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Neurological disorders in pregnant women in low- and middle-income countries—Management gaps, impacts, and future prospects: A review perspective

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Abstract

Neurological disorders during pregnancy are a substantial threat to women's health, particularly in low- and middle-income countries. Furthermore, a critical shortage of mental health workers and neurologists exacerbates the already pressing issue, where a lack of coordination of respective healthcare among multidisciplinary teams involved in managing these conditions perpetuates the current state of affairs. Financial restrictions and societal stigmas associated with neurological disorders in pregnancy amplify the situation. Addressing these difficulties would necessitate a multifaceted approach comprising investments in healthcare infrastructure, healthcare professional education and training, increased government support for research, and the implementation of innovative care models. Improving access to specialized treatment and coordinated management of antenatal neurological diseases will precipitate improved health outcomes for women and their families in low- and middle-income countries.

Keywords

fetal mortality, low- and middle-income countries, maternal mortality, neurological disorders, pregnancy

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Introduction

Pregnancy is a complicated physiological state characterized by several changes in the body's circulatory, respiratory, endocrine, and immunological systems. While these physiological modifications are necessary for fetal growth and development, exacerbation of neurological disorders in pregnant women may ensue.[1] Respective syndromes may range from minor headaches and migraines to more substantial clinical presentations, such as seizures, strokes, and phenomena associated with multiple sclerosis.[1,2] Changes in hormonal levels, pre-existing medical disorders, and pregnancy-related illnesses, such as preeclampsia or gestational diabetes mellitus may all contribute to these conditions.[1–3] Ultimately, these disorders may facilitate the development

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of severe neurological sequelae for both the mother and the fetus, thereby increasing the risk of maternal and neonatal mortality and morbidity.[1,2]

Recent research has elucidated that neurological disorders delineate a global health concern, accounting for 276 million disability-adjusted life years and ranking as the second highest etiology of mortality worldwide.[4] Compared to high-income countries (HICs), low- and middle-income countries (LMICs) bear a disproportionate share of this expenditure.[4] In addition, neurological disorders during pregnancy (NDP) are a serious public health issue, especially in LMICs where healthcare infrastructures may be less developed and inequalities may be more pronounced.

The incidence rate of certain NDPs is markedly elevated in LMICs in comparison to their prevalence in HICs.[5,6] Eclampsia, as an exemplar, is discerned in as many as 8% of pregnant individuals with antenatal complications in LMICs—a frequency that is alarming 10–30 times greater than that observed in HICs.[5] A pertinent example stems from a Nigerian research article where eclampsia was identified as an etiology of significant precedence, surmounting 28% of maternal mortality cases.[7] Mortality rates associated with NDPs further highlight this disparity: in HICs, the rates for conditions such as eclampsia rarely exceed 1.8%,[6] but in certain contexts, they may approach a staggering 15%. Such data accentuate the paramount importance of efficacious healthcare delivery and targeted interventions for NDPs, predominantly within LMIC environments. However, despite these challenges, there is a continued commitment in LMICs to enhance maternal health outcomes.[8,9]

Inadequate healthcare infrastructure, insufficient resources, and a shortage of qualified healthcare workers are among the factors that contribute to these discrepancies in NDP management.[10,11] Moreso, cultural beliefs, social stigmas, and low levels of health literacy among affected populations may make providing effective care more arduous.[5,10] Hence, as highlighted in this article, we aim to elucidate the inequalities in the management of NDPs in LMICs and their harmful consequences.

Management gaps of neurological disorders in pregnant women of LMICs

Lack of resources and shortage of essential medical supplies and diagnostic tools

The inadequacies of the healthcare system severely impede the management of neurological diseases in pregnant women in LMICs. This barrier is broad and comprises a plethora of fundamental shortcomings, such as a lack of a healthcare supply chain, medical equipment, and vital medical supplies.[11] The Royal College of Obstetricians and Gynecologists (RCOG)[12] in the United Kingdom, for example, recommends that pregnant women with epilepsy have access to regular planned prenatal treatment with a specialized epilepsy care team. Furthermore, the College recommends that women with epilepsy be regularly assessed during the antenatal period for the following: seizure risk factors, such as sleep deprivation and stress; adherence to antiepileptic drugs; and seizure type and frequency.[12] Unfortunately, the logistics of incorporating a robust program like this is monumental due to the lack of follow-up and screening services in LMICs.[13]

