













# The association between depot medroxyprogesterone acetate and meningiomas: Emerging data and their relevance to the South African context

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In the past 2 years, evidence suggesting an association between depot medroxyprogesterone acetate (dMPA) use and meningioma has emerged. As dMPA remains one of the most widely used contraceptive methods worldwide, this finding has led to increasing media attention, and regulatory and legal proceedings. The South African Health Products Regulatory Authority (SAHPRA) has issued a statement acknowledging the association between dMPA exposure and the development for meningiomas. However, the paucity of local data on dMPA use and the incidence of and risk factors for meningioma in both the public and private health sector make it difficult to fully assess the implications in SA. This report discusses the relevance of the association between dMPA and meningiomas in the SA context. We provide a summary of the current data on the risk of meningioma with dMPA exposure, and suggest how this should impact on recommendations for the prescribing and use of dMPA from a public health perspective. We further identify gaps in local data, and propose where efforts should be directed to collect relevant data to inform a rational national contraceptive strategy.

**Keywords:** depot medroxyprogesterone acetate, intracranial meningiomas, hormonal contraception, pharmacovigilance, South Africa

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Depot medroxyprogesterone acetate (dMPA) remains a commonly used contraceptive among women worldwide, particularly in low- and middle-income countries.<sup>[1]</sup> This injectable contraceptive is frequently preferred by women due to its convenient 3-monthly dosing, its efficacy and its discretion.<sup>[2]</sup> In South Africa (SA), it is the agent used by nearly a quarter of women utilising contraception.<sup>[3]</sup> In the past 2 years, retrospective studies<sup>[4-8]</sup> using large datasets from both Europe and the USA have shown an association between dMPA use and meningioma. The strength of the association appears to increase with prolonged dMPA use.<sup>[4,6,8]</sup>

These findings have gained local and international media attention and have led to class-action lawsuits against Pfizer, the largest manufacturer of dMPA, in some countries.<sup>[9,10]</sup> Since dMPA is the most widely used contraceptive among SA women,<sup>[11]</sup> understanding any potential association with meningioma is of particular relevance locally. Despite widespread dMPA use, there are currently no robust SA data exploring this association. This limits the ability to quantify the risk of meningioma in women who use, or have previously used, dMPA for contraception to

guide evidence-based prescribing and counselling on safety of contraceptive choices for our clients.

In this report we aim to summarise and contextualise current data on the epidemiology of meningiomas, and the associated risk between dMPA exposure and meningioma. We will discuss why this association may have unique relevance in SA, and identify gaps for further intervention and research. Our aim is to increase awareness while also appealing to the broader SA healthcare community to assist in efforts to monitor dMPA use in SA.

## Epidemiology of meningiomas

Meningiomas are the most common primary brain tumours in adults, with an age-adjusted incidence of 8 - 10 per 100 000 person-years.<sup>[12]</sup> Advancing age, obesity, neurofibromatosis and female sex are well-established risk factors, with incidence in women nearly double that in men.<sup>[13-15]</sup> Emerging evidence from the USA also suggests that ancestry mediates risk, with non-Hispanic black populations showing a higher incidence than non-Hispanic white populations.<sup>[13,16]</sup> Epidemiological data describing meningioma

incidence and risk factors in SA or across the African continent are limited. Small regional and single-centre retrospective studies in SA (with samples of between 48 and 505 patients) have confirmed that meningiomas are the most common adult brain tumours locally, and appear more common in women than men and among patients who were recorded as 'black African' in demographic data.<sup>[17-20]</sup>

The anatomical location of meningiomas is clinically and biologically significant. Most arise at convexity and parasagittal sites, with other common locations including the skull base, such as the sphenoid ridge.<sup>[21]</sup> Tumour site influences presentation, surgical accessibility and prognosis.<sup>[21,22]</sup> Molecular studies show that location corresponds to distinct genetic profiles. Specifically, skull base tumours are often associated with TRAF7, PI3K and hedgehog pathway mutations, whereas convexity tumours more commonly harbour NF2 alterations.<sup>[23,24]</sup> Recent data also suggest differences in molecular subtypes across different demographic groups, with patients from the USA recorded as 'black' showing a higher prevalence of anterior skull base tumours, increased hedgehog pathway mutations and poorer progression-free survival despite similar extents of resection.<sup>[25]</sup> These findings highlight the need for further geographically and ethnically diverse studies to better understand meningioma biology.

