Narrative Review Article

Environmental Pollution, Maternal Mental Health, and Pregnancy Outcomes in Low-Resource Communities

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ABSTRACT

This paper examines how environmental exposure shapes maternal mental health and pregnancy outcomes in low-resource communities through both biological and cultural pathways. Drawing on biocultural anthropology, environmental justice scholarship, and clinical research on pregnancy outcomes, it argues that pollution is not only a toxic exposure but also a structural condition that produces unequal health risks. Indoor and outdoor pollutants—including household emissions, traffic-related air pollution (notably fine particulate matter, PM2.5), and industrial contaminants—are associated with inflammation, oxidative stress, placental dysfunction, hypertensive disorders, and adverse birth outcomes. At the same time, pollution operates as a psychosocial stressor: when pregnant women recognize environmental danger but lack the resources to reduce exposure, this mismatch can intensify anxiety, hypervigilance, and chronic stress. The paper further explores how cultural interpretations of illness shape how mothers understand risk, cope with uncertainty, and respond to symptoms. By integrating structural violence with Kleinman's disease–illness framework, this study highlights how environmental injustice and lived meaning combine to influence maternal well-being. The result is a biocultural account of pregnancy that links social inequality, embodied stress, and reproductive health.

Keywords: maternal health; environmental justice; biocultural anthropology; air pollution; low-resource communities; pregnancy outcomes; psychosocial stress; structural violence

INTRODUCTION

Maternal health is one of the fundamental indicators of a society's overall well-being. Globally, disparities in maternal mortality, preterm birth, and low birth weight persist along predictable lines of income, race, and geography. Research suggests that the conditions into which a woman is born, rather than her individual choices, are among the most powerful determinants of reproductive health (1). In the United States and across much of the world, women living in low-resource communities—defined here as communities marked by limited economic capital, constrained access to healthcare and green space, and inadequate housing infrastructure, encompassing overlapping economic, structural, and social dimensions of disadvantage—face reproductive health burdens produced and maintained by societal structure. This term is used consistently throughout the paper to refer to this population.

Understanding why these disparities exist requires looking beyond individual-level health and risk factors alone. Poverty, racism, and political marginalization do not operate in isolation; these structural and systemic forces shape the physical environments in which people live, including the air they breathe, the water they drink, and the quality of the housing they sleep in. These

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structural conditions, in turn, have measurable biological consequences. Pregnancy is a period of particular physiological sensitivity, during which even low-level environmental insults can disrupt fetal development, impair placental function, and elevate the risk of serious complications for both mother and child (1).

To address the full scope of these health burdens, the paper applies a framework that analyzes both biological and social risks simultaneously. Drawing on research and theory from cultural anthropology, the paper examines how social structures, including racism, poverty, and environmental inequity, become inscribed in the body through lived experience. Rather than treating health as a product of individual biology or individual behavior, a biocultural approach situates the body within the broader political and ecological contexts that shape its development and vulnerability (1). The purpose of this paper is to apply cultural anthropology frameworks to the relationship between environmental pollution, maternal mental health, pregnancy outcomes, and cultural meaning-making in low-resource communities.

Environmental exposure is one of the most consequential determinants of maternal health and pregnancy outcomes, and its extent can vary widely by socioeconomic status and race. Individuals who reside in low-resource communities tend to experience greater exposure to both indoor environmental toxins, such as inadequate ventilation and home-based pollutants, and outdoor environmental toxins, including vehicle exhaust, industrial pollution, and heat exposure (2). Environmental injustice and systemic racism influence the spatial distribution of these hazards, placing low-resource communities closer to sources of contamination while distancing them from environmental protections.

Pollution exerts a dual impact on maternal health. First, it is associated with biological harm through mechanisms including oxidative stress, systemic inflammation, placental disruption, and increased risk of hypertensive disorders and poor birth outcomes. Second, it functions as a chronic psychosocial stressor, generating anxiety, uncertainty, and a sense of helplessness in women who recognize the danger but have little power to escape it. In this sense, environmental exposure is both embodied and interpreted: women feel pollution in their bodies, but they also make sense of it through cultural beliefs about causation, blame, fate, and accountability (1, 3). A biocultural approach is therefore required, one that encompasses both the material impacts of pollution and the meanings attached to illness in everyday life.

