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THE INTERFACE BETWEEN THE LASSA VIRUS EPIDEMIC, THE COVID-19 PANDEMIC, AND THE FOOD ENVIRONMENT IN NIGERIA: A ONE HEALTH APPROACH

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ABSTRACT

For the Nigerian populace, social and health inequities continue to be disproportionately heightened due to the triad of Lassa virus epidemic, COVID-19 pandemic, and worsening food environment. This review uses secondary data sources to examine the interface of the Lassa virus (LASV) epidemic and the COVID-19 pandemic in Nigeria and its impact on the food environment. This paper adopts One Health as a conceptual framework and takes an integrative lens to understand the interconnections and parallels between the scourges of LASV and COVID-19 on the food environment. Significant challenges relating to hunger, poverty, food insecurity, food loss and malnutrition regarding both Lassa virus and COVID-19 were uncovered. The spread of zoonotic diseases transmitted from animals to humans are worsened by unplanned urbanization, urbanization of poverty, insufficient management information systems, population increase, and climate change. The paper discusses practical measures to preparedness and response and suggests that priority should be placed on the strengthening local food environment to encourage better food diversity, access, and affordable options. A One Health approach is holistic and contingent on an informed, inclusive, community-driven, and sustainable infrastructure as well as on healthy biodiversity and functioning ecosystems, which are necessary for human and environmental health.

KEY WORDS One Health, Lassa Virus/Fever, COVID-19, Food Environment, Food security, Integrative Review

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1. INTRODUCTION

The triad of the Lassa virus (LASV) epidemic, the COVID-19 pandemic, and the worsening food environment in Nigeria constitute intractable issues, which Rittel and Weber (1973) termed as wicked problems because they are complex issues that engender social, economic and health inequities for the Nigerian populace. This paper utilized a One Health approach (intersecting human, animal, and environmental health) as a theoretical framework, and gives an overview of the LASV epidemic and the COVID-19 pandemic situations in Nigeria. The paper draws parallels from both outbreaks with focus on how the food environment, as a social determinant of health has been impacted.

The food environment is “the physical, economic, political, and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing, and consuming food, the interface between consumers and the food systems” (HLPE, 2017: 11, 28). Food environments can also be described as “the settings with all the different types of food made available and accessible to people as they go about their daily lives. That is, the range of food in supermarkets, small retail outlets, wet markets, street food stalls, coffee shops, tea houses, school canteens, restaurants, and all the other venues where people buy and eat food” (FAO, 2016:5). Globally, between 720 and 811 million people faced hunger in 2020, and about 2.37 billion people did not have access to adequate food in 2020 (FAO, IFAD, UNICEF, WFP and WHO 2021:vi; FAO, 2022). The impacts of rising poverty and reduced livelihoods are reflected clearly in rising levels of food insecurity and decreasing diet quality and the lockdown measures, lost income, and perceptions of disease risk have increased poverty and altered diets (IFPRI, 2021).

LASV and COVID-19 exposed the fragility of the food environment and the weakness in the management of our

food systems in Nigeria, threatening the lives, livelihoods, and food security of people, particularly the most vulnerable and those living in fragile contexts amid a weakened purchasing power of the populace. Currently, Nigeria grapples with an epidemic of LASV and an aftermath effect from the COVID-19 pandemic. Notably, both events (in) directly challenge the nation’s food environment with outcomes of poverty, hunger, and malnutrition, particularly the vulnerable groups, such as pregnant women, children, and the elderly. As a social determinant of health and sustainable development (McIntyre, 2003), food security is of global concern. About 10% of the global population and 19% of Africans are severely food insecure (FAO, IFAD, UNICEF, WFP, and WHO, 2020), with limited access to sufficient food because of inadequate financial capacity and other resources (Nord et al., 2005). In the 2021 Global Hunger Index, Nigeria ranked 103 out of the 116 countries and with a score of 28.3, Nigeria has a level of hunger that is serious (GHI, 2022).

