RESEARCH ARTICLE

A national overview of paediatric and adolescent and young adult surgical neuro-oncology in Pakistan

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Abstract

Objective: To build a comprehensive brain tumour database that will allow us to analyse in detail the prevalence, demographics, and outcomes of the disease in paediatric, adolescent, and young adult age groups.

Method: A national cross-sectional study was conducted at 32 centres, and data regarding patient demographics and brain tumours were collected. This data was then stratified based on age groups, healthcare sectors, socioeconomic status, tumour types, and surgical outcomes.

Result: Most of the patients who were diagnosed with brain tumours belonged to a lower socioeconomic background and went to public sector hospitals. More males were diagnosed with and treated for brain tumours in the paediatric, adolescent, and young adult populations. The most common tumour in the paediatric population was medulloblastoma (23.7%) and the most common tumour in the adolescent (27.8%) and young adult population (34.7%) was glioma. Significant improvement in KPS scores were seen for: craniopharyngioma ($p = 0.001$), meningioma ($p < 0.0005$) and pituitary adenoma ($p < 0.0005$)

Conclusion: This study shows that in all three age groups, there was a greater prevalence in males. Most of the patients belonged to a lower-middle-income class background and most patients presented to public sector hospitals. Greater knowledge of these parameters unique to each age group is the key to understanding and alleviating the burden of disease. Cancer registries, specifically brain tumour registries that keep up-to-date records of these patients, are essential to identify and keep track of these unique parameters to advance medical research and treatment strategies, ultimately lowering the disease burden.

Keywords: Pediatric, Neuro-oncology, Adolescent and young adult, AYA, Medulloblastoma, Craniopharyngioma, Epidemiology

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Introduction

Certain types of CNS tumours have an association with age group distribution, for instance, paediatric low-grade gliomas are often benign with little potential for further developing higher-grade glioblastoma lesions; the opposite is true for adult gliomas. Similarly, the adolescent and young adult (AYA) group, defined by individuals 15-39 years of age, show different risk factors, disease presentation, and treatment outcomes.[1,2] Advancements in treatment strategies have shown improvement in paediatric and older adults (>40 years) with intracranial tumours, however, outcomes in the AYA population remain dismal despite these advancements. The National Cancer Institute has identified factors contributing to the poorer outcomes of AYA oncology patients. These include differences in host and disease biology, delayed diagnosis, different treatment approaches, poor compliance, poor adherence to therapy, and unique psychosocial and economic issues. There is a need for developing targetted AYA oncology interventions in LMICs, where data are sparse.[3] Population-wide studies and registries play an essential role in cancer epidemiology by contributing to better planning of prevention, diagnosis, treatment, and rehabilitation of cancer.[4]

Data from Karachi cancer registry showed that CNS tumours are the third most common malignancies with an age-standardized incidence rate (ASIR) of 3.14 in children (ages 0-14) and 0.58 in adolescents (ages 15-19) respectively.[5] Comparatively data from the Central brain tumour registry in the United States (CBTRUS) shows that CNS tumours (both malignant and nonmalignant), have an average annual age-adjusted incidence rate (AAAIR) of 5.85 per 100,000, in persons aged 0-14 years and an

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AAAIR of 11.82 per 100,000 population among individuals between ages 15-39 years.[6]

Due to a baseline deficiency of CNS tumour data in Pakistan, epidemiological and surgical factors associated with the current burden of disease, provision of care, and outcomes in these patients have not been investigated. The purpose of this study is to provide information about brain tumour epidemiology in Pakistan, and associated family, medical and social history. This study has presented data from across the entire country to provide a holistic picture of brain tumour epidemiology, intending to pave the way to build a prospective brain tumour registry for Pakistan.

