Macrothink Institute™

Journal of Biology and Life Science
ISSN 2157-6076
2024, Vol. 15, No. 1

The Role of Sex Hormones and Race Disparities in Meningioma Incidence: A Comprehensive Review

Anjana Bharathiraja

814 N Marquis Way, Mountain House, CA, United States 95391

Tel: +1 (408) 930 1461 E-mail: anjana.bharathiraja7@gmail.com

Association: Independent Researcher

Received: September 3, 2023 Accepted: December 14, 2023 Published: January 2, 2024

doi:10.5296/jbls.v15i1.21286 URL: https://doi.org/10.5296/jbls.v15i1.21286

Abstract

Meningiomas, a slow-growing tumor originating from the meninges, affect a considerable proportion of individuals worldwide and account for approximately one-third of all brain tumors. But limited research has been conducted on meningiomas, particularly regarding the role of sex hormones and race disparities in tumor incidence and prognosis. The current review summarizes the significance of sex hormones, age, and race in meningioma development and therapy. Women have a higher risk of developing meningiomas when compared to men suggesting the potential benefit of personalized treatment approaches based on sex hormone levels.

Additionally, there are age-related disparities in meningioma risk, older persons have a higher risk of tumor development. Black Americans also have a higher incidence in meningiomas when compared to Americans of other races; contrary to the lower incidence rates observed in other African populations possibly due to differences in environmental and socio-economic factors. Further research is required to better understand the complex interplay between sex hormones, age, race, environmental and social factors in meningioma development. Collaborative research is crucial to address the current knowledge gaps in meningioma management and develop personalized strategies to manage this prevalent brain tumor.

Keywords: meningioma, sex hormones, race disparity, age, incidence rates

1. Introduction

Meningiomas are slow-growing tumors that arise from the meninges, thin layers of tissue that enclose and protect the brain and spinal cord (Merriam-Webster, n.d.). Meningiomas account for about a third of all brain tumors; over 170,000 patients are diagnosed with meningiomas each year (Cleveland Clinic, 2022). While some research studies have delved into the etiology

and epidemiology of meningiomas, limited research has been conducted on the effects of meningiomas when compared to other types of brain tumors (Baldi et al., 2018). One study illustrated an elevated risk of cognitive deficits and epilepsy in the long-term among patients with meningioma (Waagemans et al., 2011). Nevertheless, there is an urgent need for further comprehensive studies on the long-term risks posed by meningiomas.

Sex differences influence the perception and expression of diseases in humans spanning from common ailments like the common cold to more severe conditions like cancer. Men are more prone to 'over-rating' their symptoms when compared to women (Macintyre, 1993). Likewise, women may experience 'non-traditional' stroke symptoms that are harder to identify and diagnose than men, leading to delays in treatment (Berglund et al., 2017). The disparity in symptom perception and expression, coupled with a tendency of women to downplay their symptoms when compared to men (Macintyre, 1993), may influence disease diagnosis and management.

Sex also plays a pivotal role in disease management. A study on neuropsychiatric diseases highlights notable improvements resulting from sex-based treatment outcomes. A patient's sex influences the metabolism of specific drugs necessitating different dosages based on sex (Biskup et al., 2020). Primarily sex-based treatment approaches have the potential to revolutionize patient care and enhance the medical outlook for millions of individuals with a diverse range of diseases.

There are sex-based disparities in meningioma tumor characteristics and outcomes. Females have consistently higher incidences of meningiomas when compared to males as demonstrated in Figure 1 (Cea-Soriano et al., 2012; Kshettry et al., 2015) potentially due to hormonal factors, such as estrogen and progesterone, which fluctuate throughout a woman's life for instance during menstrual cycles, pregnancy, and menopause. Moreover, there are unexplained variations in the prevalence of meningiomas between men and women, and across different racial groups. Despite these intriguing findings, investigations specifically focused on understanding the interplay between sex differences and meningiomas remain scarce. Thus, a comprehensive examination of sex-based disparities in meningioma biology and treatment outcomes is essential to develop personalized and more effective approaches to managing this prevalent brain tumor.