Four claims anchor the analysis that follows. First, exposure patterns in low-resource communities reflect systematic environmental racism and structural violence—discriminatory zoning, redlining, and infrastructure neglect that generate, rather than merely permit, unequal pollution burdens, while economic constraints prevent affected families from relocating away from these hazards. Second, pollution poses risks to maternal-fetal health through the dual-burden pathway introduced above: biological mechanisms operate alongside chronic psychosocial stress generated by the awareness of unavoidable risk. Third, pregnancy constitutes a period of biocultural vulnerability in which the explanatory models mothers hold about illness—whether framed as natural, fated, structurally unjust, or a personal failing—shape neuroendocrine load and coping capacity, and public health messaging that raises risk awareness without expanding the structural capacity to act can itself become a source of distress. Fourth, because environmental hazards are socially distributed, their health costs may be transmitted intergenerationally, first through maternal exposure and subsequently to children through the biological processes of pregnancy (4). The sections that follow develop each of these claims in turn, and the recommendations that emerge from them—trauma-informed clinical care and structural policy reform—are introduced and developed where the evidence for each arises, rather than reserved for the conclusion.

ENVIRONMENTAL EXPOSURES IN LOW-RESOURCE COMMUNITIES

Indoor and Outdoor Exposures and Pollution

Indoor and outdoor environmental exposures refer to the exposure of individuals to harmful physical, chemical, and environmental stressors in their immediate surroundings. Indoor exposure includes contact with harmful substances, inadequate ventilation, and toxins present within substandard housing. Outdoor exposure includes fine particulate matter (PM2.5), traffic pollution, industrial emissions, and extreme heat, particularly in highway-adjacent, industrial, and urban heat island settings. Pollution may be broadly defined as the introduction of harmful substances into the air, water, and land, with measurable negative impacts on human health.

The Structural Distribution of Environmental Burdens

In low-resource communities, indoor and outdoor exposure is not an episodic experience but a continuous

one. The distribution of environmental burdens is fundamentally linked to social, economic, and racial hierarchies, which operate along what environmental justice scholars describe as the "path of least resistance." Polluting infrastructure, heavy industry, and high-traffic transit corridors are disproportionately sited in low-resource communities, which frequently lack the political leverage, financial capital, and legal resources needed to challenge governmental zoning decisions or corporate development.

Environmental risk is therefore unevenly distributed, with low-resource populations bearing a disproportionate share of ecological harm while wealthier communities retain the ability to secure relative environmental safety in cleaner, more resourced neighborhoods. The clustering of environmental hazards in low-resource areas is rarely accidental; it is instead a consequence of decades of discriminatory urban planning. Housing policies such as mid-twentieth-century redlining systematically devalued minority and low-income neighborhoods, which were subsequently zoned for industrial use. Those same neighborhoods continue to suffer from a lack of protective green infrastructure, overcrowded substandard housing, and proximity to local pollution sources. Disinvestment and industrial zoning suppress property values, creating a structural trap: families in low-resource communities remain confined within polluted areas because their housing alternatives are severely limited.

Mechanisms and Health Consequences of Exposure

Individuals in low-resource communities encounter pollution through inhalation, ingestion, and dermal contact during ordinary daily activities such as cooking, commuting, and sleeping. Indoor exposure is commonly associated with biomass fuel combustion and poor ventilation, while outdoor exposure results from proximity to highways, industrial facilities, and urban zones with high concentrations of fine particulate matter (PM2.5) and nitrogen oxides. These exposures are continuous, often beginning before conception and persisting throughout pregnancy—and the structural conditions of poverty and unjust zoning severely limit the ability of affected individuals to reduce their exposure.

