p=0.007) (Table 2).

Median total delays varied across sociodemographic subgroups within each cancer type; however, bivariate comparisons using Mann–Whitney U test or Kruskal–Wallis H test did not demonstrate statistically significant differences for age, occupation, education, residence, family type, or socioeconomic status in any of the three cancer groups (Table 3). Although some subgroups showed higher median delays, these differences were not statistically significant and therefore are not indicative of consistent sociodemographic gradients in delay.

For both breast and cervical cancer cases, a positive correlation was observed for total delay (in days) with number of medical contacts, indicating that total delay increased with the number of medical contacts. Surprisingly, head and neck cancer cases demonstrated a slight negative correlation, where total delay decreased with increasing number of medical contacts. Despite the varying directional relationships observed across cancer types, none of the correlations between medical contacts and treatment delay reached statistical significance (Figure 2).

On multivariable logistic regression analysis, several

Table 2. Association of Total Delay with Symptomatic Treatment among Cases (N=119)

	Site of cancer		
	Breast (n=45) [Median (IQR)]	Cervical(n=28) [Median (IQR)]	Head and neck(n=46) [Median (IQR)]
Symptomatic delay			
Yes	254.5(194-294)	191.5(87-1301)	190(141-321)
No	305.5(212-386)	6.6(0-17)	64(56-72)
U statistic (p value)	54.5(0.530)	0.00(<0.001)#	46(0.007) #

(# p<0.05 is considered statistically significant)

Table 3. Association of Sociodemographic Variables with Total Delay (in Days) Stratified by Cancer Site

Variables	Total delay [Median(IQR)]		
	Breast cancer (n=45)	Cervical cancer (n=28)	Head and neck cancer (n=46)
Age(years)			
31-45	182 (73.5-260)	108.5 (89-265)	135(99.5-321)
46-60	165 (93-371)	126 (65-199)	124(89-160.5)
≥61	224 (79-283)	84 (73-108)	118(71.5-186.5)
H/ U statistic (p value; df)	0.468 (0.791;2)	1.072 (0.585;2)	1.685 (0.431;2)
Occupation			
Housewives/ Unemployed	165 (76.5-299.5)	102 (73-172)	199 (102.5-337.5)
Employed	260 (176.75-460.5)	199 (86.5-324.5)	117 (70-164)
H/ U statistic (p value; df)	115 (0.105;1)	79 (0.215;1)	232.5 (0.067;1)
Marital Status			
Married	182 (86-306)	101.5 (73-199)	118.5 (80.5-258.5)
Widow	205 (64-375.75)	123 (77-233)	113 (75-135)
H/ U statistic (p value; df)	142 (0.873;1)	80.5 (0.717;1)	136 (0.622;1)
Education			
Illiterate	258 (160-319)	101.5 (77-233)	118 (78-244.5)
Primary School	132 (76.5-258)	147.5 (88-191.5)	134 (94-183)
High school and above	216.5 (89.5-369.5)	85 (47-120)	99.5 (56-199)
H/ U statistic (p value; df)	2.117 (0.347;2)	1.692 (0.429;2)	1.06 (0.588;2)
Place of residence			
Urban	218.5 (117.5-361.5)	84 (46-108)	134 (68-199)
Rural	165 (72-299.5)	124.5 (77-233)	125 (96-354)
H/ U statistic (p value; df)	159.5 (0.159;1)	43.5 (0.113;1)	220 (0.415;1)
Type of family			
Nuclear	153.5 (72-296)	124.5 (84-233)	134.5 (94-199)
Joint	258 (201-343)	101 (73-215)	127.5 (75-299)
H/ U statistic (p value; df)	114.5 (0.055;1)	110 (0.458;1)	248.5 (0.733;1)
SES			
I	160 (114.5-340.25)	126 (123-169)	204.5 (141-258)
II	173.5 (76-311.75)	93 (87-101)	144 (84-199)
III	186 (75.5-260.25)	102 (73-199)	94 (72-134)
IV	386 (224-501)	161.5 (62-344.5)	118.5 (101-146.5)
H/ U statistic (p value; df)	3.241 (0.356;3)	1.705 (0.636;3)	5.001 (0.172;3)