Undoubtedly, continued outbreaks of LASV and the COVID-19 pandemic continue to exacerbate food insecurity hunger severity in Nigeria. Abay et al. (2021) noted that households residing in states experiencing strict lockdown measures reported further deterioration in food insecurity and single mothers and poorer households experienced relatively larger deteriorations in food security due to disruption of school feeding services. Ibukun and Adebayo (2021) investigated the extent of food security among Nigerian households during the COVID-19 pandemic restrictions using nationally representative data and food insecurity experience scale and discovered that more than half of the households experienced severe food insecurity during the pandemic; and the dominant determinant of food security was the socioeconomic status of the household in terms of education, income and wealth status. Inegbedion (2020) also found that the pandemic adversely affected transportation, security, and farm labour, subsequently undermining

production of food and accelerating food insecurity in Nigeria. Justina (2020) asserted the spread of COVID-19 in countries, ravaged by the recurrent outbreak of Lassa fever has introduced double tension of public health emergency and surveillance in such areas and advocated for an intensified public health education, aiming at very high level of home hygiene, food safety and environmental sanitation for containing the spread of both the LASV and COVID-19.

To achieve a sustainable food environment, and prevent the global burden of disease, it is pertinent to recognize and situate LASV and COVID-19 impact on the food environment within the context of four of the 17 goals targeted by the United Nations 2030 Agenda for Sustainable Development namely, ending hunger, achieving food security and improved nutrition (SDG 2); ensuring healthy lives, and promoting well-being for all (SDG 3); protecting and restoring water-related ecosystems, forests, and wetlands (SDG 6), to reverse degraded ecosystems and halting biodiversity loss (SDG15). The constant and dynamic interaction of the ecosystem on the health and well-being of people, plants, and animals allows zoonotic disease to thrive in the environment in which we live, work, learn and play. This paper explores the impact of LASV epidemic and the ongoing COVID-19 pandemic in Nigeria on food environment using the One Health approach to confront the ever-increasing zoonotic disease burden.

2. UNDERLYING CAUSES

Nigeria, with a population of nearly 202 million (World Bank, 2021) and an annual estimated growth rate of 2.6% is faced with an increasing rate of infectious and communicable disease burden that includes zoonotic diseases (FGN, 2019). The catastrophic effects of zoonotic diseases such as Ebola, Lassa fever, Dengue, Rabies and Yellow fever have been reported in the last 5 years and Nigeria rank Rabies, Avian Influenza, Ebola Virus Disease, Swine

Influenza and Anthrax as the first five priority zoonoses (FGN, 2019). Nigeria is rated among the 10 countries with the highest burden of infectious and zoonotic diseases globally and there exist a sub-optimal surveillance system to monitor and track priority zoonoses (Ihekweazu et al., 2021). Moreover, agricultural activities that cause occupational hazards from animal rearing and farming facilitates new zoonoses, specifically the pathogenic avian influenza and H1N1 influenza (Schmidt, 2009). The constant and dynamic interaction of the ecosystem on the health and well-being of people, plants, and animals allows zoonotic disease to thrive in the environment in which we live, work, learn and play. While Nigeria experienced the first incidence of COVID-19 in February 2020, the first Lassa fever outbreak was in 1969. These zoonotic diseases affect many people and currently worsen the direct and indirect impact of the COVID-19 pandemic on the food environment (Mardones et al., 2020).

The underlying causes of diseases being transmitted from animals to humans include conversion of landscapes, as often associated with deforestation for agriculture, timber logging, mining, oil extraction, changing agriculture and food production systems, and wildlife trade (Loh, Olival, and Zambrana-Torello et al., 2015). These pandemics will likely continue for years due to rapid growth and unplanned urbanization; population increase and climate change (Jowell and Barry, 2020). The pressure of urbanization and land development provides more opportunities for pathogens to move between species and cause new outbreaks and they also are among main drivers of biodiversity loss (WHO and SCBD 2015). Rapid urbanisation, poverty, inadequate housing, unsanitary living conditions and overcrowding contribute to environments where rodents thrive and move within and between houses, increasing the risk of communicable disease infections such as Lassa virus (Adebimpe, 2015). The social ecology of rodent-borne disease transmission has been

