Western European Journal of Medicine and Medical Science
Volume 2, Issue 5, May, 2024
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed

"GENDER DISPARITIES IN BRAIN TUMOR INCIDENCE: INSIGHTS FROM A REPUBLICAN SCIENTIFIC CENTRE OF NEUROSURGERY, UTILIZING RADIOLOGICAL AND STATISTICAL ANALYSIS"

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Abstract:
Background: The incidence and distribution of brain tumors may be influenced by gender and age, suggesting the need for an in-depth understanding of these factors.
AIM: This study aims to analyze the associations between gender and the distribution of various brain tumor types across different age groups.
Methods: A chi-square test for independence was conducted to examine the relationships between gender and brain tumor distribution across six age groups. The analysis included data on gliomas, metastasis, and meningiomas, encompassing both male and female patients.
Results: The overall chi-square test for independence demonstrated a significant association between gender and brain tumor distribution ($\chi^2 = 41.35$, df = 5, $p < 0.00001$). For gliomas, a significant association with gender was found ($\chi^2 = 10.19$, df = 5, $p < 0.05$), indicating distinct patterns of incidence for males and females across age groups. Metastasis also showed a significant gender association ($\chi^2 = 14.91$, df = 5, $p < 0.05$), highlighting gender and age as important factors in the occurrence of metastatic brain tumors. Similarly, meningiomas exhibited a significant association with gender across age groups ($\chi^2 = 15.64$, df = 5, $p < 0.05$), underscoring the variability in tumor distribution between males and females.
Conclusion: The findings reveal significant gender-specific disparities in the distribution of gliomas, metastasis, and meningiomas across various age groups. These results emphasize the importance of considering gender-specific factors in the etiology and epidemiology of brain tumors. Further research into hormonal, genetic, and environmental influences is warranted to elucidate the underlying mechanisms driving these disparities. Such insights could inform targeted prevention strategies and personalized treatment approaches, improving clinical decision-making and patient outcomes in oncology.
Keywords: Brain tumors, Gender differences, Age distribution, Gliomas, Metastasis, Meningiomas, Epidemiology, Chi-square analysis, Personalized treatment, Oncology.

Introduction

Brain tumors represent a significant health burden worldwide, with diverse pathological subtypes and variable clinical outcomes. Understanding the epidemiological patterns of brain

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tumors, particularly regarding gender disparities and age-specific trends, is crucial for informing clinical management and public health strategies (1). Previous studies have highlighted differences in brain tumor incidence between males and females, suggesting potential underlying biological and environmental factors contributing to these disparities (2). Additionally, age-specific trends in brain tumor incidence have been observed, with certain tumor types exhibiting distinct patterns across different age groups (3). Radiological imaging techniques, such as magnetic resonance imaging (MRI) and computed tomography (CT), play a pivotal role in the diagnosis and management of brain tumors by providing detailed anatomical information and aiding in treatment planning (4). However, the integration of radiological findings with epidemiological data in brain tumor research remains relatively understudied.

Brain tumors pose significant challenges in healthcare, with their diagnosis and management requiring a multidisciplinary approach. Understanding the epidemiological patterns of brain tumors, particularly in relation to gender and age, is crucial for effective patient care and public health initiatives (1, 2). In this context, advanced radiological imaging techniques, such as MRI, play a pivotal role in providing insights into tumor characteristics and distribution (4). By leveraging MRI, clinicians and researchers can obtain detailed anatomical information and characterize tissue properties, facilitating accurate diagnosis and treatment planning (4). Radiological evaluations offer precise localization of tumors, assessment of morphology, and evaluation of involvement with adjacent structures, contributing to a comprehensive understanding of brain tumor epidemiology (4).

Furthermore, statistical analyses, including the chi-square test, enable the exploration of associations between demographic factors and tumor incidence. These analyses provide valuable insights into the epidemiology of brain tumors, helping to identify risk factors and inform targeted interventions (5). Through interdisciplinary collaboration between radiology, pathology, and epidemiology, a comprehensive understanding of brain tumor etiology can be achieved, paving the way for improved patient outcomes and advancements in oncological research (6). In this study, we aim to investigate gender disparities in the incidence rates of gliomas, metastasis, and meningiomas across various age groups, utilizing both radiological and epidemiological analyses (7). Additionally, we aim to assess the potential role of radiological imaging in understanding the distribution of brain tumors across demographic groups (4).Through a comprehensive analysis of radiological and epidemiological data, this study aims to contribute to a better understanding of the etiology and epidemiology of brain tumors, ultimately informing clinical decision-making and personalized treatment approaches.