(# p<0.05 is considered statistically significant); H/U statistic: H, Kruskal–Wallis test; U, Mann–Whitney U test.

factors emerged as independent predictors of prolonged total delay (≥120 days). Patients aged ≥61 years had significantly higher odds of experiencing delay compared to those aged ≤45 years (AOR = 1.89; 95% CI: 1.01–3.54; p = 0.046). Illiterate patients were more than twice as likely to experience prolonged delay compared to those

Table 4. Multivariable Logistic Regression for Predictors of Total Delay ≥120 Days

Predictor	AOR	95% CI	p-value
Age ≥61 years	1.89	1.01–3.54	0.046#
Illiterate (vs ≥High school)	2.31	1.14–4.68	0.020#
Rural residence (vs Urban)	1.67	1.02–2.91	0.041#
Lower SES (IV–V vs I–II)	2.74	1.29–5.83	0.008#
Cervical cancer (vs Breast)	0.72	0.38–1.36	0.314
Head & neck cancer (vs Breast)	0.64	0.33–1.22	0.179
No symptomatic treatment	1.92	1.08–3.41	0.026#
≥3 medical contacts	2.56	1.42–4.62	0.002#

(# p<0.05 is considered statistically significant)

with high school education or above (AOR = 2.31; 95% CI: 1.14–4.68; p = 0.020).

Rural residence was also significantly associated with increased delay (AOR = 1.67; 95% CI: 1.02–2.91; p = 0.041), as was lower socioeconomic status (AOR = 2.74; 95% CI: 1.29–5.83; p = 0.008). Patients who had not received any symptomatic treatment prior to diagnosis had higher odds of prolonged delay (AOR = 1.92; 95% CI: 1.08–3.41; p = 0.026).

Additionally, having three or more medical contacts was a strong independent predictor of prolonged delay (AOR = 2.56; 95% CI: 1.42–4.62; p = 0.002). Cancer type was not independently associated with total delay after adjustment for confounders (Table 4).

Discussion

The analysis of delays across different cancer types (breast, head and neck, and cervical) revealed a complex but consistent pattern within the same tertiary healthcare system. The most prominent component of delay for all three cancers was the system delay, defined as the interval from first medical consultation to initiation of treatment. The predominance of system delay, particularly in cervical cancer, reflects bottlenecks in diagnostic and referral pathways rather than patient-related factors alone. Similar patterns reported in Indian and LMIC studies suggest that fragmented referrals and limited diagnostic access prolong delays, especially for cervical cancer. Shorter delays in breast cancer may be due to clearer symptom recognition and more established diagnostic pathways, while head and neck cancers likely face delays due to nonspecific early symptoms requiring specialist evaluation. Across all three cancer types, diagnostic delay formed the largest part of this system interval, although differences between cancer types were not statistically significant. Similar observations have been reported from other resource-constrained settings, where delays within the diagnostic and referral pathway, rather than patient decision time alone, constitute the major bottleneck in cancer care delivery. Studies from Indian tertiary centres have likewise shown that repeated referrals, multiple provider contacts, and limited access to definitive diagnostic services substantially prolong the diagnostic phase of the care pathway, supporting the present findings that system-level processes are the dominant contributor to total delay within comparable healthcare systems [7, 12, 13].

Appraisal delay was longest for breast cancer (median 155.5 days), likely reflecting delayed recognition or underestimation of early breast symptoms such as painless lumps. In contrast, head and neck cancers showed the longest help-seeking delay (median 65 days), which may relate to initially vague or easily ignored symptoms such as throat discomfort or small oral lesions. Pre-treatment delay was longest for cervical cancer (median 49 days), possibly indicating additional time required for confirmatory investigations and referral within gynecological and oncology services. On statistical comparison across cancer types, a significant difference was observed only for pre-treatment delay, while variations in appraisal and help-seeking delays did not reach statistical significance.

