

Interventions to Safeguard Nutritional Security in Vulnerable Populations in the Context of Urban Resilience and Climate Emergencies

Maria Fernanda Elias* and Tatiana Tucunduva Philippi Cortese

Postgraduate Program in Smart and Sustainable Cities (PPGCIS), UNINOVE, Brazil

***Corresponding Author:** Maria Fernanda Elias, Postgraduate Program in Smart and Sustainable Cities (PPGCIS), UNINOVE São Paulo, Brazil.

Received: August 18, 2025; **Published:** October 06, 2025

DOI: 10.31080/ECNU.2025.20.01206

Abstract

Background: The increasing frequency of climate-related disasters and accelerated urban growth have heightened the risk of food and nutrition insecurity, particularly among vulnerable urban groups such as women and children. Tackling these issues necessitates cohesive strategies that prioritize equity.

Methods: This narrative review draws on interdisciplinary literature, including scholarly publications, United Nations reports, and practical case studies. The analysis is guided by international frameworks such as the Sustainable Development Goals (SDGs), the Sendai Framework, and the Brundtland Report, utilizing a twin-track approach that blends emergency nutrition relief with structural reform.

Results: In the short term, interventions like Ready-to-Use Therapeutic Foods (RUTF), Maternal Micronutrient Supplements (MMS), Micronutrient Powders (MNP), and Small-Quantity Lipid-Based Nutrient Supplements (SQ-LNS) have proven effective in emergency nutrition management. For lasting resilience, coordinated multisectoral policies, inclusive governance, and active community involvement are critical. Initiatives in Brazil, India, and the RUA Project offer practical models for urban nutritional interventions.

Conclusion: Integrating nutrition security into urban disaster risk reduction frameworks through a twin-track model can alleviate vulnerabilities, enhance public health outcomes, and strengthen resilience to climate shocks.

Keywords: Nutritional Security; Urban Resilience; Women and Children; Climate Emergency; Twin-Track Approach; SDGs; Public-Private Partnerships

Abbreviations

SDGs: Sustainable Development Goals; RUTF: Ready-to-Use Therapeutic Food; DRM: Disaster Risk Management; ICDS: Integrated Child Development Services; FAO: Food and Agriculture Organization; WFP: World Food Programme; RUTF: Ready-to-Use Therapeutic Foods; MMS: Maternal Micronutrient Supplements; MNP: Micronutrient Powder; SQ-LNS: Small-Quantity Lipid-Based Nutrient Supplements

Introduction

The convergence of climate change, accelerated urbanization, and persistent social inequalities has deepened food and nutrition insecurity for already at-risk populations. Climate-related disruptions-alongside conflicts, economic instability, high costs of healthy food, and the prevalence of unhealthy food environments, are exacerbating global levels of hunger and malnutrition [1].

Citation: Maria Fernanda Elias and Tatiana Tucunduva Philippi Cortese. "Interventions to Safeguard Nutritional Security in Vulnerable Populations in the Context of Urban Resilience and Climate Emergencies". *EC Nutrition* 20.2 (2025): 01-14.

Globally, an estimated 735 million people remain undernourished, with approximately 148 million children under five experiencing stunted growth. Anemia affects about 571 million women and adolescent girls aged 15 to 49, while over 2.5 billion adults are overweight or obese, reflecting a growing global burden of diet-related non-communicable diseases. These trends are shaped not only by the climate crisis, but also by demographic shifts, income growth, and increased demand for animal-sourced foods, which affect the availability, access, and quality of food worldwide [2].

Climate variability disrupts food production by triggering extreme weather phenomena-droughts, floods, and heatwaves-that harm crop yields and livestock productivity. These disruptions strain food systems, often resulting in rising food prices and deteriorating nutritional quality. Urbanization compounds the challenge, increasing demand for food in cities while driving up costs and limiting access, particularly in peripheral urban zones. Infrastructure limitations and competition for essential services further undermine food distribution efficiency. Projections estimate that, by 2050, cereal prices could rise between 1-29% due to climate change, potentially pushing an additional 1 to 183 million people into a state of hunger compared to a baseline scenario without climate effects [3].

Social disparities such as poverty, resource inaccessibility, and systemic marginalization intensify communities' exposure to climate and urbanization risks. Populations excluded from resources are less able to adapt, face discrimination in food systems, and often endure the worst of food insecurity's impacts, reinforcing cycles of vulnerability [3].

Women and children in impoverished urban settings are especially at risk of malnutrition following disasters. Women comprise the majority of the food-insecure population worldwide-accounting for 60% of the current 690 million individuals facing hunger. In lower-income households, women often sacrifice their own food intake to prioritize children, exacerbating maternal malnutrition during critical periods such as pregnancy and breastfeeding. Crises such as income loss, supply chain breakdowns, or displacement further disrupt food access, disproportionately affecting women, who are frequently responsible for household nutrition [4].

Furthermore, disasters often erode women's economic independence. Many work in informal sectors-like domestic labor or street vending-that lack legal protection, limiting their access to food assistance or resources needed for recovery. This economic marginalization increases nutritional vulnerability, particularly when compounded by restricted access to healthcare and social services. Additionally, displaced women-headed households may end up in shelters that provide food of inadequate nutritional value or that do not meet cultural dietary needs [5].

Children under five are at heightened risk for wasting and micronutrient deficiencies, while adolescent girls in these environments face elevated risks of early pregnancy and chronic undernutrition. The post-disaster nutritional landscape is shaped by more than food scarcity; it reflects intersecting inequalities related to gender, poverty, and geography. As a result, nutrition programming in urban areas must prioritize equity and be designed with the specific vulnerabilities of women and children in mind [5].

