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Systematic review

Flood Impacts on Food Security, Reflections on the Derna Flood: A Systematic Review

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Abstract
Flooding can destroy health, well-being, social stability, economic status, food security, and nutritional status. This paper presents the potential risk to food security posed by Libyan flooding. This systematic review examines the impact on food security across diverse international contexts. It discusses the components of food security, including food availability, access, utilization, and stability. Drinking water quality, socio-economic factors, vulnerable groups, and coping strategies will be discussed.
Keywords. *Flood, Food Security, Nutrition, Vulnerable Groups, Coping Strategies, Libya, Derna.*

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Introduction

Flooding is a complex disaster due to its causes, types, and impacts. Floods are the most common type of natural disaster. Flooding occurs when an overflow of water inundates dry areas. Floods usually occur after heavy rainfall, a storm from a tropical cyclone, a tsunami in coastal regions, or rapid snowmelt. Extreme weather conditions, such as floods, can have destructive consequences on an individual's health, well-being, social stability, and economic status. Food security is an essential and significant component of ensuring overall nutrition status. Floods result in famine unless public response intervenes to alleviate these effects [1- 3].

During September 2023, Storm Daniel led to destruction and flooding in the coastal areas of northeastern Libya. The outburst of the Sidi-Mansour and Derna dams caused a destructive flood in the city center of Derna. Other cities and villages that faced flooding include Alwardeia, Omar Almokhtar, Owalia, Sousa, Taknes, Toukra, Tolmeita, Albayda, Shahat, El-marj, Alfaidea, and Almokhili. The flood has caused significant damage to infrastructure and homes, displacing many people. Food prices reportedly remain higher than usual. Analysis of remote sensing data by "FAO" shows that a small portion of the flooded area is cropland. However, the effects on agriculture could be massive due to the lack of irrigation water and the potential destruction of irrigation networks. As well as the massive run-off of pollutants and sediment debris, this will likely have consequences on the fishing sector. Furthermore, "WFP" and its international and local partners reached 21,590 people with food assistance. More food distributions are taking place through the International and local Committees. There are several studies regarding climate change impacts, including flooding on food security. International flood events have increased attention to flood consequences on human life, including food security [4-7]. From 2009 to 2020, almost 12% of the people who suffered from flooding had food insecurity. Accordingly, comprehensive data collection regarding flood events and associated food security measures is required for better response, preparedness, and recovery requirements. Food insecurity is a serious and growing problem worldwide. [8, 9].

It is widespread across all countries. Food insecurity takes two forms, direct and indirect. It occurs at the individual, family, community, regional, sub-national, and national levels [10]. Before the flooding, data from phone surveys conducted by the WFP and the Libyan Bureau of Statistics and Census in 2021 revealed that 55% of the Libyan population experienced deprivation in at least one of five dimensions (food, health, education, housing, and safety). Non-traditional measures of baseline welfare, such as the Relative Wealth Index (RWI), indicated Derna below the median level of wealth in Libya. Residents of Derna, Benghazi, and El-marj, on average, fall between the 25th and 50th percentiles of the welfare distribution. By contrast, districts in the western part of Libya have higher relative wealth than the eastern flood-affected areas [11]. This review helps shed light on the interconnections of flooding and food security.

Methodology

The authors conducted a thorough review of scientific literature to find studies that explored how flooding affects food security in developing and transitional economies. After screening, 18 relevant studies were found. Since these studies

used different methods, data sources, and outcome measures, the Authors could not perform a statistical meta-analysis. Instead, authors used a narrative approach to summarize and compare findings from various contexts.

Literature-search strategy

The authors conducted a thorough search of major databases, including PubMed, Scopus, Web of Science, Science Direct, and Google Scholar, to identify relevant studies. Authors also screened grey literature and institutional repositories, such as the World Food Programme and FAO, to ensure we captured all pertinent evidence. The search covered publications from the databases' inception to December 2025 and included only studies published in English, although authors screened abstracts in other languages when English summaries were available. The authors used specific search terms, combining keywords like "flood," "climate change," and "food security," with Boolean operators to find relevant studies. Authors also manually checked the references of retrieved articles to find additional publications and removed duplicates before screening. Authors included studies that were original research, examining the impact of flooding, extreme weather, or climate-related factors on food security, agricultural production, or nutrition in developing or climate-vulnerable regions. These studies had to be published in peer-reviewed journals between 2000 and 2025. On the other hand, authors excluded studies that were reviews, reports, or policy briefs without primary data, as well as those that focused solely on environmental processes without human or food security outcomes. Additionally, studies conducted in high-income or non-flood-prone countries, or those that did not measure food security indicators or agricultural productivity explicitly, were also excluded. The selection process involved independent screening of titles and abstracts by two authors, followed by full-text evaluation, with disagreements resolved through discussion and consensus.

