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Review Article

Ecological Disruptions and Emerging Patterns of Communicable Illness Across Vulnerable Populations

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Abstract

Environmental deterioration and changing climatic conditions are creating complex challenges for infectious disease prevention in Nigeria. Rising temperatures, irregular precipitation, prolonged dry periods, flooding, deforestation and expanding human settlements can modify the distribution of disease-carrying organisms and increase contact between people, wildlife and contaminated environmental sources. These changes may influence the occurrence and transmission of several infections, including Lassa fever, dengue, yellow fever, cholera, mpox and meningococcal meningitis. This review examines the relationships between environmental disturbance, changing ecological conditions and infectious disease vulnerability in Nigeria. Existing evidence indicates that climatic variability interacts with agricultural practices, population movement, inadequate sanitation, housing conditions and limited healthcare access. However, the contribution of individual environmental factors differs across pathogens and geographical regions. Available Nigerian studies provide useful epidemiological and ecological observations, although limitations in laboratory confirmation, longitudinal surveillance and exposure measurement restrict causal interpretation. Strengthening environmental monitoring, disease surveillance, laboratory capacity and collaboration across human, animal and environmental health sectors may improve prevention and outbreak preparedness.

Keywords: Environmental Degradation; Ecological Disturbance; Infectious Disease Transmission; Zoonotic Infections; Vector-Borne Diseases; Public Health Surveillance; Nigeria; One Health Approach.

INTRODUCTION

Environmental conditions influence the geographical distribution of infectious diseases through their effects on microorganisms, animal reservoirs, insect vectors and human exposure. Changes in temperature, rainfall, humidity and land characteristics can modify the survival and reproduction of disease-associated organisms. In tropical countries, these processes are especially relevant because many infectious diseases are influenced by seasonal environmental conditions and interactions between human populations and natural habitats.

Nigeria has considerable ecological diversity, extending from humid southern forests and coastal environments to savannah landscapes and semi-arid northern regions. These geographical differences create varied conditions for agricultural production, settlement development, wildlife distribution and infectious disease transmission. Population growth, urban expansion, vegetation removal, agricultural intensification and inadequate waste management have further altered relationships between human communities and their surrounding environments.

The emergence and geographical expansion of infectious diseases cannot be explained by environmental conditions alone. Poverty, population displacement, occupational activities, housing quality, healthcare accessibility and preventive services also influence disease vulnerability. Research on emerging infections has established that changes in human activities and ecological relationships can create opportunities for pathogens to enter previously unaffected populations [1]. Biodiversity reduction may

also influence disease transmission by changing the composition of host communities and the ecological relationships regulating pathogen circulation. Nevertheless, the relationship is not uniform across pathogens, and the consequences depend on host competence, species composition and environmental conditions [2].

Nigeria faces several infectious disease challenges associated with different environmental pathways. Lassa fever involves contact with infected rodents, while dengue and yellow fever depend on mosquito vectors. Cholera transmission is closely associated with contaminated water and inadequate sanitation. Mpox involves animal-to-human and human-to-human transmission, whereas meningococcal meningitis displays strong seasonal associations with atmospheric conditions in northern regions.

This review examines the available evidence concerning these relationships, evaluates limitations in current research and discusses approaches for improving environmental and epidemiological surveillance in Nigeria.

LITERATURE REVIEW

Environmental Change and Infectious Disease Development

Changes in environmental conditions can influence infectious disease occurrence by modifying pathogen survival, host distribution and opportunities for transmission. Temperature and moisture affect the biological development of many vectors, while rainfall influences the availability of breeding sites and the distribution of water-associated organisms.

The effects of environmental change are influenced by geographical location and the biological characteristics of individual pathogens. Increasing temperatures may improve transmission conditions for certain vectors within suitable thermal limits, whereas extreme heat can reduce survival or reproductive performance in other species. Consequently, the relationship between warming and infectious disease occurrence should not be interpreted as a consistent increase across all pathogens [3]. Environmental changes can also affect human exposure indirectly. Agricultural expansion, settlement development and vegetation removal may alter wildlife habitats and bring people into closer contact with animals carrying infectious organisms. Such changes can influence opportunities for pathogen spillover, although the occurrence of contact does not necessarily establish successful transmission.