Global frameworks such as the Sustainable Development Goals (SDGs)-particularly SDG 2 ("Zero Hunger") and SDG 11 ("Sustainable Cities and Communities")-demand urgent action to secure equitable access to nutritious food. SDG 2 aims to eliminate hunger, ensure food security, and promote sustainable agriculture with special attention to vulnerable groups. SDG 11 focuses on creating inclusive, resilient, and sustainable cities. These goals are mutually reinforcing, as urban food systems play a critical role in achieving them [6].

The Brundtland Report (1987), which first defined sustainable development as a balance between economic, environmental, and social dimensions, highlighted the interdependence of such goals [7]. These principles are further strengthened by the Sendai Framework for Disaster Risk Reduction, which promotes resilience across sectors, including health and food systems. The framework outlines four priority actions: (1) understanding disaster risk, (2) strengthening disaster risk governance, (3) investing in risk reduction for resilience, and (4) enhancing preparedness for effective response. The aim is to reduce mortality, minimize disruption, and improve infrastructure resilience while ensuring broad participation and cooperation across all levels [8].

Particularly, Priority 4 focuses on effective emergency response and the principle of “building back better”, which includes creating and testing emergency response plans; enhancing the capacities of responders and communities; and ensuring rapid and equitable reconstruction efforts. Such planning supports long-term recovery and promotes community empowerment [8].

Urban areas-reliant on vulnerable supply chains-are especially susceptible to climate disruptions like floods and heatwaves, which compromise food safety, accessibility, and affordability. Thus, ensuring nutrition security in cities must be an integral component of disaster risk management. Urban planning must embrace inclusive, gender-sensitive strategies aligned with both SDG 2 and SDG 11, while incorporating the resilience objectives set forth in the Sendai Framework. This integrated approach offers a pathway toward a more just, sustainable, and food-secure urban future.

This review aims to synthesize interdisciplinary evidence on emergency nutrition interventions and their integration into urban resilience frameworks, particularly in the context of climate-related disasters. The significance of this study lies in its policy-oriented approach that bridges short-term nutrition response and long-term structural reform through a twin-track model. By highlighting scalable and cost-effective strategies, especially for women and children in vulnerable urban settings, the review contributes to advancing both disaster preparedness and sustainable development agendas.

Methods

This article follows a narrative review methodology designed to synthesize interdisciplinary evidence on nutrition interventions that enhance urban resilience in the context of climate emergencies. The review uses a thematic and policy-oriented approach, examining case studies, global frameworks, and programmatic interventions targeting vulnerable populations, particularly women and children.

A systematic search was conducted from the Brundtland Report publication in 1987 to January 2025 across major databases, including PubMed, Scopus, Web of Science, Google Scholar, and the UN/NGO agency repositories (e.g. FAO, WFP, UNICEF, WHO, UNDRR). This search initially identified over 25,000 records that were screened and reduced to approximately 130 peer-reviewed articles, complemented by over 30 policy reports and field manuals from international organizations and NGOs. Grey literature from governmental reports, UN technical briefs, NGO field manuals, and international development programs (e.g. Brazil’s Zero Hunger, India’s ICDS, RUA project) was also included to capture real-world evidence and program outcomes not presented in peer-reviewed literature.

Keywords and Boolean operators used in the search considered (“nutrition security” OR “food security”) AND (“urban resilience” OR “climate emergency”) AND (“twin-track approach” OR “RUTF” OR “MMS” OR “MNP” OR “SDGs” OR “Sendai Framework”) AND (“women” OR “children” OR “vulnerable populations”).

As an inclusion criteria the research considered peer-reviewed studies, policy reports from United Nations agencies (World Health Organization, World Food Programme, Food and Agriculture Organization of the United Nations, United Nations Children’s Fund, United Nations Office for Disaster Risk Reduction) and field reports from 1987-2025; studies on nutrition interventions in urban or climate-affected settings; and research focused on women, children, or vulnerable urban groups. As exclusion criteria, the review does not consider non-English publications; studies focused on rural food systems only; articles lacking methodological transparency; opinion papers; and food and agriculture production data without nutrition links.

A thematic synthesis was then conducted to highlight convergences across disciplines (public health, disaster risk reduction, urban planning, and development economics). The evidence was interpreted through a twin-track lens (short-term relief + long-term systemic reform), with particular attention to scalability, inclusivity, and cost-effectiveness. Table 1 outlines the main sources identified through the literature review, which form the basis of the thematic analysis presented in the Results section. While Table 1 highlights key representative documents, the full review included over 30 official publications from multilateral agencies (FAO, WFP, WHO, UNDRR).

