ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE

DEPARTMENT OF PATHOLOGY

Title: Histopathologic patterns of central nervous system tumors, a five-year retrospective study from September 2019 to August 2024 at Tikur-Anbessa Specialized Hospital, Addis Ababa, Ethiopia.

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ACRONYMS AND ABBREVIATIONS

AAAIR---------- Annual Age-Adjusted Incidence Rate

AAU---------- Addis Ababa University

AYA---------- Adolescents and Young Adults

CNS---------- Central Nervous System

CBTRUS---------- Central Brain Tumor Registry of the United States

GCT---------- Germ Cell Tumors

M: F---------- Male to Female ratio

MPNST---------- Malignant Peripheral Nerve Sheath Tumor

NHL---------- Non-Hodgkin Lymphoma

PNET ---------- Primitive Neuroectodermal Tumors

PXA---------- Pleomorphic xanthoastrocytoma

SD---------- Standard Deviation

TASH ---------- Tikur Anbessa Specialized Hospital

WHO---------- World Health Organization

WHO CNS5---------- World Health Organization Classification of Central Nervous System Tumors 5th edition

ABSTRACT

Background: Tumors of the Central Nervous System (CNS) encompass a wide range of neoplasms with different histopathologic patterns, clinical behaviors, and prognoses. Cancers affecting the brain and CNS make up about 3% of cancer cases worldwide. Prognoses for CNS tumors differ depending on the histologic type and age.

Objectives: This study focused on determining the histopathologic patterns of CNS tumors at a tertiary hospital in Ethiopia over five years, from September 2019 to August 2024.

Methods and Materials: The study is a retrospective descriptive analysis of histopathologic patterns of tumors of the CNS at Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia. It is conducted on 993 patients having a histopathologic diagnosis of CNS tumors at TASH, in which patients' data were collected from the Department of Pathology from September 2019 to August 2024.

Result: Out of the 993 CNS tumor cases found in the five-year study period and analyzed, 856 cases (85.9) were in adults and the remaining 140 cases (14.1) were in pediatric patients aged 18 years or less. Patients' ages range from 3 months to 80 years having a mean age of 36.6 years, median age 37 years, peak age in the 4th decade (25.7%), and an overall male to female (M: F) ratio of 1:1.26. The vast majority of tumors were localized to the brain (928 cases, 88.3%). Low-grade tumors (WHO Grades 1 and 2) dominated both in the spinal cord (62/64 cases, 96.9%) and the brain (594/756 cases, 78.6%) but high-grade tumors (WHO Grades 3 and 4) were more common in the brain as compared to the spinal cord tumors. Meningiomas were the most prevalent tumors representing 41.5% and showing a female predominance with a M:F ratio 1:2.3. Gliomas, Glioneuronal, and Neuronal tumors were the second most frequent tumors (20.2%) showing a male predominance with a M:F ratio 1.2:1.

Conclusion: Despite improvements in diagnostic imaging and molecular genetics, histopathologic assessment remains crucial for classifying and treating CNS tumors. The histopathologic patterns of CNS tumors in this study are generally similar to studies done in different parts of the world.

Keywords: CNS, Glioma, Meningioma, TASH, Ethiopia

1. INTRODUCTION

1.1 Background

The central "neuraxis" consists of substances of the brain and the spinal cord. Lesions located in the neuroparenchyma are frequently referred to as intra-axial, while those bordering the CNS from a meningeal or juxta meningeal location are termed extra-axial. (7).

The brain can be broadly divided into supra and infratentorial parts, with the former located superior to and the latter located below the tentorium cerebelli. The infratentorial structures, which include the cerebellum and brainstem structures (such as pons and medulla), can collectively be referred to as the contents of the posterior fossa. The supratentorial part of the CNS comprises the cerebrum, which is further divided into frontal, temporal, parietal and occipital lobes, as well as the nuclei of basal ganglia, thalamus, and hypothalamus. (7).

Connective tissue is minimal in the CNS and is mainly found in the outer layer of blood vessels, and permanent lymphoid cells are absent. The CNS tissue mainly consist of neuroepithelial cell bodies and processes. The cell types include astrocytes, oligodendrocytes, and ependymal cells. These cell types have corresponding neoplastic forms, broadly classified as gliomas which are further categorized as astrocytomas, oligodendrogliomas, and ependymomas. Related to the ependyma are the specialized cells of the choroid plexus, which produce cerebrospinal fluid and are represented in brain tumors by papillomas and carcinomas. The neurosecretory cells of the pineal gland may also undergo transformative changes, leading to pineal parenchymal tumors. (7).

The location of lesions in the CNS is extremely important when formulating differential clinical and histologic diagnoses, especially in the case of neoplasms. For instance, when dealing with an intra-axial mass, meningioma should not be a top consideration, but if a lesion originates from the dura or occupies the cerebellopontine angle (where a schwannoma could also be considered), it should be given more weight. On the other hand, diffuse gliomas and metastatic carcinomas are responsible for the majority of cerebral hemispheric tumors, especially in adulthood. Pilocytic astrocytomas, which primarily impact young individuals, show strong preference for the cerebellum and third ventricle/hypothalamic regions. Ependymomas usually arise in the fourth ventricles of children and in the spinal cords of adults, where they represent the most prevalent type of intramedullary tumors. Primary CNS lymphomas generally present as masses located in the deep, periventricular white matter or the basal ganglia, whereas germ cell tumors seldom occur outside the midline, pineal, or suprasellar regions. Central neurocytomas are generally restricted to the lateral ventricles. Similarly, myxopapillary ependymomas and CNS paragangliomas are almost

exclusively located in the conus medullaris and filum terminale of the spinal cord. Various other tumors with distinct locations encompass medulloblastoma (found in the posterior fossa), papillary tumor of the pineal area, and chordoid glioma located in the third ventricle. (7).

The yearly occurrence of CNS tumors ranges from 10 to 17 cases per 100,000 individuals for brain tumors and 1 to 2 cases per 100,000 individuals for spinal cord tumors, majority being primary tumors. CNS tumors make up almost 20% of all childhood cancers. Seventy percent of childhood CNS tumors develop in the posterior fossa of the brain, while a similar proportion of tumors in adults originate in the cerebral hemispheres above the tentorium. (13).

The clinical progression of a patient with a brain tumor is significantly impacted by the growth patterns and location of the tumor. Consequently, even benign tumors and low-grade malignancies can result in severe clinical impairments and potentially prove fatal. Due to the extensive infiltration of the brain parenchyma by diffuse gliomas, complete surgical resection without compromising neurological function is not feasible. Furthermore, any central nervous system neoplasm, irrespective of its histologic grade or classification, may prove fatal if located in a critical brain region. For instance, a benign posterior fossa meningioma may lead to cardiorespiratory arrest by exerting pressure on vital centers in the medulla. Notably, even the most highly malignant gliomas rarely metastasize outside the CNS. Additionally, some malignant pediatric tumors may disseminate through the cerebrospinal fluid when they encroach on the subarachnoid space, leading to spread far from the original tumor site. (13).

There are more than 100 different varieties of primary CNS tumors, known as 'histopathologies', each possessing its own range of clinical symptoms, treatments, and prognoses. Unlike other cancers that utilize the AJCC staging system, primary CNS tumors are not staged. Instead, primary CNS tumors are categorized according to the WHO Classification of Tumors of the CNS, which assigns grades 1 to 4 according to expected outcomes. The 2021 WHO CNS5 introduced significant changes to grading terminology and criteria. From the 2021 WHO CNS5 classification onwards, grading is based on using Arabic numerals in clinical settings. (18, 24).

1.2 Statement of the problem

CNS tumors include a diverse variety of neoplasms with different histopathologic patterns, clinical behaviors, and prognoses. Despite improvements in diagnostic imaging and molecular genetics, histopathologic assessment remains crucial for classifying and treating CNS tumors. Although rare, CNS tumors result in considerable mortality and morbidity across all age groups and are distinctive due to their complex histological nature. (17). Brain and CNS cancer poses a significant public health concern on a

global scale, given the high mortality rate, financial impact on individuals and the community, low rates of survival, and the effect on individuals' quality of life. (9).

1.3 Rationale of the study

Cancers affecting the brain and CNS make up about 3% of cancer cases worldwide. Prognoses for CNS tumors vary based on the histologic type and age, typically showing low 5-year survival rates. The rise in survival rates in high-income countries is largely due to advancements in healthcare and the introduction of new therapies. Research, especially in Western nations, has shown a rising occurrence of CNS tumors, particularly among the older population. This increase is thought to be primarily due to improvements in diagnosis following the implementation of advanced imaging techniques. (14). This also suggests that current and future increases in the diagnosis of CNS tumors are expected in Ethiopia due to the ongoing increase in service and quality of health care. The 2022 Globocan estimates indicate that in Ethiopia, tumors of the CNS ranked as the 16th leading cause of cancer morbidity and mortality, with 960 newly diagnosed cases and 803 fatalities in 2022. (22). There are no recent published studies focusing on the histopathologic characteristics of CNS tumors in Ethiopia, and this study can provide important information for future studies.

2. LITERATURE REVIEW

2.1 Histopathologic patterns of CNS tumors

According to the latest (2023) CBTRUS report, Primary CNS Tumors Diagnosed in the United States from 2016–2020, the average annual incidence (AAAIR) of all malignant and benign CNS tumors is 24.83 per 100,000 population (AAAIR = 6.94 for cancer and AAAIR for non-malignant 17.88). The overall rate was greater in women than in men (27.85 vs. 21.62 per 100,000), and in non-Hispanics as compared to Hispanics (25.24 vs. 22.61 per 100,000). The median age was 62 years.

Gliomas represent 26.3% of all CNS tumors. Glioblastoma occurs more frequently in men, while meningioma is more prevalent in women. Among children and adolescents (ages 0 to 19), the occurrence of primary CNS tumors stands at 6.13 per 100,000 population.

The most commonly reported histopathology was meningioma (40.8%), followed by pituitary tumors (17.2%) and glioblastoma (14.2%). Pituitary tumors (17.2%) and nerve sheath tumors (8.1%) made up over a quarter of all tumors (25.3%), with the majority being benign.

Gliomas affected 51%, 24.5%, 23.1% and 21.4% of people aged 0-14 years, 15-39 years, 40-64 years, and 65 years and older, respectively. Most gliomas were located in the supra-tentorial region, including the frontal, temporal, parietal, and occipital lobes, accounting for 62.2%. Glioblastoma was the most prevalent type of glioma, making up 60.2%.