Inadequate healthcare equipment also impedes the prompt diagnosis and management of pregnant women with specific diseases in LMICs by severely limiting access to vital medical supplies and diagnostic tools.[14] This is then exacerbated by a lack of oxygen, ventilators, and anesthetic machines, resulting in insufficient care for pregnant patients. These elements are especially important in cases of cerebral hemorrhage caused by an increase in antenatal cardiac output and vasodilation.[15] Acute emergencies, such as status epilepticus, necessitate the administration of specialized medications that may not be widely available in some domiciles. Similarly, hypertensive disorders in pregnancy account for 12% of maternal mortality globally, and eclamptic seizures constitute a component of disease-based mortality.[16] Hence, prompt administration of magnesium sulfate aids in the prevention of eclampsia and its associated complications. However, supply chain issues mitigating its availability in most LMICs are concurrent.[17]

Furthermore, the scarcity of advanced diagnostic imaging modalities, such as magnetic resonance imaging, computed tomography, electroencephalography, and ultrasonography, limits the diagnostic capacity of healthcare professionals in LMICs, resulting in inadequate treatment and poorer health outcomes.[18]

Shortage of hospitals, specialized clinics, and research centers

It is difficult for patients with NDPs to receive specialist care since LMICs lack hospitals, clinics, and research facilities. This lack of infrastructure may impede research into these issues and their treatments, as well as facilitate the difficulty for individuals with neurological illnesses to access the care they require.[19–21] Undoubtedly, some LMICs have made significant efforts to improve access to neurological care, especially for pregnant women.[22,23] Nonetheless, disparities persist despite these efforts. In many places in sub-Saharan Africa (SSA), for example, a lack of facilities is of major concern, which frequently leads to extended waiting times and restricted accessibility to specialized diagnostic paraphernalia. Individuals may

need to commute substantial distances in varying situations to receive the care they require, which may be exceedingly expensive and time-consuming.[19,20]

Moreover, in Ethiopia, the majority of public and government-operated health centers and rural health facilities were observed to have inadequate resources and infrastructure for managing and preventing NDP complications.[24] Similarly, in India, where NDPs are becoming increasingly common, there are only a few clinical centers that provide specialized care for these conditions.[25] The shortage of healthcare facilities is further compounded by the scarce distribution of these facilities, with few available in rural areas and an overwhelming concentration in urban centers.[26] This geographical disparity leads to limited access to healthcare services, with pregnant women in rural areas being particularly vulnerable. Consequently, delayed or missed diagnoses, inadequate treatment, and poorer health outcomes often ensue.

In LMICs, there are not many research centers dedicated to the NDP. For instance, a study that was published in the journal Practical Neurology demonstrated that Nigeria, which has a population of approximately 200 million, has 14 neurological centers despite the prevalence of NDPs.[27,28] This deprivation of facilities may limit the ability of healthcare personnel to conduct research, provide correct diagnoses, and manage neurological diseases. Individuals with NDPs may experience unfavorable outcomes as a result, and their families and communities may be overburdened.

Limited access to skilled professionals and coordinated care

Pregnancy-related neurological diseases warrant the comprehension of medical professionals. Women affected by neurological conditions, such as epilepsy, may have problems becoming pregnant in the first instance, where the facilitation of specialized fertility and antenatal care ensures safer and healthier pregnancies.[29] The dearth of neurologists in LMICs, including SSA nations, is a severe and pressing issue. The average number of neurologists per million individuals in the area is predicted to be 0.3, with 11 nations lacking neurologists.[30] If these domiciles do not have access to trained doctors, affected individuals may experience iatrogenic mismanagement and complications of their respective diseases, especially when intrapartum.

