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# Holistic review of food intoxication and mosquito-borne infections in vulnerable populations

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**Abstract**
Food intoxication and mosquito-borne infections remain two of the most significant public health threats globally, disproportionately affecting vulnerable populations such as children, pregnant women, older adults, low-income communities, migrants, and immunocompromised individuals. While food intoxication arises from ingestion of preformed toxins produced by microbial agents, mosquito-borne infections such as dengue, malaria, chikungunya, Zika, and West Nile virus—are transmitted through infected vectors. Both categories of diseases share common determinants: poor hygiene, inadequate sanitation, environmental degradation, weak immune status, malnutrition, and limited access to healthcare. This review provides a holistic synthesis of the underlying mechanisms, risk factors, epidemiological trends, clinical manifestations, and preventive strategies related to food intoxication and mosquito-borne infections. Emphasis is placed on socio-economic vulnerability, climate change, food insecurity, and nutrition-related susceptibility. The review highlights the need for multidisciplinary public health approaches integrating environmental management, food safety practices, vector control, community awareness, and policy-level interventions.

**Keywords:** Food intoxication, mosquito-borne infections, vulnerable populations, toxins, food safety, dengue, malaria, socio-economic determinants, climate change, public health

## 1. Introduction
Food intoxication and mosquito-borne diseases constitute significant global health burdens, particularly in low-resource settings (Massengo *et al*., 2023) [29]. Food intoxication results from the ingestion of food contaminated with toxins produced by bacteria such as *Staphylococcus aureus*, *Clostridium botulinum*, *Bacillus cereus*, and fungal metabolites like mycotoxins (Jovanovic *et al*., 2021) [22]. Mosquito-borne diseases, on the other hand, are transmitted through vectors like *Aedes* and *Anopheles* mosquitoes and include infections such as malaria, dengue, chikungunya, Zika, and lymphatic filariasis (Huynh *et al*., 2022) [19].
Vulnerable populations experience disproportionate effects due to socio-economic, environmental, demographic, and immunological factors (Deguen *et al*., 2022) [13]. A holistic review connecting both categories of diseases helps identify intersecting risk determinants, exposure pathways, and integrated strategies for disease prevention (Juarez *et al*., 2014) [23].

### 1.1 Understanding Food Intoxication
#### 1.1.1 Definition and Mechanism
Food intoxication occurs when individuals consume food containing preformed toxins, rather than by infection of the host. The toxins may be bacterial (enterotoxins, neurotoxins), fungal (mycotoxins), marine biotoxins, or chemical contaminants (Visciano *et al*., 2016) [45].

#### 1.2.1 Major Causative Agents
- ***Staphylococcus aureus* Enterotoxins**
  *Staphylococcus aureus* produces heat-stable enterotoxins that remain active even after cooking. These toxins cause rapid-onset symptoms often within 1-6 hours characterized by sudden vomiting, nausea, abdominal cramps, and sometimes diarrhea. Because the organism can grow in improperly handled or stored foods, contamination of dairy, meat products, and pastries is common (Pal *et al*., 2016) [38].
- ***Clostridium botulinum* Neurotoxins**
  *Clostridium botulinum* produces one of the most potent neurotoxins known, leading to

botulism. This toxin blocks acetylcholine release at neuromuscular junctions, resulting in flaccid paralysis. Symptoms include blurred vision, difficulty swallowing, muscle weakness, and potentially respiratory failure. It is commonly associated with improperly canned foods and anaerobic food environments
(Kaler *et al*., 2020) [24].