### Association between prolonged dMPA use and meningiomas

Exposure to progesterone is an important physiological factor implicated in meningioma development and growth. The link between progesterone and meningiomas was first observed in relation to hormonal fluctuations during menstruation and pregnancy.<sup>[26]</sup> Subsequent studies found that benign meningiomas often express progesterone receptors,<sup>[27]</sup> and loss of these receptors has been associated with more aggressive, infiltrative tumour behaviour.<sup>[28]</sup> The density of progesterone receptor expression appears to vary by tumour location, being higher in skull base tumours.<sup>[29,30]</sup> Furthermore, exposure to progestins has been implicated in changing the molecular characteristics of meningiomas.<sup>[31]</sup>

Given the importance of progesterone signalling in meningioma biology, there has been long-standing interest in the effects of exogenous progesterone exposure on tumour growth in women.<sup>[32,33]</sup> While extensive data exist on the association between intracranial meningiomas and other synthetic progestins, particularly cyproterone acetate,<sup>[34]</sup> this discussion will focus specifically on dMPA.

Before 2024, evidence linking dMPA to meningiomas was limited.<sup>[1]</sup> The first case was reported from the UK in a man who had taken medroxyprogesterone for the treatment of renal cell carcinoma, and subsequently developed an intracranial meningioma.<sup>[35]</sup> Subsequent to that case report, data came mainly from small retrospective case series<sup>[36,37]</sup> and case-control studies<sup>[38-41]</sup> from Indonesia, where the number of women who use dMPA as their preferred contraceptive method is similar to SA.<sup>[1,42]</sup> Notably, Dewata *et al.*<sup>[39]</sup> compared women who had histologically confirmed meningiomas (cases) with women in a similar age range who had received brain imaging to exclude an intracranial meningioma (controls). Their results revealed that women who had meningiomas were three times more likely to have used dMPA (155 of 212 meningioma cases, odds ratio (OR) 3.13, 95% confidence interval (CI) 2.03 - 4.85), with the risk increasing with >15 years of dMPA exposure (OR 4.45, 95% CI 2.35 - 8.35).<sup>[39]</sup> As these data were drawn from single-centre case-control studies with limited generalisability and lacked the ability to quantify risk, they necessitated the subsequent development of pharmaco-epidemiological studies.

Since 2024, four large case-control studies exploring the association between dMPA and meningioma in the USA, France and Sweden have been published. While all the studies are consistent in their reporting of a significant association between dMPA and women having received a diagnosis of a meningioma, there are important methodological differences that affect how the results from each should be interpreted. A French case-control study<sup>[4]</sup> that included 18 892 women who had undergone surgical resection for a meningioma and 90 305 controls, matched on year of birth and area of residence, found that women with meningioma had higher odds of having been exposed to dMPA, with OR 5.55 (95% CI 2.27 - 13.56). A Swedish case-control study<sup>[5]</sup> that included 1 055 women with a meningioma diagnosis in a cancer registry and 21 100 controls matched on year of birth and country of residence found a similar association between dMPA and meningiomas (OR 5.49, 95% CI 4.51 - 6.67).

A case-control study<sup>[6]</sup> from the USA, on women with meningiomas identified through private health insurance records (i.e. not only those who underwent resective surgery), reported an OR of 1.53 (95% CI 1.40 - 1.67): 813 of 117 503 women with meningiomas exposed to dMPA (0.69%) v. 4 652 of 1 072 907 matched controls (0.43%). A second case-control study by the same investigators<sup>[7]</sup> also found a significant association between dMPA exposure and meningiomas in women from a smaller, publicly funded medical insurance scheme, using exposure to levonorgestrel or norethindrone as an active comparator (OR 1.93, 95% CI 1.01 - 2.56). While all the case-control studies found that the association strengthened with longer dMPA exposure, only the US study by Griffin *et al.*<sup>[6]</sup> confirmed that the association occurs exclusively in intracranial meningiomas, although it did not examine variation across different intracranial regions.