Also, a critical shortage of mental health workers, such as psychologists and psychiatrists, exists. LMICs are predicted to be short of 1.18 million mental health personnel.[31] As a result, 85% of people with mental and neurological illnesses in these countries lack affordable, accessible healthcare.[32] Pregnant women with epilepsy are especially vulnerable, with one-quarter of women with epilepsy suffering from chronic postpartum depression.[33] The difficulties these women confront postpartum may correlate to a decline in mental health workers and neurologists.[34]

According to research conducted by the World Health Organization (WHO),[35] epilepsy specialists provide individualized healthcare to individuals resident in 89% of HICs, as opposed to just 56% of LMICs. Surprisingly, only six physicians in SSA specialize in rehabilitation, indicating a significant shortage of rehabilitation workers in the region.[36] This dearth of rehabilitation personnel may have an adverse effect on the management of pregnant women with neurological diseases due to a lack of healthcare professionals' availability to provide peri- and postpartum care.

Moreover, there is a significant lack of coordination of care among multidisciplinary teams involved in managing these conditions, which can exacerbate already-dangerous conditions. Neurologists, obstetricians, anesthesiologists, clinical geneticists, neonatologists, and pediatricians are among the professionals who are not adequately integrated to effectively manage the complicated needs of pregnant women with neurological diseases.[37,38] Unfortunately, they are also in short supply. According to studies, LMICs account for 48% of the worldwide population yet have only 15% of the world's anesthesiologists and 29% of the world's obstetricians. Africa and Southeast Asia, in particular, are underserved.[39] These disparities in the healthcare profession may be due to the difficulties faced by pregnant women in receiving timely care, worsening their already precarious circumstances.

Financial constraints

Neurological disorders in pregnancy are often complex and require specialized care. Without regulated and adequate funding, healthcare institutions may not have access to the resources or expertise necessary to administer optimal care for these patients. Despite its importance, there is still an inadequacy of institutional funding. For instance, a study revealed that in LMICs, over half of neurosurgical randomized controlled trials were institutionally funded (54.7%) as compared to HICs, where only 33.7% were institutionally funded.[40] The lack of government funding for research regarding neurology and neurosurgery in LMICs is evident and has affected the management of neurological disorders in pregnant women overall.[40]

Inadequate funding may also contribute to access to care inequities. Women who reside in areas deprived of resources, or LMICs, may find difficulties funding their necessary healthcare. This was especially reported in Palestine, where pregnant women with neurological diseases were unable to receive the optimum care due to the high cost of neurology services and the acquisition of safe medications. Moreover, personal patient payments were issued as no insurance in the country existed.[41] Similarly, even though Ghana's National Health Insurance Scheme

covers important medications, they are not always easily accessible at pharmacies. Brand-name medications are not covered by insurance for pregnant women with neurological issues. Many expectant women in these settings lack health insurance.[37] Contrarily, HICs have expanded state coverage and established minimum standards to enhance access for millions of women to vital prenatal, peripartum, and postpartum care.[42] Pregnant women in LMICs could not receive the same quality of treatment as those in wealthier areas as a result, leading to even bigger disparities in health outcomes. One primary issue with funding for neurological disorders in pregnancy is that these conditions are frequently regarded as rare or uncommon, making them less important for research and funding allocation.[29]

Furthermore, insufficient funding for research on neurological disorders in pregnancy in most LMICs may limit our understanding of these conditions and their sequelae. This may have a cascading impact, as a lack of understanding may facilitate a lack of effective management options for pregnant women with neurological disorders.

Poor awareness and education, training paths, and sociocultural beliefs

Limited medical knowledge and structural incompetence may have an impact on the utilization of vital medications, including those that are extensively administered, such as $MgSO_4$ for eclamptic seizures. Practitioners in LMICs may lack the essential training and confidence in delivering the said medicine, leading to hesitancy in its usage.[17]

However, managing these conditions in LMICs remains onerous. One such barrier is a lack of residency training programs, resulting in a shortage of neurologists and neurosurgeons in these fields. A survey of 19 LMICs in SSA elucidated that 10 lacked recognized neurology training programs, highlighting the need for more comprehensive training paths.[43] The shortage of training programs and education in antepartum neurological disorders may precipitate a dearth of qualified healthcare professionals in LMICs, resulting in delayed, appropriate treatment for pregnant women with these conditions. This may lead to negative health outcomes, increased maternal morbidity and mortality rates, and a financial burden on the affected individuals, their respective families, and the healthcare system.[34]

Furthermore, a lack of awareness and education among patients is another factor contributing to the disparities in healthcare. Patient misunderstanding and ignorance concerning various medical interventions in LMICs constitute major etiologies of these disparities.[5] For example, a Malaysian study found that a majority of pregnant women took medication during pregnancy, of which more than half exhibited poor knowledge regarding their medication use during pregnancy.[44] This populace also had a poor level of awareness and negative beliefs regarding medication use during pregnancy. Age and educational attainment have been demonstrated to be important predictors of awareness regarding drug usage during pregnancy.[44] This highlights how crucial it is to inform patients and their families about the advantages and disadvantages of different medical treatments.