explored with regards to housing design, agricultural practices, and consumption of meat from wild animals (Bonner et al. 2007; Taylor et al. 2008; Subramanian 2012). The increased burden of zoonotic diseases results from increasing human population growth and therefore increased food consumption, human encroachment on ecosystems that are high risk for diseases transmission, closer interaction with animals/wildlife and rapid urbanisation. Microbes can be transmitted through direct contact between animals and humans or through contaminated food. Both COVID-19 and LASV has introduced double tension to public health emergency (Justina, 2020). It is therefore imperative that we embrace the One Health approach to confront the ever-increasing zoonotic disease burden.

3. METHODOLOGY

This review takes an integrative approach to explore interconnections between the Lassa Virus epidemic in Nigeria and the COVID-19 pandemic and its impacts on the Food Environment in Nigeria. Three bibliographic databases - PubMed, SCOPUS, and Google Scholar - were searched, for studies published in English from 2015 to 2021. Search terms employed were: "Lassa fever" AND "COVID-19"; "Lassa fever" AND "Nigeria"; "COVID 19" AND "Food" AND "Nigeria"; "One Health AND Lassa Fever"; "Food environment" AND "Lassa fever"; "Food security" AND "Lassa fever." Additional studies were identified through hand and snowball searching and use of academic peers' recommendations. Some studies found through basic Google search were also included. Included publications were a mix of journal articles and grey literature. All study designs including qualitative or quantitative were incorporated. The titles and abstracts of each of about 30 publications were screened to check if the paper touches on at least one of the trios of food-environment nexus, Lassa fever in Nigeria, food security and health. Full-text articles were further assessed for further eligibility and information gathering.

