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Metabolic Gateways and Ecological Threats: An Integrative Review of Nutritional Status as a Master Modifier of Climate-Sensitive Infectious Disease Outcomes

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Abstract

Background: Anthropogenic climate change is worsening the global impact of climate-sensitive infectious diseases, especially vector-borne and waterborne illnesses, while also threatening food systems and nutritional security. This creates a harmful cycle where nutritional deficiencies weaken resistance to infections, which in turn exacerbates nutritional depletion, leading to declining health in populations. This interaction presents a significant challenge for clinical practice and public health surveillance.

Aim: This narrative review synthesizes evidence on the bidirectional pathophysiology connecting chronic systemic inflammatory diseases (CSIDs) and malnutrition, proposing an integrative framework for clinicians and environmental epidemiologists to collaboratively address this health burden.

Methods: A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, and Google Scholar for peer-reviewed articles, systematic reviews, and grey literature from 2010-2024.

Results: The analysis reveals strong evidence for pathophysiological synergies: deficiencies in vitamin A, zinc, and iron impair immune response to key CSIDs, while infections like malaria and diarrheal diseases drive nutrient loss and anemia. Current health systems operate in silos, missing crucial interactions. Our proposed framework integrates environmental exposure data with clinical nutrition indicators in electronic medical records (EMRs), standardizes nursing-led vulnerability assessments, and establishes protocols for combined nutritional and antimicrobial interventions.

Conclusion: The climate crisis necessitates a shift from pathogen-centric to person-centric care models. Integrated approaches combining clinical medicine, nutrition, and environmental science are vital for enhancing population resilience, breaking the infection-malnutrition cycle, and bolstering health security in a warming world.

Keywords: Climate-Sensitive Infectious Diseases, Nutritional Immunology, Syndromic Surveillance, Planetary Health, Clinical-Environmental Integration.

Introduction

The 21st century has ushered in an era defined not by singular pathogenic threats, but by complex, interacting syndemics—synergistic epidemics that cluster within populations and are driven by shared, overarching social and environmental conditions (Tsai et al., 2017). The most profound of these is the syndemic forged by anthropogenic climate change, which acts as a central force multiplier, simultaneously intensifying two of humanity's oldest and most devastating adversities: infectious disease and malnutrition. This convergence represents the defining health challenge of our time, a "perfect storm" where ecological disruption drives biological hazards into closer and more frequent contact with nutritionally compromised human hosts, creating a cycle of escalating vulnerability and harm (Singer et al., 2021).

Climate change is rapidly and unequivocally reconfiguring the ecological determinants of health. Rising global temperatures, altered hydrological cycles, and increased frequency of extreme weather events are expanding the geographic range and seasonal windows for a host of climate-sensitive

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infectious diseases (CSIDs). Vectors such as *Aedes aegypti* and *Anopheles* mosquitoes are finding hospitable habitats at higher altitudes and latitudes, bringing dengue, chikungunya, and malaria to naïve populations. Warmer waters accelerate the replication of pathogens like *Vibrio cholerae*, while intense rainfall and flooding events overwhelm sanitation infrastructure, spreading waterborne diarrheal diseases and creating stagnant pools for vector breeding (Rocklöv & Dubrow, 2020; Levy et al., 2016). Concurrently, these same climatic shocks—droughts, heatwaves, floods, and unpredictable growing seasons—are destabilizing global and local food systems. They reduce agricultural yields, compromise the nutritional density of staple crops, disrupt food distribution chains, and diminish household access to diverse, nutrient-rich foods (Springmann et al., 2021; Myers et al., 2017). The result is a dual burden: a heightened risk of exposure to pathogenic threats occurring in tandem with a rising prevalence of protein-energy malnutrition and specific micronutrient deficiencies, most acutely felt by the world's most marginalized communities (Agostoni et al., 2023).

