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# Epidemiology And Surgical Outcomes of Primary Brain tumours Managed at a Tertiary Hospital In Arusha, Tanzania.

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**Abstract**

**Introduction**: The epidemiology and outcome of brain tumours varies globally. We aimed to analyze the epidemiology and postsurgical outcomes of intracranial tumours in our setting. **Methods**: This is a retrospective cohort study. Data were obtained from patient clinical records between 2019 and 2020. Sub-group analysis was done to identify factors associated with postoperative outcomes (morbidity, improvement/deterioration of symptoms and mortality). Estimates of demographic and clinical data were expressed as percentages. A chi-square was used to compare the various patient outcomes between sub-groups with $\alpha$ <0.05. **Results**: 39 patients with primary brain tumours underwent surgery. Gliomas were the most common tumour (13/39) overall and craniopharyngiomas in pediatric patients (3/11). The majority presented late (>3 months), and had a poor Karnofsky performance status before surgery. Gross tumour resection was low (25.6%) and few patients underwent adjuvant therapy (28.2%). 30-day mortality rate and one-year mortality rate were high. Pediatric patients had a much worse outcome. Males had higher postoperative mortality, though females were more likely to have poor postoperative Karfnofsky performance status. Patients with gliomas accounted for the majority of the deaths. **Conclusion**: Delayed presentation and poor access to adjuvant therapies are common in our setting. Surgery improves patients' performance status.

**Keywords:** brain tumours, Arusha, Tanzania, gliomas, outcomes

## INTRODUCTION

Cancer is an increasing global health problem and is emerging as a significant public health threat in low- and middle-income countries (LMICs) (1). Cancer is a leading cause of death globally and about 64-70% of cancer-related deaths occur in LMICs(1,2). In 2020, central nervous system tumours contributed to 1.6% of all cancer diagnoses and 2.5% of all cancer-related deaths(3). The

epidemiology of brain tumours varies globally between different countries, with an increased incidence in high-income countries (HICs) as compared to LMICs(2). This has been attributed to a variety of factors such as improved healthcare assessment (getting more patients who are asymptomatic), and also due to certain environmental factors such as ionizing radiation and industrial radioactive sources (4). Also, the epidemiology of brain tumours differs by age and gender as has been shown in the increased occurrence of meningiomas in females than in males and the occurrence of craniopharyngiomas and medulloblastomas in children more than in adults(5,6). Despite the varying epidemiology, treatment of brain tumours has largely been through tumour resection with supplementation of adjunctive therapies (chemotherapy and/or radiotherapy), though advances in medical technology have made available other treatment methods such as MRI-guided laser ablation (7).

Complete tumour resection has been shown as the most important modality of treatment for various brain tumour types with some other subtypes necessitating adjuvant therapy(7). The goals of cancer treatment are to decrease the recurrence rate and increase progression-free survival and overall survival(7). Despite advances in cancer treatment, primary brain tumours are associated with poor outcomes in terms of survival and functionality as a result of the tumour itself or the treatment received(8).

Data on brain tumours in Sub-Saharan Africa, including Tanzania, is limited(). This study attempts to fill part of this information deficiency from Sub-Saharan Africa. This is a retrospective chart review of patients with primary brain tumours who underwent surgical intervention at a tertiary referral centre in Arusha, Tanzania from 2019 to 2020. We describe the distribution of brain tumours by demographics, location, clinical presentation, histological diagnosis, surgical treatment, and outcomes after treatment.

## MATERIALS AND METHODS

The study was carried out at a zonal referral hospital in the northeastern part of Tanzania. At the time of the study, it served as the only neurosurgical center in northeastern Tanzania, the catchment area including the regions of Arusha, Kilimanjaro, Manyara, and Tanga.