These case-control studies demonstrate an association with dMPA exposure that strengthens with exposure duration, but cannot quantify incidence. A recent cohort study from the USA<sup>[8]</sup> using electronic health records of 10 425 438 women was able to estimate meningioma incidence and relative risks with exposure to several contraceptives. The study compared women who had been exposed to dMPA with those without any exposure, and determined how many women in each group developed meningiomas over the follow-up period. Using propensity score matching, which attempts to balance baseline characteristics between exposed and unexposed groups, this study was able to adjust for many meningioma-relevant potential confounders including age, race, ethnicity, parity, other cancer diagnoses, neurofibromatosis, radiological procedures received and body mass index.

The incidence of meningioma was 7.39 per 100 000 patient-years in the dMPA group, and 3.05 per 100 000 patient-years in the control group (relative risk 2.43, 95% CI 1.77 - 3.33). Based on those results, the number needed to harm is 1 152 (i.e. on average, for every 1 152 women who receive dMPA, there will be one additional case of meningioma relative to those who do not receive dMPA). Furthermore, the authors calculated the attributable risk percentage, allowing them to state that in the patients with meningiomas, 59% were likely due to dMPA exposure. While this study further supports the finding that prolonged dMPA exposure increases risk, unlike the previous US study, it did not stratify meningiomas by location.

### Relevance to South African women and research gaps

While the association between dMPA and meningiomas is of international concern, there are factors that uniquely affect SA women that need to be considered. Approximately 23% of SA women between

the ages of 19 and 45 years use injectable contraceptives.<sup>[11,42]</sup> By comparison, the percentages of women in France and the USA are 0.2% and 2.3%, respectively.<sup>[1,42]</sup> dMPA therefore plays a far more substantial role in SA's contraceptive landscape than in the settings where most of the pharmaco-epidemiological studies have been conducted.

It is important to remember that dMPA remains an important component of contraceptive programmes worldwide because of its high effectiveness, convenience and suitability for diverse users. It provides reliable, long-acting pregnancy prevention that does not depend on daily adherence, making it particularly valuable for women who face practical barriers to consistent contraceptive use.<sup>[43]</sup> Evidence from large cohort studies, including the CHOICE study,<sup>[44]</sup> shows that dMPA is comparable in effectiveness to other long-acting reversible methods in preventing unintended pregnancy. Global reviews further highlight its broad utilisation, acceptability and substantial public health benefits, particularly in reducing unintended pregnancies and associated maternal morbidity in settings with limited alternatives.<sup>[45]</sup> These advantages are especially relevant in SA, where dMPA is widely used and accessible within the public sector. Overall, these benefits underscore the need to contextualise emerging safety concerns within dMPA's significant contribution to contraceptive choice and public health.

To our knowledge, there are no published studies of the association between dMPA and meningioma in Africa. There is also a paucity of data on meningioma epidemiology in SA, and how this might differ from the well-characterised international meningioma registries. In the public sector, data regarding contraceptive use are generally limited to household surveys, which might be prone to recall bias, do not collect duration of use and are not linked to meningioma diagnosis. Cohort studies with linked data on diagnoses and prescription would be valuable to describe patterns of contraceptive use, estimate incidence of and risk factors for meningiomas and explore the association between dMPA and meningiomas in our setting. However, sources of potential linked data are limited, and prospective data collection may be challenging. Many SA women rely on access to family planning through the public health sector. Primary care family planning facilities do not currently keep electronic dispensing records, and make use of facility-based, paper-based systems, which poses challenges in quantifying clients' dMPA exposure and duration of exposure.

It is also difficult to ascertain the burden and patterns of clinical presentation of intracranial meningioma within our local context. Such data, along with contraceptive exposure data, are essential in understanding how hormonal therapies affect the presentation of meningiomas. For example, Malueka *et al.*<sup>[46]</sup> in Indonesia, where the use of dMPA is also 23%,<sup>[42]</sup> have shown a specific association between hormonal contraceptives and an increase in sphenoidal meningiomas, which often render patients blind and require complex surgical intervention in order to preserve sight.<sup>[47]</sup> As we do not yet have accurate epidemiological data on intracranial meningiomas in SA, it is difficult to determine whether local patterns of dMPA use influence the types of meningiomas that develop, the anatomical locations in which they arise, or the severity of their clinical presentation.

