

Burden and Survival of Solid Cancers Among Female Adolescents and Young Adults in Karachi: A Three- Year Retrospective Analysis

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Abstract

Background: Adolescents and young adults (AYAs, 15–39 years) represent a distinct population with unique cancer patterns and outcomes. Female AYAs face additional challenges related to reproductive health and fertility preservation. This study aimed to evaluate the distribution, histopathology, stage at diagnosis, and survival of solid tumors among female AYAs in Karachi.

Methods: A retrospective analysis was conducted on 782 biopsy-confirmed female AYA patients presenting to Dow University Hospital between April 2022 and April 2025. Demographic, tumor, and survival data were extracted from the hospital registry. Tumor frequency, age-specific distribution, and stage were analyzed. Kaplan–Meier and Cox regression analyses assessed survival outcomes, and age-standardized incidence rates (ASIR) were calculated.

Results: The mean patient age was 32.9 ± 6.1 years, with 52.3% aged 35–39 years. Breast cancer was the most common malignancy (50.0%), predominantly invasive ductal carcinoma, followed by central nervous system (16.6%) and gynecologic tumors (12.0%). Younger AYAs (15–24 years) more frequently presented with early-stage disease, while older patients (30–39 years) were predominantly diagnosed at Stage III–IV. Survival varied significantly by stage ($p < 0.001$) and tumor type. Stage IV patients had a median survival of 45 months (95% CI: 38.8–51.2). Breast cancer demonstrated excellent early survival, whereas gastrointestinal and CNS tumors showed marked early and mid-term mortality. Patients aged 35–39 years had nearly double the risk of death compared to those aged 15–19 years (HR = 1.97, 95% CI: 1.05–3.70, $p = 0.036$).

Conclusions: Female AYAs in Karachi carry a substantial burden of solid tumors, with survival outcomes strongly influenced by tumor type and stage. Age-specific management, early detection, and fertility-preserving strategies are essential to improve outcomes in this vulnerable population.

INTRODUCTION

The National Cancer Institute (NCI) recognized that teenagers and young adults (AYAs) represent, unique cancer individual group, distinct from both children and elderly. World Health Organization (WHO) states, adolescence spans ages 10 to 19, while young adulthood covers 15 to 24 years¹. However, The National Cancer Institute (NCI) classifies AYAs as individuals diagnosed with cancer between the ages of 15 and 39². The incidence of cancer in this group has been increasing, with around 17,000 cases annually in Germany and 70,000 in the United States³. In comparison to elderly, AYAs have more genetic susceptibility to neoplasia, and emotional and therapy associated repercussions of cancer are frequently more severe—particularly among female patients⁴.

In 2022, female-specific malignancies accounted for 38.3% of all cancer cases diagnosed in women⁵. Breast neoplasms is a leading diagnosed disease among women, account for 2.3 million new incidents reported worldwide in 2022, establishing it the second most prevalent cancer overall after lung cancer⁵. Breast cancer also accounts for a noteworthy proportion of cancer-associated mortality, contributing to 15.4% among all cancer deaths⁵. Regarding the occurrence and mortality among females worldwide, cervical cancer is the 4th frequent type of neoplasm. It's a primary reason for cancer in 25 states and a substantial contributor to cancer-related fatalities in 37 countries^{4,5}. Cancers predominantly affecting females, such as breast or gynecological cancers, are particularly aggressive. In addition to the reproductive toxicity of many chemotherapies, many cancers provide significant obstacles to fertility preservation and can cause infertility directly, which is particularly problematic for women in the AYA age range. Alarming, recent epidemiological studies have documented a rising cancer risk among younger populations, with a noticeable shift toward earlier ages at diagnosis for breast and endometrial cancers. Prevalence rates of these cancers in young females have steadily increased over recent years⁶.

This study objective is to provide critical insights into the distribution and trends of biopsy-confirmed solid cancers among female patients aged 15 to 39 years at Dow University Hospital, the largest tertiary care center in Karachi, Sindh. By focusing on this specific demographic, the research seeks to contribute valuable data to better understand the epidemiology of young adult female cancers in Pakistan, thereby informing targeted diagnostic, therapeutic, and fertility preservation strategies.

OBJECTIVE:

The primary objective of this study is to evaluate distribution, frequency, and histopathological trends of biopsy-proven solid cancers among AYA female patients aged 15 to 39 years, over a three-year period at Dow University Hospital, Karachi.

METHODS & MATERIALS

Study Design and Data Sources, Collection and Storage:

This is a cross-sectional retrospective analysis of female cancer patients both genders aged 15-39 years to determine frequencies of different solid cancers presented from April 2022 to April 2025 to the Department of Medical Oncology at Dow University Hospital, Karachi, Pakistan.

The Medical Oncology Department's hospital-based registry served as the main source of data, which was first manually gathered using a Google Excel document. International procedures and the international classification of diseases in oncology were followed in the diagnosis and staging. Retrospective data obtained by the author comprises the patient's unique hospital medical record number, demographic details, and disease details,

including histology, morphologic, and staging information, from the moment each case is abstracted. The senior registrars conduct monthly audits to ensure the quality of the registration data, and cross-checking is carried out to improve database consistency.