Critically, these parallel crises are not merely co-occurring; they interact with devastating synergy within human biology, creating a pathophysiological feedback loop far more damaging than the sum of its parts. Nutritional status serves as the fundamental substrate for immune competence. Deficiencies in key micronutrients—such as vitamin A, zinc, iron, and selenium—compromise epithelial barrier integrity, blunt innate immune responses, and impair adaptive cell-mediated and humoral immunity, creating a state of "nutritionally acquired immunodeficiency" (Wintergerst et al., 2007). This renders individuals more susceptible to initial infection, increases the likelihood of severe clinical manifestations, and prolongs recovery. Conversely, infection acts as a powerful catabolic agent and nutrient drain. Febrile illnesses increase metabolic demand, while gastrointestinal pathogens cause direct nutrient malabsorption and loss. Furthermore, the systemic inflammatory response triggered by infections like malaria or leptospirosis actively sequesters circulating iron and zinc, making them biologically unavailable and exacerbating anemia, a condition often misinterpreted as solely dietary in origin (Farhadi & Ovchinnikov, 2018; Schaible & Kaufmann, 2007). This creates a pernicious bidirectional cycle: malnutrition begets more severe infection, and severe infection deepens malnutrition, trapping individuals—particularly children in critical developmental windows, pregnant women, and the immunocompromised elderly—in a downward spiral of recurrent illness, growth faltering, cognitive impairment, and elevated mortality (Caulfield et al., 2004).

Despite the robust, long-established evidence for this malnutrition-infection cycle, contemporary health systems remain poorly architected to address its complexity. Clinical management and public health surveillance persist in deeply entrenched silos. In clinical settings, the acute infectious presentation typically commands full attention; underlying nutritional deficits are frequently screened for only in severe, overt cases, if at all. Internists and infectious disease specialists may expertly manage antimicrobial therapy while overlooking the modifiable host factor of nutritional status that critically influences therapeutic success and recovery. Conversely, nutrition programs often operate in isolation from infectious disease control efforts. Meanwhile, in the realm of public health, environmental and epidemiological models excel at predicting pathogen exposure risk based on climatic variables but rarely integrate real-time data on community-level nutritional vulnerability, which is a key determinant of outbreak severity and population impact. This fragmented approach constitutes a critical failure of strategy in the face of a synergistic threat.

This narrative review, therefore, contends that mitigating the escalating health burden of climate change demands nothing less than an integrative paradigm shift—a move from siloed, single-disease models towards a holistic, syndemic framework. We aim to synthesize the latest evidence detailing the specific pathophysiological synergies between key climate-sensitive pathogens and nutritional deficiencies. Moving beyond mere description, our central objective is to propose a pragmatic, actionable framework designed to bridge the chasm between clinic and community, between individual care and population health. This framework is built to equip frontline clinicians—especially nurses and internists—and environmental epidemiologists with the shared tools, protocols, and data systems necessary for the collaborative detection, management, and primary prevention of this convergent crisis. It emphasizes the vital role of enhanced nursing assessment in identifying at-risk individuals, advocates for targeted nutritional interventions as a standard adjunct to infectious disease therapy, and champions the strategic redesign of medical records to function as engines for syndromic surveillance, capable of detecting the early signals of this climate-nutrition-infection nexus as it emerges in vulnerable populations.

Climate Change as an Amplifier of Ecological and Nutritional Risk

The mechanisms by which climate change amplifies disease and nutritional risk are multifaceted and interconnected. Rising global temperatures, altered precipitation patterns, and increased frequency of extreme weather events directly influence the life cycles, geographic ranges, and transmission dynamics of pathogens and their vectors (Wu et al., 2016). Warmer temperatures accelerate parasite development in mosquitoes (e.g., *Plasmodium* spp., dengue virus), expand suitable habitats for vectors like *Aedes aegypti*, and increase the replication rates of waterborne pathogens like *Vibrio cholerae* (Mordecai et al., 2019). Extreme rainfall and flooding contaminate water sources with enteric pathogens and create breeding grounds for mosquitoes, while droughts can concentrate pathogens in limited water supplies and force migration, increasing exposure risks (Teymouri & Dehghanzadeh, 2022).

Simultaneously, these same climatic shocks disrupt food systems. Heat stress reduces crop yields and nutritional density, floods destroy harvests and storage, and droughts diminish food and water availability (Naheed, 2023). This leads to a double burden: reduced overall caloric intake and a decline in the dietary diversity necessary to obtain essential micronutrients. The result is the creation of geographic and demographic hotspots where elevated environmental risk for CSIDs overlaps with high prevalence of food insecurity and malnutrition—a perfect storm for synergistic health disasters (Hadley et al., 2023).