Materials and Methods

A retrospective cross-sectional study was designed by the Pakistan Society of Neuro-oncology (PASNO) to provide information about the distinct types of brain tumours in Pakistan. Between January 1, 2019- December 31, 2019, patients from all age groups with a radiological diagnosis of brain tumour, including metastatic, were included. Data were recorded on a comprehensive online database between August 2020 and January 2021. Ethical approval was obtained from the Aga Khan University Hospital's Ethics Review Committee (Ref: 2020-3529-10977) and approval from the National Bioethics Committee was also requested and provided (Ref: No.4-87/NBC-487/20/749. Currently, in Pakistan, there is no centralized mechanism for logging patients that visit both neurosurgical centres and radiology centres, so to ensure that no patients were duplicated, data was only collected from 32 major neurosurgical centres across the country, in both the public and private sectors.

A questionnaire was designed to collect data under 4 categories. The first category dealt with patient demographics, which included assessing four socioeconomic statuses: Lower Class (e.g., blue-collar workers, labourers, daily wagers), Middle Class (e.g., graduates, mid-level office workers, homeowners), Upper Middle Class (e.g., professionals such as doctors, lawyers, engineers, etc.), and Upper Class (e.g., landowners, big businesses, etc.) For the paediatric population, parents' professions were used to identify socioeconomic status (Table-1). We also identified where the patient was seen, their surgeon or neuro-oncologist, the date of diagnosis, neuroimaging, and the mode of treatment (surgery vs. conservative management). The second section included surgery details, including any reoperations. The third section obtained specific details on the tumour's subtype, location, and laterality, the type of surgical intervention, and the details of adjuvant therapy if any. We identified five types of surgical interventions which included biopsy of the lesion, CSF diversion only, gross total resection of the tumour (GTR), subtotal resection of the tumour (STR), and other procedures. History, co-morbidities, and the patient's current survival status were also included in this section. The fourth section evaluated survival and postoperative functional status at the last follow-up. Data collection was done via a Google form by specified centre associates designated by centre heads and data were entered in a password-protected electronic database which was only accessible to the research team. Continuous variables were computed as frequencies and percentages. Means were compared using non-parametric tests of significance (Mann-Whitney U, Kruskal-Wallis H). All statistical tests were two-sided and a p-value of <0.05 was taken to be significant. Statistical evaluation was performed using Statistical Package for Social Sciences (SPSS) version 26.0

Results

Basic demographics: A total of 1288 patients were included in this study, of which 287 (10.4%) were between 0-14 years of age, 133 (4.8%) were between 15-19 years of age, and 868 (31.5%) were between 20-39 years of age. The majority of the patients in each age group were males. In the public sector, 241(84%) of the paediatric population, 95 (71%) of the adolescent population, and 548 (63%) of the young adult population went to hospitals for treatment. Furthermore,

Table-1: Sectors, genders, and socioeconomic status for each age group.

		Age Group at time of diagnosis					
		Children (<15 years)		Adolescent (15-19 years)		Young Adult (20-39 years)	
		Count (n)	%	Count (n)	%	Count (n)	%
Public or Private	Public	241	84.00%	95	71.40%	548	63.10%
	Private	46	16.00%	38	28.60%	320	36.90%
Gender of Patient	Male	162	56.40%	86	64.70%	514	59.20%
	Female	125	43.60%	47	35.30%	354	40.80%
Socio-Economic Status of Patient	Lower Class	135	47.00%	72	54.10%	420	48.40%
	Middle Class	122	42.50%	46	34.60%	317	36.50%
	Upper Class	14	4.90%	5	3.80%	53	6.10%

Table-2: Types of surgery for each age group.