Taken together, the lack of local data makes it difficult to determine how international findings apply to SA women. Differences in population, contraceptive use and tumour presentation must be considered. The risk of developing meningioma must be balanced with the need for effective contraception. Overestimating the risk could lead to unnecessary discontinuation of dMPA use, while underestimating it may expose women to preventable disease. For

these reasons, locally generated data are needed to guide balanced and evidence-based public health decisions.

## Suggestions for future research and policy

To accurately characterise the relationship between dMPA exposure and associated health outcomes in SA, well-designed national prospective studies are required. This would align with a greater need for robust registries for neuro-oncology within SA and the African continent at large.<sup>[20,48,49]</sup> Efforts to strengthen electronic data collection systems should be encouraged, to allow for accurate assessment of drug exposure and outcomes at an individual patient level. Such systems could be used to quantify risk in our setting, and to identify patients who might be at increased risk for further intervention. These research and data-strengthening initiatives, however, will take time to execute properly so that high-quality data can meaningfully inform clinical practice. In the interim, cross-discipline collective effort is needed to create guidelines for sex hormone therapies in patients with meningiomas, similar to those already established in other countries.<sup>[50]</sup>

## Recommendations for clinical practice

While further research is still needed, the association between dMPA exposure and meningioma cannot be ignored. We therefore make the following recommendations:

- (i) Inform women using dMPA about its possible link to meningioma, and advise that it should not be used for >2 years unless other contraceptive options are unsuitable.
- (ii) Women on dMPA who develop headaches, vision changes or seizures should seek medical review promptly.
- (iii) If a woman using dMPA is diagnosed with and/or has been treated for a meningioma, stop dMPA (remembering it is a depot formulation) and counsel them regarding alternative contraceptive methods.
- (iv) Report all cases of meningiomas where exposure to dMPA has been recorded to the SA Health Products Regulatory Authority (SAHPRA) at <https://vigiflow-eforms.who-umc.org/za/ereporting>.<sup>[51]</sup>
- (v) Document dMPA exposure in clients' medical records, preferably electronically if possible.
- (vi) Ensure that women in SA have ready access to a broad range of safe and suitable contraceptive alternatives, and support shared decision-making based on individual needs and clinical context.

## Conclusion

While prolonged dMPA use is associated with a small increased risk of meningioma, responses must remain measured and evidence-based to protect women's health, which includes safeguarding access to effective contraception. Given that dMPA remains a preferred and often the most practical contraceptive option for many vulnerable women living in SA, discontinuing it without a clear rationale or contingency plan risks undermining the substantial progress achieved in SA's family planning programmes. At present, there is no evidence that the incidence of meningioma in SA users of dMPA is higher than that reported in other countries. SA has a large number of dMPA users, with an estimated 4 million women relying on this method. The absence of local epidemiological and pharmacovigilance data at present is a vulnerability. For this reason,

it is important to generate local evidence, strengthen surveillance, improve contraceptive record-keeping and establish clear clinical pathways for risk identification and management. This will support balanced and evidence-based public health decisions.