A retrospective database of 39 patients with primary brain tumours (PBTs) managed between 2019 and 2020 was used. A records search was done from the neurosurgery department admissions and theatre log, followed by retrieval of the patient's clinical data. The database included patient demographics, presenting complaints and their duration, tumour location, surgical intervention, tumour histological diagnosis, preoperative and postoperative Karnofsky performance status (KPS), post-surgery complications, and patient/relative phone numbers. We excluded patients with PBTs who did not undergo surgery and those with secondary brain tumours. Also, patients with missing data preventing analysis were removed (such as histopathological diagnosis). We defined patient "delayed presentation" as patients presenting more than 3 months after onset of symptoms (9).

The diagnosis of the brain tumour was confirmed in all patients with magnetic resonance imaging (MRI) and tissue biopsy. The tumours were classified based on the World Health Organization (WHO) classification of 2016(10). Patients with a KPS score of 70 and above were labeled as independent and those with a score of less than 70 as dependent. The extent of surgery was determined by the surgeon's intraoperative judgment. Postoperative KPS scores were calculated during patient discharge.

Patients who failed to come for post-operative visits were contacted via phone and those who failed to come for

clinic visits and also could not be contacted by phone at the end of one year were labelled as lost to follow-up. Pre-op imaging with MRI was obtained in all patients, however, post-op imaging was obtained in a few patients due to financial constraints. MRI service was not available during the period of study, as were adjuvant therapy services. For such services, the patients had to be sent to other facilities.

SPSS version 25 (IBM, Armonk, NY) was used for data analysis. Descriptive statistics were used to assess demographics, quality of life measures, and mortality. Chi-square tests were used to compare the different patient subgroups (e.g. by age, and gender) and tumour characteristics and outcomes. P values less than 0.05 were considered significant. Kaplan Meier curves were drawn to estimate median survival with censoring of patients lost to follow-up and those still alive at follow-up.

This study was reviewed by the institution's ethics committee and ethical approval was granted.

## RESULTS

During the study period, 45 patients were admitted to the neurosurgical department with brain tumours. We excluded 1 patient with metastatic brain tumour, 1 patient with no histopathological diagnosis and type of surgery undertaken, and 4 patients who did not undergo surgical intervention.

39 patients with primary brain tumours (PBTs) underwent surgery between 2019 and 2020. We determined the distribution of PBTs as shown in Tables 1 and 2.

Neuroepithelial tumours and meningiomas were more common in adults than in children, the most common meningioma being meningotheliomatous. Craniopharyngiomas occurred exclusively in paediatrics.

### Presentation and Outcomes

Duration of illness ranged from 2 weeks to more than 3 years, with the majority (59%) presenting more than 3 months after symptom onset. Duration of time from presentation at our neurosurgical department to surgical management ranged from 1 day to 120 days, most (51.3%) being managed 2-4 weeks after diagnosis. Headache and focal neurological deficits (FNDs) were the most common presenting symptoms (56.4% and 51.3% respectively), others being; gait disturbances (17.9%), visual disturbances (17.9%), convulsions (12.8%), vomiting (10.3%) and altered level of consciousness (10.3%). Most patients (83.3%) had a preoperative KPS score of less than 70.

Postoperatively, complications included; FND (n=9, 23.1%), convulsions (n=2, 5.1%), pseudomeningocele (n=2, 5.1%), pneumocephalus (n=1, 2.6%), dyspnea (n=1, 2.6%) and vomiting (n=1, 2.6%). Postoperatively, 60.5% of the patients had a KPS score of less than 70.

After surgical management, 5 patients (12.8%) were lost, and 13 (33%) died within 1 year. Of those that had died, 4 died within the first 30 days post-surgical intervention, 4 patients died between 2- and 6 months post-surgery, and 5 died more than 6 months post-surgery.