		Age Group at time of diagnosis					
		Children (<15 years)		Adolescent (15-19 years)		Young Adult (20-39 years)	
		Count (n)	%	Count (n)	%	Count (n)	%
Was the patient admitted and surgery done?	Yes	261	90.90%	123	92.50%	792	91.20%
	No	26	9.10%	10	7.50%	76	8.80%
Surgery Type (First)	Biopsy	20	7.70%	12	9.80%	77	9.70%
	CSF Diversion Only	48	18.40%	11	8.90%	35	4.40%
	Gross Total Resection	101	38.70%	56	45.50%	400	50.50%
	Subtotal Resection	66	25.30%	23	18.70%	195	24.60%
	Other	26	9.961%	21	17.07%	85	10.73%
Surgery Type (Second)	Gross Total Resection	18	11.25%	4	5.97%	21	5.357%
	Subtotal Resection	20	12.50%	3	4.47%	34	8.673%
Surgery Type (Third)	Gross Total Resection	1	0.70%	1	0.01%	4	1.07%
	Subtotal Resection	1	0.70%	1	0.01%	3	0.80%

Table-3: Histopathology for each age group.

Histopathology of tumour	Age Group at time of diagnosis					
	Children (<15 years)		Adolescent (15-19 years)		Young Adult (20-39 years)	
	Count (n)	%	Count (n)	%	Count (n)	%
Brainstem Glioma	7	2.40%	0	0.00%	3	0.30%
Craniopharyngioma	42	14.60%	12	9.00%	28	3.20%
Ependymoma	32	11.10%	3	2.30%	12	1.40%
Glioma	61	21.30%	37	27.80%	301	34.70%
Haemangioblastoma	0	0.00%	1	0.80%	18	2.10%
Lymphoma	0	0.00%	0	0.00%	10	1.20%
Medulloblastoma	68	23.70%	8	6.00%	10	1.20%
Meningioma	8	2.80%	11	8.30%	139	16.00%
Metastasis	0	0.00%	0	0.00%	9	1.00%
Vestibular Schwannoma	3	1.00%	8	6.00%	48	5.50%
Pineal Tumour	3	1.00%	2	1.50%	3	0.30%
Pituitary Adenoma	1	0.30%	12	9.00%	109	12.60%
Not specified	62	21.60%	39	29.30%	178	20.50%

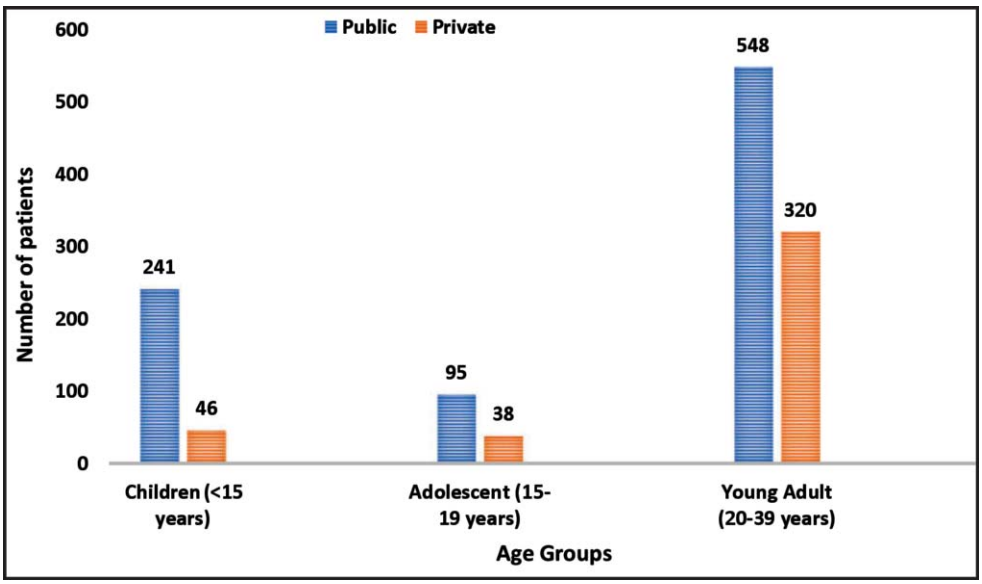

Figure-1: Patients in public vs private sector for each age group.

more than 1112 (80%) of the patients in each age group belonged to a lower- or middle-income socioeconomic background (Figure-1) (Table-1).