The data from this study shows that the maximum total delay (median = 282 days) was observed among breast cancer cases. This is in contrast to head and neck cancer cases, which had the least total delay (median = 190 days). Cervical cancer cases fell in between, with a median total delay of 199 days. The variation in median delays among all three cancer types was found to be statistically significant (p=0.026). This finding underscores the importance of a cancer-specific approach to addressing delays. A study by Macleod et al. [6] published in the British Journal of Cancer demonstrated significant variation in total delays across cancer types and found breast cancer among cancers with longest patient-initiated delays, supporting the need for cancer-specific intervention approaches, which aligns with the present study's findings.

An investigation into the relationship between total delay and symptomatic treatment yielded interesting results. Longer delays among breast cancer patients who did not receive symptomatic treatment likely reflect delayed symptom recognition and later entry into the healthcare system. This likely reflects better symptom recognition (such as detecting a lump) and earlier health-seeking among those with symptoms leading to treatment, since breast lumps are more easily noticed and often prompt quicker medical consultation compared to other symptoms. Conversely, for both cervical and head and neck cancer cases, those who had received symptomatic treatment had a higher median total delay when compared with cases who did not receive symptomatic treatment. This difference was statistically significant only for head and neck cancer cases (p=0.007). Longer delays among symptomatic treatment recipients in head and neck cancer, and to a lesser extent cervical cancer, are consistent with previous studies showing that nonspecific early symptoms often lead to repeated consultations and delayed specialist referral. In contrast, breast cancer symptoms are more readily recognized, enabling earlier diagnostic evaluation, as reported in Indian studies [7,13,14].

For breast cancer, factors like being aged 61 years or older, being employed, being illiterate, and residing in urban areas were associated with longer delays. Additionally, breast cancer cases living in joint families and those with a lower socioeconomic status (SES) experienced longer delays. Despite these observed variations, none of the sociodemographic variables were found to be statistically associated with the delay. Similar findings were observed in multiple studies conducted in India except the studies observed more delays among the females residing in rural areas [15, 16]. Urban delay likely reflects systemic healthcare bottlenecks, sociodemographic disparities, and administrative complexities prevalent in urban healthcare settings, rather than just geographic proximity or individual factors. This contrasts with the more common rural delay origins rooted chiefly in access and distance challenges

For cervical cancer, longer delays were observed among those aged 31-45 years, working on daily wages,

having a primary school education, and residing in rural areas. Patients residing in nuclear families also reported longer delays. Similar to breast cancer, none of the sociodemographic variables showed a statistically significant association with the delay. A 2023 cross-sectional study in India had similar findings where, on 230 cervical cancer patients found 70% from rural areas and a majority presenting at late stages, with factors like embarrassment, fear of loss of daily wages, and low awareness contributing to delay [14].

For head and neck cancer, a trend towards shorter delays with increasing age was observed. The maximum delay was observed in those aged 45 years or younger. Higher delays were also found among the unemployed, those with a primary school education, and urban residents. Patients residing in nuclear families and those in the upper SES class reported longer delays. Similar to the other two cancer types, none of these sociodemographic variables were statistically associated with the total delay.

For both breast and cervical cancer cases, a positive correlation was observed, meaning that as the number of medical contacts increased, so did the total delay. Kumar et al. [7] and Sebi et al. [12] also observed similar findings in their studies, reporting a positive correlation between the number of medical contacts and the total delay in diagnosis for both breast and cervical cancer cases; however, this correlation was not statistically significant, indicating that increased medical visits tended to coincide with longer delays but without sufficient evidence to confirm a meaningful association. These findings are consistent with previous studies showing that multiple health facility visits, fragmented referral pathways, and access barriers contribute to diagnostic delays, although the magnitude of this association varies across settings due to differences in health-system structure and study design [2, 5, 7].

Surprisingly, a slight negative correlation was found for head and neck cancer cases, where an increase in medical contacts was associated with a decrease in total delay. But this correlation was also not statistically significant. This unexpected finding may be due to the often-visible and rapid progression of head and neck cancer symptoms, prompting more urgent and effective follow-ups, even with multiple contacts.

The multivariable analysis provides important insight into independent predictors of prolonged total delay. Advanced age, illiteracy, rural residence, and lower socioeconomic status were significantly associated with increased odds of delayed treatment initiation, highlighting persistent social and structural inequities in access to timely cancer care. These findings are consistent with prior studies from low- and middle-income settings, which have similarly demonstrated that older age, low education, and poverty contribute to diagnostic and treatment delays.