Quality assessment

Authors assessed the quality and risk of bias in the included studies using a tailored version of the Joanna Briggs Institute (JBI) critical appraisal tools. This evaluation includes the clarity of research design and objectives, sampling methods and sample size justification, validity and reliability of measurements, statistical analysis rigor, and transparency of data collection and ethics. Each study was given an overall quality rating of High, Moderate, or Low, based on its adherence to these methodological standards. Studies rated as High-quality typically demonstrated robust methods, such as using validated food security metrics, controlling for socio-economic confounders, and presenting transparent analytical procedures.

Data abstraction

Initially, authors found 1,147 records, removed 268 duplicates, and screened 879 unique abstracts, as shown in (Figure 1). After reviewing 64 full-text articles, 18 studies met the criteria and were included in the final analysis. The authors extracted key information from each study, including authors, year, country, study design, population characteristics, sample size, measurement tools, statistical analysis, main outcomes, and conclusions related to food security and flood/climate exposure. Instead, the authors grouped the findings into three primary themes: the impact of flooding on food security, climate variability and adaptive responses, and factors that influence vulnerability. This approach provides a solid foundation for understanding the complex relationships between climate-induced flooding and food insecurity in low- and middle-income countries. The study's summary and quality are presented in (Table 1).

Results

Table 1 provides a broad overview of studies addressing food insecurity and related challenges across different regions, highlighting the diversity of research designs, sample sizes, and analytical approaches. It shows that investigations span countries such as Libya, Ghana, Nigeria, Ethiopia, Iran, Bangladesh, and Afghanistan, with methodologies ranging from cross-sectional surveys and field studies to econometric modeling and GIS-based climate projections. Household surveys dominate the evidence base, though national datasets and conceptual models also contribute to understanding systemic issues.

The findings consistently emphasize the role of environmental stressors such as floods, precipitation variability, and climate change in exacerbating food insecurity, while socioeconomic determinants including income, education, land size, and institutional strength emerge as critical factors influencing resilience. Infrastructure weaknesses, particularly in food storage and transport, are highlighted in Bangladesh and Nigeria, and health outcomes such as anemia are linked to flood exposure in Afghanistan, underscoring the multidimensional nature of food insecurity.

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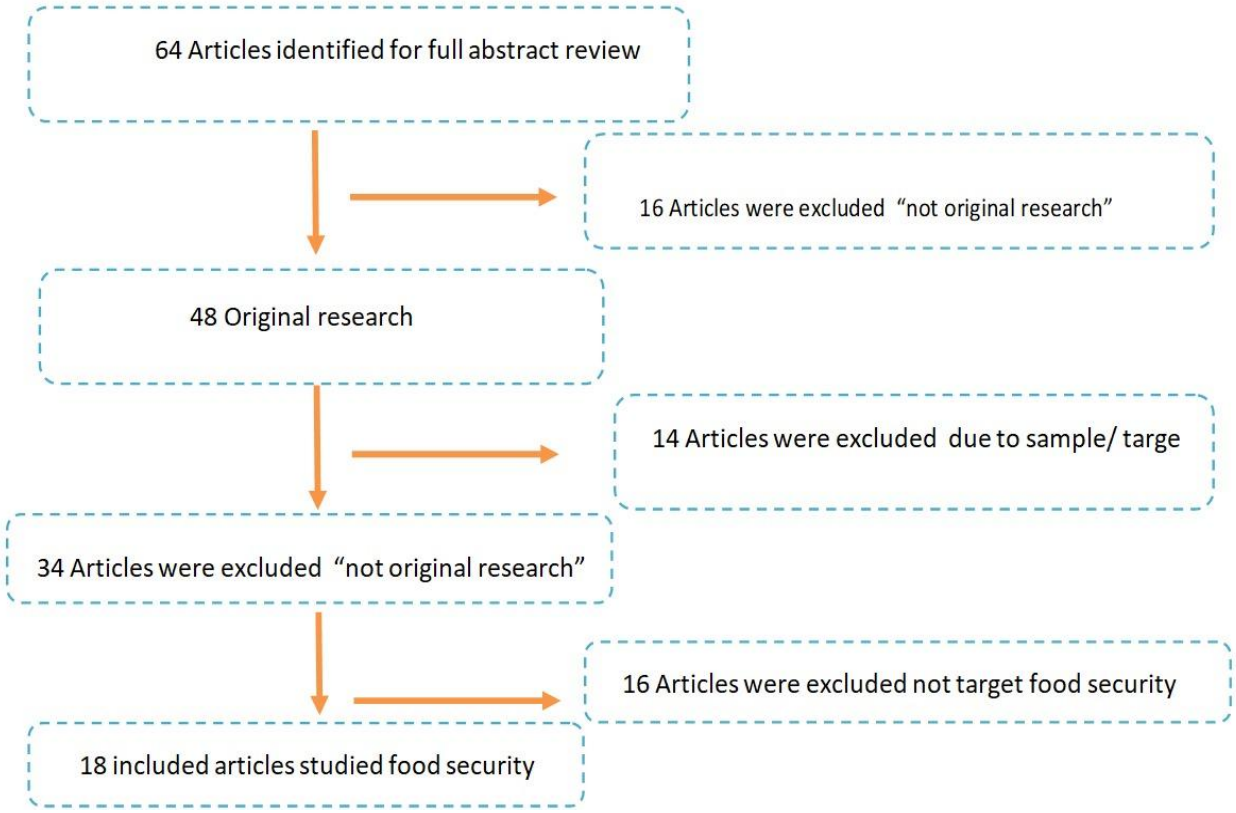