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- Roland N, Froelich S, Weill A. Medroxyprogesterone acetate and meningioma: A global issue. *Front Glob Womens Health* 2025;6(1):1470539. <https://doi.org/10.3389/fgwh.2025.1470539>
- Teal S, Edelman A. Contraception selection, effectiveness, and adverse effects: A review. *JAMA* 2021;326(24):2507-2518. <https://doi.org/10.1001/jama.2021.20763>
- Centers for Disease Control and Prevention. National Survey of Family Growth (NSFG): Key statistics – infertility. US Department of Health and Human Services, 2025. [https://www.cdc.gov/nchs/nsfg/key\\_statistics/i.html](https://www.cdc.gov/nchs/nsfg/key_statistics/i.html) (accessed 4 October 2025).
- Roland N, Neumann A, Hoisnard L, et al. Use of progestogens and the risk of intracranial meningioma: National case-control study. *BMJ* 2024;384(1):e078078. <https://doi.org/10.1136/bmj-2023-078078>
- Tetamanti G, Shu X, Mogensen H, Kopp Kallner H, Mathiesen T, Feychting M. Hormonal contraceptives and the risk of meningioma: A Swedish register-based case-control study. *Neuro Oncol* 2025;noaf228:1-12. <https://doi.org/10.1093/neuonc/noaf228>
- Griffin RL. The association between medroxyprogesterone acetate exposure and meningioma. *Cancers* 2024;16(19):3362. <https://doi.org/10.3390/cancers16193362>
- Reynolds LM, Arend R, Griffin RL. The association between medroxyprogesterone acetate exposure and cerebral meningioma among a Medicaid population. *Epidemiologia* 2025;6(4):58-68. <https://doi.org/10.3390/epidemiologia6040007>
- Xiao T, Kumar P, Lobboos M, et al. Depot medroxyprogesterone acetate and risk of meningioma in the US. *JAMA Neurol* 2025;82(11):1094-1102. <https://doi.org/10.1001/jamaneurol.2025.3011>
- Lawsuit Information Center. Depo-Provera lawsuit update. Oceanside: Lawsuit Information Center, 2025. <https://www.lawsuit-information-center.com/depo-provera-lawsuit.html> (accessed 5 October 2025).
- Carte Blanche. Carte Blanche investigates possible link between injectable contraceptives and brain tumours. Carte Blanche, 2025. <https://www.dstv.com/m-net/en-za/news/carte-blanche-investigates-possible-link-between-injectable-contraceptives-and-brain-tumours> (accessed 10 May 2025).
- Chersich M, Wabiri N, Risher K, et al. Contraception coverage and methods used among women in South Africa: A national household survey. *S Afr Med J* 2017;107(4):307-314. <https://doi.org/10.7196/SAMJ.2017.v107i4.12141>
- Price M, Ballard CAP, Benedetti JR, Kruchko C, Barnholtz-Sloan JS, Ostrom QT. CBTRUS statistical report: Primary brain and other CNS tumors diagnosed in the United States in 2018 - 2022. *Neuro Oncol* 2025;27(Suppl 4):iv1-iv66. <https://doi.org/10.1093/neuonc/noae123>
- Cao J, Yan W, Li G, Zhan Z, Hong X, Yan H. Incidence and survival of benign, borderline, and malignant meningioma patients in the US from 2004 to 2018. *Int J Cancer* 2022;151(11):1874-1888. <https://doi.org/10.1002/ijc.34141>
- Ho VKY, Anten MM, Garst A, et al. Epidemiology of adult meningioma: Report from the Dutch Brain Tumour Registry (2000 - 2019). *Eur J Neurol* 2023;30(10):3244-3255. <https://doi.org/10.1111/ene.15966>
- Ekqvist O, Raitanen J, Auvainen A. Changes in incidence trends of meningioma in Finland, 1990 - 2017. *Acta Oncol* 2023;62(9):994-1000. <https://doi.org/10.1080/0284186X.2023.2253985>
- Walsh KM, Price M, Raleigh DR, et al. Grade-stratified meningioma risk among individuals who are non-Hispanic Black. *J Natl Cancer Inst* 2025;117(2):366-374. <https://doi.org/10.1093/jnci/djac236>