- ***Bacillus cereus* Toxins**
  Bacillus cereus is a well-known foodborne pathogen that causes two distinct forms of food intoxication, each linked to different types of toxins and onset times (Tewari and Abdullah, 2015) [42]. The emetic form results from a heat-stable toxin, cereulide, which commonly develops in starchy foods such as cooked rice that are left at room temperature; symptoms typically appear within 1-5 hours and are characterized by acute nausea and vomiting (Agata *et al*., 2002) [4]. In contrast, the diarrheal form is caused by heat-labile enterotoxins such as hemolysin BL (HBL), non-hemolytic enterotoxin (NHE), and cytotoxin K (CytK) that are produced in foods like milk, meat products, vegetables, and cereals. These toxins lead to watery diarrhea, abdominal cramps, and discomfort, usually manifesting 8-16 hours after consumption. Together, these two syndromes underscore the importance of proper food handling, storage, and temperature control to prevent toxin formation in susceptible foods (Vinu *et al*., 2025) [44].
- **Mycotoxins (Aflatoxin, Ochratoxin)**
  Mycotoxins, particularly aflatoxins and ochratoxins, are toxic secondary metabolites produced predominantly by fungi such as *Aspergillus* and *Penicillium*, especially when grains, nuts, spices, and animal feed are stored under warm, humid, or poorly managed conditions. Aflatoxins most notably aflatoxin B1 are potent hepatotoxins and recognized carcinogens, frequently contaminating maize, groundnuts, and related products. Ochratoxins, especially ochratoxin A, are associated with nephrotoxicity, immune suppression, and potential carcinogenic effects, posing significant health concerns upon chronic exposure. These mycotoxins are highly stable during food processing, heat treatments, and storage, which allows them to persist in the food chain and contribute to long-term health risks in humans and animals (Więckowska *et al*., 2024) [47].
- **Natural Plant and Marine Toxins (Tetrodotoxin, Ciguatera)**
  Certain plants and marine organisms naturally harbor potent toxins that pose significant risks to human health, even when the foods are properly cooked (Taylor *et al*., 2025) [41]. Tetrodotoxin, a powerful neurotoxin found primarily in pufferfish, acts by blocking voltage-gated sodium channels, leading to rapid onset paralysis, numbness, and in severe cases, fatal respiratory failure (Lago *et al*., 2015) [25]. Similarly, ciguatera toxin produced by marine dinoflagellates and accumulated in reef fish such as barracuda, grouper, and snapper causes ciguatera fish poisoning, which presents with a combination of gastrointestinal symptoms, neurological disturbances, and the characteristic temperature reversal sensation in which hot objects feel cold and vice versa. Both toxins are notably heat-stable and resistant to cooking or food processing, making proper sourcing, handling, and species identification essential to preventing intoxication. Certain plants and marine organisms naturally harbor potent toxins that pose significant risks to human health, even when the foods are properly cooked. Tetrodotoxin, a powerful neurotoxin found primarily in puffer fish, acts by blocking voltage-gated sodium channels, leading to rapid onset paralysis, numbness, and in severe cases, fatal respiratory failure. Similarly, ciguatera toxin produced by marine dinoflagellates and accumulated in reef fish such as barracuda, grouper, and snapper causes ciguatera fish poisoning, which presents with a combination of gastrointestinal symptoms, neurological disturbances, and the characteristic temperature reversal sensation in which hot objects feel cold and vice versa. Both toxins are notably heat-stable and resistant to cooking or food processing, making proper sourcing, handling, and species identification essential to preventing intoxication.

### 1.3 High-Risk Foods
Improperly stored dairy, meat, fish, cooked rice, canned foods, spices, nuts, and grains predispose to toxin formation (Owusu-Darko *et al*., 2024) [37].

## 2. Vulnerable Populations for Food Intoxication
### 2.1 Children
Children represent one of the most vulnerable groups to food intoxication due to their underdeveloped immune systems and increased exposure to contaminated ready-to-eat foods commonly consumed at home, schools, and street food environments. Their gastrointestinal systems are still developing, making them less capable of neutralizing toxins produced by bacteria, fungi, and other foodborne pathogens (Islam *et al*., 2024) [20]. Additionally, children often have limited awareness of hygiene practices, increasing the likelihood of exposure to improperly handled or stored foods. Factors such as inadequate food safety measures in household kitchens, poor sanitation in school meal programs, and consumption of packaged snacks with long storage periods further heighten their susceptibility. Consequently, food intoxication in children can lead to rapid dehydration, severe gastrointestinal distress, and, in severe cases, long-term health complications, emphasizing the need for stringent food safety practices and hygiene education targeted at this age group (Fung *et al*., 2018) [17].

### 2.2 Pregnant Women
Pregnant women are particularly vulnerable to food intoxication due to the physiological and immunological changes that occur during pregnancy, which alter metabolic responses and reduce the body's ability to combat foodborne toxins. Hormonal shifts can slow gastrointestinal motility, increasing the absorption and impact of ingested toxins, while a naturally modulated immune system designed to protect the fetus reduces resistance to harmful substances. Exposure to bacterial toxins, such as those from *Staphylococcus aureus* or *Bacillus cereus*, can lead to severe dehydration and electrolyte imbalance, posing risks to both mother and fetus. More concerning toxins, such as mycotoxins or neurotoxins from contaminated foods, may cross the placental barrier and contribute to adverse fetal outcomes, including growth restriction, developmental abnormalities, or preterm birth. Therefore, maintaining strict food safety practices is crucial during pregnancy to minimize toxin exposure and protect maternal-fetal health (Athearn *et al*., 2004) [9].