Patient age, gender, tumour histology, duration of illness, preoperative KPS score, residency, reception of adjuvant treatment, and type of surgery done, were analyzed for survival/mortality prediction. None of these were found to be statistically significant (p-value <0.05) (see Table 3). The overall survival rate was 61.8% in one year. Survival rates for gliomas were 47% while for meningiomas was 80% and for craniopharyngiomas was 66%. Patients with glioma who received adjuvant therapy (n=8) had better survival rates (62.5% vs 33.3%)

compared to those who did not receive adjuvant treatment (n=9).

**Rates by age**

The frequency of tumours by age is shown in Table 2. All children seen had a preoperative KPS score of < 70, while among adults, 83.3% had a preoperative KPS score of <70 (mostly in those 60-79 years of age, 88.9%). Poor post-surgery KPS score (< 70) was also highest in the pediatric population (80% of paediatrics) and those aged 60-79 years of age (55.6% of adults).

Overall, mortality rates were slightly higher in adults compared to the pediatric population (7 of 13 deaths occurred in adults - 53.8%). Among adults, mortality rates were highest in those 40-59 years of age (42.9% mortality by age group; 42.9% of all adult mortality), followed closely by those aged 60-79 years of age (37.5% mortality by age group; 42.9% of all adult mortality). Those aged 18-39 years of age had the lowest mortality overall (11.1% per age group; 14.2% of all adult mortality).

Survival rates (at one year postoperatively) were lowest in the pediatric population (40% survival rates by age group; 19% overall), compared to adults (70.8% overall). Those aged 18-39 years of age, had the best survival rates (38.1% overall; 80% by age group).

**Rates by sex**

The frequency of tumours by sex is shown in Table 2. Being female was associated with poor KPS scores both pre-operatively (88.2% vs 78.9% in males) and post-operatively (70.6% vs 52.4% in males). Mortality was however highest among males (61.5% overall; 47.1% mortality rate by gender) than in females (38.5% overall; 29.4% mortality rate by gender). Overall survival rates at one year were higher in females (57.1%) as compared to males (42.9%) (Table 3).

**Treatment**

10 of our patients (25.6%) underwent gross tumour resection (STR), 26 (66.7%) underwent subtotal tumour resection (STR), and 3 (7.7%) underwent diversion procedures alone. A total of 7 patients underwent CSF diversion procedures as either VPS (5 patients) or ETV (2 patients). Four of the seven patients who underwent diversion procedures subsequently underwent tumour resection.

Adjuvant treatment such as chemotherapy and/or radiotherapy was required in 71.8% (28) of the patients. However, 10 patients (35.7%) refused further treatment after surgery, 4 (14.3%) patients died before or shortly after starting adjuvant treatment, and 3 (10.7%) were lost. Only 11 patients (39.3%) of the 28 that required adjuvant therapy underwent adjuvant treatment.

Those who underwent GTR had better survival at one year (75% survival rates) compared to those who underwent STR (62.5%). Those who underwent diversion procedures alone had the worst outcome (100% mortality at one year). Similarly, those who underwent adjuvant treatment (as chemotherapy and/or radiotherapy) had the best survival rates (54.5% one-year survival rates) as compared to those who did not undergo adjuvant treatment (30% one-year survival rates). None was however statistically significant

**Table 1; Patient characteristics**

| Clinicopathological parameter | | Frequency,n (%) | Clinicopathological parameter | | Frequency, n (%) |
|---|---|---|---|---|---|
| ***Gender*** | Male | 21 (53.8) | Adjuvant treatment | Yes | 11 (28.2) |
| | Female | 18 (46.2) | | No | 14 (35.9) |
| ***Residency*** | Urban | 24 (61.5) | | Unknown | 3 (7.7) |
| | Rural | 15 (38.5) | | Not required | 11 (28.2) |
| ***tumour location*** | Parietal lobe | 3 (7.7) | Pre-op KPS | <70 | 30 (83.3) |
| | Frontal lobe | 12 (30.8) | | >70 | 6 (16.7) |
| | Temporal lobe | 5 (12.8) | Post-op KPS | <70 | 23 (60.5) |
| | Brainstem | 2 (5.1) | | >70 | 15 (39.5) |
| | Cerebellum | 2 (5.1) | 1-year mortality | Yes | 13 (33.3) |
| | Ventricle | 5 (12.8) | | No | 21 (53.8) |
| | Sphenoid | 5 (12.8) | | Unknown | 5 (12.8) |
| | Sellar turcica | 2 (5.1) | Surgical extent | GTR | 10 (25.6) |
| | Other | 3 (7.8) | | STR | 26 (66.7) |
| | | | | CSF diversion | 3 (7.7) |