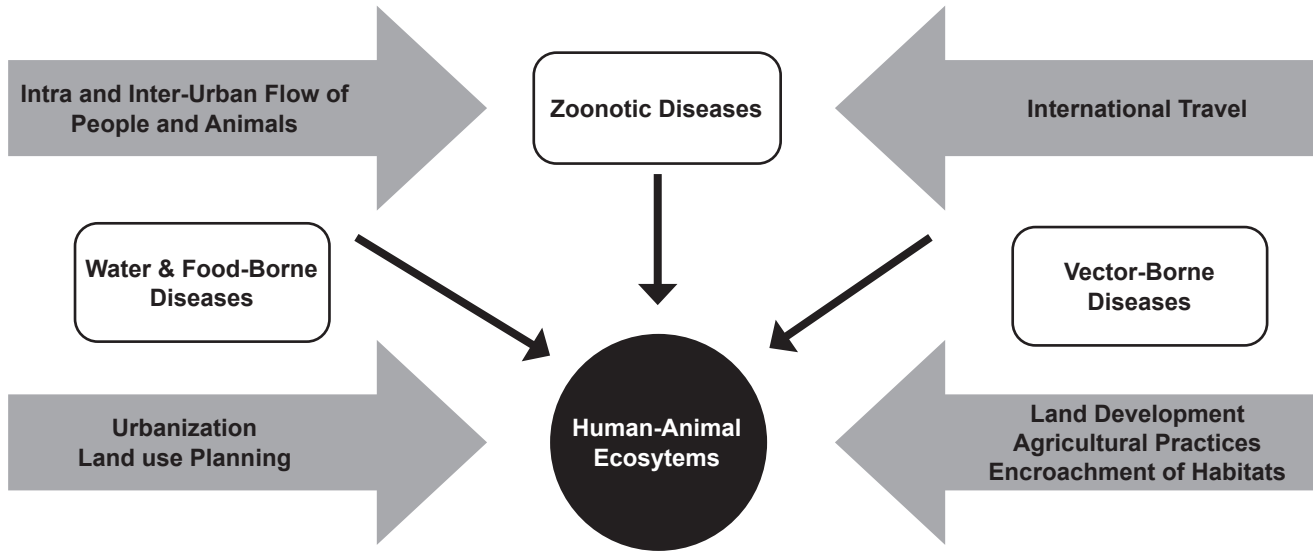
4. THEORETICAL FRAMEWORK

The interdependence of human on the natural ecosystems exposes them and makes them susceptible to various health challenges including zoonotic diseases. This interconnectivity is further complicated by rapid urbanisation and encroachment into the habitat of animals and increasing flow of people (movement) which allow diseases to spread faster and quicker (Figure 1). Majority of infectious diseases that affect human health are zoonotic and occur at the human-animal-environment interface and require a holistic and multidisciplinary methodology proffered by One Health approach. "A One Health approach is especially needed in light of the rapid global environmental and agricultural changes that are presently occurring and expected to increase over the coming decades. These are creating pressures on natural systems and increasing contact between humans and other species, facilitating emergence of both infectious and non-infectious disease problems" (USAID, 2016:6).

The focus of One Health on the human– animal–environment interface appears particularly compelling (Koch et al., 2019). One Health issues include zoonotic diseases, antimicrobial resistance, food safety and food security, vector-borne diseases, environmental contamination, and other health threats shared by people, animals, and the environment (CDC, 2018). One Health serves as an umbrella that encapsulates human, animal, plant and environmental ecosystems health and seeks to protect biodiversity and any threat to the ecological landscape. Biodiversity includes the complex network of interactions and biological structures that sustain ecosystems (McCann 2007; Maclaurin and Sterelny, 2008). Biodiversity underpins the functioning of the ecosystem and the provision of goods and services that are essential to human health and well-being, and it is a key environmental determinant of human health (WHO and SCBD, 2015). "One Health approaches are embedded

into ecohealth conceptual thinking, which are further expanded to ‘Health in Social-Ecological Systems’ addressing complex issues of human-environment systems” (Zinsstag, Waltner-Toews, and Tanner, 2015:16).

Figure 1: Contextualising Human-Animal Ecosystems in Food Environment and Disease Interface



Source: Authors, 2021

4.1. Nigeria’s One Health Strategic Plan

Nigeria’s national One Health strategic plan (2019-2023) integrates human, animals and environmental health management for an improved health security. The plan was jointly developed by the Federal Ministries of Health, Agriculture and Rural Development (FMARD), and Environment and their agencies, reinforcing Nigeria’s commitment to strengthen a multi-sectoral collaboration for health security (NCDC, 2019). One Health approach to prioritizing important zoonoses is a step that helps guide future tracking and monitoring of diseases of grave public health importance in Nigeria (Ihekweazu et al.,2021). One Health approach is required for other public health threats at the human animal-ecosystem interface, including food safety and security, antimicrobial resistance, and emerging and re-emerging infectious diseases with consequent spill over from animals to humans and vice versa. In its course to safeguards both humans, animals, and their environments from the threat of zoonotic diseases, One Health is predicated on the need for a more integrated understanding of the

connections among humans, animals, and ecosystems within the political, economic, and social systems in which they operate (USAID, 2016).

Lassa virus, a zoonotic disease endemic to Nigeria, causes contagious viral hemorrhagic fever in humans. Contextualizing Lassa Fever within One Health initiative is prudent because of the interface between the viral reservoir in multimammate rats, human infection, the environmental drivers, and factors affecting the health of both animal and human. A One Health approach to understanding the ecology of Lassa Fever will lead to an improved ability to assess the zoonotic risk to humans as well as provide an accurate depiction of the occurrence of various lineages and strains of LASV circulating among reliably identified rodent species (Arruda et al., 2021). One Health approach offers new opportunities in understanding human-animal interactions and strengthening Lassa fever outbreak, early detection and surveillance, warning alerts and rapid response implementation in vulnerable settings (Tambo, Adetunde and Olalubi, 2018).