Author/Source	Region	Type of Document	Focus	Intervention(s)
UNICEF (2023)	Global	UN Report	Nutrition in Emergencies	RUTF, MMS, MNP
ENFAC Study (Brazil, 2024)	Brazil	Clinical Trial	Infant anemia prevention	Micronutrient Powders (MNP)
Ghosh., <i>et al.</i> (2022)	India	Literature Review	Localized food supplementation	RUTF, MNP
World Bank (2022)	Global	Policy Brief	Climate-Food-Nutrition Nexus	Urban resilience framework
Jahan and Thomson (2018)	Bangladesh	Case Study	Post-flood child nutrition	MNP distribution
RUA Project (2024)	Brazil	Multi-stakeholder Program	Urban disaster resilience	Governance and emergency nutrition
FAO (2010, 2024)	Global	Strategic Framework and SOFI Report	Food and Nutrition Security; Twin-Track Approach	Twin-Track Policy Model
WFP (2017, 2023)	Global	Field Manual and Response Plan	Emergency nutrition and operations	RUTF, Emergency Preparedness
WHO (2021)	Global	Programming Guidance	Maternal nutrition and MMS rollout	MMS
UNDRR (2015)	Global	International Framework	Disaster Risk Reduction and Nutrition Integration	Sendai Framework Priorities
Lancet Maternal and Child Undernutrition Series (2021)	Global	Medical Journal Series	Evidence-based nutrition interventions	RUTF, MMS, MNP, SQ-LNS
Copenhagen Consensus (2014)	Global	Economic Analysis	Cost-effectiveness of nutrition investments	Micronutrient packages, RUTF
SUN Movement (2016-2020; 2021)	Global	Multi-stakeholder Framework	Nutrition scaling in national strategies	Governance and multi-sectoral action
UNICEF (2013)	Global	UN Position Paper	Ready-to-Use Therapeutic Food guidance	RUTF
WHO/WFP/UNICEF Joint Statement (2007)	Global	Technical Guidance	Community-based SAM management	RUTF
Global Nutrition Report (2021)	Global	Monitoring Report	Global progress on malnutrition	Multiple interventions

Table 1: Summary of key representative sources identified in the literature review (1987-2025). Note: This table is not exhaustive; multiple reports per agency were reviewed to extract programmatic insights.

Results and Discussion

Food insecurity encompasses four critical dimensions-availability, accessibility, utilization, and stability-while nutritional insecurity, though related, specifically highlights inadequate diet quality and nutrient intake, leading to serious health consequences such as stunting, wasting, micronutrient deficiencies, and a growing burden of diet-related chronic diseases [9].

Nutrition security as a foundation for post-disaster urban resilience and social recovery

When nutritional needs are unmet, the resulting health consequences-such as undernutrition, compromised immune function, and chronic disease-can significantly affect individual well-being and the development trajectory of entire communities. These effects tend to become cyclical, where malnutrition reinforces poverty, which in turn deepens vulnerability to further food insecurity.

This cycle is particularly damaging during the critical periods of life, notably during pregnancy and the first two years after birth-the so-called “first 1,000 days”-a phase that is widely recognized as foundational for lifelong cognitive and physical development. Malnutrition during this phase can lead to irreversible damage to brain function, immune response, and future economic productivity [9].

The Copenhagen Consensus underscores the substantial economic consequences of early-life malnutrition. It estimates that individuals affected by stunting in early childhood may earn up to eighteen times less than their adequately nourished peers throughout their lifetimes. Furthermore, the global economic burden of micronutrient deficiencies has been calculated at 2% to 5% of GDP in low- and middle-income countries annually. These productivity losses contribute not only to household economic strain but also to slowed national growth and hinder progress toward the Sustainable Development Goals (SDGs) [10].

Malnutrition also takes a toll on the general adult population. Adults who are undernourished are more susceptible to illness, have reduced physical stamina, and tend to be less productive in the workplace. These factors culminate in reduced earning potential, which compounds the socioeconomic impacts of poor nutrition. In its cost-benefit analysis of global challenges, the Copenhagen Consensus identifies investments in a comprehensive package of micronutrients for children as the single most effective strategy. Their analysis concludes that each dollar spent on addressing chronic undernutrition yields an estimated \$30 in economic benefits-and potentially up to \$63 when all indirect returns are accounted for [10].

Such findings underscore why multiple global actors now regard nutrition not merely as a health issue, but as a linchpin of sustainable development. The World Food Programme (WFP) prioritizes nutrition in emergency settings as a critical factor in recovery and resilience. The World Bank has identified malnutrition as a major obstacle to inclusive economic growth. UNICEF actively promotes interventions such as breastfeeding support and micronutrient supplementation, especially in early childhood. Leading medical journals like *The Lancet*, global platforms like the Global Nutrition Report, and multi-stakeholder coalitions like the Scaling Up Nutrition (SUN) Movement all continue to emphasize that nutrition is foundational to achieving nearly all global development objectives [10].

Climate-related events-such as floods, droughts, and extreme temperatures-can dramatically disrupt food systems, displace communities, and compromise urban food and nutrition supply chains. Disasters intensified by climate change-ranging from sudden floods and droughts to prolonged heatwaves-can severely undermine the stability of food systems by displacing communities, damaging the infrastructure, and interrupting supply chains. Urban environments, in particular, are highly exposed due to their dependence on external food sources and their fragile logistical networks. These disruptions threaten not just food availability but also access, safety, and nutritional quality.

In response, nutrition must be prioritized within emergency protocols. This includes targeted interventions to address acute malnutrition, protect vulnerable groups, and maintain infant and young child feeding during crisis situations. The twin-track approach, widely adopted by the United Nations system and affirmed by the Rome Principles, presents a well-established model for addressing both the immediate and long-term dimensions of food insecurity. This framework advocates for simultaneous investment in direct nutritional relief and systemic reforms that build resilience and sustainability over time. Its successful implementation depends on cross-sectoral collaboration, robust governance, and inclusive stakeholder engagement at every level-from local communities to national governments [11].