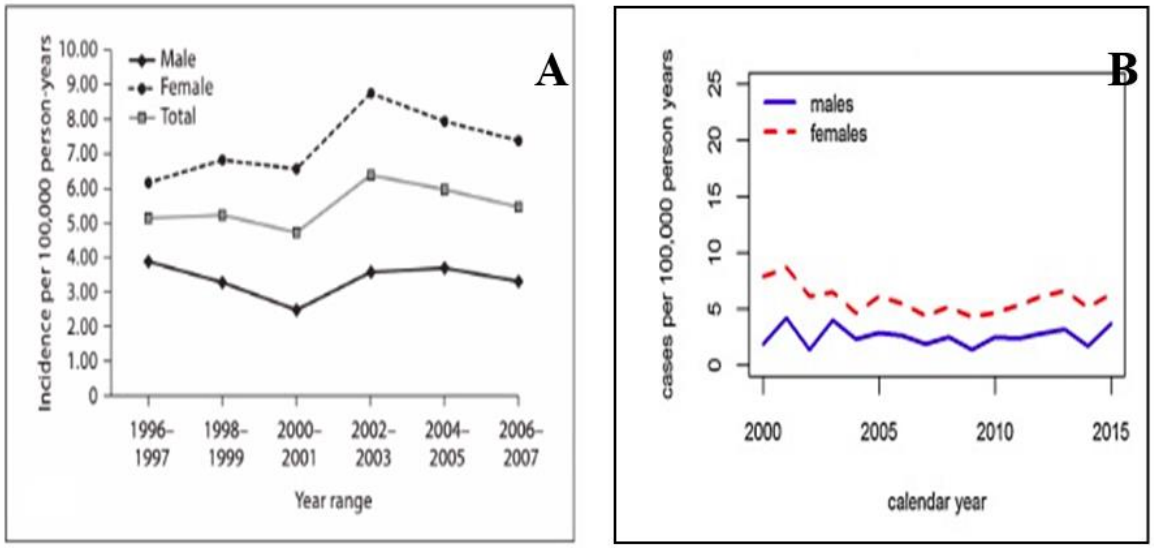

Figure 1. Two studies showcasing different incidence rates in females and males **A.** This study was conducted in Mexico and showed that females consistently had a higher incidence rate compared to males from 1997 to 2007 (Guevara et al., 2010). **B.** This study was conducted in Germany and showed that females had consistently higher incidence rate compared to males from 2000 to 2015. (Holleczek et al., 2019)

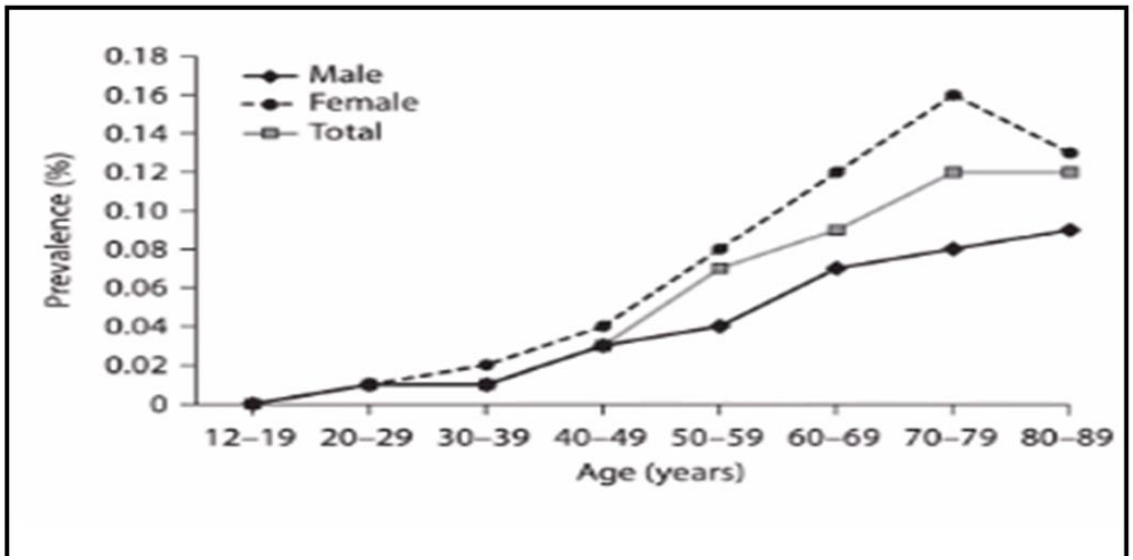

Figure 2. Females overall had a higher percent prevalence in comparison to males, and both seem to have an increase between the ages of 60 and 80. Females continue having higher percent prevalence during this time. (Guevara et al., 2010)

Uncovering the underlying mechanisms driving sex-related differences in meningioma burden can pave the way for targeted therapeutic interventions that may ultimately improve patient outcomes.