Biodiversity Reduction and Pathogen Transmission

Natural ecosystems contain diverse animal, plant and microbial communities that contribute to ecological stability. Changes in species composition can modify interactions between pathogens, reservoir hosts, predators and other organisms. Research has demonstrated that biodiversity can influence infectious disease transmission through different ecological mechanisms. However, the relationship varies according to the pathogen and host system, meaning that biodiversity loss should not automatically be considered a direct cause of every disease outbreak [4].

Human-dominated landscapes may favour certain adaptable animal species capable of surviving near settlements, agricultural fields and food-storage areas. Such ecological changes can modify the distribution of potential reservoir hosts and increase opportunities for human exposure [5]. The consequences of habitat disturbance are also influenced by the extent of environmental conversion, the types of species present and the availability of suitable alternative habitats. Disease prevention therefore requires an understanding of local ecological conditions rather than relying exclusively on broad environmental indicators.

Climatic Variability and Vector-Borne Infections

Mosquito distribution and development are influenced by temperature, precipitation, humidity and the availability of suitable breeding habitats. Changes in these conditions may alter vector abundance, seasonal activity and the geographical suitability of transmission environments. The relationship between temperature and malaria transmission demonstrates the importance of pathogen-specific environmental responses. Mosquito survival, parasite development and transmission efficiency are affected by different temperature thresholds, producing a non-linear relationship between warming and disease risk [6].

Environmental suitability models have also indicated that climatic conditions can modify the geographical distribution of mosquito-borne infections. However, actual disease occurrence depends on vector presence, pathogen introduction, human immunity and healthcare conditions [7]. In Nigeria, increasing urbanisation, inadequate drainage, uncovered water containers and irregular water supply can create conditions favourable to mosquito breeding. These factors may interact with seasonal rainfall and temperature variations, increasing exposure in certain

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communities.

Socioeconomic and Environmental Vulnerability

Environmental exposure is distributed unevenly across populations. Communities with inadequate housing, limited access to safe drinking water and insufficient healthcare facilities may experience greater infectious disease vulnerability.

Agricultural workers, individuals living near unmanaged waste sites and households situated in flood-prone locations may encounter different environmental hazards. Population displacement can further increase exposure through overcrowding, disrupted sanitation and limited access to medical services. The relationship between environmental hazards and disease outcomes is therefore influenced by social and infrastructural conditions. Climate-related health assessments need to consider these factors when examining disease patterns and planning preventive interventions [8].

Land Transformation and Lassa Fever

Lassa fever remains an important zoonotic infection in Nigeria. Its transmission is associated primarily with exposure to infected rodents, particularly Mastomys natalensis. Contact may occur through contaminated food, household surfaces, rodent excreta and activities that bring infected animals into domestic environments. Changes in agricultural landscapes, vegetation cover and settlement patterns may influence rodent distribution and opportunities for human exposure. These processes are relevant in communities where food storage is inadequate and residential buildings are located close to cultivated land.

A national geographical analysis identified relationships between Lassa fever incidence and several environmental and socioeconomic variables, including climatic conditions, agricultural activity, poverty and urbanisation. The findings also indicated that differences in diagnostic capacity and disease reporting influenced the observed geographical distribution of cases [9]. Ecological investigations have identified several small mammal species across Nigerian environments, with reservoir-associated rodents occurring in both human settlements and surrounding habitats. Seasonal variations in rodent abundance may further influence the timing of human exposure [10].

Research conducted in Ondo and Ebonyi States also documented substantial Lassa virus positivity among captured rodents during periods associated with human epidemics. These findings support the importance of animal surveillance but do not establish that a particular environmental disturbance independently caused human infection [11].

Seasonal Conditions and Meningococcal Meningitis

Northern Nigeria experiences marked seasonal differences in temperature, humidity, rainfall and atmospheric dust. These conditions influence the seasonal distribution of meningococcal meningitis, particularly within communities located in the African meningitis belt. A longitudinal investigation using hospital records from north-western Nigeria examined monthly meningitis cases over a 22-year period. Higher temperatures, reduced humidity and dust-related conditions were associated with variations in reported incidence. The findings also suggested that meteorological information could contribute to short-term disease forecasting [12]. The relationship between atmospheric conditions and meningitis is influenced by additional factors, including respiratory infections, overcrowding, vaccination coverage and population movement. Therefore, seasonal associations should not be interpreted as direct evidence that long-term climatic warming is responsible for increasing disease incidence.