Inclusion & Exclusion Criteria:

Female Patients, harboring a Biopsy proven histologically solid cancer diagnosed, age between 15-39 years were included.

Patients having age less than 15 or more than 39 years, male gender, pregnant females, patients having hematological malignancies and suspected cancers not biopsy proven were excluded from this study.

Statistics:

Descriptive statistics were used to summarize patient demographics, tumor characteristics, and clinical data. Continuous variables were reported as mean ± standard deviation (SD) or median (interquartile range, IQR), while categorical variables were presented as frequencies and percentages. Trends over the study period were evaluated using annual tumor frequencies and age-group stratification. Because data for 2025 were incomplete at the time of extraction (January–April 2025), an annualized tumor-frequency approach was used to approximate the full-year case count. The mean monthly case load from the fully completed years (2022–2024) was calculated and multiplied by 12 to obtain a standardized annual estimate. This method was applied to the partial 2025 data to generate an exploratory full-year projection for trend visualization only. The estimate does not represent a predictive incidence model and should be interpreted with caution.

All analyses were performed using SPSS version 27.0. Age-standardized incidence rates (ASIR) were calculated using the female age-group population estimates from the 2004–2025 projection study for Karachi. The direct method of standardization was applied, using the GLOBOCAN 2020 standard population as the reference.

RESULTS

Among the 782 female AYA patients, the mean age was 32.94 ± 6.07 years, with more than half (52.3%) falling within the 35–39-year age group (Table 1; Figure 1). Early-stage disease (Stages I–II) was more common among younger women, particularly those aged 15–24 years. In contrast, older AYA patients—especially those aged 30–39 years—were predominantly diagnosed at advanced stages, with Stage III accounting for the largest proportion of cases in these age groups (Table 1). Overall, the distribution shows a clear trend toward later-stage diagnosis with increasing age within the AYA population.

TABLE 1 AGE DISTRIBUTION AND STAGE AT DIAGNOSIS OF FEMALE AYA CANCER PATIENTS (15–39 YEARS), 2022–2025 (N = 782)

AGE GROUP (IN YEARS)	FEMALE (PERCENTAGE %)	STAGE I	STAGE II	STAGE III	STAGE IV
Mean ± SD	32.94 ± 6.07				
15–19	29 (3.7)	14	4	9	3
20–24	47 (6.0)	13	3	21	10
25–29	123 (15.7)	25	13	60	26
30–34	174 (22.3)	31	11	91	41
35–39	409 (52.3)	38	40	251	78
Total	782 (100)	120	71	432	158

Figure 2 illustrates the annual distribution of female AYA cancer cases from 2022 to 2025. The number of confirmed cases increased steadily from 109 in 2022 to 233 in 2023 and reached 246 in 2024. In 2025, a total of 194 cases were documented up to the time of analysis. Using the annualized tumor-frequency method described in the Data Analysis section, the projected full-year estimate for 2025 is approximately 582 cases.

Among female AYAs (15–39 years) diagnosed between 2022 and 2025, breast cancer was the most prevalent malignancy, accounting for 50.0% of all solid tumors (391/782), with the majority (244/391, 62.4%) occurring in the 35–39-year age group. CNS tumors were the second most common, representing 16.6% of cases (130/782) and predominantly affecting younger AYAs (15–34 years). Gynecologic tumors accounted for 12.0% of cases (94/782), most frequently ovarian (66/94, 70.2%) and cervical (14/94, 14.9%), primarily in patients aged 25–39 years. Gastrointestinal tumors comprised 9.1% of cases (101/782), with colorectal cancer being the most common subtype (33/101, 32.7%). Head and neck, urological, lung, bone, soft tissue sarcomas, and melanoma together accounted for less than 5% of cases. These distributions are summarized in Table 2.

TABLE 2: AGE-SPECIFIC DISTRIBUTION AND AGE-STANDARDIZED INCIDENCE RATES (ASIR) OF SOLID TUMORS AMONG FEMALE ADOLESCENTS AND YOUNG ADULTS (AYAs) AGED 15–39 YEARS, 2022–2025 (N = 782).