The predominant histopathologic category of spinal cord tumors in individuals aged 0-19 years was ependymal tumors (18.5%), closely followed by nerve sheath tumors (17.6%). In contrast, meningioma (39.9%) was identified as the most frequently occurring type of spinal cord tumor in those aged 20 years and above.

Typically, gliomas represent 44.1% of tumors found in children and teenagers. Medulloblastoma constitutes 70.2% of all embryonal tumors within this age category. (18).

A retrospective study done in Nepal analyzed 138 cases (2017-2020). One hundred and thirteen cases were brain tumors, while 25 cases were spinal cord tumors. Of the overall cases, 132 were primary, and 6 were secondary tumors. Among the brain tumors, 61 (44.2%) were extra-axial. A total of 122 tumors were low-grade. Neuroepithelial tumors accounted for majority of CNS tumors, 54 (38.9%), followed by 36 (26.0%) meningothelial tumors. The tumors were distributed evenly among both

genders. The average age of patients in the study was 37.38 years. The commonest age group was 20-39 years.

In this research, the majority of tumors were found in supratentorial area, 69.6% of all tumors.
The most frequent histologic diagnosis was meningothelial meningioma (14.5%), while pilocytic astrocytoma was the most frequent neuroepithelial tumor (10.1%). (3).

A retrospective study conducted in West Bengal, India included 42 CNS tumors (2018-2020), 29 brain and 13 spinal cord tumors, with a male: female ratio of 1.21:1. The most common age was the 6^{th} decade, and the most common tumor identified was meningioma, followed by astrocytic tumors.
The average age of meningiomas was 49.33 years with a female predominance, M:F ratio of 1:1.57. Meningothelial meningioma was found to be the most common subtype of meningioma, followed by transitional and psammomatous subtypes. Neuroepithelial tumors mainly included astrocytic tumors (21.42%) and most were CNS WHO Grade 2 tumors. In contrast to meningiomas, neuroepithelial tumors were found to be more prevalent in males, showing a M:F ratio of 2.2:1. (2).

Another study in South India included 510 CNS cases over seven years (2009-2015). It involved 405 primary brain tumors, 70 cases of spinal cord tumors, and 35 cases of metastases to the brain.
The majority of patients were between 40-60 years (58.1%). Only 18 cases were in children <18 of age.

The commonest histopathologic group in this study was meningioma. A total of 177 cases (34.6%) were found, followed by astrocytic tumors (25.2%) and nerve sheath tumors (13.8%).
The median age for meningioma was 52 years and it was most commonly observed in women. The commonest histologic subtype was transitional followed by meningothelial meningioma. There were 156 (87.5%) grade 1 meningiomas, 17 (9.6%) grade 2 meningiomas. Psammomatous meningioma was the most common subtype among spinal meningiomas.
Astrocytic tumors were the next most common histologic group in the study (128 cases). 74 of them were observed in males. The main area involved was the temporoparietal lobe of the brain. Among glial tumors, the most prevalent histologic subtype was glioblastoma grade 4, accounting for 58.5%, while diffuse astrocytoma, grade 2, represented 26.9%.

The third most common diagnosis was nerve sheath tumor, 85.9% (61/71 cases) of which were schwannomas. The most commonly affected site was the cerebello-pontine angle. (21).

A retrospective observational study on the histopathologic spectrum of neoplastic and non-neoplastic brain lesions at a tertiary hospital in south India (2019-2020) showed that for neoplastic tumors, the majority were women, accounting 51.1%. The predominant age group affected

was between the 5th decade, representing 26.1% (47 cases). The most frequently observed tumor in adults was astrocytoma, accounting for 41 cases (22.7%), closely followed by meningioma with 40 cases (22.2%) and then schwannoma with 24 cases (13.3%). Among the cases of astrocytoma, the most prevalent subtype was glioblastoma, which comprised 16 cases (39%), followed by diffuse astrocytoma with 11 cases (26.82%). Males predominate for astrocytoma with M:F ratio of 2.15:1. The frontal lobe was observed as the most frequent site of astrocytoma. Astrocytoma was the most common tumor in the 6th decade, representing 34.4%. Out of the 40 cases of meningioma observed, the most frequently encountered subtype was transitional meningioma, comprising 25 cases (62.5%), followed by meningothelial meningioma with 6 cases (15%). It was predominantly seen in females with a M:F ratio of 0.42:1. The parasagittal region was identified as the most common location for these tumors.

The tumor most prevalent in children was found to be diffuse astrocytoma, (3 out of 11 cases). Medulloblastoma and craniopharyngioma followed with similar proportions (18.18%, 2/11 each). (19).

A three-year retrospective study (1998-2000) on histopathological patterns of CNS tumors in Nepal studied 57 CNS tumor cases. The study found 49 cases (86%) as primary and 8 cases (14%) as metastatic. The most common tumor type was astrocytoma, with 22 cases (38.6%), followed by meningioma, which accounted for 14% (8 cases). Adenocarcinoma, with 7 cases (87.5%), was the commonest metastatic tumor. Grade 4 astrocytoma was the commonest astrocytoma subtype in the study. Among the 8 cases of meningioma, 87.5% were Grade 1, and one case was atypical meningioma (WHO Grade 2). For all CNS tumors, the M:F ratio was 0.9:1. A female predominance was observed in meningiomas (0.3:1). (1).

A study done in Ghana, the pattern of intracranial tumors in a tertiary hospital (2010-2015), reviewed 102 histologically diagnosed brain tumors. Glioma was the most common brain tumor accounting for 38.2%, followed by meningioma which accounted for 36.2% of tumors seen. In this study, a slight female predominance was observed with a male to female ratio of 1:1.3. Astrocytoma was the most common glioma constituting 77% the glioma cases. Meningothelial meningioma was the most common subtype of meningioma consisting of 11 (29.7%) cases. (4).

A retrospective study conducted in Cameron, central nervous system tumors histopathology (1996-2006) showed that among 231 histologically diagnosed CNS tumors, 45% male and 55% female patients with M:F ratio 1:1.2. Pediatric patients accounted for 15% (35 cases) of the cases, in whom astrocytomas (7 cases) and medulloblastomas (7 cases) were the commonest tumor types.

Intracranial tumors represented 75% of the cases while 25% were intraspinal. Out of the total 231 cases, 64 metastasis cases were identified. Most metastasis cases were intracranial, 86% of cases. Primary cases found to be malignant in 34% of cases among children and 23% of cases among adults.(5).

A two-year single-center retrospective study done in India on histopathological overview of CNS tumors analyzed a total of 38 cases (2014-2015). In this study 36 cases (94.7%) were primary. The peak age group to be affected was the 5th decade which represented 36.8% of the cases. The M:F ratio was found to be 0.81:1.22 showing a female predominance.

In primary CNS tumors, meningiomas were the commonest (15 cases) followed closely by astrocytoma (13 cases), and schwannoma (07 cases). Astrocytomas were the predominant neuroepithelial (glial) cell tumors with Grade 2 tumors being the commonest followed by Grade 4 tumors (Glioblastoma). (15).

A 6-year retrospective analysis on the prevalence of primary CNS tumors in a tertiary care center in Cairo, Egypt, documented 996 cases (from 2010 to 2015). The three predominant histological types identified were gliomas (35%), meningiomas (33.3%), and pituitary adenomas represented 15.6%. The vast majority of cases in this investigation (92.6%) were located in the brain.

The average age was 43 years, with a median age of 46 years. The age groups most frequently affected were the 5th and 6th decades of life, accounting for (23.6%) and (21.2%) respectively.

Adults comprised 89.4% of the patients. Meningiomas, gliomas, and pituitary adenomas were the commonest tumors in the adult population, representing 37.2%, 32.1%, and 17.1%, respectively. However, among pediatric patients, gliomas and embryonal tumors accounted for most of tumors with 59.4% and 17%, respectively.

Males made up 51.7% of this study population. Males were more likely to have gliomas (42.9%). However, among female patients, meningiomas accounted for the majority of cases (45.9%).
The majority of tumors in the pediatric age group were found in the posterior fossa (26.5).

The calculated average age of gliomas was 40.6 years. In terms of the distribution of sexes, male patients accounted for 63.3 percent of gliomas. Glioblastoma was the most common type (44.1%).

Meningioma accounted for 33.3% of all the tumors, with a mean age of 51 years. These tumors were more frequently found in females, constituting 66.6%. The most common were WHO grade 1, with transitional subtype accounting for 53.1% of all cases, followed by meningothelial meningioma (21.7%).

Pituitary adenomas were the third most frequent type of tumor, making up 15.6% with an average age of 43.4 years. These tumors primarily occurred in adults, with only three instances recorded in children. In males, (62.6%) of pituitary adenomas were observed, whereas (37.4%) were seen in females. (8).

There were 102 intracranial neoplasms in an 11-year retrospective study conducted in Abuja, Nigeria on histopathologic patterns of intracranial tumors. The most common diagnosis was meningioma, accounting for 41% of cases, followed by 22% for pituitary adenoma and 20% for glioma.

The M:F ratio for all tumors was equal, 1:1 with an average age at diagnosis of 35 years, standard deviation of 17.1, and tumors were more commonly found in the 4^{th} and 5^{th} decades. Most of the tumors occurred in adults with an average age of 41 and a standard deviation of 12.5 years. Meningioma was the most prevalent tumor in adults, succeeded by pituitary adenoma and glioma. In children, occurrence of intracranial tumors was 11.8%, with ages varying from 1 to 15 years and mean age of 8.3 with a standard deviation of 4.4, and an even distribution between the sexes. Gliomas and embryonal tumors accounted for 25% of pediatric tumors, with meningiomas and pineal gland tumors representing 16.7% each.

Meningioma cases, having a mean of 42.5 ± 12.8 years, showed a M:F ratio of 1:1. Meningothelial meningioma was the subtype that was detected most frequently. Pituitary adenomas accounted for 22% of cases, making them the second most common type of tumor. The M:F ratio was 2:1, and mean age of 44 ± 7 years. The third most common tumor (20%) was glioma with a M:F ratio of 1:1.7, and mean age of 32 ± 18 years. In children, gliomas were observed at a frequency of 12.5%. (12).

A study in a Tertiary Hospital in Southwest Nigeria retrospectively reviewed 115 cases of CNS tumors from 2010 to 2020, with an average age 43.7 years and a standard deviation of 17.8. The peak age most impacted was the 5^{th} decade, representing 29 individuals or 25.2% of the total. Females represented 63 cases (54.8%). Out of the 115 CNS tumor cases examined, 99 cases (86.1%) were found to be brain tumors.