*Adjuvant treatments include radiotherapy and chemotherapy. 'Not required' under adjuvant treatment means the patient's tumour histology did not require chemotherapy and/or radiotherapy. Those labeled 'Unknown' under adjuvant treatment mean they were lost to follow-up after surgical therapy though they were supposed to undergo some form of adjuvant therapy. KPS – Karnofsky performance status; GTR – gross tumour resection; STR subtotal tumour resection; CSF – the cerebrospinal fluid.*

**Table 2: Histological diagnosis by gender and age group**

| | Gender (%) | | Age in years (%) | | | | |
|---|---|---|---|---|---|---|---|
| ***WHO Class*** | ***Male*** | ***Female*** | ***0-17*** | ***18-39*** | ***40-59*** | ***60-79*** | ***Total (%)*** |
| **Neuroepithelial tumours** | 16 (59.6) | 7 (30.4) | 6 (26.1) | 7 (30.4) | 3 (13) | 7 (30.4) | 23 (59) |
| Medulloblastoma | 2 | 0 | 2 | 0 | 0 | 0 | 2 |
| Glioblastoma | 7 | 4 | 2 | 1 | 2 | 6 | 11 |
| Glioma | 1 | 1 | 2 | 0 | 0 | 0 | 2 |
| Diffuse astrocytoma | 3 | 2 | 0 | 3 | 1 | 1 | 5 |
| Anaplastic astrocytoma | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Pilocytic astrocytoma | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Pineal tumour | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Craniopharyngioma** | 0 | 3 | 3 | 0 | 0 | 0 | 3 (7.7) |
| **Meningioma** | 2 (20) | 8 (80) | 1 (10) | 2 (20) | 5 (50) | 2 (20) | 10 (25.6) |
| **Lymphomas** | 1 | 0 | 0 | 1 | 0 | 0 | 1 (2.56) |
| **Hypervascular schwannoma** | 1 | 0 | 0 | 1 | 0 | 0 | 1 (2.56) |
| **Hemangioblastoma** | 1 | 0 | 1 | 0 | 0 | 0 | 1 (2.56) |
| Total | 21 (53.8) | 18 (46.2) | 11 (28.2) | 11 (28.2) | 8 (20.5) | 9 (23.1) | 39 |

Table 3: Factors associated with mortality/survival after PBT intervention.

| Patient Characteristics | | Study sample (N=39), n(%) | Survived (n=21, 53.8%), n (%) | Mortality (n=13, 33.3%), n (%) | P value |
|---|---|---|---|---|---|
| Age | 0-17 | 11 (28.2) | 4 | 6 | **0.181** |
| | 19-39 | 11 (28.2) | 8 | 1 | |
| | 40-59 | 8 (20.5) | 4 | 3 | |
| | 60-79 | 9 (23.1) | 5 | 3 | |
| Gender | Male | 21 | 9 | 8 | **0.29, 0.48*** |
| | Female | 18 | 12 | 5 | |
| Histology | Neuroepithelial tumor | 20 | 8 | 9 | **0.19** |
| | Meningioma | 10 | 8 | 2 | |
| | Others | 9 | 5 | 2 | |
| Pre-op KPS | >70 | 6 | 4 | 1 | **0.92** |
| | <70 | 30 | 17 | 9 | |
| Residence | Rural | 15 | 7 | 5 | **1** |
| | Urban | 24 | 14 | 8 | |
| Adjuvant treatment | Yes | 11 | 6 | 5 | **0.49** |
| | No | 14 | 3 | 7 | |
| Type of resection | GTR | 10 | 6 | 2 | **0.07** |
| | STR | 26 | 15 | 9 | |
| | Diversion | 3 | 0 | 3 | |
| Duration of illness | <1mo | 2 (5.1) | 1 | 1 | **0.664** |
| | 1-3mo | 14 (35.9) | 7 | 6 | |
| | >3mo | 23 (59) | 13 | 6 | |