2. Sex Hormones

All sex hormones are present in people of both sexes but females have more progesterone and estrogen while males have more androgens. Sex hormone levels fluctuate throughout a person's lifetime with different results in persons of different sex. This review only focused on populations without hormonal imbalances.

A conducted in the United Kingdom to identify risk factors for meningioma development from a 12-year comprehensive patient database of patients of different backgrounds, ages, and sexes showed that meningiomas rarely develop in prepubertal children who have low levels of circulating sex hormones (Cea-Soriano et al., 2012; Guevara et al., 2010). It is possible that the highest risk of developing a meningioma is during early adulthood when circulating sex hormones would be at their highest. However, persons aged 60-79 years, who have fairly low levels of circulating sex hormones, are at the highest at risk for meningioma development (Cea-Soriano et al., 2012; Guevara et al., 2010; Lin et al., 2019). The mean age of male and female patients who have been diagnosed with meningioma is 62.2 and 62.6 years (Cea-Soriano et al., 2012) suggesting that factors beyond circulating levels of sex hormones play a role in meningioma development.

Meningiomas express progesterone and estrogen receptors (Cea-Soriano et al., 2012; Hsu et al, 1997; Donnell et al., 1979; Pravdenkova et al., 2006). Moreover, women are 2.5 times more likely to develop meningiomas when compared to men (Guevara et al., 2010). Several research studies from different parts of the world have delved into the role of female sex hormones in meningioma development. One study explored the association between meningioma development and hormone replacement therapy administered to menopausal women to alleviate menopausal symptoms (Blitshteyn et al., 2008). A meticulous review of records of 355,318 women from the Mayo Clinic Jacksonville electronic patient database showed that hormone replacement therapy is linked to an increased risk of developing meningiomas. Another study examined meningioma development during pregnancy and after delivery among 17 women. Sex hormones in pregnancy surge and rapidly drop after delivery. The researchers observed rapid meningioma growth during pregnancy which ceased abruptly after delivery (Lusis et al., 2012).

Research studies have investigated the potential protective effects of testosterone against meningioma development among 800 men with prostate cancer undergoing androgen deprivation therapy in the United States and the United Kingdom over a period of 15 years (Li et al., 2013; Cea-Soriano et al., 2012). Men going undergoing androgen deprivation therapy had an increased risk of meningioma growth. Thus, testosterone may have a protective effect against meningioma development.

3. Environmental Factors

Biological factors do play a role in the gender disparity in meningioma incidence observed globally (Lin et al., 2019; Wöhrer et al., 2009; Larjavaara et al., 2008; Cordera et al., 2002; Nakamura et al., 2011; Bhala et al., 2021; Ibebuike et al., 2013; Ostrom et al., 2018). Several countries report sex-based disparities in meningioma incidence limiting the likelihood of such disparities being attributed to environmental or sociocultural factors.