In this review, meningioma was the commonest histologic type of CNS tumors, accounting for 33 cases (28.7%). Meningothelial meningioma was the predominant subtype, with 24 cases. Astrocytoma constituted 22 cases (19.1%). Following this, pituitary adenoma was identified in 20 cases (17.4%). (16).

A histopathologic study of CNS tumors in India, in which 59 cases were reviewed from 2011-2015. There were more cases in males with 38 cases (64.4%) than females with 21 cases. The highest occurrence of tumors was observed in the 5^{th} decade, with 16 out of 59 cases, followed closely by the 4^{th} decade. The frontal lobe had the highest incidence with 22 cases. Neuroepithelial tumors were the most common based on the origin of cell type with 40 cases, while meningeal tumors were second with 13 cases.

The most common tumor was astrocytoma with 31 cases. The majority of lesions were classified as Grade 1 (32.7%) and Grade 4 (32.7%), with Grade 2 accounting for 29.1% and Grade 3 for 5.5%. The most common astrocytic tumor was glioblastoma, which comprised 16 cases, while 11 cases of grade 2 astrocytomas were found.

Meningeal tumors were the 2nd most frequent type of tumors. In this study, 13 cases of meningioma were recognized, comprising 7 cases in males and 6 cases in females. The histological subtype most commonly observed among meningiomas was meningothelial, accounting for 8 cases (61.6%). (11).

Another study done in Kenya reviewed 345 brain tumors to analyze histologic patterns of brain tumors between 2016 and 2019. The average age for pediatric patients was 9 years, and standard deviation of 5, while in adult patients, mean was 45 years and standard deviation 14. Among pediatric patients, 88 tumors (28.2%) were diagnosed. The highest number of tumors (19.2%) occurred in those 10 years or younger, and those aged 31-40 years followed with 17.6%. In total, two peaks in tumor diagnoses were identified, one in those aged 5-15 years and another in those aged 40-45 years. The most frequently occurring tumors in pediatric patients were gliomas (48.9%) and medulloblastomas (23.9%), while in adults, the most common were meningiomas (47.8%) and gliomas (31.3%). The majority of tumors in both age groups were benign, accounting for 56.8% and 70.1% of the cases, respectively.

Out of the total 345 tumor cases, 55.1% were observed in females. Meningiomas were the most frequent tumors, accounting for 128 (37.1%) cases, while gliomas followed with 118 (34%) cases. Among females, the most common tumor was meningioma, with accounting for 50.6% of the cases. Among males, glioma was the most common, accounting for 40.4% of the cases. (6).

A retrospective study done in Nigeria on the spectrum of intracranial tumors (2008-2012) reviewed a total of 56 cases over five years. The M: F ratio was around 1:1.1, with an average age of 36 and standard deviation of 20.35 (range, 2 to 85). Astrocytomas made up 30% (17 cases), Meningiomas accounted for 29% (16 cases), and Medulloblastoma represented 18% of the cases. Among Astrocytic tumors, most (52.9%) were classified as grade 2, followed by Glioblastoma at 35.2%. About 37.5% of meningioma cases were classified as mixed type, whereas 25% were identified as transitional. (20).

Another study done in India on the spectrum of primary intracranial tumors retrospectively reviewed 4295 (comprising 1847 female and 2448 male patients) primary intracranial tumors over a period of five years between 2010- 2014. The male-to-female (M: F) ratios were 2.4:1 for glioblastomas and 0.5:1 for meningiomas.

The largest proportion of brain tumors was diagnosed in the fourth decade. Of all the tumors, 36.3% were categorized as WHO Grade 1, 11.4% as Grade 2, 20% as Grade 3, and 18.9% as Grade 4.

Pediatric patients made up 16.2% of the cases. The pediatric population had astrocytomas as the commonest tumors, accounting for 25.1%, while embryonal tumors represented 20.6% and ependymal tumors accounted for 14.8%. Pilocytic astrocytomas were the most observed glial tumors (44%), followed by ependymomas (31%). The commonest types of tumors in adults were meningiomas (23.2%), glioblastomas (15.5%), nerve sheath tumors (12.7%), and oligodendroglial tumors (11.4%). Glioblastomas were the most prevalent glial tumors in the adult group (38%). (10).

A 5-year retrospective study of histopathologic pattern of CNS tumors at a tertiary hospital in Addis Ababa, Ethiopia analyzed a total of 565 cases with a mean age of 36.9 years and a male to female ratio of 1:1.11. Majority of tumors were intracranial (499 cases, 88.3%). Most were low grade (84. 8%), and the most common tumor types were meningioma (272 cases, 48.1%) and astrocytoma (86 cases, 15.2%). (23).

3. OBJECTIVES

3.1 General objective

To describe the histopathologic patterns of central nervous system tumors.

3.2 Specific objectives

1. Determine the relative frequency of different CNS tumors.

2. Assess histopathologic diagnoses according to demographic data including age and sex.

3. Assess the distribution of the histopathologic diagnoses based on anatomic site and grade.

4. Compare the findings with those around the world.

4. METHODS

4.1 Study Area

The study is conducted at TASH, in Addis Ababa, Ethiopia which is the largest referral hospital in the country receiving so many patients referred from different parts of the country, most importantly patients with CNS tumors.

4.2 Study Design

A quantitative retrospective descriptive study is used to analyze the histopathologic diagnosis of CNS tumors based on data retrieved from the archives of the Department of Pathology, TASH, Addis Ababa, Ethiopia from September 2019 to August 2024.

4.3 Source and Study Population

The source population is all patients with CNS tumors presenting to TASH between September 2019 and August 2024.

The study population includes all patients who have histopathologic diagnoses of CNS tumors at TASH between September 2019 and August 2024.

4.4 Eligibility Criteria

4.4.1 Inclusion Criteria

Patients of all ages with a CNS tumor, who presented to the Department of Pathology at TASH during the study period from September 2019 to August 2024, and had a histopathologic diagnosis.

4.4.2 Exclusion Criteria

Non-neoplastic lesions, neurologic lesions other than the CNS, cases with incomplete data and without a definitive diagnosis, and recurrent cases are excluded from the study.

4.5 Sample Size Determination and Sampling Procedure

All biopsy reports with a CNS tumor registered in the archives of the Department from September 2019 to August 2024 are examined.

4.6 Data Collection

All patients' reports with CNS tumors were collected from the archives of the Department in the time-frame of September 2019 to August 2024. Demographic variables such as age, sex, and tumor characteristics including tumor site, histologic type, and grade were collected from patients' biopsy reports.

4.7 Variables

4.7.1 Dependent Variables

Tumor site, histologic type, and grade

4.7.2 Independent Variables

Age and sex of the patient.

4.8 Data Management

The information gathered was put into an Excel spreadsheet and analyzed using IBM SPSS 27.

4.9 Ethical Consideration

Ethical clearance received from the Department of Pathology, TASH. Confidentiality was preserved by anonymizing the information and restricting access only to the researcher.

5. RESULT

A total of 1036 cases were reviewed and 993 cases fulfilled the inclusion criteria. Eighteen cases due to recurrence and 25 cases with incomplete information were excluded.

AGE AND SEX DISTRIBUTION

Age of patients ranges from 03 months to 80 years, with mean age 36.6 years and median age of 37 years. The standard deviation of this study is approximately 16.26. **(Table 1)**

Table 1: Age Statistics

N	993
Mean	36.6190
Median	37.0000
Std. Deviation	16.25776
Minimum	.25
Maximum	80.00

Table 2: Age Group Frequency

Age Group	Frequency	Percent
0-10 years	76	7.7
11-20 years	89	9.0
21-30 years	197	19.8
31-40 years	255	25.7
41-50 years	190	19.1
51-60 years	121	12.2
61-70 years	56	5.6
71+ years	9	.9
Total	993	100.0

The peak incidence of occurrence of CNS tumors was the fourth decade of life (25.7%) followed closely by the 3rd (19.8%) and 5th (19.1%) decades of life. **(Table 2)**

Out of the total 993 cases, females accounted for 553 (55.7%) cases while the remaining 440 (44.3%) cases were found in males. The overall M:F ratio was around 1:1.26 with a female predominance.

A total of 853 cases (85.9) were found in adults above the age of 18 years and the rest 140 (14.1%) cases occurred in pediatric patients aged 18 years or less.

In adults, the mean age was found to be 41 years, while the median age is 40 years. The standard deviation is found to be 12.9. A slight female predominance was observed with a M:F ratio of 1:1.27.

Tumors predominantly affect young to middle-aged adults, with peak age in the 4th decade (255 cases). A gradual decline was seen in cases beyond 60 years, with minimal representation in the 71+ years age group (9 cases).

In pediatric patients, the mean age was 9.88 years and median age 10 years, while the standard deviation was 5.31. Tumors were more prevalent in older children and adolescents, peaking around 10–18 years with minimal representation observed in infants below the age of 1 year (1.4%). A slight female predominance was observed with a male to female ratio of 1:1.15.

HISTOPATHOLOGY

All 993 cases were grouped into 10 major tumor categories according to the WHO CNS5. **(Table 3)**

In these categories, tumor distribution varied significantly by age, with middle-aged adults most affected overall and pediatric cases were dominated by Embryonal Tumors and Gliomas.

Meningiomas were the most frequent tumor category representing 41.5% (412). They were followed by Gliomas, Glioneuronal, and Neuronal Tumors which accounted for 20.2% (201) of all cases while tumors of the sellar region represented 18.6% (185) of all cases.

Table 3: Major Tumor Categories and Sex Distribution

Category of Tumor	Mean (in years)	SD	Median (in years)	F	M	Frequency	Percent
Meningiomas	42.3	12.42	40	69.7%	30.3%	412	41.5
Gliomas, Glioneuronal and Neuronal Tumors	31.9	19.03	30	45.3%	54.7%	201	20.2
Tumors of the Sellar Region	38.9	13.79	38	44.9%	55.1%	185	18.6
Cranial and Paraspinal Nerves	33.5	12.78	30	46.2%	53.8%	91	9.2
Hematolymphoid Tumors	36.0	.	36	100.0%	0.0%	1	.1
Germ Cell Tumors	13.0	.	13	0.0%	100.0%	1	.1
Metastases	53.7	9.24	53	16.7%	83.3%	6	.6

Mesenchymal, Non-Meningothelial Tumors	36.7	15.0	36	33.3%	66.7%	24	2.4
Embryonal Tumors	14.4	14.0	10	58.5%	41.5%	65	6.5
Choroid Plexus Tumors	13.5	13.03	11	28.6%	71.4%	7	.7
Total	36.6	16.26	37	55.7%	44.3%	993	100.0

The cases are distributed across 21 tumor types **(Table 4)** with Meningioma being the most frequent tumor (412 cases, 41.5%) followed by Pituitary Adenoma (160 cases 16.1%) and Astrocytic tumors (156 cases, 15.7%). The least represented tumors were Chordoma, Lymphoma, MPNST, and Germinoma each represented by 1 case.