The Bidirectional Pathophysiology

The biological interplay between malnutrition and infection, often termed the "malnutrition-infection cycle," is a classic concept that takes on new urgency in the climate context. Malnutrition, whether manifesting as protein-energy malnutrition or specific micronutrient deficiencies, induces a state of immune dysfunction termed "nutritionally acquired immune deficiency." Key deficiencies impair both innate and adaptive immunity: vitamin A deficiency disrupts mucosal barrier integrity and lymphocyte function; zinc is crucial for cellular immunity and cytokine production; iron deficiency anemia limits oxygen delivery and impairs neutrophil and macrophage activity; and selenium and vitamin D deficiencies modulate inflammatory responses (Wintergerst et al., 2007). This compromised host defense lowers the infectious dose required, increases pathogen virulence, prolongs illness duration, and heightens the risk of severe complications and death from CSIDs (Schaible & Kaufmann, 2007).

Conversely, infection precipitates and intensifies malnutrition through multiple pathways. Febrile illnesses like malaria and dengue increase metabolic demand and catabolism, breaking down muscle and fat stores. Gastrointestinal infections, including cholera and other diarrheal diseases, cause direct nutrient loss through malabsorption, increased gut permeability, and anorexia (Guerrant et al., 2008). Furthermore, the systemic inflammatory response to infection (e.g., in leptospirosis or severe dengue) promotes the sequestration of iron and zinc away from circulation as part of the "anemia of inflammation," making these nutrients biologically unavailable even if dietary intake is adequate (Weiss & Goodnough, 2005). This bidirectional relationship means that treating the infection without addressing the nutritional deficit is often insufficient, and providing nutritional support without controlling endemic infection yields limited long-term benefits.

Specific Synergies Between Pathogens and Nutrient Deficits

The bidirectional malnutrition-infection cycle manifests in distinct and clinically significant patterns depending on the specific pathogen and the nature of the nutrient deficit. This pathophysiological specificity means that blanket nutritional support, while beneficial, is less effective than targeted interventions informed by the local disease ecology and common deficiencies. Understanding these nuanced interactions is therefore not merely an academic exercise but a critical prerequisite for designing precise clinical protocols and effective public health strategies. The evidence points to several well-documented syndemic pairs where the synergy is particularly potent and clinically actionable.

The relationship between **malaria and iron/vitamin A** exemplifies both the complexity and the critical importance of context. Iron deficiency anemia is endemic in regions where *Plasmodium* parasites circulate, creating a challenging clinical landscape. The interaction is paradoxical: severe iron deficiency can theoretically limit parasite proliferation by restricting this essential nutrient, potentially offering a degree of protection against initial infection or parasitemia density. However, this "protection" comes at a high cost, as the same deficiency profoundly impairs erythropoiesis, dramatically worsening the severity of malarial anemia—a leading cause of pediatric mortality in endemic zones. This paradox has historically made iron supplementation in malaria-prone areas a subject of intense debate, with concerns that replenishing iron stores could exacerbate infection risk.

Contemporary World Health Organization guidelines, informed by more recent meta-analyses, now advocate for concurrent management—providing iron supplementation alongside effective malaria prevention and treatment—while emphasizing the need for careful clinical monitoring (Prentice et al., 2017). Vitamin A deficiency presents a less ambiguous synergy. It is strongly associated with an increased incidence of clinical malaria episodes and greater severity of disease, likely due to its crucial role in maintaining mucosal integrity and modulating T-cell-mediated immunity. Consequently, vitamin A supplementation programs have demonstrated a consistent, significant reduction in malaria-related morbidity and mortality, underscoring its value as a synergistic intervention (Yakoob & Qadir, 2018).

In the realm of arboviral diseases, the synergy between **dengue and zinc/vitamin D** is gaining recognition as a key modulator of disease severity. Zinc is a cornerstone of antiviral immunity, essential for the development and function of natural killer cells and T-lymphocytes. Low serum zinc levels have been correlated with an elevated risk of progressing from classic dengue fever to severe manifestations like dengue hemorrhagic fever and shock syndrome. The proposed mechanism involves impaired immune containment of the virus and a subsequent exacerbation of the cytokine-mediated vascular permeability that defines severe dengue (Roth et al., 2018). Alongside zinc, vitamin D's immunomodulatory role is increasingly scrutinized. As a potent regulator of the inflammatory response, vitamin D deficiency is hypothesized to contribute to the dysregulated "cytokine storm" observed in severe dengue cases. While large-scale interventional trial data are still maturing, epidemiological studies suggest a compelling association, positioning nutritional status as a potential lever for mitigating severe outcomes in this climate-sensitive disease (Aranow, 2011).