Figure 1. Flow diagram of article extraction

Study quality varies, with most rated high due to robust statistical methods like regression and econometric analysis, while moderate and lower-quality studies often rely on descriptive or qualitative approaches that provide valuable contextual insights but limit generalizability. Taken together, the evidence demonstrates that food insecurity is shaped by a complex interplay of environmental shocks, socioeconomic conditions, and institutional capacity, pointing to the need for integrated strategies that combine climate adaptation, social protection, and infrastructure development to mitigate risks and strengthen food systems.

Table (1). Summary of the Studies

Authors (Year)	Study Design and Country	Sample Measurements	Statistical Methods	Main Findings	Study Quality
Nouh F. et al., (2021) [8]	Cross-sectional, Libya	400 households; food insecurity survey (FIES)	Descriptive/logistic regression	65% of households' food insecure associated with income and household size	High
Bindra S.P. (2014) (9)	Analytical/descriptive, Libya	Conceptual model; water-energy-food data	Qualitative synthesis	Integrated water management enhances the food-energy nexus	Moderate
Cooper M. (2019) (13)	Quantitative, Ghana / Bangladesh	National household data + rainfall records	Panel regression	Precipitation variability linked to higher food insecurity	High
Akukwe T.I. (2020) (14)	Comparative before–after, Nigeria	300 households before/after flood	Paired t-test/chi-square	Flooding reduced the food security index post-event	High
Quaye W. (2008) (16)	Field survey, Ghana	150 households	Descriptive statistics	Identified reliance on food aid and crop diversification	Moderate

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Chemura A. (2020) (17)	Modeling, Ghana	Climate/crop yield datasets	GIS/climate modeling	Predicted decline in crop suitability under climate change	High
Musah B.A. (2013) (19)	Field survey, Ghana	120 households	Descriptive / correlation	Floods decreased food production and income	Moderate
Echendu A.J. (2020) (22)	Analytical, Nigeria	National flood / SDG data	Qualitative comparison	Flooding hinders the achievement of food-related SDGs	Moderate
Ede A. (2019) (25)	Case analysis, Nigeria	Documented infrastructure failure	Descriptive	Floods disrupt food transport and supply	Low
Osabohien R. (2018) (26)	Econometric, Nigeria	National food security data	ARDL / co-integration	Institutional strength and technology enhance food security	High
Week D.A. (2020) (29)	Field survey, Nigeria	200 households	Descriptive / regression	Floods lowered household food production	Moderate
Agidew A.M. (2018) (38)	Household survey, Ethiopia	300 rural households	Binary logistic regression	Education, land size, and income reduce food insecurity	High
Mortazavi Z. (2017) (40)	Cross-sectional, Iran	500 households	Descriptive / regression	High food insecurity is linked to low income/education	High
Hasan M.K. (2015) (41)	Field study, Bangladesh	60 rice storage facilities	Descriptive/comparative	Floods damage traditional rice storage; need improved designs	Moderate
Raihan M.J. (2018) (42)	Seasonal cross-sectional, Bangladesh	720 households	Logistic regression	Seasonal variation in food insecurity is highest pre-harvest	High
Christian A.K. (2019) (43)	Cross-sectional, Ghana	400 households	Multivariate regression	Livestock ownership improves food security /reduces anemia	High
D'Souza A. (2013) (45)	Econometric, Afghanistan	National Household Panel	Time-series regression	Conflict/food price shocks increase food insecurity	High
Oskorouchi H.R. (2018) (47)	Statistical, Afghanistan	National health dataset	Logistic regression	Flood exposure increases anemia among women	High