Gliomas, Glioneuronal and Neuronal tumors were distributed across all age groups with peaks in the 3rd (18.4%), 4th (17.9%) and 1st (16.9%) decades, with a M: F ratio of 1.2:1. Astrocytic tumors (156 cases, 15.7% of total) were observed in all age groups with notable peaks in the 1st (16%), 4th (16%), and 5th (17.3%) decades of life. They were slightly more commonly seen in males with M: F ratio of 1.23:1. Ependymomas (19 cases) dominated in pediatrics with peak ages in the 1st decade (42.1% of Ependymoma cases), and a male to female ratio of 1:1.1. Oligodendrogliomas represented 15 cases with peak age in the 4th decade (53.3%) and male to female ratio of 2.75:1. Central Neurocytomas accounted for 9 cases seen mostly in the 2nd (44.3%) and 3rd (44.3%) decades of life with a male to female ratio of 1:2. Gangliogliomas represented the remaining 2 cases.

Pituitary Adenomas were mostly observed in adults in their 4th (25% of Pituitary Adenoma cases) and 3rd (22.5% of Pituitary Adenoma cases) decades of life with a nearly equal sex distribution (M: F = 1.1:1). Craniopharyngiomas (25 cases, 2.5%) were observed in the 2nd and 3rd decades showing a male predominance, with M: F ratio of 2.57:1.

Nerve sheath tumors accounted for about 9.2% of the cases with 88 cases represented by Schwannoma, 2 cases by Neurofibroma, and 1 case by MPNST. They were most frequent in the 3rd decade (36.3%), with a male to female ratio of 1.17:1.

Embryonal tumors represented 6.5% (65 cases) of all cases where Medulloblastomas were the most prevalent (62 cases, 6.2% of total) with peak age in the 1st decade (50% of Medulloblastoma cases). The male to female ratio for Medulloblastomas was 1:1.3. The remaining 3 cases were represented by CNS Embryonal Tumor, NOS (2 cases) and Embryonal Tumor with Multilayered Rosettes (1 case).

Mesenchymal, non-meningothelial tumors (24 cases) were mostly represented by Hemangioblastoma (16 cases) with peak age in the 3rd (31.3%) and 4th (31.3%) decades, and male to female ratio of 1.67:1. The remaining 8 cases being represented by Solitary Fibrous Tumor (5 cases), Cavernous Hemangioma (2 cases) and Chordoma (1 case).

There were 7 Choroid Plexus tumors identified with 5 Choroid Plexus Papilloma, 1 case each Atypical Choroid Plexus Papilloma and Choroid Plexus Carcinoma.

There were 6 cases of Metastases represented by 2 cases of Adenocarcinoma, 1 case each of Adenocarcinoma infiltrating Meningioma WHO Grade 1, Papillary Adenocarcinoma, Hepatocellular Carcinoma and Squamous cell Carcinoma, all of them observed in adults. Hematolymphoid (High Grade Non-Hodgkin Lymphoma) and Germ Cell (Germinoma) tumors represented 1 case each.

In adults, the overwhelming majority 93.3% (796 cases) were localized to the brain. Meningiomas represented most of the cases with 47.6%, followed by Pituitary Adenomas (18.5%) and Astrocytic tumors (13%). Schwannomas represent the bulk of the remaining tumor percentage (9.4%). Meningiomas showed a significant female predilection with a male to female ratio of 1:2.3. Astrocytic tumors showed a M:F ratio of 1.4:1 with a male predominance. Schwannoma and Pituitary Adenoma showed a nearly similar gender distribution with a male to female ratio of 1.1:1 and 1.08:1, respectively. **(Tables 8, 9, and 10)**

Pediatric CNS tumors up to 18 years of age accounted for 6.7% (140 cases) of all CNS tumors and were grouped into three anatomical categories. Posterior fossa tumors were found to be the most common, representing nearly half of the cases (49.3%, 69 cases) closely followed by Supratentorial tumors (45%, 63 cases) while 8 cases (5.7%) occurred in the spinal cord.

Medulloblastoma and Astrocytic tumors represented most of the pediatric cases with 33.6% and 32.1%, respectively. Craniopharyngioma (6.4%), Ependymoma (5.7%), and Schwannomas (5.7%) represented most of the remaining cases. Meningiomas, Medulloblastomas, Astrocytic Tumors, and Ependymomas, showed a female predominance with a male to female ratio of 1:1.48, 1:1.14, 1:1.67, and 1:2, respectively. Craniopharyngiomas and Schwannomas displayed a male predominance with a M:F ratio of 3.5:1 and 1.67:1, respectively. **(Tables 8, 9, and 10)**

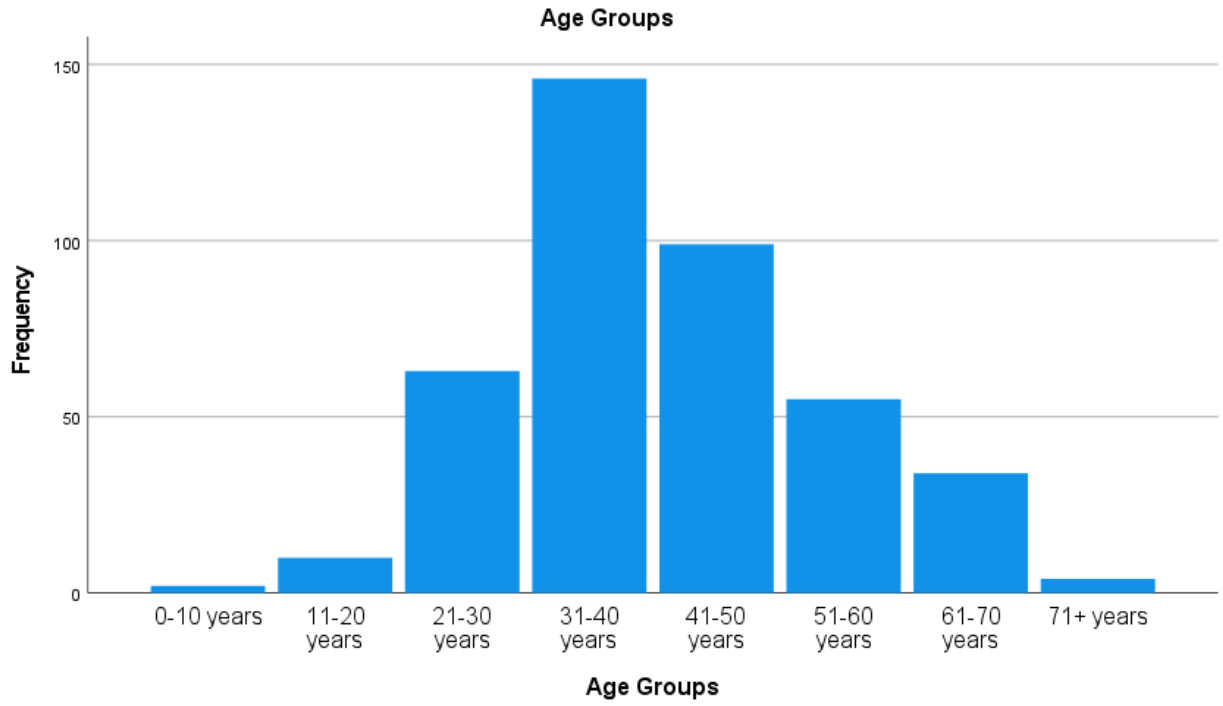
Table 4: Tumor Types

Tumor Type	Mean (in years)	SD	Median (in years)	F	M	Frequency	Percent

Meningioma	42.3	12.42	40	69.7%	30.3%	412	41.5
Astrocytic Tumors	33.4	19.91	33	44.9%	55.1%	156	15.7
Pituitary Adenoma	41.3	12.33	40.5	47.5%	52.5%	160	16.1
Schwannoma	33.7	12.71	31	46.6%	53.4%	88	8.9
Ependymoma	23.7	19.32	20	52.6%	47.4%	19	1.9
Hemangioblastoma	33.6	11.96	36.5	37.5%	62.5%	16	1.6
Secondaries	53.7	9.24	53	16.7%	83.3%	6	.6
Craniopharyngioma	23.6	12.96	24	28.0%	72.0%	25	2.5
Oligodendroglioma	32.8	10.0	34	26.7%	73.3%	15	1.5
Solitary Fibrous Tumor	40.6	17.91	40	40.0%	60.0%	5	.5
Central Neurocytoma	23.7	6.54	21	66.7%	33.3%	9	.9
Lymphoma	36.0	.	36	100.0%	0.0%	1	.1
Hemangioma	32.5	3.54	32.5	0.0%	100.0%	2	.2
Ganglioglioma	22.0	5.66	22	50.0%	50.0%	2	.2
Choroid Plexus Tumors	13.5	13.03	11	28.6%	71.4%	7	.7
Neurofibroma	29.0	22.63	29	50.0%	50.0%	2	.2
Chordoma	75.0	.	75	0.0%	100.0%	1	.1
Germinoma	13.0	.	13	0.0%	100.0%	1	.1
Medulloblastoma	14.7	14.25	11	56.5%	43.5%	62	6.2
Other CNS Embryonal Tumors	8.0	2.0	8	100.0%	0.0%	3	.3
MPNST	24.0	.	24	0.0%	100.0%	1	.1
Total	36.6	16.26	37	55.7%	44.3%	993	100.0

A total of 413 cases of Meningioma were identified, of which 1 case was found to be Meningioma infiltrated by Secondary Adenocarcinoma and it is included in the metastatic brain tumors. Meningiomas were the most frequent tumor type representing 41.5% (412). The majority of cases of Meningioma were observed in the 4th decade (146 cases, 35.4%), followed by the 5th decade (99 cases, 24.0%) with a male to female ratio of 1:2.3. Younger groups (e.g., 0–10 years) and the elderly (71+ years) were underrepresented, with 2 cases and 4 cases, respectively. **(Figure 1)**

Figure 1: Age Groups for Meningiomas



Meningothelial Meningioma was the most prevalent subtype, comprising 222 cases (53.9%), followed by Transitional Meningioma with 84 cases (20.4%). Rare subtypes, such as Lymphoplasmacyte Rich Meningioma and Metaplastic Meningioma, each had 1 case. The overwhelming majority of Meningiomas are found to be WHO Grade 1, with 347 cases (84.2%) followed by WHO Grade 2, 57 cases (13.8%), and the remaining 8 cases being WHO Grade 3. **(Table 5)**