### 2.3 Older Adults
Older adults represent a highly vulnerable group for food intoxication due to a combination of physiological, immunological, and lifestyle-related factors (Eze *et al*., 2023) [15]. As individuals age, their immune system gradually weakens, reducing the body's ability to fight off toxins and recover quickly from foodborne illnesses. Additionally, many older adults suffer from chronic conditions such as diabetes, kidney disease, or gastrointestinal disorders, which further compromise their resistance to toxins and can exacerbate the severity of symptoms. Reduced stomach acidity common with age or associated with medications like antacids also allows harmful microorganisms and toxins to survive the digestive process more easily (Ravisankar *et al*., 2016) [39]. Factors such as slower metabolism, reduced sense of taste and smell, and limited mobility may contribute to improper food storage or delayed consumption of perishable foods, increasing the risk of intoxication. Together, these factors make older adults particularly susceptible to severe outcomes from food intoxication, often requiring medical intervention and posing significant public health concerns.

### 2.4 Low-Income and Rural Communities
Limited access to refrigeration, poor storage facilities, and low food safety awareness. Low-income and rural communities are particularly vulnerable to food intoxication due to structural and environmental constraints that compromise food safety at multiple stages. Limited access to refrigeration and reliable electricity often forces households to store perishable foods at ambient temperatures, creating ideal conditions for the growth of toxin-producing bacteria such as *Staphylococcus aureus*, *Bacillus cereus*, and *Clostridium botulinum*. Inadequate storage facilities, including unhygienic containers and improper drying or preservation methods, further increase the risk of contamination by microbial toxins and mycotoxins. Additionally, low food safety awareness stemming from limited education, lack of community training, and minimal access to health information reduces the practice of safe handling, cooking, and sanitation. These factors, combined with financial constraints that push families to rely on cheaper, low-quality, or leftover foods, significantly elevate the likelihood of food intoxication in underserved rural and low-income populations (Wani *et al*., 2024) [46].

### 2.5 Immunocompromised Individuals
Immunocompromised individuals, including cancer patients undergoing chemotherapy, organ transplant recipients on immunosuppressive therapy, and people living with HIV/AIDS, are significantly more susceptible to food intoxication and its severe consequences (McKean and Ronan-Bentle, 2016) [30]. Their weakened immune systems reduce the body's ability to neutralize toxins and fight off even small doses of harmful microorganisms. As a result, toxins produced by pathogens such as *Staphylococcus aureus*, *Clostridium botulinum*, and *Bacillus cereus*, as well as mycotoxins in contaminated foods, can lead to more severe, prolonged, and potentially life-threatening symptoms compared to healthy individuals. These populations often experience rapid progression from mild gastrointestinal illness to systemic complications due to reduced immune resilience. Therefore, strict adherence to food safety measures, proper storage, thorough cooking, and avoidance of high-risk foods are essential to minimize their risk of intoxication (Madilo *et al*., 2024) [27].

## 3. Mosquito-Borne Infections: An Overview
### 3.1 Common Mosquito-Borne Diseases
Mosquito-borne diseases are infections transmitted to humans through the bite of infected mosquitoes, and they pose significant health risks globally, especially in tropical and subtropical regions. Malaria, caused by *Plasmodium* species and transmitted by *Anopheles* mosquitoes, leads to fever, chills, anemia, and in severe cases, organ failure. Dengue and Zika, transmitted primarily by *Aedes aegypti*, manifest as fever, rash, joint pain, and, in the case of Zika, can cause congenital abnormalities such as microcephaly. Chikungunya also spreads through *Aedes* mosquitoes, resulting in high fever, severe joint pain, and fatigue. Japanese encephalitis, transmitted by *Culex* mosquitoes, affects the central nervous system and can lead to neurological complications or death. West Nile Virus, primarily spread by *Culex* species, often causes mild flu-like symptoms but can progress to neuroinvasive disease in vulnerable populations, including the elderly and immunocompromised. These diseases highlight the critical need for effective vector control, surveillance, and preventive strategies in at-risk communities (Alqassim, 2024) [8].