With regards to COVID-19, the global and country-specific responses adopt a collaborative approach through surveillance, contact tracing, testing, as well as adopting biosecurity principles of Personal Protective Equipment (PPE), masks, hand washing, social distancing, remote schooling and work, lockdowns, restricted border movements and air travel. All these measures have helped contain the spread of COVID-19 and now vaccines are being administered despite the developments of variants. Collaborative efforts, awareness, and education; immediate recognition of source and vaccine development, investment in technology and the holistic approach are all principles of One Health that guided the response to the COVID pandemic. Considering the inter-connectedness between human, environment, and animal health, the One Health approach becomes an appropriate strategy to control and mitigate the effects of the ongoing coronavirus disease 2019 (COVID-19) and will be useful for risk reduction and control of emerging and re-emerging infectious diseases (Mushi, 2020).

5. THE EPIDEMIC AND PANDEMIC

5.1. Lassa Virus Epidemic

Lassa Hemorrhagic Fever (LHF) is a type of viral hemorrhagic fever causing acute viral illness. The Lassa virus is transmitted to humans by infected multi-mammate rats, the *mastomys natalensis* species complex which is the reservoir host. Rats are the animal reservoir of the LASV virus and their population dynamics are seasonally driven (Arruda et al., 2021). The risk of rodent-to-human transmission increases because humans live in proximity to the animal vector responsible for transmitting the disease. Lassa virus is typically spread through consumption of infected rats, when virus laden particles are inhaled, direct contact with excreta/urine or consuming food contaminated with faecal or urine droplets from rats, and person-to-person transmission via contact with body fluids, blood, saliva, and contaminated surfaces (Richmond and Baglolle, 2003; Tambo, Ugwu and Ngogang, 2014; Bonwitt et al., 2016; WHO, 2010, 2020a, 2021a).

Given that 90-95% of human infections are due to indirect exposure with infected

Mastomys rats, a high density and high circulation of Lassa virus in young non-immune rat population during the wet season create a potential for further human infection, and the number of infections is expected to continue to rise until the end of the dry season (WHO, 2021a). Updated models of LASV infection have estimated an annual incidence of 897,700 across West Africa with Nigeria, Ghana and Ivory Coast having the greatest number of infections and Sierra Leone, Nigeria and Guinea having the greatest rate per 100 people (Basinski et al., 2021). Mastomys rats are usually found in communities with poor sanitation or crowded living conditions with substandard living, overcrowding, poor sanitation, open sewers, and waste dumps making it easier to spread the virus.

People are also at increased risk of contracting the Lassa virus by consuming rat meat or other wild or bush meat, supposedly a savoury meal common in Nigeria. For occupations whose tasks are within and around the forest zones, such as hunters and forest officers, they are faced with Lassa fever virus infection as occupational hazards, and health care workers heightening their

chances of exposure to the vectors and worsening their morbidity and mortality rates. Although hunting rats for food also exposes persons to bites and contact with excreta, rats are a good source of protein, nutrition, and diversity in diet (Bonwitt et al., 2016).

Table 1 indicates the number of Lassa fever cases and deaths in Nigeria since 2012. Between 2012 and 2013, Nigeria recorded more than 2,900 Lassa fever cases across several states. Due to underreporting, fear, stigmatization and poor recordkeeping, many Lassa Fever incidences are unknown. In the first 12 weeks of 2022, 23 States have recorded at least one confirmed death across 92 local government areas and most of the confirmed cases are from Ondo (28%), Edo (24%) and Bauchi (15%) States (NCDC, 2022a; Figure 2). It should also be noted that the number of deaths (127) between 2016/2017 is the same as the number of deaths recorded in the first three months of 2022. It is also important to know that health care workers continue to contract Lassa virus and die from it.

