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Underrecognised legacies of preeclampsia: a biosocial DOHaD perspective for research in sub-Saharan Africa

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Preeclampsia is often approached as an acute obstetric complication, yet its longer-term implications for maternal and offspring health remain insufficiently understood, particularly in sub-Saharan Africa (SSA). Preeclampsia is a significant contributor to maternal and perinatal morbidity and mortality worldwide, with a disproportionate burden in SSA. Although its clinical management has improved, particularly in high-income countries, important questions remain regarding its causes, long-term consequences, and the extent to which existing evidence applies to SSA populations. In this viewpoint, we propose that conceptualising preeclampsia in SSA through a biosocial Developmental Origins of Health and Disease (DOHaD) lens provides a useful framework for investigating how biological, social, and environmental processes jointly shape maternal and offspring health across the life course. We review evidence and identify four priority domains for investigation: understanding context-specific causes and mechanisms; improving detection, care-seeking, and health system pathways; examining long-term maternal and offspring outcomes; and strengthening research infrastructures. We argue that advancing research on preeclampsia in SSA requires interdisciplinary approaches that integrate biological, clinical, epidemiological, and qualitative research. Such a research agenda has the potential to improve understanding of preeclampsia beyond its acute manifestations and to inform more equitable strategies for maternal and child health across the life course.

Keywords preeclampsia; sub-Saharan Africa; Developmental Origins of Health and Disease (DOHaD); life-course health; maternal health; interdisciplinary research

Hypertensive disorders of pregnancy (HDP) are a leading contributor to maternal and perinatal morbidity and mortality worldwide, accounting for approximately 14% of maternal deaths globally [1]. Among these disorders, preeclampsia is one of the most severe and consequential, with effects extending beyond the acute pregnancy complication to the long-term health of women and their children (Box 1) [2]. Despite advances in obstetric care, HDP remain a substantial global health burden, particularly in low- and middle-income countries [4,5]. The burden is unevenly distributed, with sub-Saharan Africa (SSA) experiencing some of the highest prevalence rates worldwide and Western and Central Africa reporting the greatest burden [6,7]. Epidemiological data show that women of African descent face disproportionately higher risks of developing preeclampsia, even when accounting for socioeconomic status [2,8]. The mechanisms underlying these disparities remain incompletely understood but likely involve a complex interplay of limited access to quality antenatal care [9], environmental exposures [10], nutritional factors [11,12], and broader social determinants of health [13]. While knowledge of preeclampsia and access to relevant diagnostics have expanded, particularly in high-income countries (HICs), important gaps remain regarding the causes of the condition and its long-term consequences for women and children, especially in low- and middle-income countries.

Preeclampsia should be investigated not only as an acute obstetric complication but also as a condition with long-term consequences for maternal and offspring health that are shaped by biological, social, and environmental factors.

Evidence from HICs suggests that preeclampsia is associated with foetal growth restriction, hypoxia, and systemic inflammation – processes that may influence health trajectories well beyond pregnancy. Women with a history of preeclampsia face increased risks of cardiovascular and metabolic disease later in life [14], while exposed children may be at greater risk of respiratory, neurodevelopmental and cardiovascular disorders [3,15]. These observations suggest that preeclampsia may represent an important Developmental Origins of Health and Disease (DOHaD) condition, linking adverse intrauterine exposures to long-term health outcomes. However, it remains unclear whether these findings can be generalised to SSA populations, where epidemiological, environmental, infectious, and social conditions differ substantially, and where longitudinal studies examining the life-course consequences of preeclampsia remain scarce [16–18].