The synergy in **waterborne diarrheal diseases, such as cholera and cryptosporidiosis, with zinc and vitamin A** is arguably the most direct and operationally significant. This interaction forms a vicious, self-perpetuating cycle. Acute diarrhea causes profound zinc loss through fecal excretion, and zinc deficiency, in turn, damages the intestinal mucosa, impairs immune function at the gut barrier, and delays epithelial repair. This results in more prolonged, voluminous, and severe diarrheal episodes and significantly increases the risk of subsequent enteric infections. Recognizing this, the WHO has established zinc supplementation (20 mg daily for 10-14 days) as a standard-of-care adjunct to oral rehydration therapy for all acute childhood diarrhea, a policy that has substantially reduced duration, severity, and mortality (Walker et al., 2013). Vitamin A deficiency operates on a parallel track, compromising the integrity of the gut epithelial barrier and diminishing the function of mucosal immune cells. Vitamin A supplementation has been consistently shown to reduce the incidence, severity, and mortality of diarrheal diseases, particularly in populations where deficiency is prevalent, making it another critical component of an integrated management strategy (Long et al., 2011).

For systemic infections like **leptospirosis**, the data on specific micronutrient interactions are less developed but physiologically compelling. The severe form of the disease is characterized by an intense systemic inflammatory response, multiorgan failure, and profound oxidative stress. This hypermetabolic, hypercatabolic state places enormous demand on protein reserves and depletes endogenous antioxidants like vitamins C and E and selenium (Zavala-Alvarado et al., 2021). While large-scale clinical studies are lacking, it is biologically plausible that poor baseline nutritional status—particularly protein-energy malnutrition and deficiencies in these antioxidant micronutrients—would impair the host's capacity to manage inflammation and tissue repair, thereby acting as a modifier of clinical outcomes and recovery time (Niroomandi et al., 2022). These key pathogen-nutrient synergies are summarized in **Table 1**, which provides a concise reference for the mechanisms and clinical implications of these critical interactions.

Table 1: Key Synergistic Interactions Between Climate-Sensitive Pathogens and Nutritional Deficiencies

Climate-Sensitive Pathogen	Key Associated Nutritional Deficiencies	Mechanism of Synergy	Clinical Implications
Malaria (*Plasmodium* spp.)	Iron, Vitamin A, Zinc	Deficiency impairs cell-mediated immunity & erythropoiesis; infection causes hemolysis & anemia of inflammation.	Increased severity of malarial anemia; higher risk of severe disease & mortality; complicates iron supplementation protocols.
Dengue Virus	Zinc, Vitamin D	Zinc deficiency impairs antiviral T-cell response; Vit D modulates inflammatory cytokine production.	Potential increased risk of progression to severe dengue (hemorrhagic fever/shock syndrome).
Cholera (*Vibrio cholerae*)	Zinc, Vitamin A	Diarrhea causes profound zinc loss; deficiencies damage intestinal mucosa & impair immune response.	More prolonged & severe diarrheal episodes; higher mortality; zinc is a core adjunct therapy.
Cryptosporidiosis	Zinc, Vitamin A	Similar to cholera; especially severe in malnourished children, causing persistent diarrhea & growth faltering.	Leading cause of chronic, debilitating diarrhea in undernourished populations.
Leptospirosis	Protein-Energy, Antioxidants (Vit C, E, Se)	Severe infection induces hypermetabolism, catabolism, and oxidative stress, depleting nutrient reserves.	Poor nutritional status may exacerbate multi-organ failure and delay recovery.