Discussion

Similar international Scenarios

Food security is an important global issue. Several global initiatives and partnerships to achieve food security have been established. Food security is defined as the food availability and the ability to access it by each community member. Food security is the availability of adequate, balanced, and diverse nourishing food to maintain sustainable and stable food consumption, as well as to prevent fluctuations in food production and prices. Food security is achieved when every individual has both physical and economic access to sufficient, safe, and nutritious food to meet their nutritional preferences and requirements. Furthermore, food security is integral to sustainability. Conversely, food insecurity refers to the uncertain and/or limited availability of nutritionally adequate and safe food. Food is an essential requirement for humans. Consequently, food security is recognized as a crucial element of sustainability initiatives and a key concern of national security. The purchasing power of vulnerable family members significantly impacted their ability to afford nutritious and staple foods, prompting them to adopt negative coping strategies [8-10]. The World Food Program states that there are more than 324,000 individuals, including 174,000 Libyans and 150,000 non-Libyans, who require food assistance in Libya. Flooding is negatively affecting food security due to its effects on the food system. Several studies

investigate the flooding consequences on food security [12]. For example, Cooper et al. (2019) investigated nutrition, hunger, and precipitation issues in Bangladesh and Ghana after flooding. A study revealed that both countries are experiencing irregular rainfall and the inability to produce sufficient food for their nations [13]. Akukwe et al. (2020) conducted a study in Nigeria on flooding and its impact on food security. Their research findings confirmed that floods were increasing the number of food-insecure households within the study area [14]. Furthermore, Deressa et al. (2010) investigated the relationship between climate change and agriculture. Their results reveal that age, gender, education level, and household head wealth all influence farmers' circumstances [15]. Quaye et al (2008) studied the food security situation in Ghana after flooding. The study reveals that floods and inadequate infrastructure significantly diminish farmers' ability for food security [16]. Chemura et al. (2020) conducted a study examining the effects of climate change, including flooding, on agriculture and crops in rural communities. Their findings confirmed that floods have adverse impacts on agricultural production and, consequently, food security [17]. Ola (2018) focused on the challenges posed by climate change to rural dwellers in Nigeria and concluded that food-producing farmers are highly vulnerable to the detrimental effects of floods [18]. Musah et al. (2013) in Ghana confirmed that floods have a profound impact on socioeconomic activities and contribute to the reduction of food security within the affected region [19].

Food Security Components and Availability

The (FAO) determined the food security components as: availability, access, utilization, and stability. Food is related to Sustainable Development Goals [8]. Food availability is a crucial component of food security, encompassing the sufficient availability of food quantities. Regular food availability hinges on adequate food production levels, which can only be achieved within a healthy and disaster-free environment [20]. Despite agriculture being the second most significant economic activity in Libya, following crude oil, food production levels remain below demand. Agriculture ranks as the second-largest sector in the Libyan economy, surpassing the oil and petroleum sector. However, the country heavily relies on importing most of its food supplies. Unstable climatic conditions and poor soil fertility significantly hinder farming output. Notably, only 25% of Libya's current food demand originates from domestic production, rendering the country highly dependent on food imports. Wheat, oil, maize, and milk constitute the primary commodities sourced from abroad [21]. Consequently, flooding disasters have further exacerbated production levels in both aquatic and terrestrial ecosystems, the primary food production sectors. Flooding wreaks havoc on the environment, destroying seedling stores, agricultural areas, crops, and livestock [22]. This extensive destruction negatively impacts harvest production, adversely affecting the subsequent agricultural season and intensifying the food shortage crisis. During floods, individuals face the risk of illness and physical injuries. Floods have a cascading effect and pose a significant threat to food security, directly impacting food production. Agricultural communities are disproportionately affected due to income loss and lack the financial resources to purchase essential food and non-food items. Inundated farmlands become unsuitable for cultivation, and livestock is often not secured during floods, further compromising food security. This situation is exemplified by the Derna flood, where the affected area in Libya is characterized by livestock farming. Additionally, sediments deposited on agricultural areas during flooding render these lands infertile for a prolonged period. The circumstances are contributing to a period of food insecurity. Furthermore, floods have a detrimental impact on the natural flora, fauna, and insects of an ecosystem. Additionally, aquaculture is also adversely affected, as floods cause the displacement of fish stocks, resulting in financial losses for fish farmers and a loss of valuable protein sources and other nutrients from the fish. Consequently, flooding negatively affects food availability [23].