Tumor Type / Organ System		ICD-10	15-19		20-24		25-29		30-34		35-39		TOTAL
			count	ASIR	count	ASIR	count	ASIR	count	ASIR	count	ASIR	
Breast		C50	0	0.00	9	0.06	52	0.34	86	0.57	244	1.79	391
Gynecologic Tumors	Ovary (Epithelial + Others)	C56	3	0.12	1	0.10	16	0.10	12	0.08	34	0.08	66
	Endometrium	C54	0		0		2		7		4		12
	Cervix	C53	0		0		1		1		12		14
	Vulva/Vagina	C51/52	0		0		0		0		2		2
	Gynecologic Germ Cell	C56 / C57.0–C57.9	2		5		1		1		1		10
	Gestational Trophoblastic Neoplasia (GTN)	001–002 / C58	0		0		3		2		4		9
Gastrointestinal Tumors	Gallbladder	C23	0	0.05	0	0.09	0	0.12	0	0.12	6	0.26	6
	Klatskin	C24.0	0		0		0		0		2		2
	Cholangio	C24.1	0		0		0		0		1		1
	Pancreas	C25	7		0		0		0		5		12
	Esophagus	C15	0		3		4		4		9		20
	GE-Junction	C16.0/C16.9	0		1		2		1		2		6
	Stomach + GIST	C16 / C49.5	0		0		4		8		2		14
	Colon + Rectum + Anal	C18–C21	0		10		8		6		9		33
	Liver	C22	1		0		2		1		7		11
	Appendix	C18.1	0		0		1		0		0		1
CNS Tumors		C71–C72	20	0.12	18	0.11	27	0.17	36	0.23	29	0.18	130
Head & Neck Tumors	Oral Cavity (All Subsites)	C00–C06	0	0.00	0	0.00	4	0.03	7	0.04	8	0.06	19
	Salivary & Other Glands	C07–C08	0		0		1		0		0		1
Urological Tumors	Bladder	C67	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	1
Lung		C34	0	0.00	1	0.01	2	0.01	0	0.00	1	0.01	4
Bone Tumors		C40–C41	2	0.01	1	0.01	2	0.01	4	0.03	0	0.00	9
Soft Tissue Sarcomas		C49	0	0.00	0	0.00	0	0.00	3	0.02	0	0.00	3
Melanoma		C43	0	0.00	1	0.01	1	0.01	2	0.01	1	0.01	5

Table 2. Age-specific distribution and age-standardized incidence rates (ASIR) of solid tumors among female AYA patients (15–39 years) from 2022 to 2025 (n = 782). Counts represent the number of cases in each age group, and ASIR values (per 100,000 population) were calculated using female age-group population estimates from the 2004–2025 projection study.

Histopathological breakdown of the top three malignancies (Table 3) in female AYAs (15–39 years) showed that breast cancer (391/782, 50.0%) was predominantly invasive ductal carcinoma (358/391, 91.5%), mostly in women aged 30–39 years, with smaller contributions from DCIS (11/391, 2.8%), lobular carcinoma (13/391, 3.3%), phyllodes tumor (6/391, 1.5%), LCIS (2/391, 0.5%), and Ewing sarcoma (1/391, 0.3%). CNS tumors (130/782, 16.6%) were heterogeneous: brainstem gliomas (18/130, 13.8%), pilocytic astrocytomas (11/130, 8.5%), high-grade astrocytomas (13/130, 10.0%), low-grade oligodendrogliomas (5/130, 3.8%), glioblastomas (3/130, 2.3%), schwannomas (19/130, 14.6%), meningiomas (14/130, 10.8%), ependymomas (5/130, 3.8%), chordomas (3/130, 2.3%), craniopharyngiomas (8/130, 6.2%), pituitary adenomas (18/130, 13.8%), and other rare CNS tumors (11/130, 8.5%). Female genital tract tumors (94/782, 12.0%) were mainly ovarian (66/94, 70.2%), with epithelial subtypes serous (28/66, 42.4%), mucinous (16/66, 24.2%), endometrioid (8/66, 12.1%), clear cell (1/66, 1.5%), adenocarcinoma (1/66, 1.5%), NET (1/66, 1.5%), and Mullerian (1/66, 1.5%). Sex cord-stromal tumors accounted for 5/66 (7.6%), and germ cell tumors 10/66 (15.2%). Endometrial (12/94, 12.8%) and cervical (14/94, 14.9%) cancers were mainly observed in women aged 25–39 years.

TABLE 3: AGE-SPECIFIC DISTRIBUTION OF TOP FEMALE AYA (15–39 YEARS) SOLID TUMORS BY ORGAN SYSTEM AND HISTOPATHOLOGY, 2022–2025.

ORGAN SYSTEM	HISTOPATHOLOGY			15-19	20-24	25-29	30-34	35-39	TOTAL
CA BREAST	DCIS			0	0	0	3	8	11
	Ductal carcinoma			0	8	47	80	223	358
	LCIS			0	0	0	1	1	2
	Lobular carcinoma			0	0	0	1	12	13
	Phyllodes tumor			0	0	3	2	1	6
	Ewing Sarcoma of Breast			0	1	0	0	0	1
FEMALE GENITAL TRACT TUMORS	CA OVARY	Epithelial (n=56)	Serous	0	1	5	4	18	28
			Clear cell	0	0	0	1		1
			Mucinous	0	0	6		10	16
			Endometrioid	0	0	3	4	1	8
			Adenocarcinoma	0	1	0	0	0	1
			NET	1	0	0	0	0	1
			Mullerian	1	0	0	0	0	1
	Sex Cord-Stromal Tumors (n= 10)		Granulosa Cell	0	0	0	0	1	1
			Sertoli-Leydig Cell	1	0	0	0	1	2
			Sex Cord Stromal	1	0	1	1	2	5
			Leydig Cell	0	0	0	1	0	1
			SCTAT	0	0	0	1	0	1
	Ovarian Germ Cell Tumors (n=10)		Dysgerminoma	0	0	1	1	1	3
			Immature teratoma	2	2	0	0	0	4
			Teratocarcinoma	0	1	0	0	0	1
			Mixed germ cell tumor	0	2	0	0	0	2
	CA ENDOMETRIUM		Endometrioid Adenocarcinoma	0	0	2	6	4	12
			Serous Adenocarcinoma	0	0		1		1
	CA CERVIX		SCC	0	0	1	1	12	14
	CA VULVA		SCC	0	0	0	0	1	1
	CA VAGINA		NET	0	0	0	0	1	1
	GTN		Choriocarcinoma	0	0	1	1	3	5
			Other GTN	0	0	2	1	1	4
CNS TUMORS	GLIOMAS		Astrocytoma (high -grade)	2	2	2	2	0	8
			Anaplastic Astrocytoma (high-grade)	1	0	0	1	1	3
			Oligodendroglioma (high-grade)	1	1	0	0	0	2
			Astrocytoma (low -grade)	0	0	0	1	0	1
			Pilocytic astrocytoma	5	3	2	1	0	11
			Oligodendroglioma (low-grade)	0	0	1	4	0	5
			Diffuse glioma	0	0	0	2	0	2
			Glioblastoma (GBM)	0	0	1		2	3
			Brainstem glioma	3	2	3	5	5	18
	MENINGIOMA		Benign (WHO I)	0	2	2	3	4	11
			Atypical (WHO II)	0	0	1	1		2