As a result, important questions remain regarding both the causes and long-term consequences of preeclampsia for women and children in the region. While these challenges are

Box 1. Preeclampsia, developmental origins of health and disease, and the term 'biosocial'

Preeclampsia is a complex, multisystem disorder that can rapidly progress to life-threatening complications for women and unborn children in the absence of early diagnosis and proper management [2]. It is characterised by new-onset hypertension after 20 weeks of gestation, affecting 5%-8% of pregnancies globally. The pathogenesis of preeclampsia is multifactorial (involving placental, vascular, renal, and immunological dysfunction), and disease progression is associated with significant maternal morbidity, including hypertension, multi-organ dysfunction, placental abruption and eclampsia [2]. Early identification is accomplished through blood pressure monitoring, urinary protein measurement, biochemical screening, and foetal surveillance. Management is primarily symptomatic, often requiring early delivery [3].

Developmental origins of health and disease (DOHaD) is an interdisciplinary biomedical research paradigm that investigates how early-life exposures during gestation and early childhood (malnutrition, psychosocial stress, antibiotic use, environmental toxins, etc.) shape health trajectories across the life course [19]. These exposures may influence foetal and neonatal development and contribute to protection against or disease susceptibility later in life [20,21]. Over time, the DOHaD framework has expanded into a life-course-oriented research field, shaping global health agendas such as the 'first 1000 days' initiative [22]. It now spans multidisciplinary domains including epidemiology, neuroscience, immunology, molecular biology, public health, and social sciences.

'Biosocial' is a term that refers to the dynamic interplay between biological and social factors in shaping health and disease [28,29]. Rather than treating biology and society as separate domains, biosocial perspectives emphasise how bodies, environments and the ways we live in them co-produce health outcomes. In the context of maternal and child health, this means recognising how early-life exposures, such as malnutrition, stress, or infection, interact with social conditions like poverty, stigma, gender norms, and health system access. Biosocial approaches call for interdisciplinary research and interventions that account for both biological mechanisms and the structural and cultural contexts in which health is lived and experienced.

often approached primarily through a biomedical lens, such perspectives may overlook how biological processes interact with social and structural conditions to shape health across the life course. We propose that conceptualising preeclampsia in SSA through a biosocial DOHaD lens provides a useful framework for understanding how biological, social and environmental processes jointly shape preeclampsia and maternal and child health trajectories, and for identifying critical evidence gaps that must be addressed to improve maternal and child health outcomes in the region. In the following sections, we develop this proposition and identify four priority domains for future interdisciplinary research.

A BIOSOCIAL DOHAD PERSPECTIVE ON PREECLAMPSIA IN SSA

The DOHaD paradigm offers an integrative framework for investigating how conditions during gestation and early life shape health over the life course (Box 1). In recent decades, DOHaD research has generated important insights into how early-life exposures influence later susceptibility to cardiovascular, metabolic, respiratory, and neurodevelopmental conditions [19]. Although these insights have largely emerged from studies conducted in high-income settings, several important initiatives demonstrate the relevance of life-course approaches in African populations [23]. Birth cohorts such as the Drakenstein Child Health Study [24], the Healthy Life Trajectories Initiative (HeLTI) [25] and the Early Nutrition and Immune Development trial [26] have documented how nutritional, infectious, environmental and social exposures during pregnancy and early childhood shape later health outcomes.

Despite these advances, preeclampsia remains underrepresented within DOHaD research, particularly in SSA, where the burden of disease is high and longitudinal evidence remains limited [27]. This represents a critical gap, as preeclampsia profoundly affects maternal and foetal physiology and may have implications extending far beyond pregnancy. Yet little is known about how these biological processes interact with the social and environmental conditions that characterise many SSA settings to shape health trajectories for women and their children over time.

While DOHaD research has traditionally focused on biological exposures and outcomes, an increasing number of scholars have argued for biosocial approaches that examine how biological processes are shaped by social, economic, environmental, and political conditions (Box 1). Such approaches challenge the assumption that health trajectories can be fully understood through biomedical research alone and emphasise that health and disease emerge through the dynamic interaction of bodies, environments, institutions and lived experiences [28,30].

Advancing research in sub-Saharan Africa requires interdisciplinary study designs, stronger longitudinal research infrastructures, and context-sensitive investigation of causes, care pathways, and long-term maternal and offspring outcomes.