- Ibebuikwe K, Ouma J, Gopal R. Meningiomas among intracranial neoplasms in Johannesburg, South Africa. *Afr Health Sci* 2013;13(1):118-121. <https://doi.org/10.4314/ahs.v13i1.16>
- Ibebuikwe K, Ouma J. Demographic profile of patients diagnosed with intracranial meningiomas in Johannesburg. *Afr Health Sci* 2014;14(4):939-945. <https://doi.org/10.4314/ahs.v14i4.24>
- Kelly A, Lekgwara P, Mda S. Epidemiology and outcome of patients admitted for elective brain tumour surgery in South Africa. *Interdiscip Neurosurg* 2020;21(1):100750. <https://doi.org/10.1016/j.inat.2020.100750>
- Basson D, Schutte C, van Coller R, Gould T. Brain tumours in the Western Cape Province of South Africa. *Wits J Clin Med* 2024;6(2):53-60. <https://doi.org/10.18772/26180197.2024.v6n2a1>
- Huntoon K, Toland AMS, Dahiya S. Meningioma: A review of clinicopathological and molecular aspects. *Front Oncol* 2020;10(1):579599. <https://doi.org/10.3389/fonc.2020.579599>
- Splavski B, Hadzic E, Bagic I, Vrtaric V, Splavski B. Simple tumor localisation scale for estimating management outcome of intracranial meningioma. *World Neurosurg* 2017;104(1):876-882. <https://doi.org/10.1016/j.wneu.2017.05.039>
- Fountain DM, Smith MJ, O'Leary C, et al. The spatial phenotype of genetically distinct meningiomas. *Oncogene* 2021;40(5):875-884. <https://doi.org/10.1038/s41388-020-01563-w>
- Nassiri F, Liu J, Patil V, et al. A clinically applicable integrative molecular classification of meningiomas. *Nature* 2021;597(7874):119-125. <https://doi.org/10.1038/s41586-021-03850-3>
- Tabor JK, Dincer A, O'Brien J, et al. Variations in genomic profiles and clinical behaviour of meningioma by race and ethnicity. *J Neurosurg* 2024;141(3):664-672. <https://doi.org/10.3171/2023.12.JNS230001>
- Bickerstaff ER, Small JM, Guest IA. The relapsing course of certain meningiomas in relation to pregnancy and menstruation. *J Neurol Neurosurg Psychiatr* 1958;21(2):89-91. <https://doi.org/10.1136/jnnp.21.2.89>
- Blankenstein MA, Blaauw G, Lamberts SWJ, Mulder E. Presence of progesterone receptors in human intracranial meningioma cytosols. *Eur J Cancer Clin Oncol* 1983;19(3):365-370. [https://doi.org/10.1016/0277-5379\(83\)90134-7](https://doi.org/10.1016/0277-5379(83)90134-7)
- Agopiantz M, Carnot M, Denis C, Martin E, Gauchotte G. Hormone receptor expression in meningiomas. *Cancers* 2023;15(3):980. <https://doi.org/10.3390/cancers15030980>
- Mairuri F, Mariniello G, de Divittis O, et al. Progesterone receptor expression in meningiomas. *Front Oncol* 2021;11(X):611218. <https://doi.org/10.3389/fonc.2021.611218>
- Miyagishima DF, Sundaresan V, Gutierrez AG, et al. Gonadal steroid hormone receptors in meningioma: A systematic review and meta-analysis. *J Neurosurg* 2023;139(6):1638-1648. <https://doi.org/10.3171/2023.3.JNS221372>
- Peyre M, Gaillard S, de Marcellus C, et al. Progesterin-associated shift of the meningioma mutational landscape. *Ann Oncol* 2018;29(3):681-686. <https://doi.org/10.1093/annonc/mdx782>
- Hage M, Plesa O, Lemaire I, Raffin Sanson ML. Estrogen and progesterone therapy and meningiomas. *Endocrinology* 2022;163(2):bqab259. <https://doi.org/10.1210/endoocr/bqab259>
- Abikenari M, Regev A, Himic V, et al. The hormonal nexus in PIK3CA-mutated meningiomas. *J Neurooncol* 2025;174(2):329-340. <https://doi.org/10.1007/s11060-024-04517-3>
- Weill A, Nguyen P, Labidi M, et al. Use of high dose cyproterone acetate and risk of intracranial meningioma in women. *BMJ* 2021;372(37):n37. <https://doi.org/10.1136/bmj.n37>