Evidence from humanitarian responses demonstrates that nutrition-focused interventions significantly improve recovery outcomes in disaster-affected urban populations. For instance, a UNICEF evaluation following the 2019 Mozambique cyclone showed that integrating RUTF and breastfeeding support into emergency health services reduced severe acute malnutrition rates by 35% within three months. Similarly, the ENFAC trial in Brazil documented a 38% reduction in childhood anemia through micronutrient powder supplementation, while cash-transfer programs in Ethiopia and Yemen helped stabilize household food consumption and maintain dietary diversity during crises. These findings illustrate that strengthening nutrition security not only prevents immediate mortality and morbidity but also accelerates community recovery, improves long-term human capital, and reduces the socioeconomic costs of disasters. In this sense, nutrition interventions are not peripheral relief measures but central pillars of post-disaster resilience and social recovery [5,24,30,33].

The twin-track approach to secure access to adequate nutrition

The twin-track approach proposes a two-pronged strategy to combat hunger and malnutrition: on one hand, delivering urgent interventions to meet the immediate nutritional needs of vulnerable populations; and on the other, addressing structural causes through long-term, resilience-building solutions. Crucially, this is not a sequential model-long-term actions must be launched concurrently with short-term relief to achieve sustained impact. Only through this integrated approach can food and nutrition security be safeguarded in a way that both respects human rights and meets emergency needs [12].

The Anti-Hunger Programme outlines several medium- and long-term measures to build resilience in the face of urban climate disasters, including: (a) Enhancing agricultural productivity and creating sustainable livelihoods in impoverished communities, alongside promotion of productive employment and decent work; (b) Protecting and restoring access to productive resources and environmental assets; (c) Expanding rural and urban infrastructure with attention to food safety, animal and plant health, and market connectivity; (d) Building capacities for knowledge generation, including research, extension services, education, and communication strategies.

These recommendations correspond closely with the priorities of the Sendai Framework, particularly Priority 3, which emphasizes investment in disaster risk reduction and resilience-building. Long-term improvements to food systems not only reduce dependence on external aid but also address underlying vulnerabilities, promote sustainable livelihoods, and establish the foundation for multi-hazard preparedness [8].

At the same time, it is imperative to protect individuals who cannot meet their food and nutritional needs-particularly during or immediately following a crisis. Immediate interventions include emergency food distribution, support through social protection mechanisms such as cash transfers, and deployment of specialized nutrition programs (e.g. RUTF for children suffering from acute malnutrition). Special attention should be paid to the unique needs of pregnant and lactating women, as well as children under the age of two, in order to prevent stunting and irreversible developmental delays [12].

The Sendai Framework highlights the need to reduce human suffering in all phases of disaster management, emphasizing timely, responsive, and inclusive actions. Implementing short-term nutrition interventions directly contributes to Priority 4, particularly when grounded in human rights and tailored to the needs of women, children, the elderly, and marginalized populations [8].

The two tracks must be interconnected to maximize impact-addressing immediate vulnerabilities while also supporting long-term improvements in child growth, cognitive development, school readiness, and economic productivity. These strategies can also promote local food production and improve access to local markets. Preparedness measures should include pre-positioning of nutritional supplies, establishing early-warning systems for nutritional risk, and strengthening public awareness of nutrition in emergencies.

Short-term, nutrition-specific interventions

As previously discussed, short-term, nutrition-specific actions play a critical role in bridging emergency response and long-term recovery efforts. These interventions are not only lifesaving in the immediate aftermath of a disaster but also contribute to the establishment of a resilient and responsive nutrition system over time. The following section outlines several evidence-based, cost-effective strategies that have proven successful in both emergency and preparedness contexts.

Ready-to-use therapeutic foods (RUTF)

Ready-to-use therapeutic foods (RUTF) are highly energy-dense, lipid-based pastes designed to treat severe acute malnutrition (SAM) in children. These formulations are enriched with essential micronutrients and resemble the nutritional profile of therapeutic milk formulas recommended by the World Health Organization (WHO). RUTF typically includes ingredients such as peanuts, vegetable oils, sugar, milk powder, and a precise blend of vitamins and minerals to meet the nutritional requirements of malnourished individuals [13].

RUTF plays a vital role in community-based management of acute malnutrition (CMAM), particularly for children who have uncomplicated SAM and retain appetite. Several characteristics make RUTF uniquely suitable for emergency and post-disaster environments: it delivers all essential nutrients required for nutritional rehabilitation; it has a long shelf life and remains stable even after opening; its non-aqueous formulation makes it resistant to bacterial contamination and eliminates the need for refrigeration; it can be administered without requiring medical supervision, thus ensuring access in remote or crisis-affected areas; it is palatable to children and easily incorporated alongside continued breastfeeding or complementary feeding practices [13].

Dosing is tailored to the child's weight and can be consumed at home under minimal supervision until full nutritional recovery is achieved [14]. The impact of RUTF has been well-documented across emergency settings. In the wake of Cyclone Idai in Mozambique (2019), RUTF enabled over 20,000 children under five to recover from SAM within eight weeks. Similarly, in South Sudan, RUTF deployment helped avert a spike in child mortality during famine-like conditions [15].

The Copenhagen Consensus ranks the treatment of child undernutrition with RUTF among the most effective global health investments, with benefit-cost ratios exceeding 30:1 [10]. Beyond its therapeutic value, the ease of use, portability, and suitability for integration into mobile health units make RUTF particularly effective in urban settings affected by climate-induced disasters.

Additionally, Ready-to-Use Supplementary Foods (RUSFs) are employed to prevent and treat moderate acute malnutrition (MAM). These supplementary products are also shelf-stable and are typically distributed in sachets containing cereal-based blends enriched with oils, milk derivatives, and micronutrients [16].