Rainfall Variability, Water Insecurity and Cholera

Cholera transmission is closely associated with the consumption of food or water contaminated with toxigenic Vibrio cholerae. Environmental conditions influence exposure through changes in water availability, sanitation infrastructure and the movement of contaminated materials. In Nigeria, rainfall variability and socioeconomic conditions have been investigated in relation to differences in cholera morbidity and mortality. The findings indicated that climatic variables and socioeconomic vulnerability contributed to the observed geographical and temporal patterns [13].

Flooding may damage drinking-water infrastructure, contaminate domestic water supplies and disrupt sanitation services. Drought can also increase dependence on limited or potentially unsafe water sources. However, rainfall alone cannot explain outbreak occurrence because transmission additionally depends on pathogen introduction, water quality, sanitation and access to treatment. A retrospective examination of the 2020–2021 national cholera epidemic documented 93,598 cases and 3,298 deaths across 33 Nigerian states and the Federal Capital Territory. The findings demonstrated the continuing importance of surveillance, diagnostic access and effective case management [14].

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Mosquito-Associated Infections and Environmental Conditions

Mosquito-borne infections represent another important area of environmental health research in Nigeria. Temperature, rainfall, humidity, vegetation and human water-storage practices can influence mosquito breeding and survival. Changes in drainage systems, irrigation practices and urban settlement patterns may create additional breeding opportunities. However, mosquito abundance does not necessarily indicate the presence of an infectious pathogen or active disease transmission.

Dengue and yellow fever illustrate the importance of maintaining separate surveillance systems for different mosquito-associated infections. Their transmission involves distinct epidemiological characteristics, and laboratory confirmation is necessary to distinguish actual infection from other causes of febrile illness. Research on yellow fever outbreaks in Nigeria between 2017 and 2019 documented widespread surveillance and vaccination activities. The findings highlighted the importance of population immunity and rapid public-health intervention in controlling outbreaks [15].

Wildlife Contact and Mpox

Mpox provides an example of an infection involving animal-associated exposure and subsequent human transmission. Changes in wildlife habitats, hunting practices, agricultural activities and settlement expansion may influence contact between humans and potentially infected animals. Nigeria experienced renewed recognition of human mpox cases during 2017–2018 after several decades of limited recorded activity. The clinical and epidemiological investigation established the presence of human infections across multiple locations, although it did not identify a single environmental change as the cause of re-emergence [16].

The outbreak response demonstrated the value of collaboration between public-health, veterinary and environmental sectors. Such coordination supports investigation of possible animal exposures while also addressing human-to-human transmission [17].

Deforestation, Agricultural Expansion and Reservoir Ecology

Forest conversion and agricultural expansion can alter wildlife habitats and change the distribution of species capable of carrying infectious organisms. These changes may influence animal movement, food availability and contact with domestic environments. In Nigeria, rodent investigations have demonstrated the presence of several small mammal species in different ecological settings. The findings indicate that reservoir distribution is not restricted to one geographical or vegetation category [18]. Nevertheless, broad measurements of vegetation loss cannot establish which animal species are responsible for pathogen transmission or whether a specific land-use change preceded human infection. Such relationships require repeated ecological sampling, pathogen testing and detailed exposure information.

Comparative Assessment of Major Infectious Disease Pathways

The environmental relationships discussed above differ considerably between diseases. The principal pathways and research requirements are summarised (Table 1).

Table 1: Environmental and Epidemiological Characteristics of Selected Infections in Nigeria.