This perspective may be particularly valuable for understanding preeclampsia in SSA. Although few studies have explicitly examined preeclampsia from a biosocial perspective, a growing body of qualitative research has documented how social, cultural, and structural conditions shape women's experiences of illness, care-seeking, and access to treatment. Qualitative studies from Ghana and Tanzania show that women often experience preeclampsia and eclampsia as socially and emotionally disruptive conditions, marked by limited knowledge, contradictory or insufficient information, self-blame, fear, and stigma [31,32]. In one Ghanaian study, some women misconstrued eclampsia as epilepsy, which is often interpreted as a manifestation of spiritual possession [33] and, therefore, socially stigmatised, contributing to social isolation and distress [34]. Women also reported concerns about future pregnancies and uncertainty regarding the causes and consequences of their condition [33]. Similarly, research from Uganda found that limited awareness, financial constraints, health system barriers, local beliefs and misconceptions shaped health-seeking behaviour and access to care, while social support and trusting relationships with healthcare providers facilitated timely treatment [35]. Health systems in many parts of SSA remain under-resourced and unevenly accessible, and experiences of illness are mediated by cultural beliefs, social relationships, and community perceptions [33,36,37]. Fear of mistreatment or lack of trust in health institutions may further compound delays in diagnosis and treatment [36,38]. Together, these findings suggest that preeclampsia cannot be fully understood through biological mechanisms alone but must be situated within the social and structural contexts in which women recognise symptoms, seek care, receive treatment, and make sense of their experiences.

We propose that preeclampsia in SSA should be understood as a biosocial DOHaD condition whose causes, manifestations, and long-term consequences emerge through the interaction of biological, social, environmental, and structural processes across the life course. This proposition has important implications for research design. While biomedical and epidemiological approaches remain essential for understanding preeclampsia pathophysiology and clinical sequelae, they should be complemented by qualitative and ethnographic methods capable of capturing how women, families, communities, and healthcare providers understand, experience, and respond to the condition. Methods such as ethnographic observation, qualitative interviews, and focus group discussions could illuminate how health literacy, gender norms, social support, care-seeking practices, and interactions with health systems shape disease trajectories and their long-term consequences for mothers and children [39]. Such approaches can also reveal how broader structures of inequality, deprivation, and exclusion become biologically embodied across the life course and may shape long-term health trajectories for women and their children.

We therefore argue that advancing research on preeclampsia in SSA requires interdisciplinary study designs that integrate clinical, epidemiological, and social data. The conceptual framework presented in Figure 1 summarises the biosocial DOHaD perspective advanced here and how biological, social, environmental, and health system processes interact to shape maternal and offspring health trajectories across the life course. Building on this framework, we outline several critical evidence gaps that must be addressed to test and refine this proposition and to inform contextually appropriate interventions.

CRITICAL EVIDENCE GAPS IN ADDRESSING PREECLAMPSIA IN SSA

Building on the conceptual framework (Figure 1), we identify four interconnected domains in which further research is needed to test the proposition that preeclampsia in SSA can be understood as a biosocial DOHaD condition. Although substantial evidence has been generated on the