Histopathological diagnoses were identified for each age group and were classified as mentioned in Table-3. The most common tumour type among the paediatric group accounting for 23.7% of the population, was medulloblastomas. For adolescents and young adults, gliomas were the most common tumour type - 27.8% and 34.7%, respectively.

Table-4: Table-4: Radiation therapy and chemotherapy for each age group.

		Age Group at the time of diagnosis											
		Children (<15 years)				Adolescent (15-19 years)				Young Adult (20-39 years)			
Histopathology	Type of adjuvant therapy done?	Count (n)	%	Count (n)	%	Count (n)	%	Count (n)	%	Count (n)	%	Count (n)	%
		Radiation		Chemotherapy		Radiation		Chemotherapy		Radiation		Chemotherapy	
Brainstem Glioma	Yes	2	28.6	0	0	0	0.0	0	0	0	0.0	0	0
	No	2	28.6	2	28.6	0	0.0	0	0.0	1	33.3	1	33.3
	Not specified	3	42.9	5	71.4	0	0.0	0	0.0	2	66.7	2	66.7
Craniopharyngioma	Yes	11	26.2	0	0.0	1	8.3	0	0.0	1	3.6	2	7.1
	No	12	28.6	15	35.7	4	33.3	5	41.7	10	35.7	10	35.7
	Not specified	19	45.2	27	64.3	7	58.3	7	58.3	17	60.7	16	57.1
Ependymoma	Yes	5	15.6	2	6.3	1	33.3	0	0.0	2	16.7	0	0.0
	No	15	46.9	14	43.8	0	0.0	1	33.3	4	33.3	4	33.3
	Not specified	12	37.5	16	50.0	2	66.7	2	66.7	6	50.0	8	66.7
Glioma	Yes	10	16.4	5	8.2	9	24.3	5	13.5	86	28.6	48	15.9
	No	23	37.7	25	41.0	8	21.6	10	27.0	61	20.3	81	26.9
	Not specified	28	45.9	31	50.8	20	54.1	22	59.5	154	51.2	172	57.1
Haemangioblastoma	Yes	0	0.0	0	0.0	0	0.0	0	0.0	2	11.1	0	0.0
	No	0	0.0	0	0.0	0	0.0	0	0.0	7	38.9	9	50.0
	Not specified	0	0.0	0	0.0	1	100	1	100	9	50.0	9	50.0
Lymphoma	Yes	0	0.0	0	0.0	0	0.0	0	0.0	3	30.0	2	20.0
	No	0	0.0	0	0.0	0	0.0	0	0.0	2	20.0	0	0.0
	Not specified	0	0.0	0	0.0	0	0.0	0	0.0	5	50.0	8	80.0
Medulloblastoma	Yes	20	29.4	9	13.2	1	12.5	0	0.0	4	40.0	1	10.0
	No	12	17.6	16	23.5	2	25.0	2	25.0	0	0.0	2	20.0
	Not specified	36	52.9	43	63.2	5	62.5	6	75.0	6	60.0	7	70.0
Meningioma	Yes	1	12.5	0	0.0	1	9.1	0	0.0	4	2.9	1	0.7
	No	1	12.5	2	25.0	2	18.2	2	18.2	55	39.6	50	36.0
	Not specified	6	75.0	6	75.0	8	72.7	9	81.8	80	57.6	88	63.3
Metastasis	Yes	0	0.0	0	0.0	0	0.0	0	0.0	2	22.2	1	11.1
	No	0	0.0	0	0.0	0	0.0	0	0.0	2	22.2	2	22.2
	Not specified	0	0.0	0	0.0	0	0.0	0	0.0	5	55.6	6	66.7
Vestibular Schwannoma	Yes	0	0.0	0	0.0	1	12.5	1	12.5	1	2.1	0	0.0
	No	2	66.7	0	0.0	2	25.0	2	25.0	18	37.5	16	33.3
	Not specified	1	33.3	3	100	5	62.5	5	62.5	29	60.4	32	66.7
Pineal Tumour	Yes	0	0.0	0	0.0	0	0.0	0	0.0	1	33.3	1	33.3
	No	1	33.3	1	33.3	0	0.0	0	0.0	1	33.3	1	33.3
	Not specified	2	66.7	2	66.7	2	100	2	100	1	33.3	1	33.3
Pituitary Adenoma	Yes	0	0.0	0	0.0	3	25.0	0	0.0	11	10.1	0	0.0
	No	0	0.0	0	0.0	4	33.3	5	41.7	40	36.7	41	37.6
	Not specified	1	100	1	100	5	41.7	7	58.3	58	53.2	68	62.4
Not specified	Yes	7	11.3	0	0.0	4	10.3	0	0.0	26	14.6	6	3.4
	No	15	24.2	14	22.6	6	15.4	8	20.5	31	17.4	33	18.5
	Not specified	40	64.5	48	77.4	29	74.4	31	79.5	121	68.0	139	78.1