Moreover, sociocultural beliefs play an important role in the management of neurological disorders in pregnant women in LMICs. According to a study conducted in Butajira, Ethiopia, many individuals with epilepsy believe their seizures are caused by supernatural forces and spend a large amount of personal time and money-seeking remedies from traditional healers.[45] Addressing these sociocultural ideas through education and awareness campaigns is essential for improving the care of neurological diseases in pregnant women in LMICs.

Global responsibility in assisting LMICs

The conspicuous disparities of global health inequities serve as a glaring testament to the substantial differences sustained in healthcare outcomes for NDPs between LMICs and HICs. Unfortunately, it appears that little progress has been made in reducing these differences over time.[4] The idealistic concept that every individual, regardless of socioeconomic background, has a right to realize their full health potential is rooted in the principles of the Universal Declaration of Human Rights.

However, the evident disconnect between the healthcare systems of LMICs and HICs sharply contrasts with this principle. HICs bear a profound historical responsibility to extend aid, resources, and knowledge to LMICs.[46] Yet, when examining the management of NDPs as a case study, the tangible contribution of HICs to address these imbalances has been notably sparse.

This chasm in healthcare quality and access became even more evident during the COVID-19 pandemic. Pregnant women with neurological disorders from LMICs became significantly more vulnerable during this period.[47] The pandemic exemplified how a health catastrophe may exacerbate the adverse outcomes for individuals with neurological ailments, especially in the absence of a robust healthcare system and global cooperation.[48] The healthcare of patients with neurological disorders, already precarious in LMICs, was further strained and heavily disrupted by the pandemic.

Impact of disparities in neurological disorder management in LMICs

Maternal health outcomes

The management of NDPs in LMICs poses a significant challenge to maternal health, with detrimental consequences

ranging from preterm birth and stillbirth to maternal mortality.[49] Although, some studies have demonstrated positive outcomes in managing NDPs.[50] The burden on mothers remains significant. Eclampsia, for instance, has been identified as one of the leading causes of maternal mortality in LMICs, accounting for up to 46.4% of cases in Nigeria alone.[10] The inadequate availability of quality healthcare professionals and limited access to quality care in LMICs exacerbate the already complex challenges of managing NDPs. Likewise, a study conducted in India reported that maternal and perinatal mortality occurred in women with structural malformations who experienced catastrophic intraventricular hemorrhage as a result of a ruptured cerebral cavernoma.[51]

Furthermore, maternal outcomes associated with NDPs are not limited to maternal mortality alone but also include adverse long-term neurodevelopmental deficits for both mothers and their children. For example, a study conducted in North Central Nigeria reported a case fatality rate of 3.9% for eclampsia and a stillbirth rate of 10.7%, underscoring the need for effective management of NDPs to reduce the burden on mothers and improve maternal health outcomes.[49] On the contrary, HICs report an eclampsia case fatality rate of 1% or less.[52] In reality, the estimated incidence of eclampsia in Australia and New Zealand is a pitiful 2.2 per 10,000 women.[53] In light of these challenges and stark differences between LMICs and HICs, healthcare professionals in LMICs are increasingly striving to provide comprehensive care and support to mothers with NDPs.