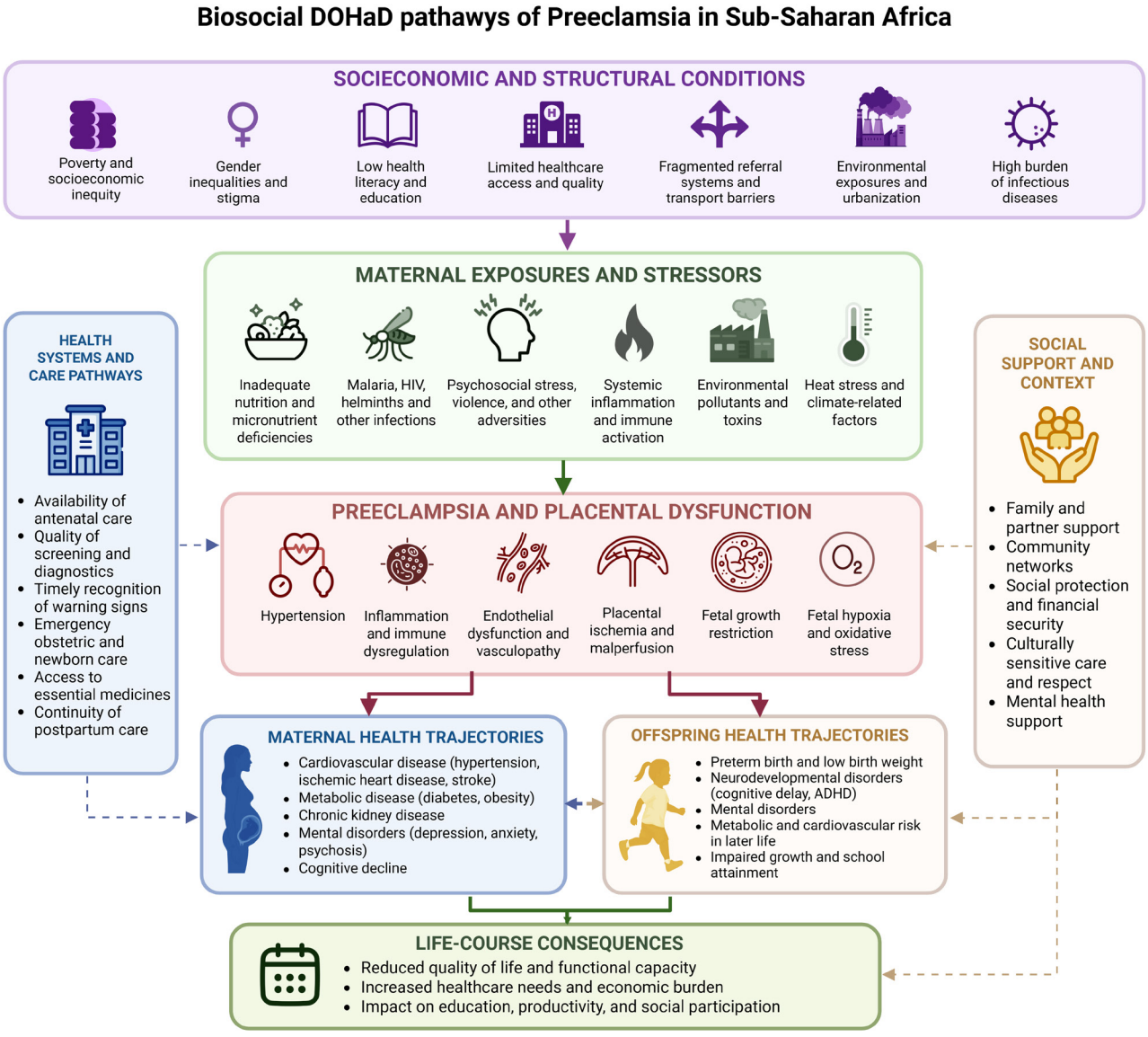


Figure 1. Biosocial Developmental Origins of Health and Disease pathways of preeclampsia in sub-Saharan Africa.

diagnosis, prediction and management of preeclampsia in high-income settings, major uncertainties remain in SSA concerning disease heterogeneity, context-specific exposures, pathways to diagnosis and treatment, and long-term maternal and offspring outcomes. These gaps are particularly consequential because delayed recognition, fragmented referral pathways, limited emergency obstetric and neonatal capacity, and inadequate postpartum follow-up may modify both acute outcomes and subsequent health trajectories [40]. The domains outlined below are not exhaustive; rather, they identify priority questions through which the proposed framework can be evaluated, refined, or challenged.

Understanding causes and mechanisms in SSA contexts

Do the biological mechanisms, risk factors, and predictive models identified in high-income settings adequately capture the causes and developmental consequences of preeclampsia in SSA? Much of the current evidence derives from populations that differ substantially from SSA populations in terms of infectious disease burden, nutritional exposures, environmental conditions, and healthcare access. Consequently, it remains unclear whether established biological pathways and biomarkers fully capture disease processes in SSA contexts.