Anaplastic / Malignant (WHO III)		1	0	0	0	1	2
EPENDYMOMA		0	0	2	2	1	5
SCHWANNOMA		0	2	6	5	6	19
CHORDOMA		0		1	1	1	3
CRANIOPHARYNGIOMA		0	2	2	2	2	8
PITUITARY	Adenoma	0					
			3	3	6	6	18
	NET			1			1
OTHERS		6	0	0	3	2	11

Survival differed significantly by stage at diagnosis (Log-rank $p < 0.001$, Figure 3). Median survival was reached only for Stage 4 patients, with a median of 45.0 months (95% CI: 38.8–51.2). For Stage 2 disease, median survival was not reached during the follow-up period, indicating that more than 50% of patients remained alive at last follow-up. Survival differences across age groups were not statistically significant by the Log-rank test (Chi-square = 8.60, $df = 4$, $p = 0.072$). However, Cox proportional hazards regression indicated that age group was a borderline predictor of survival (Omnibus test: Chi-square = 8.54, $df = 4$, $p = 0.074$). Removing age from the model significantly worsened model fit (Chi-square = 10.83, $df = 4$, $p = 0.029$). Patients aged 35–39 years had nearly double the risk of an event compared to those aged 15–19 years (hazard ratio = 1.97, 95% CI: 1.05–3.70, $p = 0.036$). The age distribution of the cohort was 3.9% (15–19 years), 6.5% (20–24 years), 17.0% (25–29 years), and 24.1% (30–39 years).

Kaplan–Meier analysis demonstrated significant differences in survival by tumor type (Log-rank Chi-square = 67.65, $df = 7$, $p < 0.001$; Figure 4). Among the major cohorts, breast cancer showed excellent short-term survival, with 100% at 3 months and 99% at 16 months. Gastrointestinal tract tumors had high early survival (99% at 1 month) but declined to 43% by 29 months. Female genital tract tumors maintained 100% survival through 20 months, decreasing to 98% at 21 months and 83% at 36 months. Central nervous system tumors experienced earlier events, with survival falling from 100% at 1 month to 96% at 29 months and 60% at 44 months. Smaller cohorts—including head and neck, lung, bone, sarcomas, and urological tumors—had very few events, limiting median survival estimation. Survival estimates by tumor type are summarized in Table 4. Overall, survival varied widely by stage, age, and tumor type, highlighting the heterogeneity of outcomes among female AYA solid tumors.

TABLE 4: SURVIVAL ESTIMATES FOR FEMALE AYA SOLID TUMOR PATIENTS (15–39 YEARS) BY TUMOR TYPE.

TUMOR TYPE	MEDIAN FOLLOW-UP (MONTHS)	KEY SURVIVAL ESTIMATES (%)
Gastrointestinal Tract (GIT)	29	1 month: 99.1%
		9 month: 95.6
		29 month: 42.8
Breast	16	3 month: 99.5
		11 month: 98.9
Female Genital Tract	78	20 month: 100
		36 month: 83.4
Central Nervous System (CNS)	44	1 month: 100
		12 month: 98.8
		44 month: 59.7

Table 4. Survival estimates for female AYA solid tumor patients (15–39 years) by tumor type. Cumulative survival proportions and standard errors are presented at selected time points, highlighting differences in outcomes between major tumor cohorts including breast, gastrointestinal tract, female genital tract, and CNS tumors.

DISCUSSION

This study provides a comprehensive overview of solid tumors among 782 female adolescents and young adults (AYAs, 15–39 years) in 2022–2025, highlighting age-specific distribution, stage at diagnosis, histopathology, and survival outcomes. Our findings broadly align with global trends and highlighting unique local patterns. According to GLOBOCAN 2022 estimates, the age-standardized incidence rate (ASIR) for AYAs is markedly higher in females (52.9 per 100,000) than in males (28.3 per 100,000), reflecting a greater cancer burden among young women (10).