Disease	Principal transmission pathway	Relevant environmental conditions	Important research requirement
Lassa Fever	Contact with infected rodents or contaminated materials	Agricultural expansion, settlement patterns and seasonal conditions	Rodent surveillance and household exposure assessment
Dengue	Infected mosquito bites	Rainfall, temperature, humidity and water storage	Vector identification and molecular confirmation
Yellow Fever	Infected mosquito bites	Vector habitats and environmental conditions	Vaccination monitoring and pathogen-specific surveillance
Cholera	Contaminated food and water	Flooding, drought and sanitation disruption	Water-quality testing and outbreak investigation
Mpox	Animal-associated exposure and human contact	Wildlife interaction and habitat modification	Animal surveillance and human contact investigation
Meningococcal Meningitis	Respiratory transmission	Dry air, dust and seasonal atmospheric conditions	Seasonal monitoring and laboratory confirmation

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DISCUSSION

Interactions Between Environmental and Social Determinants

The reviewed literature indicates that infectious disease patterns in Nigeria are influenced by interactions between environmental conditions and socioeconomic circumstances. Temperature, rainfall and habitat alteration may modify exposure opportunities, while housing, sanitation, food storage and healthcare accessibility influence whether those opportunities result in infection.

The geographical distribution of Lassa fever illustrates this relationship. Rodent occurrence, agricultural activities and settlement conditions may contribute to exposure, but diagnostic capacity and surveillance coverage also influence the number of reported infections. Consequently, areas with greater reported incidence are not necessarily the only locations experiencing substantial exposure. The association between biodiversity and infectious disease transmission also requires careful interpretation. Some ecological communities may contain species that reduce pathogen transmission, whereas others may support competent reservoir hosts. The removal of certain species can therefore produce different outcomes depending on the local ecological structure [19].

Limitations of Existing Evidence

Several methodological limitations affect the interpretation of environmental and infectious disease research in Nigeria.

First, many studies use administrative disease records that may not accurately represent the location where infection occurred. Second, suspected cases are sometimes recorded without laboratory confirmation. Third, environmental measurements may be obtained from weather stations or satellite products that do not capture conditions experienced by individual households.

Another limitation concerns the distinction between historical associations and causal relationships. A disease outbreak occurring after flooding or vegetation removal does not independently establish that the environmental event caused the outbreak.

The quality of evidence also differs between study designs. Narrative reviews, ecological analyses, hospital-based investigations and prospective field studies provide different levels of information. Transparent reporting of study selection and evidence limitations is therefore necessary when preparing research syntheses [20].

Public Health and Environmental Management

Environmental management can contribute to infectious disease prevention when interventions are designed around clearly identified transmission pathways. Protecting household food supplies, improving drainage, maintaining safe drinking-water systems and strengthening waste management can reduce several established exposure risks. Mosquito control requires measures addressing stagnant water and breeding habitats, while Lassa fever prevention requires attention to food protection, household cleanliness and rodent exclusion. These interventions should be evaluated according to their actual health outcomes. Environmental restoration may provide important ecological benefits, but its ability to reduce a particular infection must be established through appropriate epidemiological monitoring.

Strengthening Disease Surveillance

Effective surveillance requires information from multiple sources, including human clinical services, veterinary investigations, ecological monitoring, meteorological records and laboratory testing. A coordinated system could help identify changes in reservoir distribution, mosquito abundance, water contamination and human infection patterns. However, combining these datasets requires consistent geographical identifiers, reporting periods and diagnostic definitions. Nigeria's experience with Lassa fever and other infectious diseases demonstrates the value of strengthening laboratory networks and improving access to diagnostic services. Better surveillance can also reduce the likelihood that changes in testing or reporting will be mistaken for genuine changes in disease occurrence.

Future Research Priorities

Future investigations should prioritise longitudinal studies connecting measurable environmental changes with confirmed human infections. Research should include repeated animal sampling, household exposure assessment, vector identification and water-quality monitoring.

Studies should also examine differences between rural, peri-urban and urban communities. These settings have different environmental characteristics and may experience different patterns of contact with potential reservoirs and vectors. Environmental prediction models should be evaluated using independent geographical and temporal datasets. Their usefulness should be judged by whether they improve outbreak preparedness and public-health decisions rather than statistical performance alone.