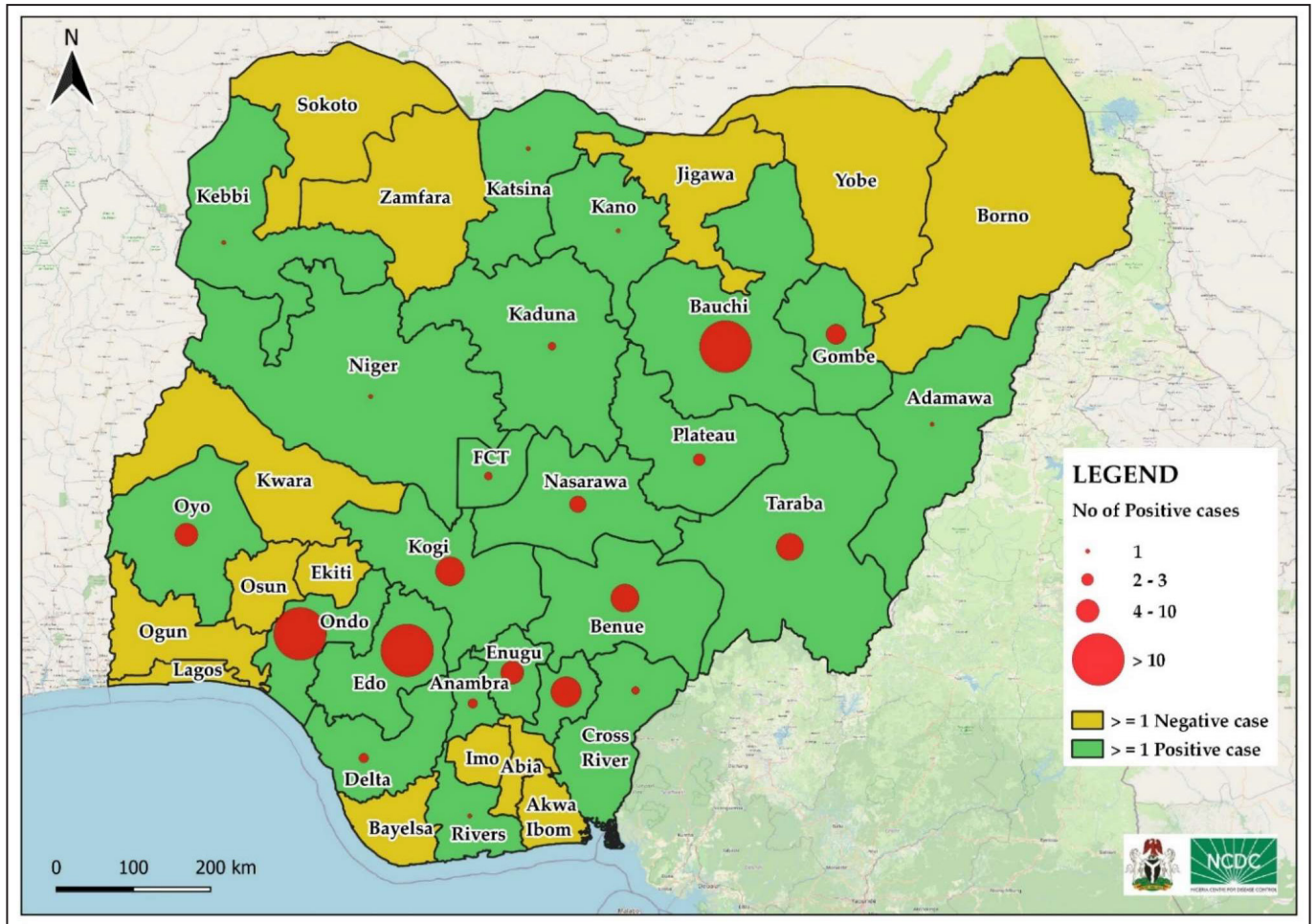
Table 1: Lassa Fever Cases in Nigeria (2012-2022)

Year	Suspected Cases	Confirmed cases	Deaths
2012-2013	NA	2900	NA
2015	NA	64	NA
2016-2017	1022	322	127
2018	3498	633	171
2019	5057	833	174
2020	6791	1189	244
2021	4654	510	102
2022 (January-March)	3539	681	127
Total	24,561	7132	945

Source: Adapted by authors from NCDC (2021, 2022a); Toromade, 2021; Data gaps exists due to poor record keeping.

Note: NA (Not available).