Breast cancer accounted for 50.0% of all female AYA solid tumors in our cohort, with the majority (62.4%) occurring in women aged 35–39 years. This mirrors global data: Li et al. (2024) reported that breast cancer is the most frequent malignancy among female AYAs worldwide, constituting 48–52%

of all solid tumors in this population, while the Global Burden of Disease study noted a 33% increase in breast cancer incidence among AYAs between 1990 and 2021 (6, 7). Locoregional data further support our findings. The Karachi Cancer Registry (KCR, 2017–2021) reported breast cancer as the most common malignancy among females across all age groups, with an age-standardized incidence rate (ASIR) of 76.1 per 100,000, far exceeding other tumor sites (8). SEER data from the United States further confirm these trends, reporting an incidence rate of 23.6 per 100,000 for breast cancer among female AYAs (2018–2022) (9). Furthermore, female breast cancer was the most commonly diagnosed cancer worldwide in 2020, with approximately 2.26 million new cases, representing 11.7% of all new cancers (10).

The majority of breast cancers occurred in the 35–39-year age group (62.4%), whereas younger AYAs (15–24 years) were more frequently diagnosed with CNS tumors, which accounted for 16.6% of all cases. This is consistent with global data, where CNS tumors represent 12–18% of solid tumors in AYAs aged 15–39 years, with higher incidence in adolescents and young adults under 30 [6,14]. Gynecologic tumors were the third most common group in our cohort, comprising 12.0% of cases. Ovarian cancers predominated (70.2%), followed by cervical cancers (14.9%), primarily affecting women aged 25–39 years. These observations parallel findings from the Indian AYA registry, where ovarian and cervical cancers contributed 10–14% and 8–10% of female AYA malignancies, respectively [14]. Gastrointestinal (GI) tumors accounted for 9.1% of cases, with colorectal cancers being the most frequent subtype (32.7%). This is slightly higher than reported in SEER and European AYA cohorts, where GI tumors constitute 5–8% of female AYA cancers (15, 13). Notably, our data also demonstrate early presentation of GI tumors in younger AYAs, consistent with global trends indicating rising colorectal cancer incidence in individuals under 40 years (16).

Survival outcomes in our cohort strongly correlated with stage at diagnosis. Stage I–II patients had excellent short-term survival, whereas Stage IV patients exhibited a median survival of 45 months (95% CI: 38.8–51.2). This is comparable to SEER data, where Stage IV breast cancer in AYAs showed median overall survival of 40–50 months [15]. European AYA studies report 5-year survival of 85–90% for early-stage breast cancer and 35–50% for metastatic cases, reflecting similar stage-dependent survival patterns [14,13]. Our findings underscore the critical impact of delayed diagnosis, particularly in older AYAs (30–39 years), where Stage III–IV disease comprised 78.1% of cases. Regional data from Pakistan and India also demonstrate high proportions of advanced-stage presentation (47–65%) among female AYAs, largely attributed to limited screening, delayed health-seeking behavior, and socioeconomic barriers [11,12,13].

Histopathological analysis revealed that invasive ductal carcinoma dominated breast malignancies (91.5%), while CNS tumors displayed heterogeneous subtypes, including brainstem gliomas, pilocytic astrocytomas, and high-grade astrocytomas. Ovarian tumors were primarily epithelial, with serous and mucinous subtypes accounting for over 66% of cases. These distributions are consistent with published histopathological profiles in both regional and global AYA populations (17, 18).

The Kaplan–Meier analysis in our cohort reveals stark heterogeneity in outcomes across tumor types among female AYAs. While patients with Breast cancer showed excellent early outcomes, mirroring European AYA data that report five-year relative survival of ~85% for AYAs (vs ~89.5% in older adults) [14], those with gastrointestinal (GI) tumors experienced dramatic declines: despite ~99% survival at 1 month, survival dropped to ~43% by 29 months in our cohort aligning with data that metastatic colorectal carcinoma in AYA often carries poor prognosis, with 5-year survival frequently under 20% (15). Among patients with Central nervous system cancer, survival fell from 100% at 1 month to ~60% by 44 months, consistent with European registry data showing 5-year relative survival for AYA CNS tumors around 59–62% (13). These variations underscore that while some AYA cancers (e.g. breast) have favorable short-term outcomes, others especially GI and CNS tumors carry substantial long-term mortality risk. The findings highlight the need for subtype- and tumor-specific interventions, close follow-up, and early detection strategies tailored to AYA populations.

LIMITATIONS AND CONTEXT:

Despite providing a comprehensive overview of female AYA solid tumors in our cohort, this study has several limitations. First, it is a single-center retrospective study, which may limit the generalizability of our findings to broader regional or national populations. Second, although follow-up was sufficient to capture short- and mid-term outcomes, long-term survival data beyond 5 years are not yet available, particularly for slowly progressing malignancies such as CNS tumors. Third, socioeconomic and lifestyle factors, which may influence both cancer incidence and survival, were not systematically captured, limiting the ability to explore these associations. Moreover, global comparisons — while useful — must be interpreted with caution given differences in registry completeness, healthcare infrastructure, and population demographics.