The health consequences of these exposures are both physical and psychological. Pollution particles can enter the circulatory system and reach the placenta, where they trigger inflammation, reduce blood flow, and impair fetal development, contributing to respiratory and cardiovascular problems, preterm birth, and low birth weight (1, 5). Because exposure is ongoing rather than episodic, it also generates sustained psychological stress: the combination of recognized environmental risk and structural inability to act on that risk produces chronic worry, which in turn activates the body's stress response systems. Elevated cortisol and disrupted hormonal regulation during pregnancy have been linked to increased rates of prenatal anxiety, postpartum depression, and overall psychological distress (6).

BIOLOGICAL PATHWAYS LINKING POLLUTION TO MATERNAL HEALTH AND PREGNANCY OUTCOMES

Table 1 summarizes the key empirical studies discussed in this section and in the section that follows, organized by population, exposure type, and primary outcome. In order to fully comprehend the impact of environmental injustice on maternal health and pregnancy outcomes, clinical outcomes must be understood in light of the pathophysiological pathways activated by toxicant exposure. Inhaled contaminants, particularly fine particulate matter and gaseous oxides, do not remain confined to the respiratory system. Instead, their small size enables them to penetrate deeply into the pulmonary alveoli, cross the blood-air barrier, and enter systemic circulation. Once in the bloodstream, these substances act as catalysts for a cascade of biological disturbances marked by systemic inflammation, oxidative stress, and endothelial dysfunction, endangering both maternal biology and fetal development.

Postpartum Depression

Exposure to environmental pollution during pregnancy has been increasingly linked to higher rates of postpartum depression, as shown across multiple studies. In a study conducted in Mexico City, researchers found that pregnant women exposed to higher levels of particulate matter had elevated symptoms of postpartum depression, such as anhedonia, six months after giving birth (7). The findings demonstrate how pollution may interfere with neurological and hormonal systems, particularly through inflammation and disruption of the body's stress-response system. Similarly, a 2024 study examining traffic-related air pollution found that women exposed to higher levels of nitrogen oxides, especially in low-resource communities, showed increased symptoms of postpartum depression and anxiety (8). These effects were particularly pronounced in low-resource communities and in women who experienced pregnancy complications such as hypertension, indicating that

Table 1. *Summary of key empirical studies linking environmental exposure to maternal mental health outcomes discussed in the Biological Pathways and Pollution as a Psychosocial Stressor sections. Bracketed numbers correspond to the reference list.*

Study	Location	Population	Exposure Type	Outcome	Main Finding
Niedzwiecki *et al*., 2020 (7)	Mexico City, Mexico	Pregnant women	Fine particulate matter (PM2.5)	Postpartum depression	Higher PM2.5 exposure associated with elevated depressive symptoms, including anhedonia, at six months postpartum.
Hu *et al*., 2024 (8)	United States	Pregnant women in low-resource communities	Traffic-related air pollution (nitrogen oxides)	Postpartum depression and anxiety	Nitrogen oxide exposure combined with hypertensive disorders of pregnancy was associated with increased postpartum depressive and anxiety symptoms.
Bastain *et al*., 2021 (MADRES cohort) (3)	Los Angeles, USA	Pregnant women	Nitrogen dioxide (NO2), fine particulate matter (PM2.5)	Postpartum depression	Second-trimester NO2 exposure more than doubled the likelihood of depression at 12 months postpartum; PM2.5 exposure also increased risk.
Ji *et al*., 2024 (2)	Los Angeles, USA	Pregnant women and newborns	Prenatal air pollution	Inflammatory, cardiovascular, and metabolic biomarkers	Prenatal exposure was associated with altered inflammatory, cardiovascular, and metabolic biomarkers in mothers and newborns.
Lamichhane *et al*., 2021 (12)	Seoul, South Korea	Pregnant women	Ambient air pollution (nitrogen dioxide)	Anxiety and depressive symptoms	NO2 exposure, particularly during the second trimester, was associated with significantly higher rates of anxiety symptoms.
Li *et al*., 2021 (11)	Nanjing, China	Pregnant women	Fine particulate matter (PM2.5)	Anxiety / perceived mental stress	PM2.5 exposure was associated with an approximate 13.76% increase in anxiety disorders; risk awareness amplified distress.
Lamichhane *et al*., 2021 (13)	South Korea	Pregnant women	Ambient air pollution	Perceived stress	Air pollution exposure was associated with elevated perceived stress, correlated with anxiety-related symptoms.
Xavier *et al*., 2023 (9)	Natal, Brazil	Pregnant women with hypertensive disorders of pregnancy (n = 501)	Not applicable (clinical hypertensive-disorder cohort)	Maternal and neonatal complications	49% had gestational hypertension; severe preeclampsia/eclampsia was associated with higher rates of emergency cesarean delivery, NICU admission, perinatal death, and preterm birth before 34 weeks.