Food access

Food access is the ability and capacity to obtain nutritious, sufficient food. Food chains and systems are destroyed due to floods, negatively impacting food access [24]. In the city of Derna, food prices reportedly continue to be higher than usual. The volatility in food prices after flooding makes an extra constraint on the local community, leading to inaccessibility. Flooding often damages roads in Derna, cutting off physical access between areas [25]. Food access is further limited by the destruction of transportation, roads, and infrastructure, all of which are needed for food transportation. Small villages and rural areas become more isolated from regular and normal food access [26]. Disruptions in the food supply chain raise food prices. The flooding may cause increases in food prices in Derna districts due to infrastructure damage, which influences chains of local supply. The national impact on unemployment is also affected. However, in the affected regions, the impact on private and self-employment, which makes up about 5% of

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the population, could be more important, due to job loss and income reduction, especially within the agricultural community [11].

Food utilization

Food utilization refers to the human body's capacity to absorb and utilize the essential nutrients derived from the diet. Due to its intricate nature, food utilization stands as the most significant yet least extensively researched aspect of food security. Food utilization consists of various factors, including food safety, daily required nutritional intake, diet quality, nutrient loss, food consumption patterns, and the occurrence of food-borne diseases. Furthermore, food availability and access do not guarantee adequate utilization of the essential nutrients. Nutrient loss is a direct consequence of flooding. A study conducted in Nigeria revealed that 71.4% of respondents attributed a loss of nutritional quality in food to flooding. Flooding has a detrimental impact on the quality and yield of fruits, vegetables, and cereals. Crop damage resulting from flooding facilitates the proliferation of bacterial and fungal infections. Consequently, farmers may opt for alternative crops that are resistant to flooding, albeit with reduced nutritional value. Furthermore, the economic repercussions of flooding can hinder food access. Financial access to food exhibits a significant correlation with food utilization, surpassing physical accessibility [27- 31].

Food stability

Food stability is ensuring that available, accessible, and utilized food is always. Food system disasters due to flooding affect food stability. A reduction in agricultural production due to flooding decreases food availability. Consequently, a shortage in food supply raises food prices and minimizes food accessibility. Accordingly, consumers are forced to decrease their food consumption [32, 33].

Impacts of a flood on drinking water quality

Floods cause many issues, including damage to water supply systems, a shortage in drinking-water supplies, and rupture of the water transport system. Moreover, the most serious consequence of flooding is drinking water contamination. Contamination sources include agricultural or industrial waste, bacteria, sewage, heating oil, chemicals, and other substances. According to the World Bank, in terms of physical damages, water and sanitation damages on the Derna coast are US$136 million (13% of total physical damages) [11, 34-36]. Extreme weather conditions have historically been linked to the presence of Cryptosporidium oocysts and Giardia cysts in freshwater bodies, with occurrences up to two to three times more frequent during and after floods. Consequently, water-borne diseases such as enteric fever, cholera, and dysentery were more prevalent among the residents of flood-affected regions [37].

Socio-economic Factors and Flood

Social insecurity and high increases in food prices are common variables after flooding. Both variables are related to flood-food insecurity. In addition to the mentioned two variables, household characteristics such as age, gender, marital status, education, occupation status, and family size, household head age play an important role in food security after the flood. In many studies, young household head age was a protective factor against food insecurity after the flood [38]. Studies confirm that older people are often associated with more food insecurity. Furthermore, the family is at significantly less risk of food insecurity if the family head's educational qualification is secondary or higher. Previous literature indicated that higher levels of education among household heads act as a protective factor against family food insecurity after the flood [39]. Furthermore, food insecurity risk increased significantly when housework in freelance occupations was compared to those who work in government work. Accordingly, poverty before flooding is identified as a significant risk factor for post-flood family food insecurity. Food insecurity increased significantly when a household was poor before the flood [40]. Also, evidence suggests that families producing some of their food have higher food security than those who purchase all their consume. On the other hand, families who mainly depend on their food production have more stored food for future use [41]. Accordingly, agricultural land ownership was identified as a protective factor against post-flood food insecurity [42]. Animals are a valuable source of high-quality food and income for many families, contributing to greater food security. These scenarios are like events in Derna and around the world [43].