Despite the uphill task, some studies have demonstrated positive maternal outcomes in managing NDPs in LMICs. For instance, a single-center Argentinian study demonstrated that 90% of pregnant women with epilepsy had normal pregnancies.[50] However, the data are noticeably contradicted by several studies, such as those of Ducci et al., which analyzed the impact of pregnancy on women with myasthenia gravis (MG). The course of MG in 50% of pregnancies deteriorated. In fact, obstetric complications were reported in the majority of the pregnancies, with preterm premature rupture of membranes being the most common.[51] In 66.7% of cases, the majority of patients choose a cesarean section delivery as a result of their inability to give birth naturally.[51] This highlights the importance of a multidisciplinary approach to diagnosis and management, as neurological manifestations during pregnancy may not always be a primary neurological disorder but secondary to systemic illness. Previous studies conducted in Pakistan have indicated a strong correlation between premature birth and postnatal depression in mothers, and a decrease in positive feelings toward their children.[54] This finding is particularly significant in the context of LMICs, where preterm birth rates are disproportionately higher compared to HICs. This highlights the potential impact of postnatal depression on mothers in these settings, which may go unreported.[55]

As depicted by the aforementioned information, the management of NDPs in LMICs remains a critical challenge to adequate maternal health. These negative maternal outcomes associated with NDPs, including maternal mortality and long-term neurodevelopmental deficits, are a significant public health concern. Healthcare professionals in LMICs should strive to improve access to quality care, and policymakers should prioritize investments in maternal health to enhance positive outcomes for mothers and their children.

Fetal health outcomes

Neurological disorders that occur during pregnancy pose a significant risk for both the mother and the developing fetus. Although much attention has been focused on the maternal outcomes of these disorders, the impact on fetal health is equally alarming. A range of adverse fetal outcomes has been linked to various NDPs, including low birth weight, preterm birth, stillbirth, neonatal mortality, and long-term neurodevelopmental deficits.[56]

A recent study conducted in 29 LMICs with more than 300,000 pregnancies investigated the correlation between severe maternal complications and perinatal deaths. The study revealed that a significant percentage of late fetal deaths (7.5%) and early neonatal deaths (10%) was caused by life-threatening eclampsia, making it the primary obstetrical reason behind such deaths.[57] In contrast, a Norwegian population-based cohort study determined that the risk of stillbirth was 5.2 per 1000 pregnancies with preeclampsia.[58] Concurrently, studies have also shown that neurological disorders, such as epilepsy and eclampsia, during pregnancy may lead to negative outcomes for both the mother and fetus. Among the 74 pregnant epileptic women in a study conducted in Nigeria, 41.9% had premature deliveries and gave birth to underweight neonates, while 8 stillbirths were recorded.[8] Similarly, a prospective study in northeastern Nigeria involving 23 pregnant epileptic women recorded negative outcomes, such as spontaneous abortion, stillbirth, intrauterine fetal mortality, neonatal sepsis, and congenital malformation.[59]

Research conducted in a university hospital in Egypt with 250 pregnant women who had eclampsia found 7 stillbirths, 5 antenatal, 2 intrapartum, and 24 early neonatal deaths, totaling a perinatal mortality rate of 11.9%.[9] These figures show how serious the issue is and how vital it is to address neurological diseases during pregnancy, especially in LMICs.

Future prospects

Strengthening healthcare systems

As previously elucidated, the lack of organized, developed, and funded healthcare systems is one of the most prominent etiologies of such neurological disparities in

pregnant women domiciled in LMICs. Therefore, the primary resolution to such disparities is the organized development of healthcare institutions. The strengthening of healthcare systems with the focused intention of addressing disparities in neurological complications is a complex, multifaceted approach. Key attention has to be placed on the various integral domains, including health governance, funding and financing, improving the delivery of healthcare providers, investing in and retaining necessary medical professionals to develop a capable workforce, and improving health information systems. Collectively, these measures may not only reduce neurological inequities and inequalities in pregnant women but also contribute toward successful economic development in line with the preplanned and established sustainable development goals.