pollution and existing health stressors can interact to worsen mental health outcomes. Further evidence from the MADRES cohort study reinforces the long-term impact of pollution on maternal mental health: researchers found that exposure to nitrogen dioxide during the second trimester was associated with more than double the likelihood of experiencing depression up to 12 months postpartum, while exposure to fine particulate matter also significantly increased risk (3). This highlights not only the importance of the timing of exposure during pregnancy, but also the lasting effects pollution can have well beyond childbirth. In conclusion, the findings from these three studies suggest that air pollution is associated with postpartum depression, potentially through hormonal imbalance and the indirect amplification of other health vulnerabilities such as weakened immune systems (3, 7).

Placental Disruption and Inflammation

Placental structure and cell destruction are the shared proximal factors responsible for adverse delivery results. The placenta, rather than being a solid shield, represents a highly adaptable organ participating in nutrition transfer, barrier immunoprotection, and endocrine regulation, which serves as a target organ for environmental toxicity (5). Air pollution, both indoor and outdoor, exerts its influence on placental development via three related mechanisms: local inflammation, cellular oxidation, and vascular remodeling failure (1). At the cellular level, inhaled air pollutants increase the production of reactive oxygen species (ROS), which trigger nitrosative/oxidative stress, causing mitochondrial dysfunction and metabolism dysregulation in placental cells (1, 2). The resulting effect triggers an elevation in the production of pro-inflammatory cytokines by placental tissues, such as C-reactive protein (CRP), interleukin-6, and TNF-α (2). This local "oxi-inflammation" chain of events results in increased permeability of the barrier system at the placental level, through which environmental biomarkers can enter the bloodstream and interfere with hormone regulation in the fetus (2, 5). As a result, exposure to air pollution during pregnancy is associated with the emergence of altered inflammatory, cardiovascular, and metabolic biomarkers in mothers and babies, which may prime the fetal environment for constant stress before birth (2).

Hypertensive Disorders

This combination of systemic inflammation and oxidative stress is associated with serious damage to the maternal cardiovascular system. Normal pregnancy requires the remodeling of uterine spiral arteries to ensure low-resistance and high-volume blood flow to the developing fetus. However, persistent exposure to environmental contaminants, circulating cytokines, and reactive oxygen species is associated with endothelial dysfunction, including vascular stiffness and constriction (1). When environmental contaminants reach the maternal-fetal interface, arteries constrict and uterine vascular resistance increases (1). Due to the resulting hypoxic microenvironment, the maternal heart must pump blood at significantly higher pressure, increasing the risk of gestational hypertension and preeclampsia (5). These pollution-related health hazards are supported by empirical evidence. A study by Xavier *et al.* found that among 501 pregnant women with hypertensive disorders, 49% had gestational hypertension and others experienced severe preeclampsia or eclampsia (9). Women with severe preeclampsia or eclampsia were at significantly increased risk for emergency cesarean delivery, prolonged hospitalization, NICU admission, perinatal death, and premature birth before 34 weeks gestation (9). These findings suggest that pollution-related inflammation and vascular dysfunction may contribute to severe maternal and neonatal complications.