*KPS – Karnofsky performance status; GTR – gross tumour resection; STR subtotal tumour resection; CSF – the cerebrospinal fluid. * - Yates chi-square corrected for continuity.*

## DISCUSSION

This study is a retrospective review of the pattern of PBTs managed at a referral hospital in Arusha, Tanzania. To our knowledge, this is the first study to look at the epidemiological profile and treatment outcomes of primary brain tumours in Tanzania. Our main findings were; predominance of gliomas (33%), majority presenting late (59% presenting >3 months after symptom onset) having poor preoperative KPS performance status (83.3%

with KPS <70), low rate of gross tumour resection (25.3%), and 1 year survival of >50%.

**Presentation**

Most of our patients were adults similar to other studies(2,8,11,12). The mean age in our study was 35.8 years, corresponding to other Sub-Saharan Africa (SSA) studies(2,6,13), different from other parts of the world(11,14). This variability illustrates the global variations of PBT epidemiology. Further studies investigating this variation could be helpful. The mean age of diagnosis for our pediatric cases was 8.9 years, consistent with studies done in Nigeria (8.3-9 years) and Sudan (9 years)(6,15,16). Conversely, other studies show lower mean ages among pediatric patients were; 7 years, 7.2 years, and 4 years respectively(13,17,18). The reasons for this disparity are not certain but we assume it may be geographical as those reporting an incidence of 8.3-9 years are all from African countries whereas those reporting lower mean age are non-African.

In our series, there was an overall male predominance, which concurs with the findings of other studies(2,18,19). Conversely, other studies have reported a higher rate of PBTs among females than males(5,13,20). Some studies have shown no gender predominance(6). These differing rates of PBT occurrence by gender could be explained by the higher rates of meningiomas in some studies that preferentially affect women. The hormonal relationship between estrogen/progesterone and meningiomas (which may express estrogen/progesterone receptors) may explain the reason why meningiomas occur more commonly among women (21).

Congruent to other studies, we found that headache and focal neurological deficits were the most common presenting symptoms (11,13). The common occurrence of headaches in most studies for PBTs shows how common headache complaints can be mismanaged in primary care settings.

**tumour characteristics**

Gliomas were the most common tumour subtype followed by meningioma, correlating with studies done in Ghana, India, and the United States of America(5,13,20). Other studies have however documented a predominance of meningioma to gliomas(2,6,12,19).

The occurrence of meningioma in our study was more common in females than in males similar to other studies(5,7), although other published data have shown no significant gender preference for meningioma occurrence(6,19). Consistent with other studies, we found male predominance in patients diagnosed with gliomas and most cases occurred in adults(22,23).

In this study, craniopharyngioma was the most common tumour diagnosed in pediatrics followed equally by medulloblastoma, glioblastoma, and gliomas. Various studies in pediatrics have reported varying rates of occurrence of various tumour subtypes(6,12–14,17). These differences have been hypothesized to be influenced by viral and bacterial infections, ionizing radiation, and other environmental factors though these factors have not been conclusively proven(2).

**Intervention**

Surgical services for brain tumours in our setting are a challenge. Firstly, the cost of surgical intervention is higher than most people can afford, and secondly, we lack advanced surgical technology for the removal of tumours such as MRI-guided laser ablation, neuronavigation, microscopy, and neuroendoscopy.