Surgery and adjuvant treatment: The percentages of patients undergoing different types of surgeries are detailed in Table-2. It is important to note that 3.65% of the patients underwent a second surgery for gross total resection and 4.84% of the patients underwent a second surgery for subtotal resection. Patients who underwent chemotherapy and radiation therapy were also identified. In the paediatric population, only 9 (13.2%) of the children with medulloblastomas received chemotherapy and 20 (29.4%) of the children received radiation therapy. In the adolescent population, 5 (13.5%) of the patients with gliomas received chemotherapy but 22 (59.5%) were lost to follow-up. Of the patients with gliomas, 9(24.3%) received radiation but 20 (54.1 %) were lost to follow-up. In young adults 48 (15.9%) of the patient with gliomas received chemotherapy, however, 172 (57%) of the patients were lost to follow-up. Furthermore, 86 (28.6%) of the young adult population received radiation for gliomas and 61 (20.3 %) did not, however, 154 (51%) were lost to follow-up.

Table-5: Patient survival for each age group and tumour type.

		Age Group at time of diagnosis					
		Children (<15 years)		Adolescent (15-19 years)		Young Adult (20-39 years)	
Histopathology	Current Status	Count (n)	%	Count (n)	%	Count (n)	%
Brainstem Glioma	Alive	2	29%	0	0%	0	0%
	Deceased	0	0%	0	0%	2	67%
	Lost to follow up	5	56%	0	0%	1	33%
Craniopharyngioma	Alive	30	71%	7	58%	15	54%
	Deceased	4	10%	0	0%	4	14%
	Lost to follow up	8	19%	5	42%	9	32%
Ependymoma	Alive	11	34%	2	67%	9	75%
	Deceased	12	38%	1	33%	1	8%
	Lost to follow up	9	28%	0	0%	2	17%
Glioma	Alive	29	48%	26	70%	173	57%
	Deceased	16	26%	2	5%	22	7%
	Lost to follow up	16	26%	9	24%	106	35%
Haemangioblastoma	Alive	0	0%	0	0%	11	61%
	Deceased	0	0%	1	100%	3	17%
	Lost to follow up	0	0%	0	0%	4	22%
Lymphoma	Alive	0	0%	0	0%	2	20%
	Deceased	0	0%	0	0%	3	30%
	Lost to follow up	0	0%	0	0%	5	50%
Medulloblastoma	Alive	30	44%	2	25%	3	30%
	Deceased	21	31%	0	0%	0	0%
	Lost to follow up	17	25%	6	75%	7	70%
Meningioma	Alive	4	50%	7	64%	93	67%
	Deceased	1	13%	0	0%	7	5%
	Lost to follow up	3	38%	4	36%	39	28%
Metastasis	Alive	0	0%	0	0%	1	11%
	Deceased	0	0%	0	0%	3	33%
	Lost to follow up	0	0%	0	0%	5	56%
Vestibular Schwannoma	Alive	1	33%	3	38%	24	50%
	Deceased	0	0%	1	13%	6	13%
	Lost to follow up	2	67%	4	50%	18	38%
Pineal Tumour	Alive	0	0%	1	50%	0	0%
	Deceased	1	33%	0	0%	0	0%
	Lost to follow up	2	67%	1	50%	3	100%
Pituitary Adenoma	Alive	0	0%	10	83%	68	62%
	Deceased	0	0%	0	0%	1	1%
	Lost to follow up	1	100%	2	17%	40	37%
Not specified	Alive	20	32%	13	33%	58	33%
	Deceased	14	23%	3	8%	28	16%
	Lost to follow up	28	45%	23	59%	92	52%