### 3.2 Transmission Mechanism
Environmental conditions like stagnant water, rainfall, and temperature significantly affect mosquito breeding. Mosquito-borne infections are primarily transmitted when female mosquitoes inject pathogens into the human bloodstream during blood feeding. The mosquito first acquires the pathogen by feeding on an infected host, after which the pathogen undergoes development within the mosquito before becoming infectious (Acevedo-Guerrero, 2025) [3]. Environmental factors play a crucial role in mosquito breeding and disease transmission: stagnant water provides ideal sites for egg-laying, while rainfall and high humidity enhance larval survival. Temperature influences the rate of pathogen replication within the mosquito, with warmer conditions accelerating development and increasing transmission potential. Human behaviors, such as inadequate water storage, poor waste management, and lack of protective measures, further amplify exposure, particularly in vulnerable communities with limited resources (Al-Khalaifah *et al*., 2025) [5].

## 4. Vulnerable Populations for Mosquito-Borne Diseases
### 4.1 Urban Slum Dwellers
Urban slum dwellers are highly vulnerable to mosquito-borne infections due to overcrowded living conditions, poor drainage systems, and inadequate sanitation. Stagnant water from clogged drains, open containers, and insufficient waste disposal provides ideal breeding sites for mosquitoes such as *Aedes* and *Culex* species (Tyagi *et al*., 2025) [43]. Limited access to mosquito protection measures, such as bed nets or repellents, coupled with high population density, facilitates rapid disease transmission. These conditions contribute to frequent outbreaks of diseases like dengue, chikungunya, and malaria, disproportionately affecting children, the elderly, and other at-risk individuals within slum communities. Effective vector control and improved urban infrastructure are essential to reduce disease burden in these populations (Abbasi, 2025) [1].

### 4.2 Pregnant Women
Pregnant women are particularly susceptible to mosquito-

borne infections, which can have severe consequences for both the mother and the developing fetus. Zika virus infection during pregnancy can lead to congenital abnormalities such as microcephaly, neurological deficits, and developmental delays in the infant. Malaria in pregnancy is associated with maternal anemia, placental infection, and low birth weight, increasing the risk of neonatal morbidity and mortality. Hormonal and immunological changes during pregnancy can also exacerbate disease severity, making prevention strategies such as the use of insecticide-treated bed nets, repellents, environmental management, and timely medical interventions crucial to safeguarding maternal and fetal health (Mohammed *et al*., 2025) [32].

### 4.3 Children
Children are among the most vulnerable groups to mosquito-borne infections due to their developing immune systems and limited ability to tolerate severe disease (Carbone *et al*., 2025) [12]. Malaria in children often leads to complications such as severe anemia, cerebral malaria, and multi-organ failure, contributing to high mortality rates in endemic regions. Similarly, dengue infection can progress to dengue hemorrhagic fever or dengue shock syndrome more rapidly in children, resulting in significant morbidity and, in severe cases, death. Preventive measures, including vector control, early diagnosis, prompt treatment, and community education, are essential to reduce the disease burden and protect this high-risk population (Tariq *et al*., 2025) [40].

### 4.4 Elderly Individuals
Elderly individuals are at increased risk of severe outcomes from mosquito-borne infections due to age-related immune decline and the presence of comorbidities such as diabetes, hypertension, and cardiovascular diseases (Jeng *et al*., 2025) [21]. Infections like dengue can lead to severe hemorrhagic manifestations, while West Nile Virus may progress to neuroinvasive disease, causing encephalitis, meningitis, or long-term neurological complications. Reduced physiological resilience and delayed immune responses make timely diagnosis and medical care critical for preventing complications in this population.

### 4.5 Migrants and Refugees
Migrants and refugees often face heightened vulnerability to mosquito-borne diseases because of overcrowded shelters, inadequate sanitation, and limited access to healthcare services (Alkhatib *et al*., 2025) [6]. Poor drainage, stagnant water, and insufficient vector control in temporary settlements create ideal breeding grounds for mosquitoes. Additionally, disruption of healthcare infrastructure and limited awareness of preventive measures increase the risk of outbreaks. Targeted interventions, including vaccination where available, distribution of insecticide-treated nets, and health education, are essential to protect these populations from infection.