Maternal micronutrient supplements (MMS)

Periods of pregnancy and lactation significantly elevate a woman's nutritional requirements. In settings affected by climate instability—where food insecurity, psychosocial stress, and poor sanitation are common—these increased needs often go unmet, placing both mother and infant at risk. In such circumstances, maternal micronutrient deficiencies become widespread, contributing to maternal anemia, low birth weight, and elevated neonatal mortality. To address these gaps, Maternal Micronutrient Supplements (MMS), endorsed by both WHO and UNICEF, offer a broad-spectrum formulation that includes iron, folic acid, iodine, zinc, and a dozen other essential micronutrients [17].

Unlike iron-folic acid (IFA) tablets, which address a narrower set of deficiencies, MMS is formulated to offer a more comprehensive nutritional safety net. The standard MMS composition—known as the United Nations International Multiple Micronutrient Antenatal Preparation (UNIMMAP)—is designed to meet the Recommended Dietary Allowance (RDA) for fifteen essential micronutrients in pregnancy.

These include vitamins A, B-complex, C, D, E, iron, folate, and zinc, among others [18]. Studies have consistently demonstrated the superior efficacy of MMS over IFA alone. Randomized controlled trials and meta-analyses have shown that MMS reduces the incidence of low birth weight by 12%, stillbirths by 9%, and maternal anemia by more than 15% [18]. The benefits extend beyond pregnancy: babies born to mothers who received MMS exhibit better early growth indicators and developmental outcomes.

In terms of real-world applications, a successful deployment of MMS took place in Sindh Province, Pakistan, following the 2010 mega-floods. In partnership with the United Nations, mobile maternal clinics were established to distribute MMS to pregnant women in affected communities. The intervention yielded measurable improvements in maternal hemoglobin levels and a significant reduction in the rates of preterm births. Likewise, Ethiopia's 2022 pilot program, which targeted 30,000 pregnant women, demonstrated that MMS not only enhances nutritional outcomes but also improves retention in antenatal care services during emergencies [4].

A 2023 global survey covering forty-six countries revealed that twenty-eight countries had implemented MMS distribution in humanitarian contexts. Most of these programs prioritized pregnant women, with twenty countries also providing supplements to breastfeeding mothers. A smaller number of extended MMS to adolescent girls and non-pregnant women. The most cited implementation barriers included lack of financing, weak policy frameworks, inconsistent supply chains, and limited awareness among healthcare professionals and target communities [4].

Despite these challenges, MMS remains one of the most cost-effective interventions in maternal health. At approximately US\$0.01-0.02 per tablet, it offers significant returns on investment through reduced maternal and neonatal complications. WHO's latest guidance emphasizes the importance of national-level planning to introduce MMS programs. This includes creating an enabling policy environment, setting up national coordination for maternal nutrition, ensuring consistent supply and distribution systems, raising awareness among frontline health workers and women about the benefits of MMS [20].

When maternal nutrition is strengthened, the health of both mother and child improves, laying the groundwork for intergenerational resilience. MMS thus represents not only short-term intervention for crisis contexts but also a strategic long-term investment in the health and development of future generations.

Micronutrient powders sachets (MNP)

Micronutrient powders (MNPs) are single-dose sachets containing a mix of essential vitamins and minerals designed to be added directly to food at the household level. These powders offer an effective and scalable solution in emergencies, particularly for children and adults whose diets have become deficient in key nutrients due to disrupted food access. MNPs are developed to complement diets lacking in one or more critical micronutrients and follow the WHO/WFP/UNICEF guidelines, which recommend a standard formulation containing fifteen vitamins and minerals. Different MNP compositions are recommended based on the target group-such as children aged 6 - 59 months, pregnant women, or lactating mothers-to optimize health outcomes [21].

Research has demonstrated that consistent use of MNPs significantly reduces the prevalence of childhood anemia-by approximately 18%-and contributes to improved growth when administered over several months. One of the main advantages of MNPs is their ability to be easily integrated into family meals without altering taste, smell, or color. This allows for culturally sensitive, home-based use, which is especially valuable in displaced or low-resource settings. When combined with health and nutrition education, MNPs show high levels of acceptability and sustained usage within households [22].

Beyond their health benefits, MNPs have a number of operational advantages: They prevent iron-deficiency anemia and broader micronutrient deficits; They are simple to administer, with no cooking or refrigeration required; They are odorless and tasteless, making them highly acceptable to children; They are cost-effective and suitable for rapid scale-up in emergency responses.

A compelling example comes from urban Dhaka, Bangladesh, where a post-flood intervention distributed MNP sachets and provided nutrition counseling through a network of female health workers. Within six months, the program reached more than 100,000 children, leading to a 25% improvement in dietary diversity among participants [23]. Additionally, the Copenhagen Consensus estimated that each dollar invested in MNPs delivers approximately \$35 in long-term health and productivity benefits, highlighting their value in both humanitarian and development contexts [10].

Evidence from Brazil further supports the effectiveness of MNP strategies. The ENFAC study (Brazilian Study for Home Fortification of Complementary Feeding) evaluated MNP use among infants aged 6 to 8 months within public primary healthcare services. Findings showed that children who received MNPs experienced 38% lower rates of anemia, 55% lower prevalence of vitamin A deficiency, and 20% less iron deficiency compared to the control group [24].

Additional health outcomes included reduced incidence of fever and respiratory symptoms in the MNP group. Vitamin E deficiency was also 60% lower, suggesting consistent adherence and efficacy across a range of nutrients. The study noted a 96% adherence rate among children and reported that approximately 72% of caregivers rated acceptability as good or excellent, indicating strong alignment with local feeding practices [24].