Table 5: Frequency and WHO Grade for Meningioma Subtypes

Diagnosis	WHO Grade	Count	Percent

Anaplastic Meningioma	3	6	1.5
Angiomatous Meningioma	1	5	1.2
Atypical Meningioma	2	49	11.9
Chordoid Meningioma	2	5	1.2
Clear Cell Meningioma	2	3	.7
Fibrous Meningioma	1	16	3.9
Lymphoplasmacyte Rich Meningioma	1	1	.2
Meningothelial Meningioma	1	222	53.9
Metaplastic Meningioma	1	1	.2
Microcystic Meningioma	1	8	1.9
Psammomatous Meningioma	1	10	2.4
Rhabdoid Meningioma	3	2	.5
Transitional Meningioma	1	84	20.4
Total		412	100.0

The Convexity was the most frequently involved site, with 94 cases (22.8%) followed by the Sphenoid Wing: 56 cases (13.6%) and Parasagittal: 45 cases (10.9%) areas. Rare sites like the Craniovertebral Junction, Optic Nerve Sheath, and Pineal were observed in only 1 case each. Only 22 cases (5.3%) of Meningiomas were observed in the spinal cord. **(Table 6)**

Table 6: Sites of Meningioma

SITE	Frequency	Percent
Brain (Extra-axial)	35	8.5

Clinoid	12	2.9
Clival	8	1.9
Convexity	94	22.8
CPA	15	3.6
Craniovertebral Junction	1	.2
Falcotentorial	3	.7
Falx	11	2.7
Foramen Magnum	8	1.9
Intraventricular	2	.5
Olfactory Groove	20	4.9
Optic Nerve Sheath	1	.2
Orbit	3	.7
Parasagittal	45	10.9
Pineal	1	.2
Planum Sphenoidale	8	1.9
Posterior Fossa	2	.5
Sellar/Suprasellar	39	9.5
Skull Base	23	5.6
Sphenoid Wing	56	13.6
Spinal Cord Extramedullary	22	5.3
Tentorial	3	.7
Total	412	100.0

A total of 156 cases of astrocytic tumors were observed representing 15.7% of all cases. The majority (82 cases) were high-grade tumors (WHO Grades 3 and 4). They were slightly more common in males with a male to female ratio of 1.23:1. They affected all age groups, peaking in middle-aged adults, 41-50 years (27 cases, 17.3%), followed by the 1st (25 cases, 16%) and 4th (25 cases, 16%) decades. Astrocytomas were distributed across various regions of the CNS with the frontal lobe (39 cases, 25%) and posterior fossa (26 cases, 16.7%) being the most frequently involved sites. **(Figures 2 and 3)**

Glioblastomas were the most common subtype accounting for 46.2% (72 cases) of astrocytic tumors. They are predominantly seen in older adults (41–50 years: 31.9%, 51–60 years: 19.4%). The remaining WHO Grade 4 astrocytic tumor is represented by 1 case of Diffuse Pediatric Type-High Grade Glioma. There were 6 cases of Anaplastic Astrocytoma (WHO Grade 3), and 1 case of High-Grade Astrocytoma with Piloid Features.

The low-grade tumors are dominated by Pilocytic Astrocytoma accounting for 30.1% (47 cases). Pilocytic Astrocytomas predominantly affect younger patients (0–10 years: 38.3%, 11–20 years: 40.4%). Diffuse Astrocytomas (WHO Grade 2) accounted for 10.9% (17 cases) of astrocytic tumors with peaks in young adults (21–40 years: 64.7%).

Eight cases of Pleomorphic Xanthoastrocytoma and 2 cases of Anaplastic Pleomorphic Xanthoastrocytoma (WHO Grade 3) were identified. One case of Subependymal Giant Cell Astrocytoma and another single case of Astroblastoma were also found. **(Table 7)**

Table 7: Frequency, Age Group, and Sex Distribution for Astrocytic Tumors

Astrocytoma Subtype	Pediatric (%)	Adult (%)	F	M	Frequency	Percent
Glioblastoma and Gliosarcoma	2.8%	97.2%	38.9%	61.1%	72	46.2
Pilocytic Astrocytoma	72.3%	27.7%	55.3%	44.7%	47	30.1
Diffuse Astrocytoma (WHO Grade 2)	11.8%	88.2%	47.1%	52.9%	17	10.9
Anaplastic Astrocytoma (WHO Grade 3) and High-Grade Astrocytoma with Piloid Features	14.3%	85.7%	28.6%	71.4%	7	4.5

Pleomorphic Xanthoastrocytoma	40.0%	60.0%	40.0%	60.0%	10	6.4
Astroblastoma	0.0%	100.0%	100.0%	0.0%	1	.6
Subependymal Giant Cell Astrocytoma	100.0%	0.0%	0.0%	100.0%	1	.6
Diffuse Pediatric Type-High Grade Glioma	100.0%	0.0%	100.0%	0.0%	1	.6
Total	28.8%	71.2%	44.9%	55.1%	156	100.0

Figure 2: Age Groups for Astrocytic Tumors

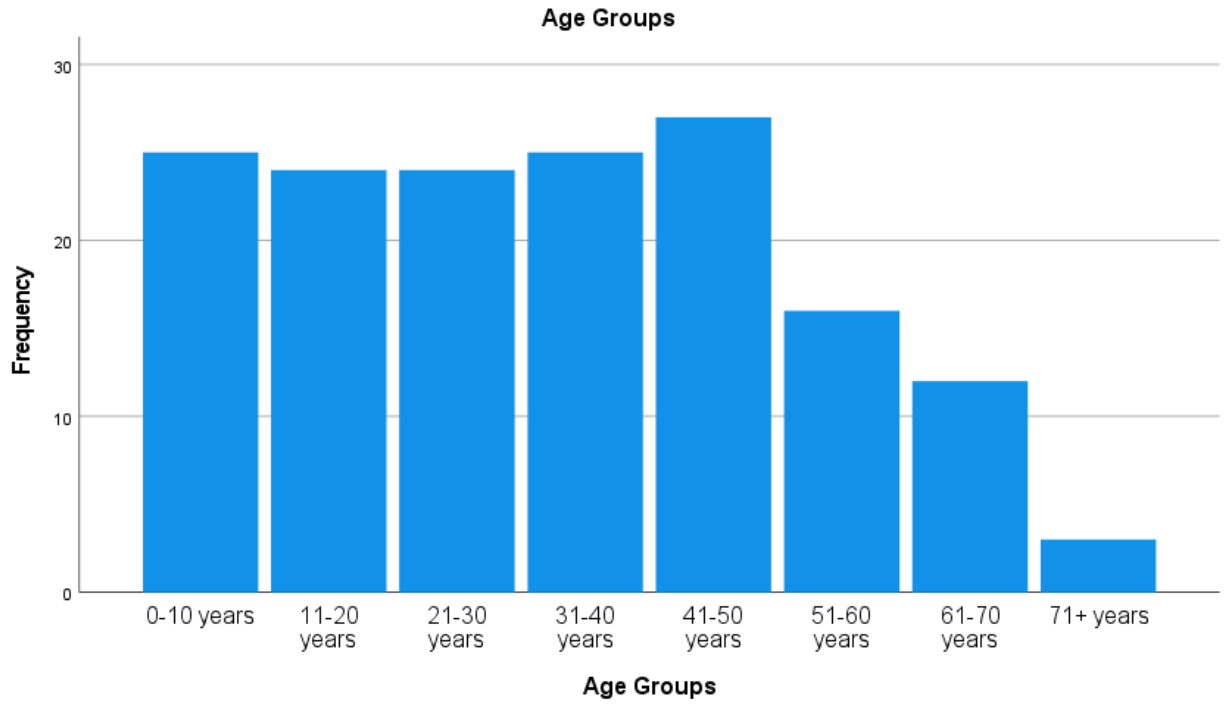
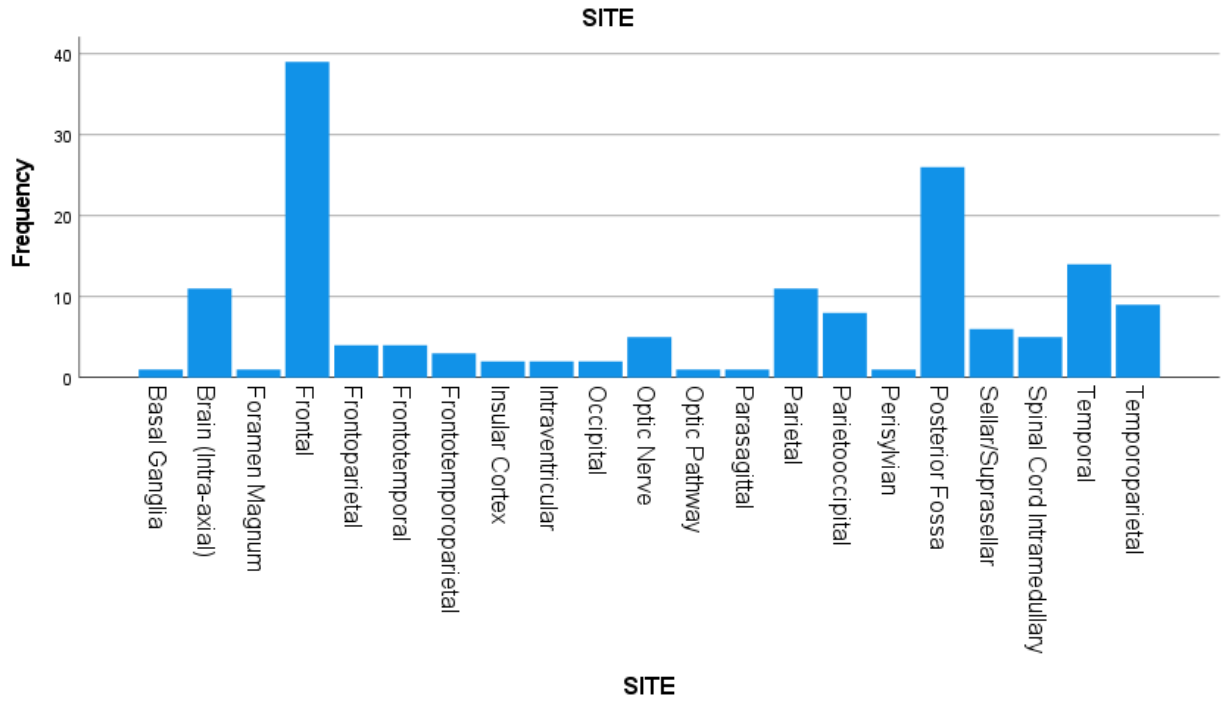


Figure 3: Sites for Astrocytoma



MAJOR SITE AND WHO GRADE

Tumor distribution between the brain and spinal cord was also assessed with the majority found to be localized to the brain (928 cases, 93.5%). Spinal cord tumors contributed only to a smaller proportion of the cases (65 cases, 6.5%). **(Figure 4)**

In the pediatric age group, 140 cases were identified and 94.3% (132 cases) occurred in the brain while the spinal cord comprised the remaining 5.7% (8 cases). In the adult population, 853 cases were found and the brain predominated accounting for 93.3% (796 cases) whereas the spinal cord represented only 6.7% (57 cases). **(Figure 4)**

Pituitary Adenoma (160 cases), Cavernous Hemangioma (2 cases), Secondary/Metastatic tumors (6 cases), Germinoma (1 case), High-Grade NHL (1 case), Chordoma (1 case), MPNST (1 case) and Astroblastoma (1 case) were not graded according to the WHO CNS5 (17.42%).