Gross tumour resection (GTR) in our study was accomplished in 25.6%, and subtotal resection in 66.7%. Compared to SSA, studies done in High-Income-Countries (HICs) have shown higher rates of GTR(2,12,20). This low rate of surgical intervention for brain tumours in SSA is attributed to the fact that neurosurgery is one of the largely undeveloped surgical fields in Sub-Saharan Africa with inadequate technological

advancements restricting aggressive tumour surgery(7,12).

We observed low rates of adjuvant therapy in our patients (among those who were supposed to receive adjuvant therapy, 27 patients out of the 39 total); 40.7% (n=11) underwent treatment, 51.9% (n=14) refused treatment and 11.1% (3 patients) were lost to follow-up after surgical treatment. Poor accessibility to neurooncological services in our region has been identified as an impediment to optimal care of brain tumours in developing countries including our country(24). Our facility currently does not offer radiotherapy, which may explain the loss of follow-up and possibly the refusal of treatment.

**Outcomes**

Patients in our study overall showed an improvement in functional status as assessed by KPS score. This illustrates that tumour resection can improve quality of life as has been shown in other studies(8). We observed poor KPS scores both pre- and postoperatively in women, although males accounted for 61.5% of all mortality agreeing with the observed national data on cancer mortality(1). We could not find valid reasons for this observation.

Improved postoperative KPS scores were seen mostly with meningiomas similar to other studies(7,12). Laeke et al., in Ethiopia a 43% improvement in the postoperative KPS scores among these patients while Kakusa et al., in Uganda, reported a median KPS of 55 which was higher compared to other tumour subtypes(7,12). Patients with gliomas were more likely to have poor KPS scores postoperatively as has also been shown by Kakusa et al., who reported a median KPS score of 0 among patients with gliomas(12).

30-day and one-year mortality rates in our study were higher compared with other studies done in similar settings(12). This could be attributed to the low number of our patients receiving adjuvant therapy and most of them present with poor functional status due to delayed presentation to surgical care. We found that pediatric patients had the worst outcomes compared to adults as they contributed to most of the deaths and poor KPS scores. Other studies have failed to show a difference in outcomes between adults and children(12). In our study, patients with gliomas who did not receive adjuvant therapy had higher mortality compared to those who received adjuvant therapy.

**Pediatrics Treatment and Outcomes**

Few of our pediatric patients underwent gross tumour resection, unlike other studies that report higher rates of GTR(14,17,24). Similarly, we also observed that few of our pediatric patients underwent adjuvant therapy as compared to other studies(15,17). These low rates of adequate tumour therapy might have contributed to the low survival rates observed in our pediatric patients when compared to others in similar settings(14,24,25). Half of these deaths were of those with gliomas, and there was no difference in gender mortality rates. The poor outcomes seen in our study could be attributed to patient delay in tertiary care as indicated by the low preoperative KPS scores.

**Limitations**

Potential sources of bias in this study include; selection bias and information bias. Primary brain tumour is a rare diagnosis, therefore to ensure that we have a good sample size convenience sampling method was used which is a potential source of selection bias. Information bias was a result of the retrospective nature of the study. Information bias was managed by ensuring complete patient records were retrieved and also where information was lacking, phone calls were made to the patients and/or relatives to obtain the missing information.

Also, our study is a single institution study with a relatively small patient cohort which may have accounted for some measurement bias in this study. The short period of post-operative analysis (1 year) is also a hindrance to the true measure of outcomes of patients with brain tumours.

## Conclusions

This study has given insight into the epidemiology of PBTs in Arusha, Tanzania. Gliomas are the most common PBTs. Most of our patients presented >3 months after symptom onset and with poor performance status. Most of them underwent partial tumour resection and had poor access to adjuvant therapies which may have contributed to poor postsurgical outcomes. We recommend further studies in other regions of Tanzania and Africa are required to determine the overall burden of primary brain tumours and evaluate the neuro-oncology need.

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