Why This Matters in Low-Resource Settings

These physiological systems carry particular weight in low-resource settings, since these biological processes do not operate in isolation. Rather, they coexist with the socio-environmental stressors already present in these communities in a synergistic way. Women in low-resource communities carry higher allostatic load due to poor nutrition, housing insecurity, and economic constraints (10). When pollution-induced endothelial dysfunction and placental inflammation are introduced to a body already predisposed to prolonged socioeconomic stress, the maternal system lacks the physiological reserves to withstand the resulting physiological and psychological burden. Furthermore, due to structural zoning imbalances, these communities are subjected to continual, inescapable environmental exposures, denying their cardiovascular and neuroendocrine systems the recovery intervals that wealthier groups enjoy. As a result, the biological mechanisms of pollution may connect structural poverty to severe, life-threatening clinical crises such as preeclampsia and neonatal death.

Pollution as a Psychosocial Stressor

Pollution has traditionally been understood from a biomedical perspective, in which harm follows directly from inhaling or otherwise absorbing toxicants. Pollution may also be understood as an effective psychosocial stressor. For pregnant women, pollution can function as both a physical hazard and a perceived psychological threat, affecting mental health irrespective of whether or not they breathe polluted air.

The Perceived and Lived Environmental Threat

Environmental pollution emerges as a major source of psychosocial stress in the sense that it turns the surroundings of a pregnant woman from being protective to becoming a menace every day. Unlike psychological stressors that often have a clear beginning and end, pollution is an omnipresent, often invisible danger that forces individuals to rely on sensory cues, such as the smell of smog, a visible layer of haze, or the grit of particulate matter, to evaluate their safety. Another

factor that exacerbates this issue is the maternal instinct to protect the fetus. The notion of her own biological system endangering the life growing inside her womb significantly changes her perception of her surroundings.

How Uncertainty, Helplessness, and Chronic Vigilance Shape Maternal Stress

The psychological impact of pollution on maternal well-being is shaped by a cycle of uncertainty, helplessness, and constant vigilance. Pregnant women face significant ambiguity about the precise bounds of safety, continually confronting unanswered questions about how microscopic exposures may affect their child's long-term development. This uncertainty is accompanied by a strong sense of helplessness, as air quality is a systemic issue that an individual cannot easily manage, avoid, or resolve, resulting in a state of psychological distress in which protective maternal instincts are frustrated. This arrangement leaves the mother in a state of perpetual vigilance, involving behaviors such as constantly checking air quality applications, sealing windows, and modifying her schedule, all of which keep the sympathetic nervous system continuously activated, limiting the psychological relaxation needed to alleviate chronic stress.

How Awareness of the Risk Worsens Distress

While public health education is vital for physical protection, growing awareness of environmental risks can threaten maternal psychological well-being: heightened knowledge can be self-defeating, undermining the expectant mother's peace of mind. Once a pregnant woman becomes closely familiar with the possible negative consequences that might follow exposure to toxic chemicals—including low birth weight, premature delivery, and brain development disorders—information overload can turn general background concern into acute distress. This is corroborated by clinical research showing an approximate 13.76% increase in anxiety disorders among women with high awareness of environmental threats (11). This psychological stress, produced by heightened risk awareness, in turn generates additional physiological stress by elevating cortisol and adrenaline levels in the body.

Anxiety

The link between air pollution and anxiety disorders among pregnant women has been repeatedly observed across multiple studies. A prospective cohort study conducted in Seoul, South Korea, found that exposure to ambient air pollution, particularly nitrogen dioxide, was associated with significantly higher rates of anxiety symptoms among pregnant women, especially during the second trimester (12). Similarly, a study conducted in Nanjing reported that exposure to PM2.5 pollution increased the likelihood of anxiety disorders by approximately 13.76%, with women who were highly aware of pollution risks showing greater psychological distress (11). Research published in Scientific Reports further demonstrated that air pollution increases perceived stress levels among pregnant women, which are closely associated with anxiety-related disorders (13). Together, these studies suggest that environmental pollution is associated with anxiety disorders through both physiological stress responses and heightened psychological awareness of environmental danger (11-13).