Functional outcomes: Karnofsky Performance Scale (KPS was used to assess patients' functional status and predict the length of survival before and after surgery.[7] In the paediatric population significant improvement in KPS scores was seen for craniopharyngiomas ($p = 0.003$) and medulloblastomas ($p = 0.049$). In adolescents and young adults significant improvement in KPS scores were seen for craniopharyngioma ($p = 0.001$), meningioma ($p < 0.0005$), and pituitary adenomas ($p < 0.0005$). Survival status for patients in each age group was identified based on histology as detailed. In the paediatric population, 30 (71%) of the children with craniopharyngiomas were alive at the most recent follow-up. Furthermore, 11 (34%) of the children with ependymomas, 29 (48%) of children with gliomas, and 30 (44%) of children with medulloblastomas were alive at the most recent follow-up. In adolescents, 26 (70%) of the patients with gliomas survived but 9 (25%) were lost to follow-up. In young adults, 173 (57%) of the patients survived, however, 106 (35%) were lost to follow-up. 93 (67%) of the patients with meningiomas, 24 (50%) of the patients with vestibular schwannoma, and 68 (62%) of the pituitary adenoma

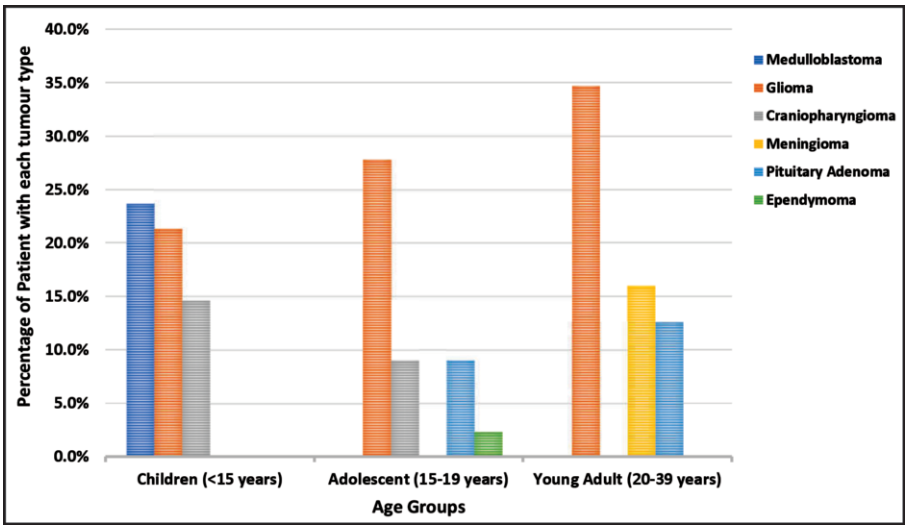

Figure-2: Type of tumour in each age group.