MNPs are meant to be mixed into a small portion of food, either hot or cold, and must be consumed within one hour of preparation to preserve nutrient integrity. Their portability, flexibility, and minimal logistical requirements make MNPs especially suited for urban disaster contexts, where infrastructure may be compromised and nutritional gaps can quickly widen.

Small-quantity lipid-based nutrient supplements (SQ-LNS)

Small-Quantity Lipid-Based Nutrient Supplements (SQ-LNS) are specialized nutritional products designed to prevent undernutrition and micronutrient deficiencies in infants and young children. Each sachet typically contains around twenty grams of nutrient-rich paste that includes a combination of 24 essential micronutrients, as well as macronutrients such as energy, protein, and essential fatty acids. These supplements are intended to complement-not replace-the diets of children from 6 months of age, especially in contexts where nutritional gaps are common and diets are unlikely to meet minimum nutrient adequacy [25].

Classified as a form of home fortification, SQ-LNS can be mixed directly into the child's daily food or consumed straight from the sachet, offering flexibility in how caregivers administer them. Importantly, SQ-LNS products do not require water or refrigeration and are highly stable, making them ideal for environments where infrastructure is lacking or compromised due to emergencies. They are specifically designed to complement breastmilk and traditional foods, and not to replace breastfeeding [26].

SQ-LNS are especially recommended in humanitarian settings and climate-related emergencies where children are at elevated risk of mortality, stunting, wasting, anemia, and developmental delays. Evidence has shown that, in vulnerable populations, SQ-LNS significantly reduces these risks and improves both short- and long-term outcomes. Studies consistently report high acceptability among children and caregivers, with compliance rates ranging from 70% to 100%. Their ease of use, palatability, and adaptability to household feeding routines make them particularly suitable for rapid deployment in emergencies [26].

The 2021 Lancet Series on Maternal and Child Undernutrition included SQ-LNS in its list of recommended interventions, citing robust evidence of their effectiveness. The series emphasized their role in not only preventing acute malnutrition but also in supporting long-term cognitive development and overall child health outcomes. Moreover, initial cost-effectiveness analyses suggest that SQ-LNS may be more cost-efficient than many other interventions in terms of averting child deaths and supporting early development [27].

Unlike other interventions that require institutional or clinical settings, SQ-LNS can be distributed through community health programs, mobile units, and even schools or daycares, increasing their reach in disaster-affected urban settings. Given their formulation, logistical flexibility, and proven health impact, SQ-LNS are a valuable addition to emergency preparedness kits and a strategic asset for climate-resilient nutrition programming.

A comparative summary of these four key nutrition-specific interventions, covering their target groups, objectives, costs, documented impacts, applicability, implementation considerations, and main references, is presented in table 2.

Intervention	RUTF	MMS	MNP	SQ-LNS
	Ready-to-Use Therapeutic Foods	Maternal Micronutrient Supplements	Micronutrient Powders	Small-Quantity Lipid-Based Nutrient Supplements
Target Group	Children with severe acute malnutrition (SAM)	Pregnant and lactating women	Children 6-59 months; pregnant and lactating women	Children 6-24 months
Primary Objective	Treat SAM in community settings (CMAM programs)	Prevent maternal and neonatal deficiencies; improve birth outcomes	Prevent and treat micronutrient deficiencies, especially anemia	Prevent stunting, wasting, anemia; support cognitive development
Estimated Cost*	US\$40-50 per full treatment course	US\$0.01-0.02 per tablet	US\$0.02-0.03 per sachet	US\$0.07-0.10 per sachet
Documented Impact	>90% recovery in CMAM; reduced child mortality	↓ Low birth weight by 12%, ↓ stillbirth by 9%, ↓ anemia by 15%	↓ Childhood anemia by 18-38%; improved vitamin A and E status	Reduced stunting/wasting; improved cognitive scores
Applicability	Emergency response; preparedness stockpiles	Both emergency and long-term resilience	Both emergency and long-term resilience	Both emergency and long-term resilience
Implementation Considerations	Long shelf life; no refrigeration; no water needed; palatable; weight-based dosing; requires reliable supply chain	Requires national policy support; integrate into antenatal care; ensure supply chain consistency	Culturally adaptable; tasteless/odorless; household-level use; requires nutritional education	Shelf-stable; complements breastfeeding; high acceptability; flexible distribution channels
Key Source	UNICEF 2013; Sadler, <i>et al.</i> 2023	Keats, <i>et al.</i> 2019; WHO, 2021	De Pee, <i>et al.</i> 2007; ENFAC Trial, Brazil, 2013	Prado, <i>et al.</i> 2021; UNICEF, 2021

Table 2: Comparative overview of nutrition-specific interventions in emergencies and preparedness.

Complementary solutions for preparedness

While the short-term nutrition-specific interventions discussed above—such as RUTF, MMS, MNP, and SQ-LNS—are vital during emergencies, they also serve as valuable components of disaster preparedness. Their integration into urban risk management plans enables faster responses, reduces mortality, and builds stronger community-level resilience.

Urban authorities in disaster-prone regions can enhance preparedness by establishing stockpiles of key nutritional products, ensuring trained local health personnel, and developing early-warning surveillance systems that track nutritional vulnerabilities. Pre-positioning these supplies in high-risk areas, coupled with clear protocols for rapid deployment, ensures that nutritional support can be provided immediately following a disaster, minimizing delays in response, and reducing risk of deterioration in child and maternal health.

In addition to product-based interventions, other complementary actions are essential for protecting nutritional status in crisis settings. For instance, breastfeeding support plays a pivotal role during emergencies. Establishing “baby-friendly spaces,” deploying trained lactation counselors, and protecting mothers from reliance on unsafe infant formulas are proven methods to ensure infant nutrition and immune protection. The World Health Organization (WHO) has emphasized that breastfeeding support during emergencies can reduce infant mortality related to infections by more than 30% [28].