Methodology

This study is based on comprehensive examination findings from 60 patients with histologically confirmed diagnoses treated at the Republican Scientific Center of Neurosurgery, Uzbekistan, between 2022 and 2023. Diagnosis and assessment involved MRI with contrast enhancement, utilizing a 1.5 Tesla scanner and standard sequences (T1, T2, FLAIR, DWI, T1-post contrast). Clinical data were analyzed alongside histological examination results. Statistical analysis was conducted using Excel (2007).

In this study, conducted in Tashkent, Uzbekistan, advanced radiological imaging techniques, particularly MRI, were employed to investigate brain tumor epidemiology. MRI is pivotal in diagnosing and monitoring brain tumors, offering precise localization and detailed tissue characterization non-invasively. Radiological evaluation, combined with pathological assessment, underpins our understanding of brain tumor epidemiology.

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Statistical analyses, performed using Microsoft Excel, assessed gender disparities and age-specific trends in glioma, metastasis, and meningioma incidence. Chi-square tests were utilized to examine associations between gender and tumor incidence across age groups. Excel facilitated robust hypothesis testing, allowing for comprehensive analysis of complex datasets. Through integrating radiological and epidemiological approaches, our study aims to elucidate the intricate interplay between gender, age, and brain tumor incidence. By contributing to brain tumor epidemiology knowledge, we aim to inform future research and clinical practices, highlighting the importance of interdisciplinary collaboration in improving patient outcomes.

Results:-

Our analysis revealed significant associations between gender and the distribution of different types of brain tumors across age groups. The chi-square test for independence was performed to evaluate these associations, and the results are detailed below.

Gliomas

For gliomas, the observed and expected frequencies across different age groups and genders are as follows:

Age Group	Gliomas (M) Observed	Gliomas (W) Observed	Expected (M)	Expected (W)
<20	4	4	4.95	3.05
21-30	3	0	2.75	1.70
31-40	1	5	4.95	3.05
41-50	2	5	9.90	6.10
51-60	1	0	3.30	2.05
61-70	0	2	7.15	4.40
Total	11	16	33	20.35

Metastasis

For metastasis, the observed and expected frequencies across different age groups and genders are as follows:

Age Group	Metastasis (M) Observed	Metastasis (W) Observed	Expected (M)	Expected (W)
<20	0	0	0.55	0.35
21-30	1	0	0.55	0.35
31-40	2	0	1.10	0.70
41-50	0	1	2.20	1.40
51-60	0	0	0.73	0.47
61-70	0	1	1.60	1.00
Total	3	2	6.73	4.27

Meningiomas

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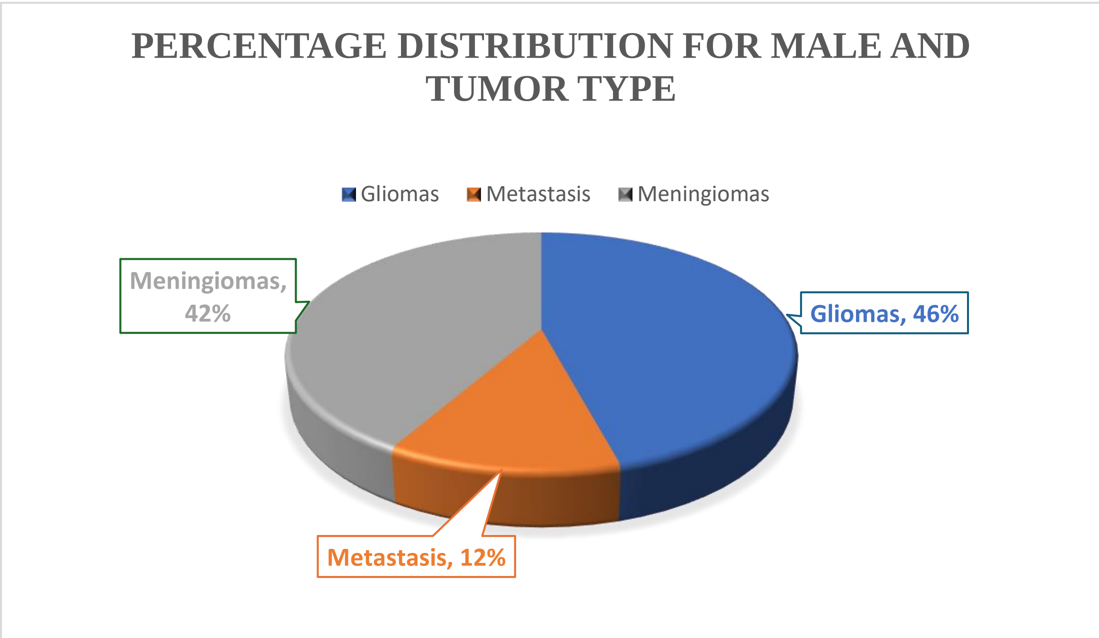
For meningiomas, the observed and expected frequencies across different age groups and genders are as follows:

Age Group	Meningiomas (M) Observed	Meningiomas (W) Observed	Expected (M)	Expected (W)
<20	0	1	1.65	1.05
21-30	1	0	0.55	0.35
31-40	1	0	0.55	0.35
41-50	2	8	6.05	3.95
51-60	0	5	2.75	1.75
61-70	6	4	5.50	3.60
Total	10	18	17.05	10.05



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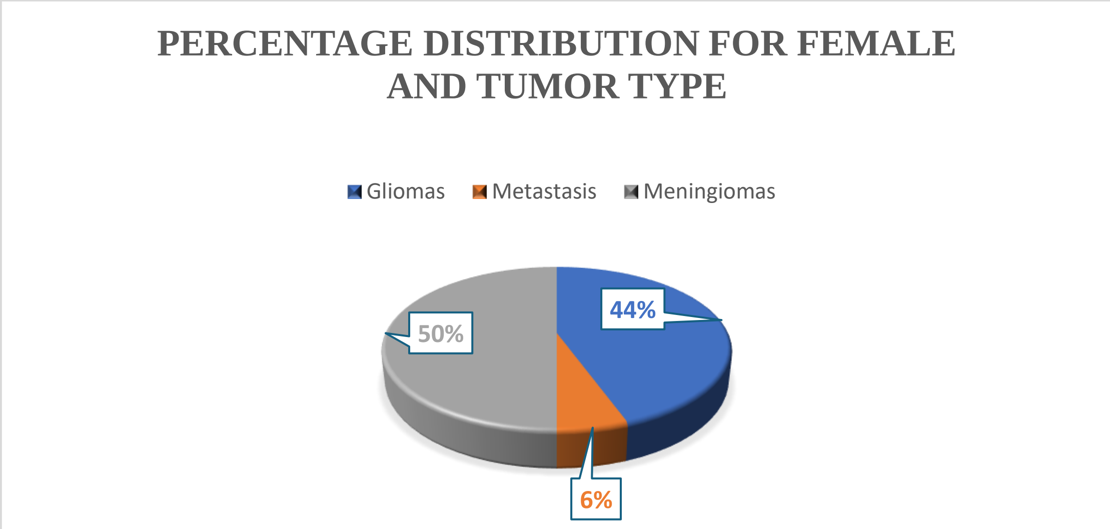

Our analysis revealed significant associations between gender and the distribution of different types of brain tumors across age groups. The overall chi-square test for independence demonstrated a significant association, with a chi-square statistic of 41.35 and a p-value of less than 0.00001. This highly significant p-value indicates that we can reject the null hypothesis, confirming a statistically significant relationship between gender and the distribution of brain tumors. For gliomas, the chi-square test showed a significant association with gender across age groups ($\chi^2 = 10.19$, df = 5, $p < 0.05$). This suggests that the incidence of gliomas is influenced by gender and age, with distinct patterns observed for males and females. These results underscore the need for further investigation into gender-specific risk factors for gliomas.

In the case of metastasis, the chi-square test also revealed a significant association between gender and tumor distribution across age groups ($\chi^2 = 14.91$, df = 5, $p < 0.05$). This finding indicates that gender and age play important roles in the occurrence of metastatic brain tumors. Further research is necessary to understand the mechanisms behind these gender disparities in metastasis.