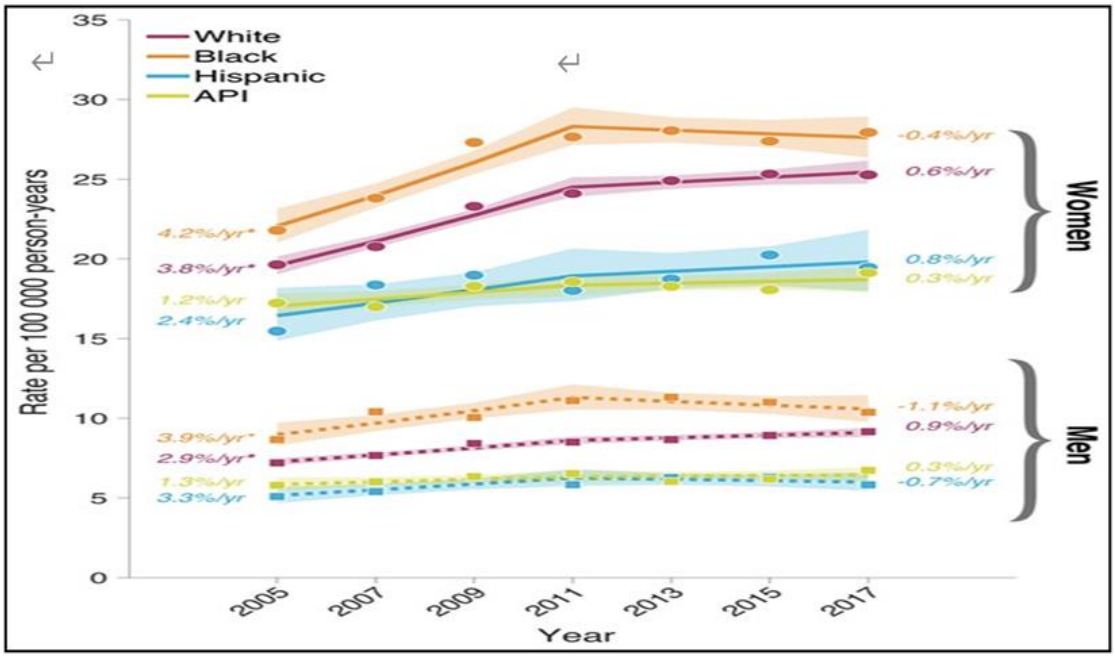

Figure 3. The graph refers to non-Hispanic Whites as White, non-Hispanic Blacks as Black, Hispanics as Hispanic, and Asian and Pacific Islanders as API. Overall, the most notable change is the decrease of non-Hispanic Black women and men and non-Hispanic White women and men's fitted temporal trends. (Bhala et al., 2021)

Race-based disparities in meningioma incidence usually go unnoticed. In the United States, black Americans have a higher incidence in meningiomas when compared to Americans of any other race as demonstrated in Figure 3 (Lin et al., 2019; Bhala et al., 2021). But limited research has been done to explain race-based disparities in meningioma incidence in the United States. Black Americans, who have genetic ancestry derived from both African and European populations, may have a genetic predisposition to develop meningioma. However, South Africans, have lower meningioma incidence rates; the average incidence of meningioma observed in Johannesburg is 4% lower than that observed in the United States (Ibebuike, 2013).

4. Discussion

The presented review delves into the intricate relationship between sex hormones, age, race, and meningioma incidence. Sex hormones play a significant role in the development of meningiomas as evidenced by a higher prevalence of these tumors in women, and their link with hormone replacement therapy and hormonal changes during pregnancy. Therefore, personalized treatment approaches that consider a patient's hormonal status may be beneficial in meningioma management.

However, the connection between sex hormones and meningioma development remains unclear. Age-related disparities in meningioma risk dispute the sole role of sex hormones in meningioma development. Post-menopausal women, the demographic with the least circulating sex hormones, should have the lowest risk of developing meningiomas (Brzozowska & Lewinski, 2020). But women aged 70 years and older have the highest risk of developing meningiomas. It is possible that other factors, such as genetic predisposition,

cumulative environmental exposures, and hormonal fluctuations across the lifespan interact to influence meningioma development at different stages of life. Thus, future research should focus on elaborating on the intricate interactions between sex hormones, age, and other factors to better inform treatment strategies.

There are race disparities in meningioma incidence; higher incidences have been observed among black Americans. But a the lower incidence of meningioma reported in Johannesburg, South Africa, a city with a predominantly African population, challenges this assumption.

It is possible that the high incidence in meningiomas in African Americans stem from the racial disparities in the American healthcare system . Environmental and socio-economic factors may also contribute to racial disparities in meningioma incidence. Nonetheless, understanding the complex interplay of these factors is essential to develop targeted interventions that address the specific needs of diverse populations.

This review relied on few studies to understand the long-term effects and risks posed by meningiomas, especially cognitive deficits and epilepsy. A more comprehensive review is needed to determine the true extent of the impact of meningiomas on patients' quality of life. Moreover, additional research is required to investigate possible sex-based differences in cognitive and functional outcomes among patients with meningioma and recovery after meningioma resection.

In conclusion, this review sheds light on the significance of sex hormones in meningioma development and the potential for personalized sex-based treatment approaches. The interplay between sex hormones, age, and race in meningioma biology is a complex and evolving field that requires further investigation to pave the way for tailored medical interventions for improved patient outcomes. A collective effort from researchers worldwide is essential to address the current gaps in knowledge and develop more effective strategies to manage meningioma, a prevalent brain tumor. By doing so, we can advance our understanding of meningiomas and move closer to achieving better patient care and outcomes.

