



The Epidemiology of Food Insecurity: A Global Perspective

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Abstract

Food insecurity, defined as the lack of consistent access to safe, nutritious food, poses a significant threat to global health and well-being. This paper examines the epidemiology of food insecurity, highlighting its widespread prevalence, diverse causes, and detrimental health consequences. We explore the complex interplay of factors contributing to food insecurity, including poverty, conflict, climate change, and inadequate food systems. The paper delves into the impact of food insecurity on individuals and populations, examining its effects on nutritional status, physical and mental health, child development, and overall well-being. We further discuss the challenges of measuring food insecurity and the need for a comprehensive approach to addressing this global challenge. Finally, we examine strategies for mitigating food insecurity, emphasizing the importance of sustainable agriculture, social safety nets, equitable food distribution systems, and targeted interventions to improve food access, affordability, and availability.

Keywords: Food insecurity, global health, epidemiology, poverty, conflict, climate change, malnutrition, hunger, nutrition, child development, health outcomes, sustainable agriculture, food systems, social safety nets, food distribution

1 Introduction

Food insecurity, a pervasive and multifaceted global challenge, is characterized by the lack of consistent and reliable access to sufficient quantities of safe, affordable, and nutritious food to support an active and healthy life. This condition, impacting millions across the globe, represents a significant threat to human health, development, and societal stability. While often associated with poverty and economic hardship, food insecurity is a complex issue with roots in a confluence of factors, including socioeconomic disparities, environmental degradation, political instability, and inadequate infrastructure. The consequences of food insecurity are far-reaching, affecting not only physical health through malnutrition and undernutrition, but also mental well-being, cognitive development, and overall human potential. This paper aims to examine the intricate epidemiology of food insecurity, exploring its global prevalence, the complex web of underlying causes, the far-reaching health and societal consequences, and potential strategies for creating more resilient and equitable food systems. This investigation will delve beyond simple statistical reporting, seeking to understand the dynamic interplay between individual vulnerabilities, systemic factors, and environmental contexts that contribute to this challenge. By integrating insights from various disciplines, including public health, nutrition, economics, and social sciences, this paper seeks to provide a comprehensive overview of the current state of knowledge, identify critical knowledge gaps, and ultimately contribute to the development of effective, sustainable, and equitable solutions to address this persistent global problem. The examination will acknowledge the diversity in experience of food insecurity across different geographic regions and demographic groups, recognizing that effective solutions must

be context-specific and sensitive to the unique challenges of different communities. Ultimately, this exploration aims to provide a scientific basis for evidence-based policies and programs designed to ensure food security and promote nutritional well-being for all.

2 The Global Prevalence of Food Insecurity

Food insecurity, a significant global health and development challenge, is not confined to specific geographic regions or economic contexts, but rather represents a pervasive issue affecting populations in both developed and developing countries. Despite progress made in recent decades, the sheer magnitude of the problem remains staggering, impacting the lives of billions of individuals worldwide. According to the Food and Agriculture Organization of the United Nations (FAO), a substantial proportion of the global population, exceeding two billion people, currently experiences some degree of food insecurity, ranging from mild food insecurity characterized by uncertainty about access to adequate food, to severe food insecurity characterized by the experience of hunger and malnutrition. This section will examine the global prevalence of food insecurity, exploring the regional variations in its distribution and the significant trends observed over time, including the impact of recent global events such as the COVID-19 pandemic (1).

While food insecurity is a global concern, its prevalence and severity exhibit marked disparities across different regions of the world. Sub-Saharan Africa and South Asia consistently demonstrate the highest rates of food insecurity, often experiencing a combination of factors that contribute to this heightened vulnerability, such as pervasive poverty, recurring climate shocks, fragile political systems, and limited access to

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essential infrastructure and resources. These regions are often characterized by high rates of undernutrition, micronutrient deficiencies, and stunting in children, which have long-lasting consequences for physical and cognitive development. Latin America and the Caribbean also experience significant levels of food insecurity, although generally at lower levels than those observed in Africa and Asia (2). Within these regions, certain sub-regions and specific populations, such as indigenous communities, rural inhabitants, and marginalized groups, may experience disproportionately high rates of food insecurity due to a combination of geographic isolation, economic marginalization, and lack of access to essential services. Developed countries, while generally experiencing lower overall rates of food insecurity, are not immune to this problem, with vulnerable populations, such as low-income households, the elderly, and individuals experiencing homelessness, often experiencing food insecurity due to factors such as poverty, unemployment, and lack of access to affordable and nutritious food sources. The geographical distribution of food insecurity is not static but rather a dynamic and complex phenomenon, influenced by a range of factors that may shift over time, requiring continuous monitoring and adaptive intervention strategies (3).