In essence, health governance begins with the establishment and consequent commitment of policies and frameworks—in this case, the due recognition of the existence of neurological disparities in pregnant women, followed by a strong resolve to tackle them. In addition, this should be followed by mechanisms of coalition between different stakeholders, oversight, and, most importantly, accountability. Primarily, such an effort should begin with the development and adaptation of national guidelines for the recognition and management of neurological complications in pregnant women. It is a well-established fact that there is generally a paucity of well-designed guidelines in LMICs.[60] Therefore, investing time and resources to study such neurological complications in pregnant women and then decipher the best mechanisms of treatment for them via evidence-based approaches is duly warranted. An extremely pertinent example comes from Kerala, an Indian state. The creation of the Kerala Registry of Epilepsy and Pregnancy in 1998 resulted in a registry audit comprising 1469 participants, which aided in the formal drafting of guidelines for managing epilepsy during pregnancy that were specifically adapted to the South Indian context.[61]

In the meantime, guidelines developed in other countries, such as the RCOG Guidelines for Epilepsy in Pregnancy,[12] may be adapted. From the central government and health bodies' perspective, there has to be a firm resolution to explore partnerships with established research centers located internationally; such programs should allow for the easy movement of staff and should provide due permissions for such research centers to establish field hospitals and research camps in LMICs. For instance, the National Institute for Health and Care Research and the National Department of Health and Social Care (DHSC) of the United Kingdom have established a global research initiative that installs health researchers in LMICs the opportunity to conduct joint studies with the institution. These research projects aim to further the clinical care and prevention of epilepsy in LMICs, with a focus on the most economically disadvantaged populations.[62] Similarly, government bodies and stakeholders must advocate for policies and programs that prioritize maternal health, including expanding access to prenatal care and improving sanitation measures.

The issue of increased funding for maternal health services in LMICs is one that is quite challenging. The acute shortage of resources undoubtedly makes this laborious. However, it has to be accepted that the resolve to improve outcomes for neurological complications in pregnant women requires, to begin with, an increased investment of funds; advocacy, public health campaigns, and media outreach are examples of tools to facilitate this. The development of alliances with the commercial sector and charitable organizations is another option to consider. Such efforts have been successful in Kenya and Ghana.[63] Through the creation of social impact bonds, for example, these partnerships can help increase funding, investments, and workable payment plans in regions with limited resources. It is also possible to complement local money by applying for international funding through the WHO, the United Nations International Children's Emergency Fund (UNICEF), and the United Nations Fund for Population Activities (UNFPA), which would increase the total amount of resources available.[64]

Improving access to maternal and maternal-neurologic services is of paramount importance in this crusade. Primarily, this may be achieved through the sustained development of healthcare mechanisms. Following the Alma-Ata declaration, primary health care units were established as the optimal method of improving health care in the community, with the increased significance of community workers. Such programs have performed remarkably well in countries, such as Ethiopia.[65] There is a need to explore and incorporate a maternal neurological aspect into these endeavors through the formation of dedicated maternal neurological health extension workers and the expansion of maternal health institutions within the community. In addition, there has to be meticulous planning in the development of tertiary maternity hospitals for the provision of neurological care to pregnant persons; such initiatives have previously failed in Haiti and SSA owing to improper planning and mismanagement.[66] Budget prioritization and novel concepts, such as hospital twinning, may aid in the facilitation and establishment of sustainable long-term maternal and maternal neurological specialist centers in the future.

Investing in staffing and workforce development is crucial to reducing neurological disparities in pregnant women. Of particular importance is not only sustained funding in medical training, such as increasing the number of neurological and obstetric physicians and nursing training quotas, but also the retention of such staff, which is essential. Ghana sets a great example in this regard by not only continually investing in staff training but also improving salaries, incentivizing jobs in rural areas with a dearth of staff.[67] In addition, fostering collaborations between

highly specialized centers, such as the Duke Neurosurgery and Neurology Program, allowing staff from LMICs to train for a specific period of time in highly specialized centers, and exporting those skills back home, can go a long way in this regard.[68] Finally, improving health information systems can help revolutionize disease diagnosis and point-of-care treatment.