CULTURAL INTERPRETATION OF ILLNESS

Medical anthropology distinguishes between disease and illness, a concept developed by Arthur Kleinman (14). Disease refers to the biological condition, while illness refers to how people interpret and give meaning to symptoms through cultural and social beliefs (14). Women living in low-resource, polluted environments experience both, as pollution increases risks such as miscarriage while mothers simultaneously develop explanatory models that shape stress levels and healthcare decisions. Illness is often normalized, making symptoms appear to be a regular part of life, which may help psychological coping but delay medical care (14). Some women interpret illness as fate or divine will, reducing guilt while also lowering motivation to prevent harm, whereas others understand illness as a form of structural injustice tied to poverty and environmental neglect (14). At the same time, some mothers internalize illness as personal failure despite limited structural control, contributing to significant psychological distress. This reflects a broader gap between perceived control and actual control under conditions of structural inequality (14). When responsibility feels high but control remains low, chronic stress can develop, increasing cortisol levels and the risk of preterm birth and low birth weight (12). Interventions that focus solely on individual behavior often fail because they neglect the structural and cultural barriers limiting women's ability to reduce environmental risk. The following section develops two implications of this gap between perceived and actual control: the need for trauma-informed clinical care that engages patients' own explanatory models, and the need for structural

policy reform that expands the actual control women have over their environments.

IMPLICATIONS FOR CARE AND POLICY

The evidence reviewed above—biological, psychosocial, and cultural—points toward two implications that are developed here rather than introduced only as closing recommendations.

The first is the need for trauma-informed clinical care. Because pollution operates simultaneously as a physiological stressor and a psychosocial one, prenatal care that addresses only physical symptoms risks missing the anxiety, hypervigilance, and helplessness that chronic environmental exposure can produce, as described above in the discussion of pollution as a psychosocial stressor. Trauma-informed approaches—screening for environmental-related distress, validating patients' perceptions of risk rather than dismissing them as excessive, and coordinating between obstetric and mental health providers—are consistent with the dual-burden pathway described throughout the Biological Pathways section. Because explanatory models of illness vary, as discussed above, trauma-informed care in this context also requires clinicians to ask how a patient understands her own risk, rather than assuming a single biomedical framework will resonate with every woman.

The second is structural policy reform. The Structural Distribution of Environmental Burdens section outlined how discriminatory zoning, redlining, and industrial siting concentrate pollution in low-resource communities and constrain residents' ability to relocate. Because the awareness paradox identified above means that risk communication alone can increase distress without reducing exposure, policy reform aimed at the sources of exposure—zoning reform, enforcement of air-quality standards near residential areas, and investment in green infrastructure—is a necessary complement to individual-level clinical intervention rather than a substitute for it.

Together, these implications reflect the paper's central argument: individual-level interventions cannot resolve health disparities that originate in structural conditions, and clinical responses to maternal distress should be paired with efforts to change the environments that produce it.

CONCLUSION

This narrative review suggests that environmental exposures in low-resource communities represent a complex structural problem with serious consequences for maternal mental health and pregnancy outcomes, one that appears to operate through the combined influence of biological processes and psychological variables. Drawing on evidence from studies of placental inflammation and hypertension, as well as frameworks of toxic stress, cultural illness interpretation, and structural violence, the paper argues that pollution can be understood as structural violence made visible in the body. The findings highlight a key awareness paradox: public health efforts to improve environmental risk literacy, when delivered without structural mitigation, may unintentionally worsen maternal anxiety and add to the physiological stress burden they are meant to reduce. As discussed above, achieving reproductive equity requires moving beyond individual-level interventions toward the trauma-informed clinical care and systemic policy reform outlined in the preceding section, addressing the discriminatory zoning practices and environmental neglect at the root of these inequities. Recognizing the dual burden of physiological injury and psychological suffering is essential for designing integrative interventions that support the health of mothers and their pregnancies in low-resource communities.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest related to this work.

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