## 5. Shared Determinants of Food Intoxication and Mosquito-Borne Infections
### 5.1 Poor Sanitation and Hygiene
Poor sanitation and hygiene are central contributors to both food intoxication and mosquito-borne infections. Contaminated water, improper waste disposal, and unsafe food handling practices create environments conducive to microbial growth and toxin production in food. Simultaneously, stagnant water from blocked drains, discarded containers, or open sewage becomes an ideal breeding ground for mosquitoes, particularly *Aedes* and *Culex* species. Lack of handwashing, unclean cooking areas, and insufficient personal hygiene further facilitate the ingestion of pathogens and increase vector-human contact. Addressing sanitation gaps through improved waste management, clean water supply, and hygiene promotion can significantly reduce the dual burden of these diseases (Gwadabe *et al*., 2025) [18].

### 5.2 Malnutrition
Malnutrition weakens the immune system, reducing the body's ability to combat both ingested toxins and mosquito-borne pathogens. Protein-energy malnutrition, micronutrient deficiencies (such as vitamins A, C, D, and zinc), and anemia compromise cellular and humoral immunity, making individuals more susceptible to severe outcomes. In the context of food intoxication, malnourished individuals may experience prolonged gastrointestinal illness, impaired recovery, and higher risk of complications. Similarly, malnutrition exacerbates the severity of malaria, dengue, and other vector-borne infections by impairing immune responses and prolonging disease course. Nutritional interventions and supplementation in high-risk populations are therefore essential components of disease prevention (Moran *et al*., 2025) [33].

### 5.3 Climate Change
Climate change has a profound effect on the prevalence of both food intoxication and mosquito-borne diseases. Rising global temperatures accelerate mosquito life cycles and pathogen replication rates, increasing the risk and intensity of outbreaks of dengue, malaria, and other vector-borne infections (Megersa and Luo, 2025) [31]. Similarly, higher humidity and heat favor the growth of toxin-producing bacteria and fungi in stored foods, promoting the development of mycotoxins and other foodborne hazards. Extreme weather events, such as floods and droughts, further disrupt sanitation systems and compromise food safety. Adaptation strategies including climate-resilient infrastructure, predictive disease modeling, and strengthened food storage practices are vital to mitigate these impacts (Okafor and Uhuegbu, 2025) [35].

### 5.4 Socio-Economic Inequality
Socio-economic inequality magnifies exposure to both foodborne and vector-borne diseases. Low-income communities often live in overcrowded housing with limited access to clean water, refrigeration, and proper waste disposal, increasing the likelihood of food contamination and mosquito breeding (Ayelazuno and Tetteh, 2025) [11]. Inadequate healthcare access further delays diagnosis and treatment, raising morbidity and mortality rates. Poverty-driven behaviors, such as consuming improperly stored or unsafe foods, also contribute to food intoxication risk. Policies targeting equitable access to sanitation, safe food, housing improvements, and healthcare services are critical to reducing vulnerability among marginalized populations (Mamun and Alam, 2025) [28].

## 6. Clinical Manifestations
### 6.1 Food Intoxication
Food intoxication presents with a spectrum of clinical manifestations depending on the type of toxin and the individual's susceptibility (Nehzomi and Shirani, 2025) [34]. The most common symptoms include rapid-onset nausea,

vomiting, and diarrhea, often appearing within hours after ingestion of contaminated food. Neurotoxins, such as those produced by *Clostridium botulinum*, can cause neurological symptoms including blurred vision, difficulty swallowing, muscle weakness, and in severe cases, flaccid paralysis, which can be life-threatening without timely intervention. Chronic exposure to mycotoxins, such as aflatoxin and ochratoxin, may lead to long-term complications, including hepatotoxicity, liver cirrhosis, and increased risk of liver cancer (Awuchi *et al*., 2022) [10]. Early recognition and supportive care are critical for minimizing morbidity and preventing severe outcomes, especially in vulnerable populations.

### 6.2 Mosquito-Borne Diseases

Mosquito-borne diseases exhibit a wide range of clinical manifestations depending on the pathogen involved (Lee *et al*., 2018) [26]. Dengue and chikungunya typically present with high fever, rash, and severe joint pain, while severe dengue can progress to dengue hemorrhagic fever, characterized by plasma leakage, severe bleeding, and shock, which can be fatal if not promptly treated. Japanese encephalitis and West Nile virus primarily affect the central nervous system, causing neurological symptoms such as seizures, altered consciousness, and in severe cases, long-term neurological deficits. Malaria, caused by *Plasmodium* species, commonly presents with cyclical chills, fever, and sweating, and can lead to anemia, organ failure, and cerebral complications in severe infections. Early diagnosis, vector control, and timely medical intervention are essential to reduce morbidity and mortality from these infections.