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Biodiversity Conservation and Community Protection

Conservation programmes and environmental restoration may contribute to improved ecological stability and reduce certain forms of human exposure. However, the effects of restoration projects depend on the habitats involved, the species present and the management practices adopted. The global assessment of biodiversity and ecosystem services highlights the continuing deterioration of natural systems and the importance of maintaining ecological functions [21]. Urban expansion also requires careful planning because poorly managed settlement development can create favourable conditions for mosquito breeding and increase human exposure to vector-associated infections [22].

Climate Information and Disease Preparedness

Meteorological information may support public-health preparedness when environmental observations are linked with reliable disease surveillance. Seasonal forecasting has been investigated as a means of improving preparedness for meningitis outbreaks in African regions [23]. Vector surveillance programmes can also benefit from coordinated monitoring, community participation and integrated control measures. These activities are supported by international vector-control strategies that encourage collaboration across public-health and environmental sectors [24]. Yellow fever prevention requires a different approach because vaccination coverage and timely outbreak response remain central components of disease control. International elimination programmes provide a framework for improving population protection and preparedness [25].

Strengthening Integrated Surveillance

Nigeria would benefit from stronger coordination between environmental agencies, healthcare institutions, veterinary services and research organisations. An integrated surveillance framework should connect meteorological observations, land-use information, animal testing, vector identification, water-quality assessment and human disease confirmation. The One Health approach provides an institutional framework for coordinating these activities and addressing health risks at the human–animal–environment interface [26].

Improving Healthcare Infrastructure

Healthcare facilities require adequate laboratory equipment, trained personnel, diagnostic supplies and effective referral arrangements. Early identification of infections can improve treatment decisions and support more accurate epidemiological reporting. Health-system planning should also account for environmental hazards, including flooding, heat exposure and disruptions to essential services. Climate-resilient healthcare frameworks provide guidance for strengthening institutional preparedness [27].

Community-Based Prevention

Community participation is necessary for successful environmental health interventions. Educational programmes should explain safe food storage, household waste management, mosquito breeding prevention, drinking-water protection and appropriate healthcare-seeking practices. Residents can also contribute valuable information about changes in animal activity, water availability and environmental conditions. Community observations should complement scientific investigations rather than replace laboratory confirmation.

Cross-Sectoral Policy Development

Environmental and public-health policies should be developed through cooperation between relevant government departments. Land-use planning, agricultural development, water management, wildlife conservation and infectious disease prevention should be connected through shared planning and monitoring systems. The selection of One Health operational tools should reflect national institutional capacity, local epidemiological conditions and clearly defined public-health objectives [28].

Improving Outbreak Detection and Response

Disease surveillance should include timely notification, laboratory confirmation, geographical mapping and consistent reporting of suspected and confirmed cases. The Nigerian mpox surveillance experience demonstrates the importance of monitoring changes in disease distribution over successive reporting periods [29].

Cholera preparedness should prioritise safe drinking water, effective sanitation, rapid case identification and access to appropriate treatment. These measures address immediate transmission pathways while reducing vulnerability to future environmental disturbances [30]. Long-term planning should integrate climate information into national health preparedness without assuming that every change in disease incidence is attributable to climatic conditions. Such planning should be guided by local epidemiological evidence, uncertainty assessment and the ability of health services to respond effectively [31].

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CONCLUSION

Environmental and ecological changes are relevant to infectious disease prevention in Nigeria because they influence interactions between human populations, animal reservoirs, vectors and contaminated environmental sources. Evidence from Lassa fever, cholera, yellow fever and meningitis demonstrates that disease patterns are shaped by different combinations of climatic, ecological and socioeconomic factors. However, existing research does not establish a uniform causal relationship between long-term climatic changes, habitat deterioration and every emerging infection. Limitations in laboratory confirmation, geographical coverage and longitudinal exposure measurements continue to restrict interpretation. Strengthening disease surveillance, improving access to diagnostic services, protecting drinking-water supplies and supporting effective vaccination programmes remain important public-health priorities. Future investigations should combine environmental observations with animal testing, vector monitoring and confirmed human infections. Coordinated action across healthcare, veterinary and environmental institutions can improve outbreak preparedness. Conservation and sustainable land management should also be evaluated for their potential health benefits, using locally relevant evidence and measurable outcomes.

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