Infection, inflammation, and developmental programming

The interaction between infectious disease-driven inflammation and preeclampsia is poorly understood, yet highly relevant in SSA. Diseases such as malaria, HIV and other viral and chronic helminth infections are known to cause persistent immune activation, which can lead to placental inflammation and ischemia. Subsequently, this promotes endothelial dysfunction, vascular permeability, and impaired vascular adaptation, all of which are recognised hallmarks of preeclampsia pathogenesis [41–44]. Although several biological pathways have been associated with preeclampsia, including elevated cytokine activity, impaired placental development, and exacerbation of endothelial and angiogenic dysfunction, the evidence remains largely observational and heterogeneous, limiting firm causal inference. If preeclampsia in SSA is understood within a biosocial DOHaD framework, an important question is whether infectious and inflammatory exposures during pregnancy modify biological pathways and developmental trajectories, contributing to the long-term consequences of preeclampsia for both women and children. Longitudinal studies are needed to clarify how infectious and inflammatory exposures influence both preeclampsia risk and long-term maternal and child health outcomes.

Biomarkers and molecular subtypes: missing local information and implementation

Biomarker-based, short-term risk stratification tools such as the sFlt-1/PlGF ratio have shown promise in HICs [45], but are rarely implemented in SSA due to cost, infrastructure, and lack of local validation. Maternal exposures that are common in SSA, such as malnutrition, infection, and environmental stressors, may modify biomarker profiles and give rise to region-specific molecular subtypes of preeclampsia. Without mechanistic studies grounded in SSA contexts, predictive models developed elsewhere may misclassify risk or fail to capture the diversity of disease presentations. A regionalised biomarker research agenda is therefore needed not only to improve diagnostic accuracy but also to enhance our understanding of population-specific disease pathways and long-term maternal and offspring outcomes. Once successfully validated and implemented, biomarker-based approaches may offer important advantages in resource-constrained settings by providing additional screening opportunities and enabling early identification of women who require intensified clinical monitoring and management, thereby helping to reduce life-threatening adverse outcomes for both mother and child.

Detection, care-seeking, and health system pathways

Preventive strategies for preeclampsia hinge, among other measures, on timely care-seeking [2], making it essential to understand how symptoms are recognised, interpreted, and acted upon in SSA settings. Limited maternal health literacy can delay care because many women may not fully understand the significance of warning signs or the importance of prompt medical attention [46]. Although research on maternal health literacy in different African countries has expanded over the last two decades, culturally appropriate and rigorously evaluated interventions remain scarce [47]. Midwives can play a critical role in maternal health education and in supporting women's health literacy [48], yet their perspectives are rarely integrated into research or policy design. Future studies should examine how maternal information seeking, midwifery engagement, and communication infrastructures shape timely care-seeking, and whether these processes influence maternal and child outcomes over the life course.

At the same time, access to and understanding of relevant health information are insufficient when care is difficult to access or poorly organised. Healthcare access disparities across urban-rural, socioeconomic, and educational lines remain a central barrier to effective preeclampsia prevention and management in SSA. Innovations in biomarkers and diagnostics are of limited value if women cannot reach facilities, and improved health literacy means little if financial barriers block access to care. Rural SSA communities face major healthcare infrastructure and workforce shortages, and even where services exist, fixed clinic schedules, stockouts, false reassurance, and delayed referral can undermine timely diagnosis and treatment [49,50]. Testing the proposed framework will require research that examines not only what women know, but also how referral pathways, facility organisation, and social support shape the ability to act on preeclampsia symptoms.

