Global Disparities in Paediatric Brain Tumour Surgery

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Abstract

Paediatric brain tumours are the leading cause of cancer-related mortality in children worldwide, yet outcomes differ markedly across regions. These differences reflect variation in health system capacity rather than tumour biology alone. This review examines global disparities in paediatric brain tumour surgery, with a focus on how limitations in diagnosis, surgical expertise, and perioperative care shape outcomes in low- and middle-income countries. In resource-limited settings, delays in diagnosis and restricted access to neuroimaging often result in children presenting with advanced disease, larger tumours, and associated hydrocephalus. These factors increase operative risk and limit the likelihood of safe and complete resection. Surgical outcomes are further influenced by constraints in perioperative care, including limited paediatric anaesthesia, intensive care support, and specialized nursing. Gaps in multidisciplinary coordination and restricted access to adjuvant therapies further compromise treatment completion. Long-term follow-up and survivorship care remain inconsistent in many settings, contributing to unrecognized recurrence and avoidable long-term morbidity. Addressing these disparities requires a shift from short-term solutions toward sustained health system strengthening. Priority areas include workforce development, regional surgical capacity, reliable diagnostic and pathology services, and robust cancer registries to support continuity of care and improve survival for children with brain tumours.

Keywords: Paediatric neurosurgery, Brain Tumour, Healthcare Disparities, Global health, Lower middle-income countries.

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Introduction

Across the world, access to neuroimaging, paediatric neurosurgical expertise, operative resources, and perioperative support varies markedly. In some settings, timely imaging and surgery are readily available. In others, delayed diagnosis, limited surgical capacity, and fragmented postoperative care constrain treatment options. These differences mean that children with similar tumours may encounter vastly different surgical pathways and outcomes. Paediatric brain tumours remain the leading cause of cancer related mortality in children globally, yet survival and functional recovery differ widely between regions, reflecting persistent inequities in access to specialized care.[1] Neurosurgery occupies a central role in paediatric neuro-oncology. Surgical intervention establishes diagnosis, enables reduction of tumour burden, and often provides lifesaving relief from raised intracranial pressure. Disparities in neurosurgical capacity therefore represent a critical determinant of outcome for children with brain tumours worldwide.

Review of literature

Reported incidence of paediatric brain tumours is higher in high-income countries (HIC), likely due to wider availability of diagnostic imaging and more complete cancer registries. In contrast, low- and middle-income countries (LMICs) bear a disproportionate burden of mortality (Figure). Five-year survival for common tumours such as medulloblastoma exceeds 75 to 80% in many high-income settings, whereas survival in several LMIC cohorts

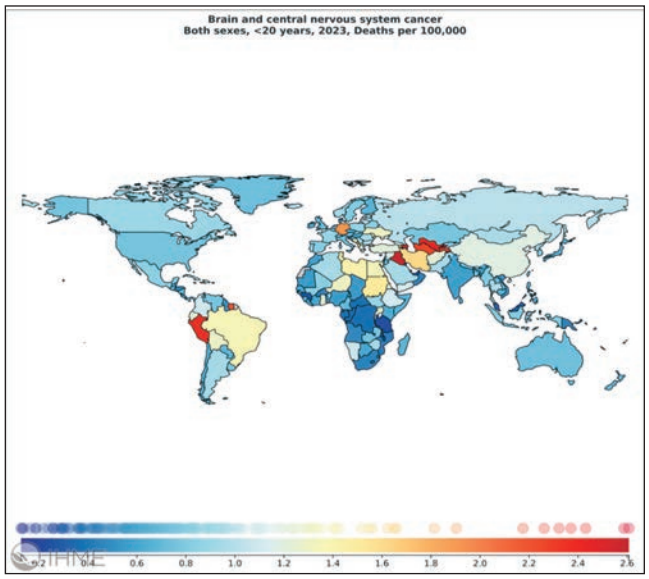

Figure: Heat Map from Global Burden of Disease 2023 showing distribution of deaths from Brain and Central Nervous System Tumours per 100,000 in age group <20 years.

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remains below 40%.[1,2] In some regions, operative mortality alone has been reported at rates of 10 to 15%.[3] Incomplete cancer surveillance in LMICs limits accurate estimation of disease burden. Even so, cohort studies repeatedly show that many children present late in the course of disease, often within fragmented systems of care.[4] These factors converge to alter survival trajectories long before adjuvant therapy is considered.