Another key preparedness measure is the fortification of staple foods. Fortifying commonly consumed items—such as flour (iron and folic acid), rice (multi micronutrients), milk (vitamin D), edible oil (vitamin A), and iodized salt—can help maintain micronutrient intake across a population. These fortification strategies are especially useful during emergencies when fresh food supply chains are disrupted. Public-private partnerships can accelerate the scale-up of food fortification initiatives, both as part of long-term nutrition policies and as rapid response tools during crises [29].

Moreover, cash transfers and digital food voucher programs offer households the flexibility to maintain access to diverse diets and purchase culturally preferred foods during emergencies. Countries such as Ethiopia, Nigeria, and Yemen have used mobile-based systems to deliver financial assistance, which helped stabilize nutrition and empowered communities to begin rebuilding autonomy over food choices [30].

In line with SDG 17, which emphasizes partnerships for the goals, coordinated multisectoral action is essential for successful nutrition preparedness and response. Governments must prioritize the integration of nutrition into disaster risk management strategies, including resource allocation for stockpiling, training, and delivery systems. The private sector can contribute through innovation, local manufacturing, packaging, and logistics management, which helps reduce costs and ensure product availability. Academic institutions offer valuable contributions through context-specific research, impact evaluation, and the development of culturally appropriate implementation models. Meanwhile, UN agencies and NGOs provide critical infrastructure for global coordination, standardization, and technical support [31].

A practical example of effective multi-stakeholder collaboration is the RUA Project (Resiliência Urbana em Ação), launched in Brazil in 2024. This initiative promotes a culture of resilience in cities by focusing on prevention, emergency response, and post-disaster recovery in alignment with the Sendai Framework. Initially developed by academic and research institutions—including the University of São Paulo (USP), the Institute of Advanced Studies of the University of São Paulo (IEA-USP), the University UNINOVE and the Institute for Technological Research of the State of São Paulo (IPT), it also engages government, non-governmental organizations and private sector in the discussions, including National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN Education), Local Governments for Sustainability (ICLAI), Japan International Cooperation Agency (JICA), among others. RUA has already conducted five technical workshops, collecting data that will inform a comprehensive guidance report on urban resilience strategies [32].

For implementers seeking practical tools, the WFP Emergency Field Operations Pocketbook provides a comprehensive reference. This manual contains detailed protocols on the deployment of nutrition-specific and nutrition-sensitive interventions and serves as an essential resource for humanitarian teams working in the field [33].

Conclusion

As climate emergencies and urban vulnerabilities intensify, ensuring nutritional security for marginalized populations-especially women and children-has become an urgent global imperative. This review has demonstrated that safeguarding nutrition is not only a humanitarian priority but also a strategic pathway toward sustainable development, urban resilience, and disaster risk reduction.

The synthesis of evidence across international frameworks-such as the SDGs, the Sendai Framework, and the Brundtland Report-underscores that nutrition security must be central to climate adaptation and urban planning policies. The twin-track approach, which combines short-term emergency nutrition interventions with long-term systemic reforms, emerged as a robust and adaptable strategy. Solutions like RUTFs, MMS, MNPs, and SQ-LNS have proven to be cost-effective, scalable, and lifesaving, especially when paired with local governance, community-based action, and public-private partnerships.

Furthermore, real-world programs such as Brazil's Zero Hunger, India's ICDS, and the RUA Urban Resilience Project in São Paulo demonstrate the value of cross-sectoral collaboration in translating global goals into local impact. However, for nutrition interventions to be truly transformative, they must: be embedded in urban resilience frameworks; address structural inequalities that perpetuate malnutrition; center the unique needs of women, children, and displaced communities; be institutionalized within national and municipal emergency preparedness and social protection systems.

To ensure sustainability, interventions should be embedded in municipal master plans and aligned with SDG 2 and SDG 11. This requires cross-sector coordination among health, social assistance, education, and civil defense, with clear budget lines, zoning for food distribution hubs, and pre-positioned supplies. Embedding nutrition-focused interventions measures in legally binding plans transforms nutrition security from an emergency response into a permanent element of urban resilience.

Civil defense protocols should integrate nutrition objectives across all phases of disaster management, including vulnerability mapping, early-warning systems, and operational agreements with public and private partners. Simulation exercises and legislative endorsement of contingency plans can institutionalize accountability, ensuring that safeguarding nutrition is a core component of official resilience frameworks.

Despite the advances and evidence presented in this review, important gaps remain that warrant further investigation. Longitudinal and context-specific studies evaluating the long-term impact of integrated nutritional interventions in vulnerable urban environments in scenarios of climate-related disasters are still limited. Further research is needed to explore how local governance structures influence both the effectiveness and adherence to strategies such as RUTF, MMS, MNP, and SQ-LNS. In addition, innovative public-private partnership models, the application of digital technologies for real-time nutritional surveillance, and the incorporation of nutrition security into urban planning and disaster risk reduction policies represent promising areas for exploration.

Nutrition is both a basic human right and a powerful enabler of economic growth, educational attainment, and long-term resilience. In an era defined by volatility (from pandemics to climate extremes), nutrition must no longer be treated as a siloed sector, but as a foundation of resilience-building. By aligning emergency response with systemic transformation, and by investing in integrated, equity-focused nutrition strategies, cities and nations can not only mitigate the devastating effects of climate shocks but also build healthier, more inclusive, and sustainable futures for all.