CONCLUSION

Female adolescents and young adults (AYAs) bear a significant and unique burden of solid tumors, particularly breast, gynecologic, CNS, and gastrointestinal cancers, with survival strongly influenced by tumor type and stage. The heterogeneity of outcomes underscores the need for tumor-specific management protocols, early detection programs, and age-adapted cancer care strategies. Strengthening regional cancer registries, improving public awareness, and implementing targeted screening initiatives are essential to enhance early diagnosis and optimize outcomes in this vulnerable population. Future multicenter and population-based studies incorporating molecular, genetic, and socio-demographic factors are critical to guide effective interventions and health policy planning for AYAs in low- and middle-income settings.

Abbreviations

AYA

Adolescents and young adults
ASIR
Age-standardized incidence rates
NCI
National Cancer Institute
WHO
World Health Organization
DCIS
Ductal carcinoma in situ
LCIS
Lobular carcinoma in situ
KCR
Karachi Cancer Registry
SEER
Surveillance, Epidemiology, and End Results

Declarations

Ethics Approval and Consent to Participate:

The study was approved by the Institutional Review Board of Dow University of Health Sciences (221st meeting, held on 13 September 2025; IRB reference number: *IRB-4230DUHS/EXEMPTION/2025/435*). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written **informed consent was not obtained** as this was a retrospective study based on anonymized patient data. The requirement for informed consent was **waived by the Institutional Review Board** of Dow University of Health Sciences.

Consent for Publication:

All authors consent to publication.

Availability of Data and Materials:

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

Competing Interests:

The authors declare that they have no competing interests.

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Author Contributions

- **Batool Aslam Memon (Principal Investigator):** Conceptualization, study design, data collection, supervision, and critical revision of the manuscript for important intellectual content.
- **Maryum Nouman:** Study design, supervision, data collection, and manuscript revision.
- **Maryam Nasrummin Allah:** Statistical analysis, data interpretation, manuscript drafting, and corresponding author.
- **Jahan Ara Hasan, Munazza Jamil, Omema Saleem:** Data collection.
- **Kiran Marvi and Mohsin Raza:** Data collection, data interpretation, and manuscript drafting.
All authors read and approved the final manuscript.

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Not Applicable.

References

1. World Health Organization. (n.d.). *Adolescent health: WHO health topic page on adolescent health*. Retrieved February 12, 2019, from http://www.who.int/topics/adolescent_health/en
2. Scott, A. R., Stoltzfus, K. C., Tchelebi, L. T., Trifiletti, D. M., Lehrer, E. J., Rao, P., Bleyer, A., & Zaorsky, N. G. (2020). Trends in cancer incidence in US adolescents and young adults, 1973–2015. *JAMA Network Open*, 3(12), e2027738. <https://doi.org/10.1001/jamanetworkopen.2020.27738>
3. Jordan, F., Huber, S., Sommer, S., Schenkirsch, G., Frühwald, M. C., Trepel, M., Claus, R., & Kuhlen, M. (2021). A retrospective 5-year single-center study highlighting the risk of cancer predisposition in adolescents and young adults. *Cancers*, 13(12), 3033. <https://doi.org/10.3390/cancers13123033>