Globally, there has been a significant decline in the prevalence of food insecurity over the past few decades, attributable to factors such as increased agricultural productivity, improved access to markets, and targeted social safety net programs. However, this progress has been uneven, and the overall number of individuals experiencing food insecurity remains unacceptably high. Furthermore, this progress has been punctuated by periods of stagnation and even reversal, often triggered by global economic crises, climate-related disasters, and political instability. Notably, the COVID-19 pandemic has had a profound impact on global food security, disrupting food supply chains, leading to widespread economic downturns, and exacerbating existing inequalities, resulting in a sharp increase in the number of people experiencing food insecurity worldwide (4). The pandemic has particularly affected vulnerable populations, such as those dependent on informal employment, migrant workers, and individuals living in poverty, and it has highlighted the fragility of global food systems and the need for more resilient and equitable approaches to food production, distribution, and access. Furthermore, the increasing frequency and intensity of climate change related events, such as droughts, floods, and extreme temperatures, are posing new challenges to food security, disrupting agricultural production, and exacerbating existing vulnerabilities. The intersection of these factors has led to a complex landscape of food insecurity that requires a multifaceted and adaptive approach (5).

3 Causes of Food Insecurity: A Complex Interplay of Factors

Food insecurity, a multifaceted global challenge, is not the result of a single, isolated cause, but rather stems from a complex interplay of interconnected factors spanning economic, social, environmental, and political dimensions. This section delves into the intricate web of drivers that contribute to food insecurity, focusing on poverty, conflict, climate change, and the inadequacies of current food systems. Understanding the complex interplay of these factors is essential for developing effective and sustainable strategies to promote food security for all (6).

Poverty, encompassing both income poverty and multidimensional deprivations, remains one of the most fundamental and pervasive drivers of food insecurity globally.

Individuals and families living in poverty often lack sufficient financial resources to purchase adequate, nutritious food, leaving them vulnerable to hunger and malnutrition. The cycle of poverty and food insecurity is often self-perpetuating, as malnutrition can lead to poor health, decreased productivity, and limited opportunities for economic advancement, thus trapping individuals and families in a state of chronic vulnerability. Poverty also limits access to other essential resources, such as clean water, sanitation, and healthcare, which further exacerbate the risk of food insecurity and malnutrition. The intersection of poverty with other factors, such as gender inequality, social marginalization, and lack of access to education, can further amplify vulnerability to food insecurity. Addressing poverty requires holistic, multifaceted approaches that encompass not only income support but also investments in education, healthcare, and economic development (7).

Conflicts, both armed and internal, are significant drivers of food insecurity, disrupting food production, distribution, and access, and leading to widespread displacement, loss of livelihoods, and severe humanitarian crises. Conflicts often lead to the destruction of agricultural infrastructure, disruption of markets, and displacement of farming populations, resulting in reduced food production and increased food prices. Armed conflicts can also restrict humanitarian access, impeding the delivery of food aid and other essential services to vulnerable populations. Moreover, conflicts can undermine social and economic structures, destabilizing food systems and creating long-lasting disruptions that impede recovery and rehabilitation. In regions experiencing conflict, individuals often face a double burden of food insecurity, resulting not only from physical scarcity of food but also from the lack of security, displacement, and loss of livelihoods that characterize conflict situations. Addressing the root causes of conflict and promoting peace and stability are essential for creating conditions that support food security in conflict-affected regions (8).

Climate change, characterized by increasing global temperatures, altered rainfall patterns, and more frequent and intense extreme weather events, is increasingly recognized as a major driver of food insecurity, posing significant threats to agricultural production and food systems worldwide. Droughts, floods, heat waves, and other climate-related disasters can damage crops, livestock, and food infrastructure, leading to widespread food shortages and volatile food prices. The impact of climate change is particularly severe in regions that are already vulnerable to food insecurity, such as arid and semi-arid areas, coastal regions, and small island developing states, where populations are disproportionately reliant on agriculture and natural resources for their livelihoods. Climate change can also lead to changes in crop yields, reduced nutrient content of food, and the spread of pests and diseases, further exacerbating the risk of food insecurity and malnutrition. Addressing climate change requires concerted global action to reduce greenhouse gas emissions and implement adaptation measures that enhance resilience in vulnerable regions (9).