Delays in diagnosis represent one of the earliest and most consequential barriers to care.[4] Early recognition is critical for favorable outcomes, yet in many LMIC settings, non-specific symptoms such as headache, vomiting, or gait disturbance are frequently attributed to infectious or nutritional causes. As a result, many children experience delays of several months between the onset of symptoms and definitive diagnosis. Limited access to neuroimaging remains a major barrier. In many poor countries, especially in parts of sub-Saharan Africa, MRI availability is extremely poor.[5] Even where imaging exists, financial cost and long travel distances often delay or prevent access. Consequently, many children present with larger tumours, frequently complicated by hydrocephalus and neurologic deficits.[3] These factors increase surgical risk and reduce the likelihood of complete resection.

Surgical outcomes are also closely linked to workforce capacity. The global distribution of paediatric neurosurgeons is profoundly unequal. While some HIC have multiple paediatric neurosurgeons per million children, many LMICs have none.[6] Paediatric brain tumour surgery in these settings is frequently performed by general neurosurgeons or non-specialist surgeons with limited paediatric training. Migration of trained specialists to higher-resource environments further reduces local capacity.[7,8] Low surgical volumes and limited exposure to complex cases restrict opportunities to develop and maintain expertise. This lack of experience is associated with higher complication rates and poorer long-term outcomes, in part because achieving complete tumour resection is more difficult.

Even when surgery is available, outcomes are shaped by the strength of the surrounding perioperative system. Safe neurosurgical care requires paediatric anaesthesia, reliable blood banks, intensive care support, and trained nursing. In many LMIC settings, these elements are limited or absent.8 Postoperative complications occur more frequently in the absence of intensive care support and are associated with higher mortality. Furthermore, limited multidisciplinary coordination and scarce centres offering radiotherapy or chemotherapy further delay or prevent adjuvant treatment, while the combined costs of surgery and ongoing therapy can be financially devastating. In addition, limited multidisciplinary coordination restricts access to adjuvant therapies such as radiotherapy and chemotherapy. As a result, even a technically successful surgery may represent only a partial step in an incomplete treatment pathway.

Follow-up care is a critical yet often overlooked component of paediatric brain tumour management. Survivors are at risk of late complications that may emerge months or years after treatment, many of which are not clinically apparent without structured surveillance. Studies from high-income settings consistently show that regular follow-up allows earlier detection of recurrence and treatment-related morbidity, with clear benefits for long-term function and quality of life.[9] In contrast, evidence from LMIC suggests that formal survivorship programmes are uncommon, and long-term monitoring is frequently fragmented or absent.[10] Children may be lost to follow-up because of distance from treatment centers, financial constraints, or limited understanding of the need for ongoing care. When continuity in care is disrupted, disease recurrence and late effects are often identified only after significant progression, which limits the opportunity for timely intervention. Gaps in follow-up therefore extend the impact of health system inequities well beyond the operating room and shape outcomes long after initial treatment has ended.

There is growing evidence that outcomes can improve when disparities are addressed at the level of health systems rather than through isolated interventions.[11] Long-term partnerships between high- and low-resource centres have shown promise.[12] Programmes that focus on sustained training and mentorship allow local teams to build surgical capacity over time and adapt skills to their own contexts. Another approach is the development of regional centres of excellence. By concentrating expertise and resources, these centres can manage complex cases more safely while also serving as hubs for training and mentorship. However, surgical capacity cannot be strengthened in isolation. Meaningful progress depends on parallel investment in diagnostic imaging, anaesthesia services, intensive care, pathology, and rehabilitation. Alignment with global initiatives may help sustain these efforts. Programmes such as the World Health Organization Global Initiative for Childhood Cancer provide a framework that can help support data collection to maintain registries, guide policy development, and enable mechanisms of sustainable funding.[13]

Conclusion

Disparities in outcomes for paediatric brain tumours ultimately reflect differences in health system capacity

rather than inherent differences in disease. Delays in diagnosis, along with gaps in neurosurgical capacity and perioperative support, continue to disadvantage children in resource-limited settings. Neurosurgery represents a critical point of intervention where meaningful improvements in equity are possible. Reducing these disparities will require sustained investment in training and infrastructure, alongside stronger regional collaboration across the full continuum of care. Ensuring that a child's chance of survival is determined by timely access to quality care, rather than location, should remain a central goal of global paediatric neuro-oncology.

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