## 7. Prevention and Control Strategies

### 7.1 Food Safety Measures

Effective food safety measures are essential to prevent food intoxication and reduce public health risks (Fung *et al*., 2018). Maintaining cold chains and proper cooking temperatures ensures that pathogens do not proliferate in perishable foods, while thorough cooking can inactivate many heat-sensitive toxins. Hand hygiene and safe food handling practices, including washing hands, cleaning utensils, and avoiding cross-contamination, significantly reduce microbial contamination during food preparation. Mycotoxin control involves proper drying, sorting, and storage of grains, nuts, and spices to prevent fungal growth and toxin accumulation. Additionally, community training and awareness programs on food hygiene educate populations about safe food practices, storage, and preparation techniques, empowering vulnerable communities to minimize exposure to harmful toxins (Frazzoli, 2020) [16].

### 7.2 Vector Control Measures

Vector control measures are crucial for preventing mosquito-borne infections and reducing disease transmission (Alqassim, 2024). Elimination of stagnant water sources, such as uncovered containers, clogged drains, and puddles, prevents mosquito breeding. Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) provide effective barriers against mosquito bites, especially during peak biting hours. The use of mosquito repellents and protective clothing offers personal protection, particularly in high-risk areas. Additionally, biological control methods, such as introducing larvivorous fish into water bodies, help reduce mosquito larvae populations naturally. Implementing these strategies collectively can significantly lower the incidence of diseases like malaria, dengue, and chikungunya in vulnerable populations (Alpern *et al*., 2016) [7].

### 7.3 Public Health and Policy Interventions

Public health and policy interventions play a pivotal role in controlling both food intoxication and mosquito-borne infections. Strengthening disease surveillance systems enables timely detection of outbreaks, monitoring of trends, and rapid response to emerging threats. Integrating food safety and vector-control programs ensures a coordinated approach, addressing both microbial contamination in foods and vector proliferation in the environment. Improving housing conditions, sanitation infrastructure, and access to clean drinking water reduces exposure to pathogens and breeding sites for mosquitoes. Moreover, targeted support for vulnerable populations, including nutritional supplementation, maternal and child health services, and community education, enhances resilience and reduces disease susceptibility, ultimately improving public health outcomes in high-risk communities (Okoli *et al*., 2024) [36].

### 7.4 Community Awareness and Education

Community awareness and education are vital components of preventing food intoxication and mosquito-borne infections (Abdullah *et al*., 2024). Awareness programs on safe food handling teach individuals how to properly store, prepare, and cook food, reducing the risk of microbial contamination and toxin formation. Simultaneously, behavior change communication for mosquito breeding prevention encourages communities to eliminate stagnant water, use protective measures, and adopt environmentally safe practices to control vector populations. Empowering communities through education not only enhances individual protective behaviors but also fosters collective action, creating sustainable reductions in disease transmission and improving overall public health resilience (Dushkova and Ivlieva, 2024) [14].