Inefficient and unsustainable food systems, characterized by high levels of food waste, inequitable distribution of food resources, and limited access to markets, contribute significantly to food insecurity. Food waste occurs at every stage of the food supply chain, from agricultural production to processing, distribution, and consumption, resulting in substantial losses of food that could otherwise be used to nourish people. Furthermore, inequities in the distribution of food resources often leave marginalized populations and vulnerable groups with limited access to affordable and nutritious food.

Table: Focusing on Causes and Their Impact

| Cause of Food Insecurity | Description | Impact on Food Security |
|--------------------------|--|---|
| Poverty | Lack of sufficient financial resources; limits access to food and other necessities. | Reduced ability to purchase adequate food, chronic vulnerability. |
| Conflict | Disruption of food production, markets, and humanitarian aid; displacement of populations. | Reduced food supply, increased food prices, limited access to aid. |
| Climate Change | Extreme weather events, altered rainfall patterns; reduced agricultural production. | Crop losses, disrupted food systems, increased food prices. |
| Inadequate Food Systems | High food waste, inequitable distribution, limited market access, unsustainable agriculture. | Limited availability and accessibility of nutritious food, environmental degradation. |

Limited access to well-functioning markets, particularly in rural and remote areas, can also restrict access to essential food supplies. Furthermore, unsustainable agricultural practices, such as deforestation, overuse of pesticides, and depletion of natural resources, can undermine long-term food security, threatening the ecological foundations of food production. Addressing the inadequacies of current food systems requires a holistic and integrated approach that encompasses sustainable agricultural practices, equitable distribution of food resources, reduction of food waste, and investments in infrastructure and market access (10).

4 Consequences of Food Insecurity: Detrimental Health Impacts

Food insecurity, a global challenge of immense proportions, extends its reach far beyond the immediate experience of hunger, exerting a profound and pervasive influence on individual and population health across the lifespan. The ramifications of inadequate access to nutritious food are multifaceted, impacting physical, mental, and developmental domains, often creating a cascade of adverse health outcomes that perpetuate cycles of vulnerability. This section aims to provide a detailed exploration of these consequences, focusing on the complex interplay between food insecurity and malnutrition, its adverse effects on physical health and immune function, the profound burden it places on mental well-being, and the particularly damaging impacts it has on child development. This comprehensive understanding is crucial for informing effective strategies that go beyond addressing immediate hunger needs to encompass long-term health promotion and disease prevention (11).

Food insecurity is inextricably linked to malnutrition, a complex condition encompassing a spectrum of nutritional imbalances, including undernutrition, micronutrient deficiencies, and overnutrition. Undernutrition, characterized by a chronic lack of sufficient energy and protein intake, manifests in various forms, including wasting (acute malnutrition reflected in low weight-for-height), stunting (chronic malnutrition reflecting low height-for-age), and underweight (low weight-for-age). These conditions compromise organ function, impair growth and development, and weaken immune responses, making individuals more susceptible to infections and chronic diseases. Micronutrient deficiencies, resulting from inadequate intake of essential vitamins and minerals, are often “hidden hunger” conditions, with subtle but debilitating effects on physical and cognitive function (12). Iron deficiency, for instance, contributes to anemia, leading to fatigue, impaired cognitive performance, and increased maternal mortality. Iodine deficiency can lead to thyroid dysfunction and impaired brain development. Vitamin A deficiency can increase the risk of blindness and compromised immune function. Zinc deficiency can impair growth, weaken immunity, and contribute to diarrheal diseases. Paradoxically, food insecurity can also contribute to overnutrition and obesity, particularly when access to healthy,

affordable foods is limited, leading to a greater reliance on inexpensive, highly processed, and energy-dense foods with limited nutritional value. This form of malnutrition increases the risk of type 2 diabetes, cardiovascular disease, and certain types of cancer. The coexistence of multiple forms of malnutrition within the same communities presents complex challenges for public health interventions, requiring comprehensive and tailored approaches (13).