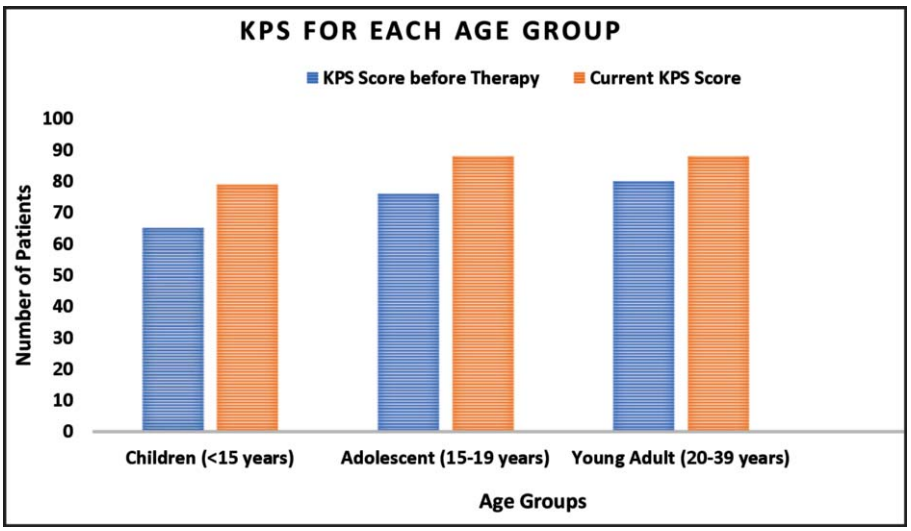

Figure-3: Mean KPS for each age group.

patients were also alive till the end of our study.

Discussion

CNS cancer registries from other parts of the world have shown an association of age groups with certain types of neoplasms, disease prognosis, and response to treatment. PBTES has built a database through which CNS tumours in the paediatric, adolescent, and young adult populations can be further assessed. In our study, approximately 46% of our patients are from the paediatric and AYA age groups combined There were three things common to all three age groups: 1) the majority of the patients belonged to a lower-middle-income class background 2) more patients presented to public sector hospitals and 3) greater incidence of disease in males. Furthermore, most patients underwent surgery, with gross total or subtotal resection of the tumours being the commonest surgical intervention and only a small percentage of the population received appropriate chemotherapy and radiation therapy across the three age groups, however, due to a lack of adequate records for therapy the data is inconclusive. Our study identified medulloblastoma as the most common paediatric brain tumour and glioma as the most common brain tumours in the adolescent and young adult population. Karnofsky Performance Scale (KPS) can be used to assess the length of survival before and after surgery. However, improvement in these scores after surgery is not reflective of a complete cure. These individuals need to be closely followed to know if indeed they lead disease-free lives after surgery. In our study, it is notable that for each age group, the majority of the patients with the most common tumours survived. However, approximately 40% of all our patients were lost to follow up which is why our data is not reflective of true survival rates.

Data from the Karachi Cancer Registry shows that between 2017 to 2019, 52.5% of the patients diagnosed with CNS tumours were males and 91.8% of the patients were greater than or equal to 20 years of age.[5] This data however did not look at incidence in young adults specifically. Comparatively, studies done in other parts of the world have shown that more female patients are diagnosed with brain tumours as compared to males.[6]

CNS tumours are a heterogeneous group of neoplasms, with each tumour type having significantly diverse mechanistic pathways, survival potential, and treatment options. However, diagnostic testing, first-line treatment, and clinical signs and symptoms are similar.[8] Children less than 4 years of age with malignant tumours continue to have a poor prognosis and a high rate of treatment-related toxicities.[9] Data from CBTRUS shows that in children (0-14) years old malignant tumours have an average annual age-adjusted mortality rate of 0.70 per 100,000 in this age group and were the fourth most common cause of death and most common cause of

cancer-related death.[6] Udaka et al identified medulloblastomas as the most common solid tumour of the brain, comprising 20-25% of all paediatric brain tumours diagnosed before 15 years of age.[10-12] These tumours can be life-threatening, so healthcare professionals seeing children should be able to identify signs and symptoms, provide timely referrals and order appropriate investigations. Advances in neuroimaging have aided the timely diagnosis of CNS tumours but, varied presentation and perceived rarity does result in underdiagnosing.