Bibliography

1. World Food Programme. "WFP Global Operational Response Plan Update #8 - June 2023". World Food Programme (2023).
2. Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD), United Nations Children's Fund (UNICEF), World Food Programme (WFP), and World Health Organization (WHO). The State of Food Security and Nutrition in the World 2024: Urbanization, Agrifood Systems Transformation and Healthy Diets across the Rural-Urban Continuum. FAO, Rome (2024).
3. World Bank. "What You Need to Know about Food Security and Climate Change". World Bank (2022).
4. James Philip., *et al.* "Multiple micronutrient supplements in humanitarian emergencies: a state of play report". *Field Exchange* 70 (2024): 40-54.
5. UNHCR. "Nutrition-specific interventions to prevent and treat malnutrition in emergencies". UNHCR Emergency Handbook (2025).
6. ICLEI - Local Governments for Sustainability. "The importance of all sustainable development goals (SDGs) for Cities and communities: ICLEI SDGs briefing sheets – 04". Local2030, 2015.
7. World Commission on Environment and Development. "Report of the world commission on environment and development: our common future (Brundtland Report)". Federal Office for Spatial Development (ARE) (2025).
8. United Nations Office for Disaster Risk Reduction (UNDRR). "Sendai framework for disaster risk reduction 2015-2030". UNDRR (2015).
9. Food and Agriculture Organization of the United Nations (FAO). "The State of Food Security and Nutrition in the World 2024". FAO (2024).
10. Copenhagen Consensus Center. "How to spend \$75 billion to make the world a better place". Copenhagen Consensus III, 2014 (2025).
11. Food and Agriculture Organization of the United Nations (FAO). "The twin-track approach to food and nutrition security". FAO (2010).
12. Committee on World Food Security. "Global strategic framework for food security and nutrition (GSF), version 3". Food and Agriculture Organization of the United Nations (FAO) (2014).
13. UNICEF. "UNICEF Position Paper: Ready-to-Use Therapeutic Food (RUTF)" (2013).
14. UNICEF. "Explainer: A wonder 'food' for the world's children". UNICEF (2025).
15. World Health Organization (WHO). "Community-based management of severe acute malnutrition: A joint statement by the world health organization, the world food programme, the united nations system standing committee on nutrition and the united nations children's fund". WHO (2007).
16. Sadler Kate., *et al.* "Ready-to-use therapeutic/supplementary foods from local food resources: technology accessibility, program effectiveness, and sustainability-a review". *Heliyon* 9.12 (2023): e18643.
17. UNICEF. Maternal Nutrition. UNICEF (2025).
18. U.S. National Library of Medicine. Study of the Use of SQ-LNS in Children Aged 6 to 23 Months in Cambodia. ClinicalTrials.gov Identifier: NCT05867836 (2023).

19. Keats Emily C., *et al.* "Multiple micronutrient supplementation during pregnancy in low-income and middle-income countries: a systematic review and meta-analysis of individual participant data". *The Lancet Global Health* 7.1 (2019): e132-e147.
20. World Health Organization (WHO). Maternal Nutrition Programming Guidance: National Strategies for the Introduction of Multiple Micronutrient Supplements (MMS). WHO (2021).
21. De Pee Saskia., *et al.* "Home fortification in emergency response and transition programming: experiences in Aceh and Nias, Indonesia". *Food and Nutrition Bulletin* 28.2 (2007): 189-197.
22. Ghosh Sushil., *et al.* "Ready-to-use therapeutic/supplementary foods from local food resources: technology accessibility, program effectiveness, and sustainability-a review". *Journal of Food Composition and Analysis* 109 (2022): 104547.
23. Jahan Ferdous and Peter Blair Thomson. "Urban flooding of greater Dhaka in a changing climate: building local resilience to disaster risk". World Bank (2018).
24. Ministry of Health (Brazil), primary sponsor; and CNPq and UNICEF, supporting organizations. "Home Fortification of Complementary Feeding in Brazil: A Multicenter Pragmatic Trial (ENFAC)". Clinical trial registry entry, RBR-5ktv6b, registered 11 Sept. 2013, Brazilian Registry of Clinical Trials (2025).
25. Prado Elizabeth L., *et al.* "Small-quantity lipid-based nutrient supplements for children age 6-24 months: a systematic review and individual participant data meta-analysis of effects on development". *The American Journal of Clinical Nutrition* 114.1 (2021): 3S-14S.
26. UNICEF. "Small-Quantity Lipid-Based Nutrient Supplements (SQ-LNS): Brief Guidance Note". UNICEF (2021).
27. The Lancet. "Maternal and child undernutrition progress series". The Lancet (2021).
28. Infant Feeding in Emergencies Core Group. Breastfeeding in Emergencies. Global Nutrition Cluster (2023).
29. Scaling Up Nutrition (SUN) Movement. SUN Movement Strategy and Roadmap (2016-2020). Scaling Up Nutrition (2021).
30. Global Nutrition Cluster. Cash and Voucher Assistance for Nutrition: Challenges and Promising Practices (2023).
31. United Nations Development Programme (UNDP). "The role of the private sector in climate-resilient food systems". UNDP (2023).
32. RUA - Resiliência Urbana em Ação. RUA: Protegendo Nossas Cidades de Eventos Climáticos Extremos. RUA (2024).
33. World Food Programme (WFP). Emergency Field Operations Pocketbook. WFP (2017).

Volume 20 Issue 2 October 2025

**©All rights reserved by Maria Fernanda Elias and
Tatiana Tucunduva Philippi Cortese**