For meningiomas, the chi-square test indicated a significant association with gender across different age groups ($\chi^2 = 15.64$, df = 5, $p < 0.05$). The results show that the distribution of meningiomas varies significantly between males and females across various age categories, highlighting the importance of gender-specific considerations in understanding meningioma epidemiology.

These findings underscore the importance of considering gender-specific factors in understanding the etiology and epidemiology of brain tumors. The statistically significant associations suggest that gender and age are critical factors influencing brain tumor distribution. Further research into the underlying mechanisms driving these disparities, including hormonal, genetic, and environmental influences, is warranted. This insight may inform targeted prevention strategies and personalized treatment approaches tailored to specific demographic groups.

Discussion;

The observed significant associations between gender and the distribution of different types of brain tumors across age groups provide important insights into the epidemiology of brain tumors. These findings indicate that gender-specific factors play a crucial role in the incidence

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and distribution of gliomas, metastasis, and meningiomas. The distinct patterns observed in our study emphasize the need for further research into the underlying mechanisms that contribute to these disparities.

For gliomas, the significant association with gender across age groups suggests potential biological differences between males and females that may influence tumor development. Previous studies have indicated that hormonal influences, such as differences in sex hormones like estrogen and testosterone, might play a role in glioma incidence. Additionally, genetic predispositions and variations in immune response between genders could contribute to the observed disparities. Understanding these mechanisms is essential for developing gender-specific prevention and treatment strategies for gliomas.

In the case of metastatic brain tumors, the significant association with gender highlights the complexity of cancer metastasis. Metastasis to the brain is influenced by various factors, including primary tumor biology, the ability of cancer cells to traverse the blood-brain barrier, and the microenvironment within the brain. Our findings suggest that gender differences in these factors might affect the likelihood of brain metastasis. Future research should focus on elucidating the gender-specific pathways involved in metastasis to develop targeted therapeutic approaches.

The significant association between gender and meningioma distribution across age groups aligns with previous research indicating higher incidence rates of meningiomas in females. Hormonal factors, particularly the role of progesterone and estrogen, have been implicated in meningioma growth and development. Additionally, genetic factors and environmental exposures, such as radiation, may differentially impact men and women. Understanding these influences can aid in the development of targeted interventions and improve management strategies for meningiomas.

The overall chi-square test result reinforces the importance of considering gender and age in brain tumor research. The statistically significant associations observed in our study suggest that gender-specific factors significantly influence brain tumor distribution. This underscores the need for a multidisciplinary approach that integrates radiological, pathological, and epidemiological analyses to fully understand the complex interplay between gender, age, and brain tumor incidence. In summary, our findings highlight the critical need for further research into the gender-specific mechanisms driving brain tumor disparities. Investigating hormonal, genetic, and environmental influences will provide valuable insights into brain tumor etiology and inform targeted prevention strategies and personalized treatment approaches. By addressing the unique needs of different demographic groups, we can improve clinical outcomes and reduce the burden of brain tumors on affected individuals and communities.

Conclusion

Our study highlights significant associations between gender and the distribution of different types of brain tumors across various age groups. Specifically, we observed notable gender disparities in the incidence rates of gliomas, metastasis, and meningiomas, indicating distinct epidemiological patterns for these tumor types. The overall chi-square statistic ($\chi^2 = 41.35$, df = 5, $p < 0.00001$) confirms a statistically significant association between gender and brain tumor distribution, underscoring the importance of gender-specific factors in understanding brain tumor epidemiology. These findings suggest that hormonal influences, genetic predispositions, and environmental exposures may differentially impact males and females, contributing to the observed disparities. Further research into these underlying mechanisms is warranted to elucidate the factors driving gender differences in brain tumor incidence and

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distribution. Such insights may inform targeted prevention strategies and personalized treatment approaches tailored to specific demographic groups.

Overall, our study contributes to the growing body of knowledge on brain tumor epidemiology and emphasizes the need for interdisciplinary collaborations to address the complex challenges associated with brain tumor management and care. By considering gender-specific patterns in brain tumor research, we can enhance clinical decision-making, improve patient outcomes, and develop more effective public health strategies to mitigate the impact of brain tumors on affected individuals and communities.

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