5. Conclusion

Sex hormones, specifically estrogen and progesterone, play a pivotal role in meningioma development. But the intricate connection between sex hormones and meningioma development has not been fully elucidated due to age-related disparities and other factors. Moreover, the role of racial disparities in meningioma occurrence, especially among black Americans, has not been explored. Different explanations have been proposed, such as genetics and differences in healthcare systems, however the current pool of literature does not have sufficient evidence to support any of these proposed explanations. A deeper exploration of environmental and socio-economic factors behind meningioma incidence is needed. Moreover, further collaborative research is required to bridge any knowledge gaps and develop tailored interventions to refine patient care, understand the complex mechanisms underlying meningioma growth, and ultimately, enhance the management of meningioma.

Acknowledgments

Not applicable.

Authors contributions

The paper was written and researched by the sole author, Anjana Bharathiraja. They have read and approved the final manuscript.

Funding

Not applicable.

Competing interests

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

References

Baldi, I., Engelhardt, J., Bonnet, C., Bauchet, L., Berteaud, E., Grüber, A., & Loiseau, H. (2018). Epidemiology of meningiomas. *Neurochirurgie*, *64*(1), 5-14. https://doi.org/10.1016/j.neuchi.2014.05.006

Berglund, A., Schenck-Gustafsson, K., & von Euler, M. (2017). Sex differences in the presentation of stroke. *Maturitas, 99*, 47-50. https://doi.org/10.1177/17474930221090133

Bhala, S., Stewart, D. R., Kennerley, V., Petkov, V. I., Rosenberg, P. S., & Best, A. F. (2021). Incidence of benign meningiomas in the United States: current and future trends. *JNCI Cancer Spectrum, 5(*3), pkab035. https://doi.org/10.1093/jncics/pkab035

Biskup, E., Martinkova, J., & Ferretti, M. T. (2020). Gender medicine: Towards a gender-specific treatment of neuropsychiatric disorders. *Handbook of Clinical Neurology*, *175*, 437-448. https://doi.org/10.1016/B978-0-444-64123-6.00029-1

Blitshteyn, S., Crook, J. E., & Jaeckle, K. A. (2008). Is there an association between meningioma and hormone replacement therapy?. *Journal of Clinical Oncology, 26*(2), 279-282. https://doi.org/10.1200/JCO.2007.14.2133

Brzozowska, M., & Lewiński, A. (2020). Changes of androgens levels in menopausal women. *Menopause Review/Przegląd Menopauzalny, 19*(4), 151-154. https://doi.org/10.5114/pm.2020.101941

Cea-Soriano, L., Blenk, T., Wallander, M. A., & Rodríguez, L. A. G. (2012). Hormonal therapies and meningioma: is there a link?. *Cancer Epidemiology, 36*(2), 198-205. https://doi.org/10.1016/j.canep.2011.08.003

Cea-Soriano, L., Wallander, M. A., & García Rodríguez, L. A. (2012). Epidemiology of meningioma in the United Kingdom. *Neuroepidemiology, 39*(1), 27-34. https://doi.org/10.1159/000338081

Cleveland Clinic. (May 9, 2022). *Meningioma*. https://my.clevelandclinic.org/health/diseases/17858-meningioma

Cordera, S., Bottacchi, E., D'alessandro, G., Machado, D., De Gonda, F., & Corso, G. (2002). Epidemiology of primary intracranial tumours in NW Italy, a population based study: stable incidence in the last two decades. *Journal of Neurology, 249*, 281-284. https://doi.org/10.1007/s004150200005

Donnell, M. S., Meyer, G. A., & Donegan, W. L. (1979). Estrogen-receptor protein in intracranial meningiomas. *Journal of Neurosurgery, 50*(4), 499-502. https://doi.org/10.3171/jns.1979.50.4.0499

Guevara, P., Escobar-Arriaga, E., Saavedra-Perez, D., Martinez-Rumayor, A., Flores-Estrada, D., Rembao, D., ... & Arrieta, O. (2010). Angiogenesis and expression of estrogen and progesterone receptors as predictive factors for recurrence of meningioma. *Journal of Neuro-oncology, 98*, 379-384. https://doi.org/10.1007/s11060-009-0086-z