Low-grade tumors (593 cases, 78.5%) dominate brain tumors while higher-grade tumors represent a lower proportion (162 cases, 21.5%) of the cases. **(Figure 6)**

Figure 4: Major Site and Age Group Distribution

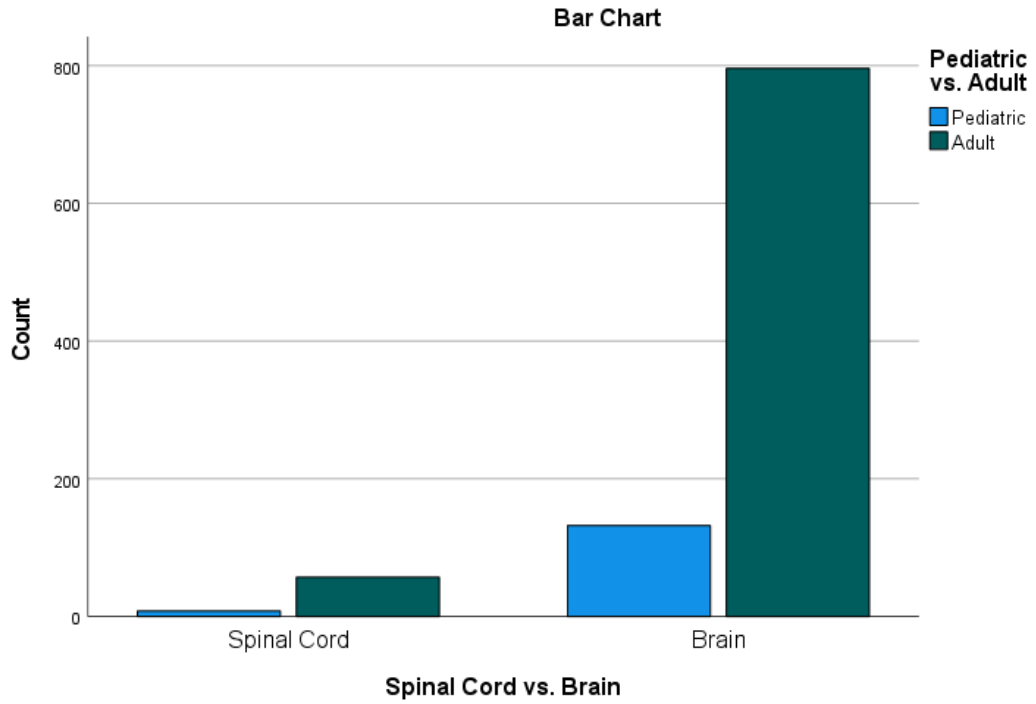


Figure 5: Major Site and Sex Distribution

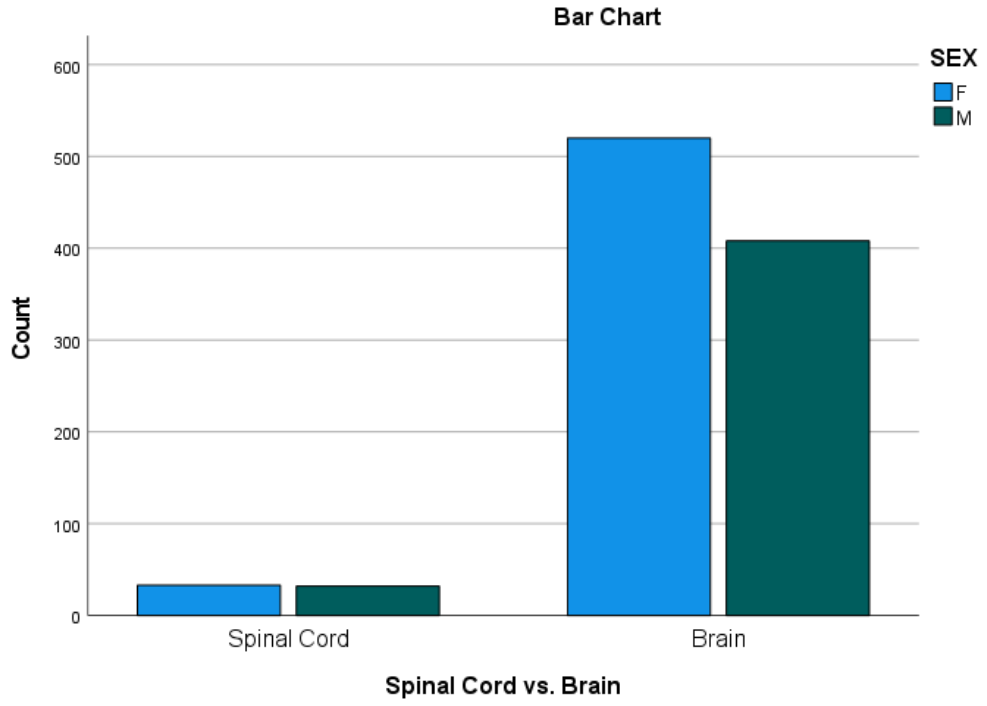


Figure 6: Major Site and WHO Grade

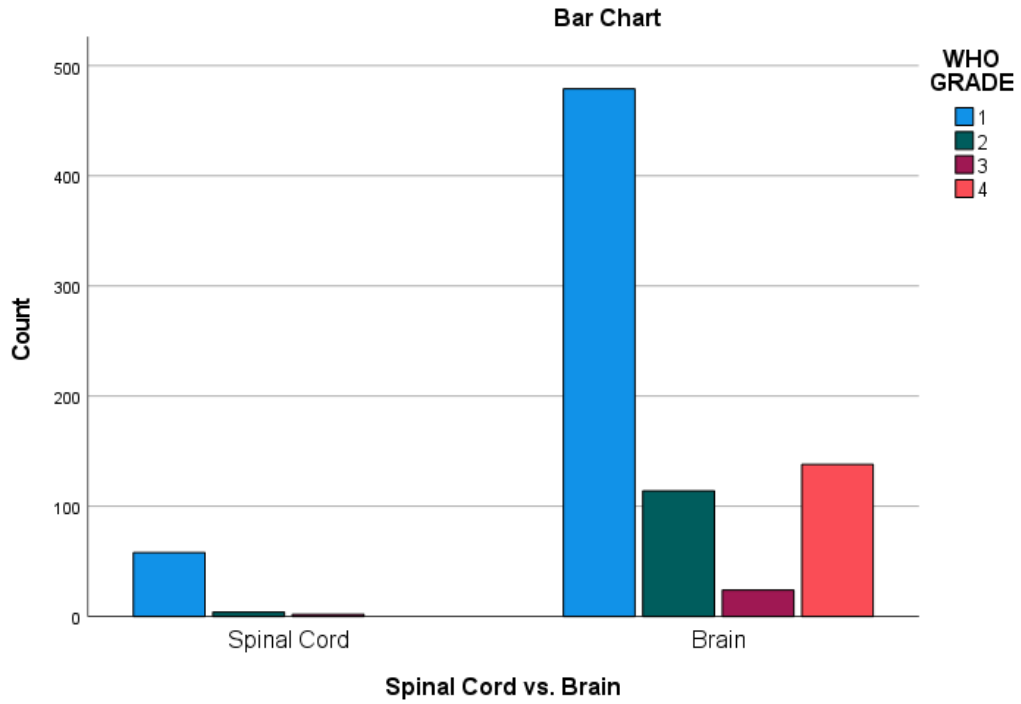


Table 8: Tumor Type Frequency, Age Group and Sex Distribution in the Brain

Tumor Type	Pediatric (%)	Adult (%)	Female (%)	Male (%)	Total Count	Total (%)
Meningioma	1.3%	98.7%	69.2%	30.8%	390	42.0%
Astrocytic Tumors	27.8%	72.2%	45.7%	54.3%	151	16.3%
Pituitary Adenoma	1.3%	98.8%	47.5%	52.5%	160	17.2%
Schwannoma	8.5%	91.5%	52.5%	47.5%	59	6.4%
Ependymoma	53.3%	46.7%	46.7%	53.3%	15	1.6%
Hemangioblastoma	7.7%	92.3%	38.5%	61.5%	13	1.4%
Secondaries	0.0%	100.0%	16.7%	83.3%	6	0.6%
Craniopharyngioma	36.0%	64.0%	28.0%	72.0%	25	2.7%
Oligodendroglioma	6.7%	93.3%	26.7%	73.3%	15	1.6%
Solitary Fibrous Tumor	0.0%	100.0%	40.0%	60.0%	5	0.5%

Central Neurocytoma	22.2%	77.8%	66.7%	33.3%	9	1.0%
Lymphoma	0.0%	100.0%	100.0%	0.0%	1	0.1%
Hemangioma	0.0%	100.0%	0.0%	100.0%	2	0.2%
Ganglioglioma	50.0%	50.0%	50.0%	50.0%	2	0.2%
Choroid Plexus Tumors	57.1%	42.9%	28.6%	71.4%	7	0.8%
Neurofibroma	100.0%	0.0%	0.0%	100.0%	1	0.1%
Chordoma	0.0%	100.0%	0.0%	100.0%	1	0.1%
Germinoma	100.0%	0.0%	0.0%	100.0%	1	0.1%
Medulloblastoma	75.8%	24.2%	56.5%	43.5%	62	6.7%
Other CNS Embryonal Tumors	100.0%	0.0%	100.0%	0.0%	3	0.3%
Total	14.2%	85.8%	56.0%	44.0%	928	100.0%