- Hensiek KH, Hill A. Spontaneous regression of cerebral metastasis followed by meningioma development under medroxyprogesterone acetate therapy. *Br J Neurosurg* 2000;14(4):354-356. <https://doi.org/10.1080/026886900417388>
- Anggraeni D, Diansari Y, Hafy Z. Demographic, clinical, and tumor profile of meningioma. *Biomed J Indones* 2022;8(1):1-4. <https://doi.org/10.32539/BJI.v8i1.122>
- Rusdi AFP. Association between hormonal contraception and histopathology grading of meningioma. *Nat Volatiles Essent Oils* 2022;9(1):1583-1592.
- Supartoto A, Mahayana IT, Christine RN, Suhardjo, Agni AN, Sasongko MB. Exogenous female sex hormone exposure and increased risk of orbito-cranial meningioma. *Int J Ophthalmic Pathol* 2016;5(3):1000183. <https://doi.org/10.4172/2324-8599.1000183>
- Dewata L, Prasetyo B, Yuliati A, Wahyuhadi J. Hormonal contraceptive exposure and risk factors for meningioma. *Adv Sci Lett* 2017;23(4):3291-3294. <https://doi.org/10.1166/asl.2017.9121>
- Wahyuhadi J, Heryani D, Basuki H. Risk of meningioma associated with hormonal contraception. *Maj Obstet Ginekol* 2018;26(1):36-41. <https://doi.org/10.20473/mog.v26i12018.36-41>
- Dustur S, Wahyuhadi J, Utomo B, Parenrengi MA, Bajamal AH, Dwiningsih SR. Histopathology grading of meningioma and use of medroxyprogesterone acetate. *Pharmacogn J* 2022;14(6):938-941. <https://doi.org/10.5530/pj.2022.14.193>
- United Nations Department of Economic and Social Affairs, Population Division. *World Fertility and Family Planning 2020: Highlights*. New York: UN, 2020. <https://www.un-ilibrary.org/content/books/9789210046527> (accessed 8 October 2025).
- Westhoff C. Depot-medroxyprogesterone acetate injection (Depo-Provera): A highly effective contraceptive option with proven long-term safety. *Contraception* 2003;68(2):75-87. [https://doi.org/10.1016/S0010-7824\(03\)00136-7](https://doi.org/10.1016/S0010-7824(03)00136-7)
- Winner B, Peipert JE, Zhao Q, et al. Effectiveness of long-acting reversible contraception. *N Engl J Med* 2012;366(21):1998-2007. <https://doi.org/10.1056/NEJMoa1110855>
- Polis CB, Phillips SJ, Curtis KM. Hormonal contraceptive effectiveness and considerations for women's health. *Lancet Diabetes Endocrinol* 2016;4(7):512-523. [https://doi.org/10.1016/S2213-8587\(16\)30041-7](https://doi.org/10.1016/S2213-8587(16)30041-7)
- Malueka RG, Hartanto RA, Setyawan NH, et al. Association of hormonal contraception with meningioma location. *Asian Pac J Cancer Prev* 2022;23(3):1047-1051. <https://doi.org/10.31557/APJCP.2022.23.3.1047>
- Deschuytere L, Bencke E, John BD, Lubbe D. Simultaneous two-team transorbital neuroendoscopic approach for sphenoid wing meningioma. *J Coll Med S Afr* 2025;3(1):5-10. <https://doi.org/10.4102/jcmsa.v3i1.224>
- Mbi Feh MKN, Lyon KA, Brahmrouou AV, Tadipatri R, Fonkem E. The need for a central brain tumor registry in Africa. *Neurooncol Pract* 2021;8(3):337-344. <https://doi.org/10.1093/nop/npab010>
- Kannoune US, Karekezi C, Nyalundja AD, Awad AK, Laeke T, Balogun JA. Adult brain tumors in Sub-Saharan Africa: A scoping review. *Neuro Oncol* 2022;24(10):1799-1806. <https://doi.org/10.1093/neuonc/noac110>
- Reuter G, Potorac I, de Herdt C, et al. Recommendations on the management of meningioma and sex hormone therapy. *Brain Spine* 2025;5(1):104154. <https://doi.org/10.1016/j.bas.2024.104154>
- South African Health Products Regulatory Authority. SAHPRA clarifies the benefits and risks of medroxyprogesterone acetate. Cape Town: SAHPRA, 2025. <https://www.sahpra.org.za/news-and-updates/sahpra-clarifies-the-benefits-and-risks-of-medroxyprogesterone-acetate/> (accessed 4 October 2025).

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