Hsu, D. W., Efird, J. T., & Hedley-Whyte, E. T. (1997). Progesterone and estrogen receptors in meningiomas: prognostic considerations. *Journal of Neurosurgery, 86*(1), 113-120. https://doi.org/10.3171/jns.1997.86.1.0113

Ibebuike, K., Ouma, J., & Gopal, R. (2013). Meningiomas among intracranial neoplasms in Johannesburg, South Africa: prevalence, clinical observations and review of the literature. *African Health Sciences, 13*(1), 118-121. https://doi.org/10.4314/ahs.v13i1.16

Kshettry, V. R., Hsieh, J. K., Ostrom, Q. T., Kruchko, C., Benzel, E. C., & Barnholtz-Sloan, J. S. (2015). Descriptive epidemiology of spinal meningiomas in the United States. *Spine, 40*(15), E886-E889. https://doi.org/10.1097/BRS.0000000000000974

Larjavaara, S., Haapasalo, H., Sankila, R., Helén, P., & Auvinen, A. (2008). Is the incidence of meningiomas underestimated? A regional survey. *British Journal of Cancer, 99*(1), 182-184. https://doi.org/10.1038/sj.bjc.6604438

Li, Q., Coulson, H., Klaassen, Z., Sharma, S., Ramalingam, P., Moses, K. A., & Terris, M. K. (2013). Emerging association between androgen deprivation therapy and male meningioma: significant expression of luteinizing hormone-releasing hormone receptor in male meningioma. *Prostate Cancer and Prostatic Diseases, 16*(4), 387-390. https://doi.org/10.1038/pcan.2013.45

Lin, D. D., Lin, J. L., Deng, X. Y., Li, W., Li, D. D., Yin, B., ... & Sheng, H. S. (2019). Trends in intracranial meningioma incidence in the United States, 2004-2015. *Cancer medicine, 8(*14), 6458-6467. https://doi.org/10.1002/cam4.2516

Lusis, E. A., Scheithauer, B. W., Yachnis, A. T., Fischer, B. R., Chicoine, M. R., Paulus, W., & Perry, A. (2012). Meningiomas in pregnancy: a clinicopathologic study of 17 cases. *Neurosurgery, 71*(5), 951-961. https://doi.org/10.1227/NEU.0b013e31826adf65

Macintyre, S. (1993). Gender differences in the perceptions of common cold symptoms. *Social science & Medicine*, *36*(1), 15-20. https://doi.org/10.1016/0277-9536(93)90301-J

Merriam-Webster. (n.d.). In *Merriam-Webster.com dictionary*. Retrieved June 25, 2023, from www.merriam-webster.com/dictionary/meningioma

Nakamura, H., Makino, K., Yano, S., Kuratsu, J. I., & Kumamoto Brain Tumor Research Group. (2011). Epidemiological study of primary intracranial tumors: a regional survey in Kumamoto prefecture in southern Japan—20-year study. *International Journal of Clinical Oncology, 16*, 314-321. https://doi.org/10.1007/s10147-010-0178-y

Ostrom, Q. T., Gittleman, H., Truitt, G., Boscia, A., Kruchko, C., & Barnholtz-Sloan, J. S. (2018). CBTRUS statistical report: primary brain and other central nervous system tumors diagnosed in the United States in 2011–2015. *Neuro-oncology, 20*(suppl_4), iv1-iv86. https://doi.org/10.1093/neuonc/noy131

Pravdenkova, S., Al-Mefty, O., Sawyer, J., & Husain, M. (2006). Progesterone and estrogen receptors: opposing prognostic indicators in meningiomas. *Journal of Neurosurgery, 105*(2), 163-173. https://doi.org/10.3171/jns.2006.105.2.163

Waagemans, M. L., van Nieuwenhuizen, D., Dijkstra, M., Wumkes, M., Dirven, C. M., Leenstra, S., ... & Stalpers, L. J. (2011). Long-term impact of cognitive deficits and epilepsy on quality of life in patients with low-grade meningiomas. *Neurosurgery, 69*(1), 72-79. https://doi.org/10.1227/NEU.0b013e318212badb

Wöhrer, A., Waldhör, T., Heinzl, H., Hackl, M., Feichtinger, J., Gruber-Mösenbacher, U., ... & Hainfellner, J. A. (2009). The Austrian Brain Tumour Registry: a cooperative way to establish a population-based brain tumour registry. *Journal of Neuro-oncology, 95*, 401-411. https://doi.org/10.1007/s11060-009-9938-9