Figure 7: Age Group Distribution in the Brain

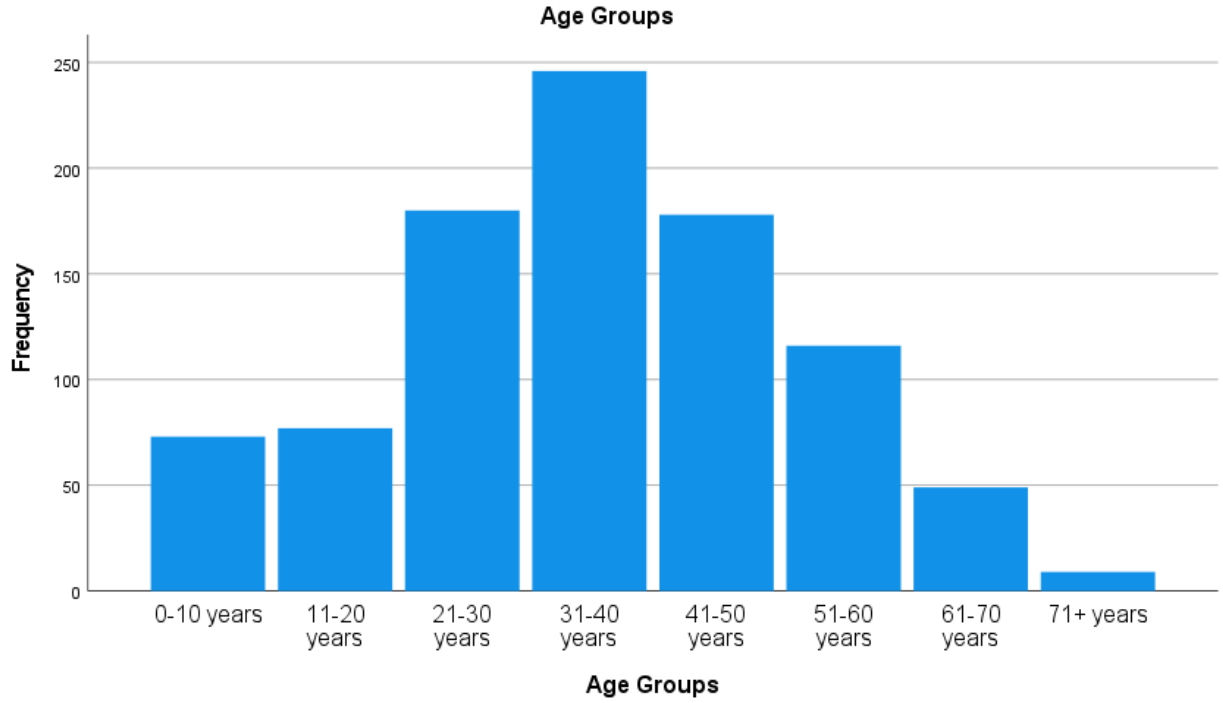


Table 9: Tumor Type and Age Group Distribution in the Brain

Tumor Type	0-10 years (%)	11-20 years (%)	21-30 years (%)	31-40 years (%)	41-50 years (%)	51-60 years (%)	61-70 years (%)	71+ years (%)	Total Count	Total (%)
Meningioma	0.5%	1.5%	16.2 %	36.4%	23.8 %	13.1 %	7.4%	1.0%	390	42.0%
Astrocytic Tumors	15.2%	15.2%	15.9 %	15.9%	17.2 %	10.6 %	7.9%	2.0%	151	16.3%
Pituitary Adenoma	0.0%	2.5%	22.5 %	25.0%	24.4 %	22.5 %	3.1%	0.0%	160	17.2%
Schwannoma	0.0%	11.9%	32.2 %	28.8%	18.6 %	6.8%	1.7%	0.0%	59	6.4%
Ependymoma	53.3%	0.0%	20.0 %	13.3%	6.7%	6.7%	0.0%	0.0%	15	1.6%
Hemangioblastoma	0.0%	7.7%	23.1 %	38.5%	23.1 %	7.7%	0.0%	0.0%	13	1.4%
Secondaries	0.0%	0.0%	0.0%	0.0%	33.3 %	50.0 %	16.7 %	0.0%	6	0.6%
Craniopharyngioma	8.0%	36.0%	40.0 %	8.0%	4.0%	4.0%	0.0%	0.0%	25	2.7%
Oligodendroglioma	6.7%	0.0%	26.7 %	53.3%	6.7%	6.7%	0.0%	0.0%	15	1.6%
Solitary Fibrous Tumor	0.0%	20.0%	20.0 %	20.0%	0.0%	40.0 %	0.0%	0.0%	5	0.5%
Central Neurocytoma	0.0%	44.4%	44.4 %	11.1%	0.0%	0.0%	0.0%	0.0%	9	1.0%
Lymphoma	0.0%	0.0%	0.0%	100.0 %	0.0%	0.0%	0.0%	0.0%	1	0.1%

Hemangioma	0.0%	0.0%	50.0 %	50.0%	0.0%	0.0%	0.0%	0.0%	2	0.2%
Ganglioglioma	0.0%	50.0%	50.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	2	0.2%
Choroid Plexus Tumors	42.9%	14.3%	42.9 %	0.0%	0.0%	0.0%	0.0%	0.0%	7	0.8%
Neurofibroma	0.0%	100.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1	0.1%
Chordoma	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0 %	1	0.1%
Germinoma	0.0%	100.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1	0.1%
Medulloblastoma	50.0%	29.0%	12.9 %	3.2%	1.6%	0.0%	1.6%	1.6%	62	6.7%
Other CNS Embryonal Tumors	100.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3	0.3%
Total	7.9%	8.3%	19.4 %	26.5%	19.2 %	12.5 %	5.3%	1.0%	928	100.0 %

The spinal cord tumors were grouped into Extra and Intramedullary tumors which accounted for 81.5 % (53 cases) and 18.5% (12 cases), respectively. The sex distribution of spinal cord tumors is nearly equal with a M:F ratio of 1:1.03.

The majority of spinal cord tumors are represented by Schwannomas (29 cases, 44.6%) and Meningiomas (22 cases, 33.8%). The bulk of the remaining cases are accounted by Astrocytomas (5 cases, 7.7%), Myxopapillary Ependymoma (4 cases, 6.2%), and Hemangioblastoma (3 cases, 4.6%) while Neurofibroma and MPNST each represented 1 case. **(Table 10)**

Low-grade tumors (62 cases, 96.9%) dominate spinal cord tumors while higher-grade tumors represent only 3.1% (2 cases) of the cases. **(Figure 6)**

Astrocytomas are the predominant tumor type in children (60%) followed by Schwannomas (37.5%), while Schwannomas (45.6%) and Meningiomas (36.8%) prevail in adults. Rare tumors like Myxopapillary Ependymoma occur solely in adults. **(Table 11)**

Table 10: Tumor Type Frequency, Age Group and Sex Distribution in the Spinal Cord

Tumor Type	Pediatric (%)	Adult (%)	Female (%)	Male (%)	Total Count	Total (%)
Astrocytoma	60.0%	40.0%	20.0%	80.0%	5	7.7%
Myxopapillary Ependymoma	0.0%	100.0%	75.0%	25.0%	4	6.2%
Hemangioblastoma	33.3%	66.7%	33.3%	66.7%	3	4.6%
Meningioma	4.5%	95.5%	77.3%	22.7%	22	33.8%
Schwannoma	10.3%	89.7%	34.5%	65.5%	29	44.6%
Neurofibroma	0.0%	100.0%	100.0%	0.0%	1	1.5%
Malignant Peripheral Nerve Sheath Tumor	0.0%	100.0%	0.0%	100.0%	1	1.5%
Total	12.3%	87.7%	50.8%	49.2%	65	100.0%

The most common age group was the 3rd decade (17 cases, 26.2%), followed by the 2nd and 5th decades with 12 cases each (18.5%), reflecting a younger to middle-aged demographic predominance. **(Figure 8)**

Tumors in middle-aged groups (21–50 years) included a high prevalence of schwannomas (76.5%) and meningiomas (33.3%). Schwannoma was predominantly seen in the 3rd decade (44.8%) while Meningiomas show peaks in the 5th (27.3%) and 6th decades (18.2%). Tumors in younger age groups (≤20 years) were dominated by astrocytomas (40%). **(Table 8)**