Enhancing awareness and education

Enhancing educational and situational awareness, a key facet of public health, may go a long way toward improving maternal and fetal outcomes. To achieve this, it is essential to pay attention to tailoring public health programs to incorporate cultural and religious beliefs. Studies originating from Ethiopia have delineated the effectiveness of maternal health education pregnancy-associated complication readiness.[69] First, developing culturally appropriate educational materials, including local languages, symbols, and illustrations, to ensure the information regarding the identification, diagnosis, and outcomes of neurological complications of pregnancy is easily comprehended. Comparable initiatives in Nigeria have incorporated the use of educational pamphlets and the propagation of Yoruba-language songs, both of which have played a pivotal role in disseminating knowledge pertaining to pregnancy and enhancing preparedness among women.[70] There is a need to effectively collaborate with community figures and leaders, including religious elders, celebrities, and community health workers, to disseminate messages and enhance awareness of such neurological complications that drastically affect the welfare of pregnant women.[71] In addition, another tool to be used in mass media is devising and conducting interviews with reputed doctors and healthcare specialists and broadcasting them for the public to view. Thus, by spreading awareness of how to identify neurological complications during pregnancy, individuals will then seek appropriate medical attention. Another device to be used is community outreach events, for instance, the setting up of fairs, health workshops, lectures, and seminars. Empirical studies have shown the effectiveness of these public health interventions.[72] Long-term, a future generation that is well informed and has the fundamental knowledge and abilities to support healthy pregnancies and recognize neurological deficits may be ensured by the appropriate integration of maternal health education into the regular school curriculum. As a result, maternal and neonatal health outcomes may improve, and the prevalence of neurological diseases in LMICs may decrease.

Addressing sociocultural beliefs

The perception of neurological complications during pregnancy in LMICs is significantly influenced by societal, religious, and cultural beliefs. Consequently, addressing these beliefs remains essential. However, such efforts should be conducted with a nuanced comprehension of cultural factors and the broader social context. To this end, initiatives such as community outreach programs, focus group discussions, and interactive question-and-answer sessions may be organized with the involvement of prominent cultural figures, religious leaders, and healthcare professionals to dispel false myths and beliefs surrounding neurological complications. Studies underscore that communities in LMICs, including Mozambique, often harbor superstitious beliefs, such as the misconception that pregnancy-related complications portend ill omens for affected families.[73] Therefore, it is important to continue educating the populace to dispel these myths while also respecting their perspectives and those of the local community.

Furthermore, in alignment with the United Nations' recognition, traditional birth attendants (TBAs) serve as trusted sources of health information and treatment methods. Owing to the great level of faith local populations place in TBAs' practices, research performed in Mozambique has highlighted the crucial role TBAs play within the maternity care frameworks that are now in place in these locations.[73,74]

The medical expertise of TBAs is frequently insufficient to ameliorate maternal issues and lower mortality rates in LMIC settings, according to numerous studies.[75,76] Therefore, offering medical training continues to be a crucial direction to pursue to properly interact with TBAs. Studies have demonstrated that collaborations with TBAs may improve interventions for maternal health. The Lufwanyama Neonatal Survival Project in Zambia, for instance, highlights how training TBAs in community medical procedures, such as clinical evaluations and antimicrobial chemotherapeutic delivery, may have a significant positive impact in rural African communities.[77] Disseminating educational packages to TBAs has proven highly beneficial. For example, training TBAs in education programs such as the American Academy of Pediatrics' neonatal resuscitation protocol and the WHO's Essential Newborn Care program has been shown to enhance their basic obstetric knowledge and their ability to identify issues necessitating referral, as evidenced in Guatemala.[78] Similarly, improved intervention to tackle gender formalities (which inherently limit autonomy and decision-making ability), partnering with non-governmental organizations, and encouraging public advocacy may all collectively assist in addressing sociocultural norms. These may traditionally hinder the prompt diagnosis and uptake of treatment for pregnant women suffering from such neurological complications.

Conclusion

The management of neurological problems during pregnancy in LMICs is complicated by a lack of hospitals, specialist clinics, and research facilities. The scarcity of

healthcare facilities is exacerbated by their sparse distribution, with few available in rural areas and an overwhelming concentration in metropolitan areas. Furthermore, there is a scarcity of NDP-focused research centers in LMICs. Individuals with NDPs have limited access to specialized care due to a shortage of neurologists, mental health professionals, and rehabilitation workers. Pregnant women with neurological illnesses require multidisciplinary care that is not well integrated in LMICs, aggravating their already perilous circumstances. Furthermore, these countries' financial constraints have an impact on the management of neurological disorders in pregnant women. To address these problems, governments, stakeholders, and international organizations will need to actively collaborate to improve healthcare quality and guarantee that pregnant women with neurological diseases receive the care they deserve.

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Author contribution(s)

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