The strong association between a higher number of medical contacts and prolonged delay suggests inefficiencies in referral pathways and potential misdiagnosis or under-referral at primary and secondary care levels. This underscores the need for streamlined referral systems and fast-track diagnostic pathways. The finding that absence of symptomatic treatment was independently associated with prolonged delay may reflect delayed symptom recognition or underestimation of disease severity in early stages. Notably, cancer type did not remain a significant predictor after adjustment, suggesting that system- and patient-level factors exert a stronger influence on delays than disease-specific factors alone.

Conclusion

In this cohort of 119 patients with breast, cervical, and head and neck cancers in North-western India, total delay from symptom onset to treatment initiation was prolonged and differed significantly by cancer type, with the longest median delay observed in breast cancer, followed by cervical and head and neck cancers. Across all three cancers, the largest component of total delay occurred within the health system, and was mainly driven by diagnostic delay. Although delays varied by sociodemographic characteristics, no independent sociodemographic predictor of prolonged delay was identified, while multiple healthcare contacts were associated with longer overall pathways, indicating inefficiencies in referral and diagnostic processes.

These findings highlight that reducing cancer care delays in this setting requires strengthening system-level performance, particularly early diagnosis and streamlined referral pathways, rather than focusing solely on patient characteristics. Targeted efforts to shorten the diagnostic interval and expedite treatment initiation are likely to yield the greatest impact on timely cancer care and patient outcomes.

Recommendation

educing cancer-related delays in high-burden settings such as North-Western India requires a multi-level, cancer-specific approach.

1. Appraisal Delay

Community awareness, frontline worker training, and integration of cancer symptom education into existing NCD programmes can improve early symptom recognition.

2. Help-Seeking Delay

Mobile outreach services, fast-track referrals, and social protection measures may facilitate earlier healthcare access.

3. Diagnostic Delay

One-stop diagnostic services, decentralised pathology with tele-support, and provider training are key to shortening diagnostic pathways.

4. Pre-treatment Delay

Pre-scheduled treatment slots, patient navigation, and digital tracking systems can enable timely treatment initiation.

5. Cancer-Specific Strategies

Breast cancer interventions should emphasise self-examination and rapid assessment; cervical cancer should

focus on VIA screening and HPV vaccination; head and neck cancer control should prioritise tobacco cessation, oral screening, and expedited ENT referral.

6. System Reforms

Expedited financial approval, regional diagnostic hubs, and time-bound referral and treatment benchmarks are essential to reduce avoidable delays.

Limitations

First, appraisal and help-seeking delays partly relied on patient recall and may be subject to recall bias, although timelines were cross-verified with medical records wherever feasible. Second, the cross-sectional and single-centre design limits causal inference and generalisability of the findings to other settings.

Strengths

First, the study comprehensively assessed multiple components of delay across three high-burden cancers using a standardized framework. Second, use of total enumeration sampling and documented clinical records, along with multivariable analysis, strengthened the validity and programmatic relevance of the findings.

Key messages

Early detection, , timely care, and prevention are key to reducing cancer burden.

Author Contribution Statement

All authors contributed to the conception and design of the study. Data collection and statistical analysis were performed by the authors. The first draft of the manuscript was written by the first author, and additional content was contributed by co-authors, who also critically revised the manuscript for important intellectual content. Senior authors contributed to the overall conception of the paper and approved the final version. All authors commented on previous versions of the manuscript, read, and approved the final manuscript.

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Scientific approval / thesis statement

The study was conducted as part of an approved academic research project and constitutes a component of a postgraduate thesis. Scientific approval for the study was obtained from the Institutional Research Committee prior to commencement.

Ethical approval and consent to participate

Ethical approval for the study was obtained from the Institutional Ethics Committee of Government Medical College, Amritsar. Written informed consent was obtained from all study participants prior to data collection. Confidentiality and anonymity of participant information were strictly maintained throughout the study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Study registration

This study was an observational cross-sectional study and was not registered in a clinical trial or research registry, as registration was not mandated for this study design.

Conflicts of interest

The authors declare that there are no conflicts of interest associated with this study.

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