Figure 8: Age Group Distribution in the Spinal Cord

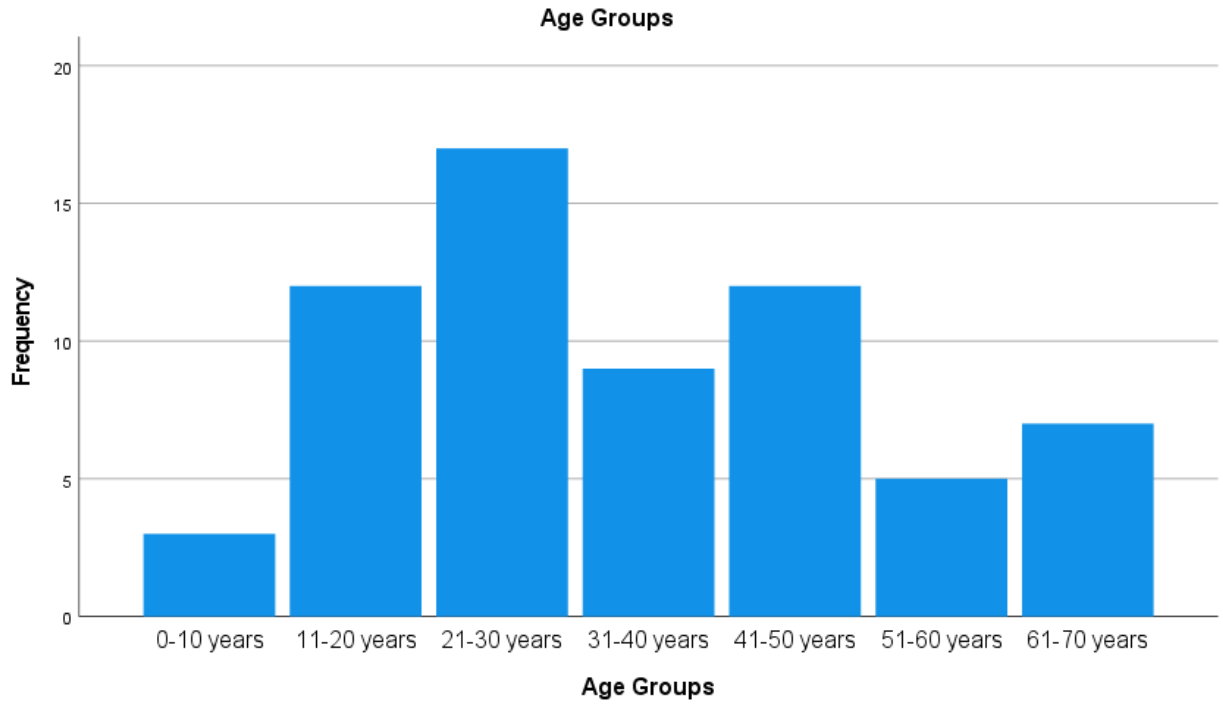


Table 11: Tumor Type and Age Group Distribution in the Spinal Cord

Tumor Type	0-10 years (%)	11-20 years (%)	21-30 years (%)	31-40 years (%)	41-50 years (%)	51-60 years (%)	61-70 years (%)	Total Count	Total (%)
Astrocytoma	40.0%	20.0%	0.0%	20.0%	20.0%	0.0%	0.0%	5	7.7%
Myxopapillary Ependymoma	0.0%	50.0%	25.0%	0.0%	0.0%	0.0%	25.0%	4	6.2%
Hemangioblastoma	0.0%	33.3%	66.7%	0.0%	0.0%	0.0%	0.0%	3	4.6%
Meningioma	0.0%	18.2%	0.0%	18.2%	27.3%	18.2%	18.2%	22	33.8%
Schwannoma	3.4%	13.8%	44.8%	13.8%	13.8%	3.4%	6.9%	29	44.6%
Neurofibroma	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	1	1.5%
Malignant Peripheral Nerve Sheath Tumor	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1	1.5%
Total	4.6%	18.5%	26.2%	13.8%	18.5%	7.7%	10.8%	65	100%

6. DISCUSSION

In this study, the results of the 993 CNS tumors were contrasted with the findings from various literatures in different parts of the world.

The age of patients ranges from 03 months to 80 years, with a mean age of 36.6 years and median of 37 years. The standard deviation in this study is approximately 16.26. This is similar to studies done in Nepal and Nigeria (3, 20) while other studies done in Southwest Nigeria, Egypt and the US showed higher mean and median ages (16, 12, 18).

The peak incidence of occurrence of CNS tumors was the fourth decade of life (25.7%) followed closely by the 3rd (19.8%) and 5th (19.1%) decades of life. A gradual decline was seen in cases beyond 60 years, with minimal representation in the 71+ years age group 0.9%. A study done in India showed similar peak age in the 4th decade while other studies done in South India and West Bengal reported peak ages in the 5th and 6th decades, respectively. (10, 19, 2)

The overall M:F ratio was found to be around 1:1.26 with a female predominance which was similar to most studies done including Kenya, Southwest Nigeria, India, Cameron, Ghana, and Nepal. (6, 16, 15, 5, 4, 1)

A total of 853 cases (85.9) were found in adults above the age of 18 years and the rest 140 (14.1%) cases occurred in pediatric patients aged 18 years or less. Many studies also showed similar reports where adult cases are predominant over pediatric cases. (10, 22, 5)

Meningiomas were the most frequent tumor category representing 41.5% (412). They were followed by Gliomas, Glioneuronal, and Neuronal Tumors which accounted for 20.2% (201) of all cases. These findings are in line with most reports done in the USA, India, Nigeria, and Kenya. (18, 22, 10, 2, 16, 6).

Meningiomas were mostly seen in adults peaking in the 4th (35.4%) and 5th (24%) decades of life which had a similar peak age in a study done in Kenya (6), and in our study the male to female ratio is 1:2.3 showing a female predominance, with similar higher ratios in females reported in most studies done in the USA, India, Nepal, Nigeria, Egypt and Kenya among others. (18, 22, 10, 1, 16, 12, 6)

Meningothelial Meningioma was the most prevalent subtype, comprising 222 cases (53.9%), followed by Transitional Meningioma with 84 cases (20.4%). A similar highest frequency for Meningothelial Meningiomas was reported in West Bengal, India, Ghana, and Nigeria. (2, 4, 16)

The overwhelming majority of Meningiomas are found to be WHO Grade 1, with 347 cases (84.2%) followed by WHO Grade 2, 57 cases (13.8%), and the remaining 8 cases (1.9%) being WHO Grade 3. Studies from Egypt, West Bengal, and South India also reported similar results. (16, 2, 19)

The Convexity was the most frequently involved site, with 94 cases (22.8%) followed by the Sphenoid Wing: 56 cases (13.6%) and Parasagittal: 45 cases (10.9%) areas.

Gliomas, Glioneuronal and Neuronal tumors, second most frequent tumor category, were distributed across all age groups with peaks in the 3rd (18.4%), 4th (17.9%) and 1st (16.9%) decades showing a slight male predominance, with a male to female ratio of 1.2:1. Astrocytic tumors (156 cases, 15.7% of total) were observed in all age groups with notable peaks in the 5th (17.3%), 4th (16%), and 1st (16%) decades of life. They were slightly more commonly seen in males with a male to female ratio of 1.23:1. In several studies similar predominance in males was reported including the US, West Bengal and South India. (18, 2, 19, 22)

Astrocytomas were distributed across various regions of the CNS with the frontal lobe (39 cases, 25%) and posterior fossa (26 cases, 16.7%) being the most frequently involved sites. The most frequently involved site was the frontal lobe in studies done in US and South India. (18, 19)

Glioblastomas were the commonest astrocytic tumors as reported in several studies including the USA, South India, Nepal, and Egypt. (18, 22, 19, 1, 12) Similarly, in our study, Glioblastomas were the most common subtype accounting for 46.2% (72 cases) of astrocytic tumors. They are predominantly seen in older adults (41–50 years: 31.9%, 51–60 years: 19.4%).

In adults, the mean age was found to be 41.01 years, median age 40 years and standard deviation 12.9. Tumors predominantly affected young to middle-aged adults, peaking in the 4^{th} decade (255 cases). A gradual decline was seen in cases beyond 60 years, with minimal representation in the 71+ years age group (9 cases). Comparable results were reported in a study done in Kenya showing mean age of 45 years and peak age in the 4^{th} decade. (6)

Meningiomas accounted for most of the cases in adults with 47.6%, followed by Pituitary Adenomas (18.5%) and Astrocytic tumors (13%). Schwannomas represent the bulk of the remaining tumor percentage (9.4%). In studies done in Egypt, Kenya, and India Meningiomas predominated while Astrocytic tumors were the commonest in a study done in South India. (12, 6, 10, 19)

In adults, Meningiomas showed a significant female predilection with a male to female ratio of 1:2.3. Astrocytic tumors showed a male to female ratio of 1.4:1 with a male predominance which is similar to reports from India. (10, 19)

Pediatric CNS tumors up to 18 years of age accounted for 6.7% (140 cases) of all CNS tumors and were grouped into three anatomical categories. Posterior fossa tumors were found to be the most common, representing nearly half of the cases (49.3%, 69 cases) closely followed by Supratentorial tumors (45%, 63 cases) while 8 cases (5.7%) occurred in the spinal cord. The mean age was 9.88 years, median age 10 years, and standard deviation 5.31. Tumors were more prevalent in older children and adolescents, peaking around 10–18 years with minimal representation observed in infants below the age of 1 year (1.4%). The male to female ratio was 1:1.15. A similar study from Kenya also found the pediatric mean age as 9 years and the posterior fossa was the commonest site reported in Egypt. (6, 12)

Medulloblastoma and Astrocytic tumors represented most of the pediatric cases with 33.6% and 32.1%, respectively. Craniopharyngioma (6.4%), Ependymoma (5.7%), and Schwannomas (5.7%) represented most of the remaining cases. Similarly, Embryonal and Astrocytic tumors predominated in studies done in India, Egypt, Kenya, and Cameron. (10, 12, 6, 5)

Tumor distribution between the brain and spinal cord was also assessed with the majority found to be localized to the brain (928 cases, 93.5%). Spinal cord tumors contributed only for a smaller proportion of the cases (65 cases, 6.5%). CNS tumors have also been found to be predominant in the brain in most studies including South India, Nepal, and Cameron. (22, 3, 5)

Low-grade tumors (WHO Grades 1 and 2) dominated both in the spinal cord (62/64 cases, 96.9%) and brain (594/756 cases, 78.6%) but High-grade tumors (WHO Grades 3 and 4) are more common in the brain as compared to the spinal cord tumors which was similar to findings in India, Nepal and Kenya. (10. 3, 6)

The spinal cord tumors were grouped into Extra and Intramedullary tumors which accounted for 81.5 % (53 cases) and 18.5% (12 cases), respectively. The majority of spinal cord tumors are represented by Schwannomas (29 cases, 44.6%) and Meningiomas (22 cases, 33.8%) with a similar finding reported in Egypt. (12)

7. LIMITATIONS OF THE STUDY

Our study is based solely on histomorphology and is majorly limited by the lack of IHC and molecular studies, which makes it difficult to embrace and apply the full latest WHO CNS5 classification. The study was also compromised by poor data archiving manifested by missing request papers and incomplete information in some of the cases.

Despite these limitations, the sample size of the study and TASH being the largest referral hospital in the country receiving so many patients with CNS tumors make it a representative study.

8. CONCLUSION

Based on our study, brain tumors heavily outnumber spinal cord tumors, adults affected more than the pediatric population, and overall female predominance was observed. Low-grade tumors were found to be more common than high-grade tumors.

In our study, Meningiomas were the commonest tumor type, and female predominance was observed whereas Gliomas and Neuronal tumors, being the second most common tumors, were more common in males. In the spinal cord, extramedullary tumors were more frequent than intramedullary tumors where Schwannomas and Meningiomas were the frequent tumor types. These findings are comparable to most overseas studies.

In pediatric patients, where the posterior fossa is the most involved site, our study showed the frequency of Embryonal tumors is nearly equal to Glial tumors in contrast to other studies where most reported that Glial tumors were more common than Embryonal tumors.

9. RECOMMENDATION

The latest WHO CNS5 classification is, for the most part, dependent on various immunohistochemical and molecular studies where the cases tend to have a definitive diagnosis, hence, incorporation of the WHO recommendation into the laboratory in the future is crucial in CNS tumor diagnosis. In fact, the feasibility and applicability of these methods is questionable due to the lack of financial and trained personnel reasons but it should be considered in the future when the services advance.

Proper data archiving, possibly a better digital system, in the laboratory, is mandatory to ensure the safekeeping of data and improve the outcomes of future studies. Better interactions with clinicians and training are also advisable to prevent the issue of incomplete information in request papers as some of the data lacked important information.

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