4. Huang, Z., et al. (2024). Global trends in adolescent and young adult female cancer burden, 1990–2021: Insights from the Global Burden of Disease study. *ESMO Open*, 9(11), 103958. <https://doi.org/10.1016/j.esmoop.2024.103958>
5. Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., & Jemal, A. (2024). Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 74(3), 229–263. <https://doi.org/10.3322/caac.21834>.
6. Li, W., Liang, H., Wang, W., et al. (2024). Global cancer statistics for adolescents and young adults: Population-based study. *Journal of Hematology & Oncology*, 17, 99. <https://doi.org/10.1186/s13045-024-01623-9>.
9. Qu, Z., Li, Z., Pei, S., Lu, Y., Liu, Q., Ding, P., Yang, Y., Zhang, L., Wang, J., & Fang, Y. (2025). Global, regional, and national burden of breast cancer in adolescents and young adults aged 15–39 years from 1990 to 2021 based on the Global Burden of Disease Study 2021. *Cancer Innovation*, 4(4), e70016. <https://doi.org/10.1002/cai2.70016>
10. Pervez, S., Jabbar, A., Haider, G., Qureshi, M., Ashraf, S., Lateef, F., Khurshid, M., Bashir, I., Zaidi, M., Mushtaq, N., Fadoo, Z., Quraishy, M., Yaqoob, N., Alam, E., Qureshi, H., Aa, J., & Ma, Q. (2023). Karachi Cancer Registry (KCR): Consolidated data of 5-years 2017-2021. *Journal of College of Physicians and Surgeons Pakistan*, 33(05), 560–565. <https://doi.org/10.29271/jcpsp.2023.05.560>
11. SEER Program. (2022). *Cancer statistics review: Adolescents and young adults (15–39 years)*. National Cancer Institute. <https://seer.cancer.gov>.
12. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA a Cancer Journal for Clinicians*, 71(3), 209–249. <https://doi.org/10.3322/caac.21660>
13. Sultan, N., Memon, S. A., Mooghal, M., Wali, S., Khan, W., Tahseen, H., Khan, M., & Monis, D. (2022). Ethnic predisposition, risk factors and breast cancer presentation; a 10-year data. Single centered prospective cohort study from Karachi. *Annals of Medicine and Surgery*, 82, 104612. <https://doi.org/10.1016/j.amsu.2022.104612>
14. Darling, H., Mohan, R., & Sud, R. (2023). Epidemiology of cancer in adolescents and young adults from a tertiary care hospital in Southern India. *Journal of Cancer Research and Therapeutics*, 19(7), 2036–2044. https://doi.org/10.4103/jcrt.jcrt_1185_22
15. Trama, A., Stark, D., Bozovic-Spasojevic, I., Gaspar, N., Peccatori, F., Toss, A., Bernasconi, A., Quarello, P., Scheinmann, K., Jezdic, S., Blondeel, A., Mountzios, G., Bielack, S., Saloustros, E., & Ferrari, A. (2023). Cancer burden in adolescents and young adults in Europe. *ESMO Open*, 8(1), 100744. <https://doi.org/10.1016/j.esmoop.2022.100744>
16. Bernasconi, A., Toss, A., Zattarin, E., Mousavi, S. M., Blum, M., Kuehni, C. E., Katalinic, A., Trallero, J., Rapiti, E., Maso, L. D., Botta, L., Rossi, S., Peccatori, F., & Trama, A. (2025). Prognosis of Breast Cancer in European female adolescents and young adults (AYAs): EUROCARE-6 retrospective cohort results. *The Breast*, 82, 104472. <https://doi.org/10.1016/j.breast.2025.104472>
17. Bhutada, J. S., Hwang, A., Liu, L., Deapen, D., & Freyer, D. R. (2021). Poor-Prognosis Metastatic cancers in Adolescents and young Adults: Incidence patterns, trends, and disparities. *JNCI Cancer Spectrum*, 5(3). <https://doi.org/10.1093/jncics/pkab039>
18. Wang, Y., Huang, X., Cheryala, M., Aloysius, M., Zheng, B., Yang, K., Chen, B., Fang, Q., Chowdary, S. B., Abougergi, M. S., & Chen, S. (2023). Global increase of colorectal cancer in young adults over the last 30 years: an analysis of the Global Burden of Disease Study 2019. *Journal of Gastroenterology and Hepatology*, 38(9), 1552–1558. <https://doi.org/10.1111/jgh.16220>
19. Wang, M., Bi, Y., Jin, Y., & Zheng, Z. (2024). Global incidence of ovarian cancer according to histologic subtype: a Population-Based Cancer Registry study. *JCO Global Oncology*, 10(10), e2300393. <https://doi.org/10.1200/go.23.00393>
20. Wu, J., Heidelberg, R. E., & Gajjar, A. (2023). Adolescents and young adults with cancer: CNS tumors. *Journal of Clinical Oncology*, 42(6), 686–695. <https://doi.org/10.1200/jco.23.01747>

Figures

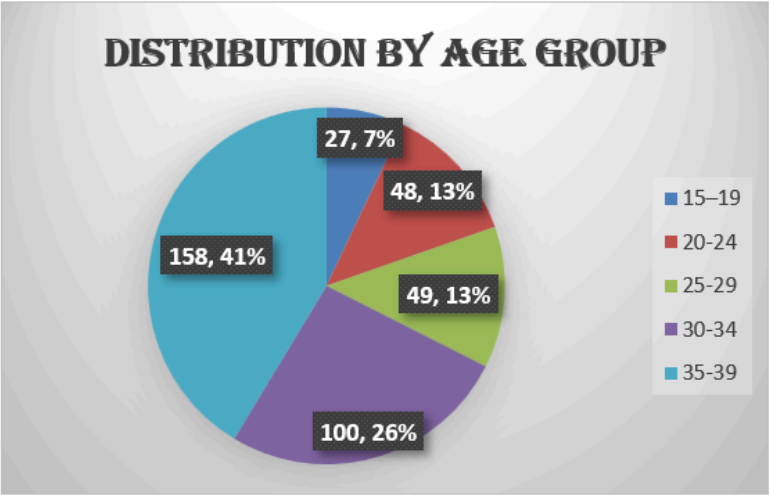


Figure 1

Distribution of Age Group by 5-year Interval among Female AYA.