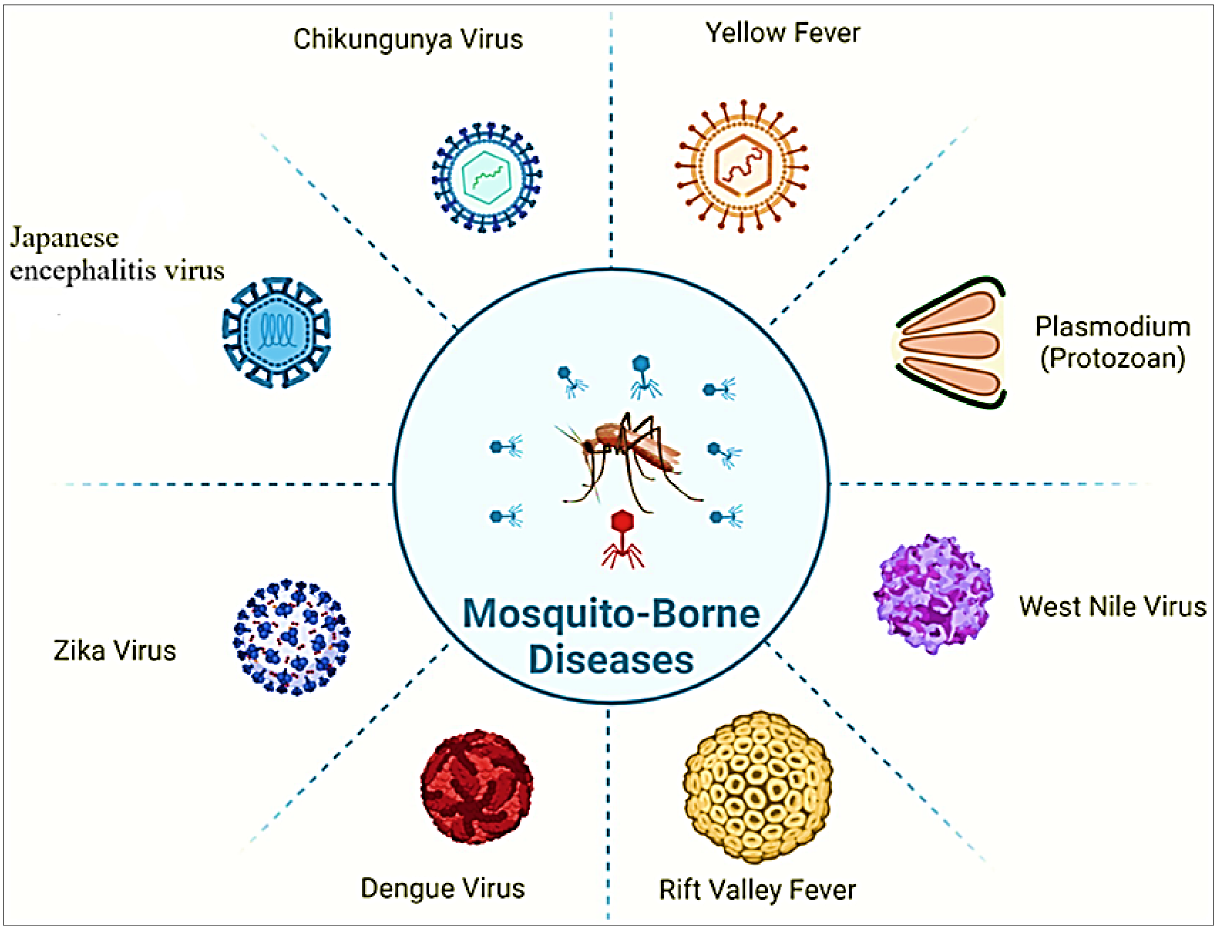


**Fig 1:** Overview of Major Mosquito-Borne Diseases and Causative Agents (Zhang *et al*., 2024) [50].

Figure 1 illustrates an overview of major mosquito-borne diseases and their causative agents, highlighting the role of mosquitoes as critical vectors in transmitting a wide range of viral and protozoan pathogens that pose significant global public health challenges. The figure depicts key viral infections such as dengue virus, Zika virus, chikungunya virus, yellow fever virus, Japanese encephalitis virus, West Nile virus, and Rift Valley fever virus, alongside the protozoan parasite *Plasmodium*, the causative agent of malaria. By visually organizing these pathogens around the mosquito vector, the figure emphasizes the central role of mosquito species particularly *Aedes*, *Anopheles*, and *Culex* in disease transmission cycles. This representation underscores the diversity of mosquito-borne pathogens, their wide geographic distribution, and their contribution to morbidity and mortality worldwide, reinforcing the need for integrated vector control strategies, early surveillance, and preventive public health interventions (Zhang *et al*., 2024) [50].

## Conclusion

Food intoxication and mosquito-borne infections remain significant threats, particularly among vulnerable populations. Both shares overlapping determinants such as inadequate sanitation, poor nutrition, climate change, and socio-economic constraints. A holistic approach that integrates food safety strategies, environmental management, vector control, community engagement, and strong public health systems is essential to reduce the burden of these diseases. Targeted interventions for high-risk groups including children, pregnant women, the elderly, and low-income communities can significantly reduce morbidity and mortality. Coordinated efforts across health sectors, policymakers, and community institutions are crucial for sustainable prevention and healthier societies.

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