The adverse effects of malnutrition, stemming from food insecurity, have a profound impact on physical health and immune function, creating a cycle of vulnerability to disease. Undernutrition significantly impairs the immune system, reducing the body’s ability to fight off infections, making individuals more susceptible to a wide range of diseases, including respiratory infections, diarrheal diseases, tuberculosis, and HIV/AIDS. Micronutrient deficiencies further compromise immune function, leading to increased morbidity and mortality from infectious agents. Chronic malnutrition can also lead to long-term health problems, including cardiovascular disease, type 2 diabetes, liver disease, and some types of cancer. The chronic inflammation associated with malnutrition and chronic infections can contribute to the pathogenesis of these diseases, leading to a double burden of communicable and non-communicable diseases. Furthermore, the physiological stress associated with chronic food insecurity can accelerate cellular aging, increase the risk of chronic inflammation, and contribute to premature mortality. The interplay between malnutrition, impaired immunity, and increased susceptibility to chronic diseases places a heavy burden on healthcare systems and further perpetuates cycles of poverty and ill-health (14).

The psychological consequences of food insecurity are often underestimated, yet they are a significant component of the overall health burden. The chronic stress and anxiety associated with the uncertainty and fear of not having enough food can take a heavy toll on mental health, increasing the risk of anxiety disorders, depression, post-traumatic stress disorder (PTSD), and other mental health conditions. The constant worry about food can consume mental resources, making it difficult to concentrate, problem-solve, and engage in meaningful social activities. The stigma associated with food insecurity can lead to social isolation, shame, and feelings of inadequacy, further eroding mental well-being. Children experiencing food insecurity may develop behavioral problems, emotional dysregulation, and learning difficulties, which can have long-lasting consequences for their development and overall quality of life. The mental health burden of food insecurity also extends to caregivers, who often experience high levels of stress and anxiety related to their inability to provide for their families’ basic needs. Addressing the psychological consequences of food insecurity requires integrated mental health services within food security programs, including access to counseling, stress management techniques, and social support networks (15).

Food insecurity during childhood has particularly devastating and long-lasting consequences for cognitive development,

physical growth, and overall well-being, impacting human potential across the lifespan. Chronic undernutrition during critical periods of brain development can lead to irreversible deficits in cognitive function, including impaired attention, memory, language skills, and executive function. These deficits can hinder academic achievement, limit future employment opportunities, and contribute to a cycle of poverty and underachievement. Stunting, a common manifestation of chronic malnutrition, leads to irreversible deficits in physical growth, affecting height, organ development, and overall health throughout the lifespan. Children experiencing food insecurity are also more vulnerable to infections, which can further compromise their development and increase their risk of mortality. Moreover, the stress and anxiety associated with food insecurity can negatively impact a child's emotional and social development, leading to behavioral problems, social isolation, and difficulties forming healthy relationships. Addressing food insecurity during childhood requires targeted interventions that prioritize adequate nutrition, early childhood development programs, and supportive environments that foster physical, cognitive, and social-emotional well-being. The long-term societal consequences of childhood food insecurity are substantial, underscoring the urgent need for prevention and early intervention strategies (16).

5 Challenges in Measuring Food Insecurity

Accurately measuring the prevalence and severity of food insecurity presents significant methodological and conceptual challenges. While the importance of tracking and monitoring food insecurity is widely recognized, the multifaceted nature of this phenomenon and the complexities of data collection and analysis make it a difficult task. This section delves into the specific challenges researchers and policymakers face when attempting to define, measure, and monitor food insecurity, emphasizing the inherent limitations and potential biases that can affect the accuracy and reliability of available data. Understanding these challenges is essential for developing more robust measurement tools and ensuring that interventions are informed by sound evidence (17).

One of the primary challenges in measuring food insecurity stems from the complex and multi-dimensional nature of the concept itself. Food insecurity is not simply a matter of having enough food; it encompasses a range of related issues, including food availability (the presence of sufficient quantities of food), food affordability (the ability to purchase adequate food), food access (the ability to obtain food through various means), and food utilization (the ability to absorb and use nutrients from food). These dimensions are interconnected and influenced by a variety of factors, including economic conditions, social structures, environmental factors, and political stability. Defining and operationalizing these concepts for measurement purposes requires careful consideration of the specific context and the nuances of different dimensions of food insecurity. For example, an individual may have access to a sufficient quantity of food, but that food may lack the necessary nutritional content, leading to micronutrient deficiencies. Similarly, a household may have the financial resources to purchase food, but access to local markets may be limited or unreliable. Furthermore, food insecurity can manifest in different forms, ranging from mild uncertainty about food access to severe hunger and malnutrition. Capturing this full spectrum of experiences requires the use of a variety of assessment tools and indicators. The complexity of the concept also leads to variations in definitions and measurement approaches across different regions and organizations, making it difficult to compare data and track trends over time (18).