Frontline Assessment and Integrated Care

Nursing professionals are uniquely positioned at the frontline of care to identify and interrupt the malnutrition-infection cycle. Their role extends beyond administering antimicrobials to conducting holistic vulnerability assessments. A Climate-Health-Nutrition Nursing Assessment should be standardized for use in primary care and emergency settings in high-risk regions (Sauer et al., 2016). This assessment includes: Environmental Exposure History: Documenting recent exposure to floods, vector breeding sites, or contaminated water; Dietary & Nutritional Screening: Using simple tools like the Mini Nutritional Assessment (MNA) or mid-upper arm circumference (MUAC) measurement, alongside questions on dietary diversity and food insecurity; and Symptom Surveillance for Synergy: Actively looking for signs where common presentations are compounded (e.g., a child with diarrhea who also has pallor and angular cheilitis suggesting iron and B-vitamin deficiencies) (Sullivan et al., 2022). Nurses are also pivotal in administering and educating on combined interventions, such as coordinating the timing of zinc supplementation with oral rehydration therapy for diarrhea or providing nutritional counseling alongside malaria prophylaxis for pregnant women (Hantoul et al., 2024).

Leveraging Medical Records for Syndromic Surveillance and Clinical Decision Support

The electronic medical record (EMR) is an underutilized asset in combating this syndemic. Currently, data on nutritional status and environmental exposures are rarely structured or codified in ways that facilitate population-level analysis or clinical alerts (Gunasekeran et al., 2021). An integrative framework requires enhanced EMR data fields to include structured data on: food security screening results (e.g., Hunger Vital Sign), key micronutrient status (where available), MUAC/BMI, and potential environmental exposures (e.g., "lives in flood-prone zone," "occupation: rice farmer"). This structured data, when aggregated and anonymized, can power environmental-nutritional syndromic surveillance. Public health departments could monitor, for example, an increase in "acute febrile illness + vitamin D deficiency" codes in a region experiencing a dengue outbreak, or a spike in "watery diarrhea + zinc deficiency" following a flood, enabling more targeted resource deployment and community messaging (Birkhead et al., 2015). Furthermore, EMRs can be equipped with clinical decision support (CDS) tools. For a patient diagnosed with malaria, the CDS could prompt: "Patient has MUAC <125mm. Consider assessing for iron deficiency anemia and providing nutritional counseling and supplementation per protocol." This transforms the EMR from a passive repository into an active tool for integrated care.

A Proposed Integrative Framework for Clinicians and Epidemiologists

To effectively translate the understanding of synergistic burdens into measurable improvements in population health, a deliberate and structured approach to collaboration is essential. Moving beyond theoretical acknowledgment requires a practical, operational framework that systematically bridges the traditional divide between clinical care and environmental epidemiology. We propose a five-pillar integrative framework designed to align the objectives, tools, and workflows of these disciplines, creating a cohesive system for detection, management, and prevention. This framework is not a replacement for existing expertise but a scaffold for its integration, ensuring that the clinician's insight into individual pathophysiology and the epidemiologist's analysis of population-level risk factors inform and reinforce one another (Gentili et al., 2022).

The foundational first pillar is **Unified Risk Assessment**. Current tools typically assess infectious disease risk or nutritional vulnerability in isolation. An integrated approach demands the development of composite risk indices and mapping tools that dynamically overlay geospatial data on climatic variables (e.g., temperature, precipitation anomalies), vector habitat suitability, and water security with sub-national data on food insecurity, dietary diversity, and prevalence of specific micronutrient deficiencies (Wang et al., 2021). Such tools would allow public health officials to identify geographic "hotspots" where high environmental risk for CSIDs coincides with populations exhibiting high nutritional vulnerability, enabling proactive, targeted resource allocation before an outbreak surge (Kraus et al., 2022). At the individual patient level, this translates to clinical intake tools that systematically capture an environmental exposure history alongside standardized nutritional screening, creating a holistic risk profile from the first point of care.

The second pillar, **Standardized Clinical Protocols**, aims to codify integrated management into daily practice. This involves the creation and widespread dissemination of joint clinical guidelines for priority CSIDs—such as dengue, malaria, and acute diarrheal disease—that mandate nutritional assessment as a core component of the diagnostic workup (Kamel Boulos & Zhang, 2021). These protocols must move beyond suggestion to specify evidence-based adjunctive nutritional therapies: for example, explicitly recommending zinc supplementation for all cases of acute watery diarrhea, or outlining the assessment and management of anemia in a patient with malaria, consistent with the latest WHO guidance (Scricciolo et al., 2020; Walker et al., 2013). Such protocols empower frontline clinicians, particularly in resource-constrained settings, with clear, actionable steps to address the synergistic component of disease.