Diet Quantity/Quality and Flood

Flood exposure reduces family calorie consumption. Del Ninno et al (2002), in their study on Bangladeshi flooding, found a rise in rice and vegetables prices and a decrease in calorie consumption. In these contexts, children and women are the most affected. Del Ninno et al. (2002) state that there is a decline in energy consumption after the flood by 227 kcal [44]. In the Afghanistan flood, each 1% increase in wheat flour price led to a 0.25% decline in protein consumption and a 0.07% reduction in energy intake. After the Afghanistan flood, a severe micronutrient deficiency occurred [46]. Furthermore, a large section of the population (mainly females at reproductive age) suffers from vitamin A deficiency and iron anemia [47]. Also, a reduction in calorie consumption of approximately 60 kcal/ day for each adult. This reduction equals 3% of the recommended daily requirements. These small changes in daily energy intake have long-term negative effects on body weight. Also, Del Ninno et al. (2003) found that the 1998 Bangladeshi flood decreased the budget for fruits, milk, and rice. In Derna, several studies are required to assess all the macro and micronutrient consumption using validated dietary intake assessment tools [44, 48, 49]. Furthermore, fluctuation in food prices is more prevalent after the flood. Food security in Libya has been a concern, especially since 2014, due to sharp rises in food prices. Food price increase is higher in food items like meat, chicken, bread, rice, cooking oil, and couscous, which are also reported to be most in demand after the floods. This increase in prices affects diet quality and quantity directly and indirectly. Accordingly, the purchasing ability of vulnerable households in the flood-affected areas decreased their ability to pay for nutritious foods [11].

The Vulnerable Groups during the Flood

The children of Libya are grappling with yet another tragedy after over a decade of conflict. Over 350,000 children are estimated to have been exposed to the flood, and more than 16,000 have been displaced in eastern Libya. In addition to the immediate injury and death, the floods posed a severe threat to children's safety and health. The diarrhea and cholera outbreaks, malnutrition, and dehydration significantly increase among children after a flood. [50]. The most vulnerable groups to food security during floods in Asia are the poor, women, and children. Floods are often associated with stunting and wasting among children, especially when malnutrition levels are high before the storms [51, 52]. Furthermore, food shortages would exacerbate baseline food insecurity, which is estimated to range between 11–14% in Derna, Al Marj, and Benghazi. Food prices and shortages tend to have a stronger negative impact on women, who decrease food intake by shifting their diet to non-diverse dishes and decreasing their intake to feed other members of their famil [11].

Coping Strategies

Recommendations on post-flood food insecurity and adaptive practices can mitigate the adverse effects of flooding on food security. Effective planning practices can significantly reduce the consequences of floods on food security. Numerous coping strategies have been implemented globally. These strategies involve substituting less preferred food items or less expensive ones, reducing the number of meals per day, reducing or limiting the quantity of food consumed per meal, decreasing adult consumption to increase children's consumption, relying on support from relatives and neighbors, and considering micronutrient supplementation for vulnerable groups even before the onset of the crisis [49]. Flood control can be effectively managed through the implementation of environmental infrastructure, sustainable land-use planning, and robust solid waste and drainage management systems. Enhanced knowledge of flooding and its adverse effects on food security can facilitate the identification of the root causes of the problem, enabling swift and high-quality interventions to address it. Tailoring solutions to the diverse geographical and topographic zones of the country is crucial for their success [53-56]. Prevention of negative coping strategies, such as low food consumption, relying on lower-quality food, and preparing a limited number of meals per day, should be a topic of nutrition education, counseling, and intervention campaigns.

Conclusion

Flooding is the most common natural disaster, impacting all aspects of life, including food security. This review summarizes the link between floods and food security, vulnerable groups, and coping strategies.

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Authors' contributions

This research was conducted in collaboration between both authors. Author FN conceived the idea. Authors FN and SE contributed to the conceptualization process. Authors FN and SE conducted a comprehensive literature review jointly. Author FN drafted the initial manuscript. Author SE reviewed and edited the manuscript. Authors FN and SE .reviewed and approved the final manuscript

Declaration of interest

The authors have declared that no competing interests exist.

Declaration of generativity in scientific writing

The authors do not use AI and AI-assisted technologies in the writing process of this article.

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