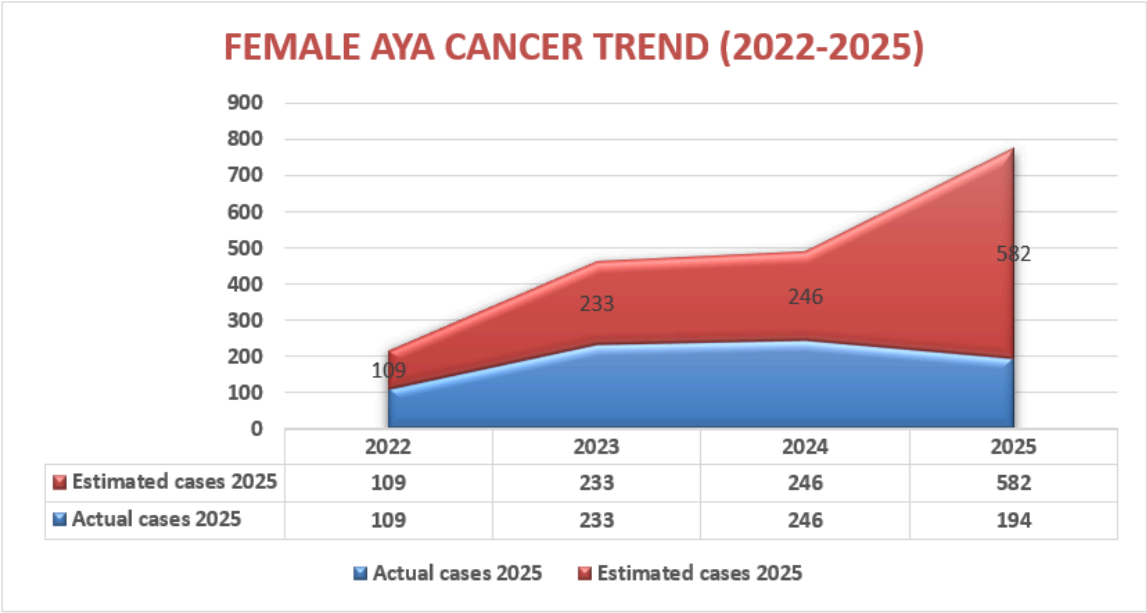


Figure 2

Annual distribution of female AYA cancer cases (2022–2025). Blue bars/line represent actual reported cases for 2022–2024 and partial 2025 data ($n = 194$), while the red line indicates the estimated total cases for 2025 ($n \approx 582$) based on current trends.

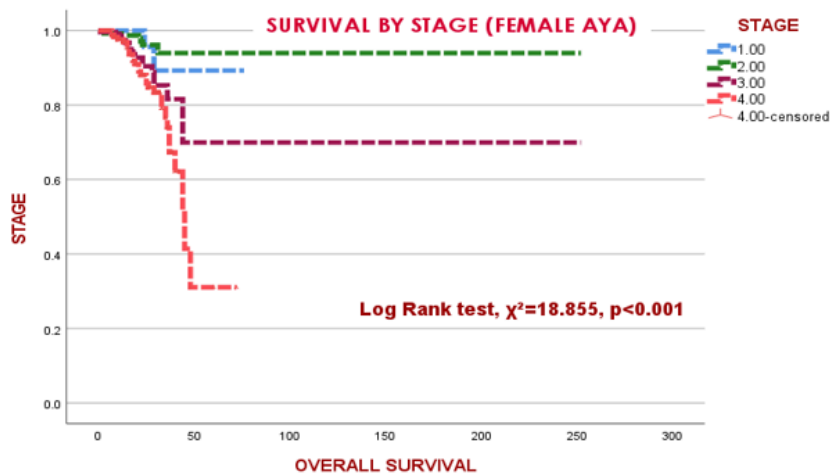


Figure 3

Kaplan–Meier survival curves stratified by stage at diagnosis among female AYA solid tumor patients (15–39 years). Survival differed significantly by stage (Log-rank $p < 0.001$), with Stage 4 patients exhibiting the poorest outcomes (median 45.0 months, 95% CI: 38.8–51.2).

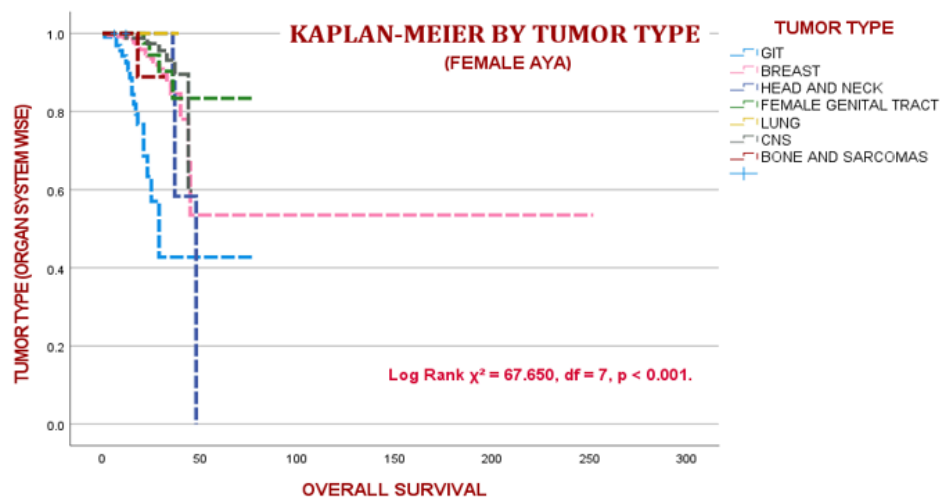


Figure 4

Kaplan–Meier survival curves by tumor type among female AYA solid tumor patients (15–39 years). Significant differences in survival were observed across tumor types (Log-rank Chi-square = 67.65, $df = 7$, $p < 0.001$), with breast cancer showing the highest early survival and CNS and gastrointestinal tumors demonstrating earlier declines.