Collecting accurate and reliable data on food insecurity, particularly in remote, conflict-affected, and marginalized areas, presents numerous practical challenges. Many of the populations most vulnerable to food insecurity are also the most difficult to reach and survey due to geographical isolation, limited infrastructure, security concerns, and cultural sensitivities. Household surveys, a common method for collecting data on food insecurity, can be time-consuming, expensive, and prone to biases. Self-reported data on food consumption and food security status can be influenced by recall bias, social desirability bias, and lack of standardized data collection methods. Furthermore, relying solely on household surveys may miss critical information on the experience of individuals within households, particularly vulnerable groups such as women, children, and the elderly. Collecting data on food insecurity in conflict-affected areas is particularly challenging due to security risks, population displacement, and limited access for humanitarian organizations. In such contexts, data collection may rely on convenience sampling or proxy measures, which may not be representative of the population as a whole. Furthermore, the transient and volatile nature of food security in these areas requires frequent and ongoing data collection, which can be logistically challenging and costly. The ethical considerations of conducting research in vulnerable populations must also be carefully considered, ensuring informed consent, data privacy, and minimal disruption to the lives of participants (19).

The reliability and validity of data on food insecurity are critical for making informed decisions about resource allocation, program design, and policy development. However, data on food security can vary significantly in quality and reliability depending on the methods used for collection, analysis, and interpretation. The use of different survey instruments, data collection methods, and analytical techniques can lead to inconsistencies in the data and challenges in comparing findings across different studies and settings. The accuracy of data on food security can also be influenced by the skills and training of data collectors, the time of year in which data are collected, and the presence of recall or response biases. Furthermore, food security data can be affected by measurement error, which can lead to inaccuracies in prevalence estimates and challenges in assessing the effectiveness of interventions. Ensuring the reliability and validity of data requires adherence to rigorous methodological standards, including the use of standardized survey instruments, the training of data collectors, and the implementation of quality control measures. In addition, researchers must use sophisticated analytical techniques that address potential biases and measurement error. Furthermore, the validity of the data depends on the cultural relevance of the measurement tools and the ability of individuals to accurately interpret and respond to the survey questions.

6 Conclusion

Food insecurity, as a persistent and pervasive global challenge, represents a significant barrier to achieving equitable and sustainable human development. The profound consequences of inadequate access to safe and nutritious food extend far beyond the immediate experience of hunger, undermining individual and population health, hindering economic progress, and threatening social stability. Addressing this complex issue requires a concerted, multi-sectoral, and globally coordinated approach that moves beyond short-term interventions to tackle the systemic root causes of food insecurity and build resilient and equitable food systems for future generations. This conclusion synthesizes the key insights from this exploration of the epidemiology of food insecurity,

highlighting the urgent need for action and outlining a comprehensive pathway toward a future where food security is a reality for all. The preceding sections have demonstrated the multi-faceted nature of food insecurity, exposing its complex interplay of economic, social, environmental, and political factors. Poverty, conflict, climate change, and inadequate food systems each contribute to this challenge, often creating a synergistic effect that exacerbates vulnerabilities. The detrimental impacts of food insecurity extend to physical, mental, and developmental health, with particularly severe consequences for children, who are most vulnerable to the long-term effects of malnutrition. Furthermore, the challenges associated with measuring food insecurity underscore the need for continued innovation and rigorous methodological approaches to accurately monitor and evaluate the effectiveness of interventions. Addressing this complex challenge requires a holistic, multi-sectoral approach that transcends traditional disciplinary boundaries. Governments, international organizations, civil society, communities, and individuals must work together to create the necessary policy, institutional, and social environments to ensure food security for all. This approach must be founded on a commitment to human rights, equity, and sustainability.

Ethical issue

Authors are aware of and comply with, best practices in publication ethics specifically about authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. Authors adhere to publication requirements that the submitted work is original and has not been published elsewhere in any language.

Competing interests

The authors declare that no conflict of interest would prejudice the impartiality of this scientific work.

Authors' contribution

Conceptualization, Akmaral Baspakova; methodology, Zh. A.; formal analysis, Gulmira Yerimbetova; investigation, Akmaral Baspakova, Gulmira Yerimbetova; resources, Zhanat Ashimova; writing—original draft preparation, Akmaral Baspakova, Nadiar M. Mussin; writing—review and editing, Akmaral Baspakova, Nadiar M. Mussin.

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Data Availability Statement

All data generated or analyzed during this study are included in this published article.

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