Long-term consequences

From missed diagnosis to missed developmental support

Delayed or absent diagnosis of preeclampsia in SSA often results in presentation at a crisis point, marked by multi-organ dysfunction, eclamptic seizures, stillbirth, or other adverse outcomes. Such delays are exacerbated by fragmented referral systems and insufficient emergency obstetric capacity, substantially worsening maternal and neonatal outcomes. Among exposed newborns, the absence of neonatal intensive care in many SSA settings may further limit the capacity to buffer the biological consequences of intrauterine stress and prematurity on long-term development [40]. While research from HICs suggests that preeclampsia may influence health trajectories across the life course, little is known about how these effects unfold in SSA settings, where diagnosis, treatment, and developmental support are often more limited.

High burden of and low attention to mental health and psychosocial sequelae

Preeclampsia has been linked to elevated rates of postpartum depression and psychosis, and women with a history of preeclampsia show a higher incidence of long-term cognitive decline and stroke [51]. In children, in utero exposure to preeclampsia appears to contribute to the cumulative risk for mental disorders such as autism spectrum disorder and attention-deficit/hyperactivity disorder [52]. Additionally, the psychosocial toll of experiencing a high-risk pregnancy, especially in contexts with limited support systems, may have cascading effects on parenting, bonding, and early childhood development. These latter processes are central to DOHaD but are not well-captured in current models of disease origin and development. Research that includes maternal and child mental health as both a mediator and outcome of preeclampsia-related stress in SSA is thus urgently needed.

Building research infrastructure for biosocial DOHaD research

Addressing the evidence gaps outlined above will require research infrastructures capable of capturing both biological and social dimensions of preeclampsia across the life course. Although several important birth cohorts and biobanking initiatives have been established in SSA, these remain concentrated in a limited number of countries and often focus primarily on clinical and biological data [53,17]. As a result, few studies can examine how biological, epidemiological, social, behavioural, and environmental factors interact to shape long-term maternal and child health outcomes following preeclampsia.

Rather than establishing entirely new research platforms, future efforts could build on existing cohort infrastructures and surveillance systems by integrating longitudinal follow-up of women with hypertensive disorders of pregnancy and their children. Such approaches would provide a feasible foundation for testing the biosocial DOHaD proposition advanced in this article.

CONCLUSIONS

Addressing preeclampsia in SSA requires a shift from short-term risk mitigation to a broader life-course approach to maternal and child health. Here, we propose that conceptualising preeclampsia in SSA through a biosocial DOHaD lens provides a useful framework for investigating how biological, social, environmental, and structural factors interact to shape maternal and offspring health across the life course. Evaluating this proposition will require interdisciplinary research that extends beyond the immediate clinical management of preeclampsia to examine its longer-term consequences and the biological, social, and structural contexts in which they emerge. Three priorities follow from this perspective.

First, future research should build on and strengthen existing longitudinal research infrastructures capable of integrating biological, clinical, epidemiological, environmental, and social data across pregnancy and after birth. Where feasible, this could include extending existing birth cohorts and Health and Demographic Surveillance Systems, particularly those of the INDEPTH Network, to incorporate long-term follow-up of women with HDP and their children. This would

leverage established longitudinal surveillance platforms while facilitating linkage with routine Health Management Information Systems and facility-based maternal and child health records.

Second, research should move beyond predominantly observational approaches towards interventional and implementation research that evaluates strategies to improve maternal and child health outcomes. Studies like the HeLTI study [25] illustrate the value of integrating longitudinal follow-up with preventive interventions and mechanistic investigation. Comparable approaches focusing on preeclampsia could evaluate interventions targeting maternal nutrition, infectious disease, health literacy, referral systems, and postpartum follow-up while simultaneously investigating their biological and developmental effects.

Third, future studies should adopt genuinely interdisciplinary research designs that integrate clinical, epidemiological, biological, and qualitative approaches. Such integration is essential for understanding not only whether preeclampsia influences long-term maternal and offspring health, but also how biological, social, and structural processes interact to shape these trajectories. Depending on the research question, biomarker analyses and other molecular methods may complement these approaches where scientifically appropriate and operationally feasible.

Ultimately, advancing this research agenda has the potential not only to improve early detection and clinical management of preeclampsia but also to reduce its long-term consequences for women and their children across the life course.

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