There are very few specialized paediatric hospitals worldwide and in a lower-middle-income class country such as Pakistan, there are no such hospitals.[12-14] Poverty and its effect on child health is a societal problem and there is a dire need to build capacity, which can be achieved by targetted interventions and policy changes at the national levels.[15]

In the last two decades, there has been progress in the management of adolescent and young adult malignancies, yet patients continue to experience inferior outcomes compared with younger and older cohorts. It is hypothesized that this can be due to unique tumour biology, delayed diagnosis, and overall approach to treatment and follow-up.[1] Akin to our study, other studies show that glioma, particularly low-grade glioma are the most common brain tumours in the AYA age group worldwide followed by meningioma as the second most common.[6,10,16] While surgery is the first step in treating most brain tumours, various studies have shown that individuals from the AYA age group do not present similarly to the paediatric or adult age group.[1] Malignant tumours among persons aged 15-39 years had an average annual age-adjusted mortality rate of 0.97 per 100,000 and were the 12th most common cause of death and 2nd most common cause of cancer death in this age group. Malignant brain and other CNS tumours among persons age 40+ years had an average annual age-adjusted mortality rate of 9.14 per 100,000 and were the 26th most common cause of death overall and the 12th most common cause of cancer death.[6] Lack of standardized therapeutic approaches, poor compliance with therapy, and unique genetic and biological features can also contribute to poor outcomes. In addition, the young adult population also faces the unique psychosocial issues of fertility preservation and contraception. Financial constraints, quality-of-life issues, survival, long-term morbidity, and non-availability of palliative and, end-of-life care, are some of the issues recognized by the National Comprehensive Cancer Network.[1,3]

A systematic analysis by Kocarnik et al showed that between 2010 to 2019, the cancer burden had grown fastest in the low-middle income demographic with the highest estimated number of deaths in the middle-income demographic.[16] This study looked at 29 different cancer groups, including brain and CNS tumours. Healthcare use in low-income settings resulted in fewer opportunities to identify signs of non-communicable illness that can be treated in the early stages.[17] In a low-middle income country such as Pakistan, it can be inferred that disease burden and survival in our country have a similar pattern. Information about the prevalence of a disease provides essential population-based information to various healthcare infrastructure members and influences, the direction of future research and medical practices. For CNS tumours, these statistics are not commonly calculated but can revolutionize treatment and patient care.[9] Information from studies conducted in different corners of the world is a source of invaluable guidance for our current treatment strategies but greater knowledge of our own population's unique environmental, genetic, and socioeconomic factors is crucial to medical advancement and patient-centric care at a national level.

Our study had some limitations. Firstly, it was retrospective and was limited by the data available in hospital records. Although the largest and highest volume centres hospitals were included in the study, they were not a comprehensive list of all provincial neurosurgical centres in Pakistan, as some centres did not consent to share data. However, these were generally lower-volume centres (less than 5 cases per year). The centres selected for this study were all surgical institutions and patients who present outside neurosurgical clinics or practices in other centres (such as private clinics) may not be captured in our study, particularly those with metastatic brain tumours.

Conclusion

Paediatric, adolescent, and young adult populations have their unique demographics, risk factors, disease presentation, disease progression, and outcomes for brain tumours. Our study showed that the majority of the patients belonged to a lower-middle-income class background and hence, presented to public sector hospitals. Greater knowledge of these parameters unique to each age group is the key to understanding and alleviating the burden of disease. Cancer registries, and specifically brain tumour registries, which keep up-to-date records of these patients are essential to identify and keep track of these unique parameters to advance medical research and treatment strategies which will ultimately result in lowering the disease burden.

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