The third pillar, **Interoperable Data Systems**, addresses the critical infrastructure gap. The electronic medical record (EMR) must evolve from a passive documentation tool into an active node in a learning health system. This requires advocating for and designing data standards that incorporate structured fields for core environmental (e.g., “flood exposure in last 30 days,” “occupation: farmer”) and nutritional (e.g., food security screening result, MUAC, relevant micronutrient levels) determinants. This structured data enables two-way flow: clinical findings can be aggregated and anonymized to feed real-time syndromic surveillance systems that track the nutrition-infection nexus, while public health alerts based on environmental risk models can be pushed back into EMRs as clinical decision support prompts for clinicians serving high-risk zip codes (Dash et al., 2019).

The fourth pillar, **Interdisciplinary Education**, targets the human capital necessary for sustained collaboration. It requires curricular reform to foster a shared language and mindset. Medical, nursing, and physician assistant training must incorporate core concepts in environmental epidemiology, such as climate-sensitive disease transmission and the use of geospatial data (Chen et al., 2022). Conversely, public health and epidemiology programs must strengthen training in clinical nutrition, including the interpretation of nutritional biomarkers and the principles of therapeutic dietary intervention. Joint simulation exercises and case-based learning that present complex syndemic scenarios can build the practical skills for interdisciplinary problem-solving (Cohen et al., 2022).

Finally, the fifth pillar, **Community-Coordinated Prevention**, recognizes that the most effective interventions are often upstream and integrated. This involves moving beyond vertical programs to implement bundled, cross-sectoral interventions at the community level. Examples include co-distributing insecticide-treated bed nets with micronutrient-fortified lipid-based supplements for young children, integrating nutrition education and seed distribution for climate-resilient, nutrient-dense crops into malaria control programs, or ensuring that water, sanitation, and hygiene (WASH) projects in flood-prone areas are coupled with nutrition surveillance (Bhutta et al., 2020). This pillar leverages community health workers as critical integrators who can deliver messages and interventions that address both the environmental exposure and the nutritional vulnerability simultaneously. The structure and objectives of this five-pillar framework are detailed in **Table 2**, which outlines the specific actions required from both clinical and epidemiological practitioners.

Table 2: Integrative Framework for Action: Bridging Clinical Care and Environmental Epidemiology

Pillar	Objective	Clinical Actions	Environmental Epidemiology Actions
1. Unified Risk Assessment	Identify high-risk individuals & communities *before* crises.	Implement nursing-led clinic intake screening for food insecurity & environmental exposure.	Develop composite risk maps overlaying climate forecasts, vector habitat, and sub-national food security data.
2. Standardized Protocols	Ensure consistent, evidence-based management of the synergistic burden.	Adopt clinical pathways that mandate nutritional assessment for CSIDs and prescribe adjunctive supplements (e.g., zinc for diarrhea).	Validate & update protocols by analyzing population-level data on how nutritional status modifies outbreak outcomes.
3. Interoperable Data	Create a learning health system that links individual care to population trends.	Document structured nutritional & exposure data in EMRs; use CDS prompts for integrated care.	Build surveillance systems that ingest anonymized clinical data to detect emerging nutrition-infection syndemics.
4. Interdisciplinary Education	Build a shared knowledge base and collaborative capacity.	Include climate-health-nutrition modules in medical, nursing, and public health curricula.	Train field epidemiologists in clinical assessment of malnutrition and its interaction with endemic diseases.
5. Community-Coordinated Prevention	Implement upstream, bundled interventions for resilience.	Lead community health worker programs on integrated prevention (e.g., vector control, nutrition gardens).	Design & evaluate the effectiveness of bundled interventions (e.g., bed nets + micronutrient powders) on disease burden.

Conclusion

The escalating climate crisis is not a future threat but a present-day multiplier of ancient synergies between infection and malnutrition. The traditional, pathogen-centric model of disease management is inadequate for this complex reality. We must advance towards a person-centric, ecological model that views the patient within their environmental and nutritional context. This requires dismantling disciplinary silos between internal medicine, nursing, nutrition, and environmental health. The integrative framework proposed here provides a roadmap for this essential collaboration. By enhancing clinical assessments, leveraging EMRs for intelligent surveillance, and implementing bundled prevention strategies, healthcare systems can build resilience. The goal is to disrupt the vicious cycle of malnutrition and infection, protecting the most vulnerable and securing population health in an increasingly unstable climate. The time for integrated action is now; our response to this converging storm will define health equity and security for decades to come.

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