Figure 2: Confirmed Lassa fever cases by States in Nigeria, Week 12, 2022



Source: NCDC, 2022a

5.2. COVID-19 Pandemic

A novel Coronavirus (SARS-coV-2) disease emerged in late 2019 and sparked the ongoing COVID-19 global pandemic. The intermediate animal host or zoonotic source could be a domestic animal, a wild animal, or a domesticated wild animal and, has yet not been identified. The first human cases of COVID-19 (SARS-CoV-2) were first reported by officials in Wuhan City, China, in December 2019 (WHO, 2020b). There are suggestions of the zoonotic origin in bats, phylogenetic analysis of the emerging viruses suggesting an initial single-locus zoonotic spillover event in November, 2019 (Rembaut, 2020) and then the human-to-human transmission or transmitted to an intermediary animal prior to jumping to humans (WHO, 2021b). There is still ongoing research to determine a clear origin of this pandemic. However, the emergence of 2019-nCoV in Wuhan creates a sense of deja vu with the severe acute respiratory syndrome coronavirus (SARS-CoV) epidemic in China in 2003 and Coronaviruses are enveloped, positive stranded RNA viruses of mammals and birds (Kock et al., 2020). The infection from COVID-19 continues to spread globally and with multiple variants Alpha (UK), Beta (South Africa) and Delta (India). Globally, by April 7, 2022, there are about 496 million cases and 6.2 million deaths. Nigeria also recorded 255,468 confirmed cases and 3142 deaths of COVID-19 (NCDC, 2022b) (Table 2). Compared to the rest of the world, it seems the impact of COVID-19 is minimal in Nigeria either due to natural circumstances, underreporting, denials, lack of tracing and testing or other socio-political or socio-cultural factors.

The COVID-19 virus spreads (CDC, 2021; WHO, 2021c; Ochu et al., 2021) primarily through breathing in air when close to an infected person who is exhaling small droplets and particles that contain the virus or droplets of saliva or discharge from the nose. It can also be transmitted when an infected person coughs or sneezes small droplets and particles containing the virus on the eyes, nose, or mouth, or through air-borne; faecal-oral sources, mother-to-newborn; nosocomial routes, on fomites (contaminated surfaces), and through people to animals. There continues to be an encroachment and disturbance into wildlife spaces (Dale et.al. 2021).

Table 2: Confirmed COVID-19 Cases by State in Nigeria

States	Confirmed cases	Death cases
Lagos	99,226	769
FCT	28,623	248
Rivers	16,639	154
Kaduna	11,249	88
Plateau	10,252	75
Oyo	10,219	202
Edo	7,694	321
Ogun	5,810	82
Delta	5,370	111
Ondo	5,173	109
Kano	4,985	127
Akwa Ibom	4,657	44
Kwara	4,601	64
Osun	3,311	92
Gombe	3,307	66
Enugu	2,952	29
Anambra	2,825	19
Nasarawa	2,720	39
Imo	2,560	58
Katsina	2,418	37
Abia	2,173	34
Benue	2,129	25
Ebonyi	2,064	32
Ekiti	2,004	28
Bauchi	1,957	24
Borno	1,629	44
Taraba	1,473	34
Bayelsa	1,315	28
Adamawa	1,203	32
Niger	1,148	20
Cross River	875	25
Sokoto	817	28
Jigawa	669	18
Yobe	609	9
Kebbi	480	16
Zamfara	375	9
Kogi	5	2

Source: NCDC, 2022b

5.3. Parallels between LASV and COVID-19

The parallels from both the Lassa virus (epidemic) and COVID-19 (pandemic) are shown in Table 3.

Table 3: Parallels Between Lassa Virus and COVID-19

Indicators	Lassa Virus Epidemic	COVID-19 Pandemic
Geographic origin	Lassa Village, Borno State, Nigeria	Wuhan, China
Year	1969	2019
Source	Zoonotic; Infected Mastomys rats	Zoonotic; Infected Bats; Mammals & Birds
Spatial spread	West Africa	Global (All continents)
Transmission	Animal to Human; Human -to-Human	Animal to Human; Human -to-Human
Exposure	Direct and Indirect	Direct and Indirect
Health symptoms	Fever, diarrhea, headache, vomiting, abdominal pain, sore throat, cough, bleeding from nose, gum, eyes, mouth, hearing loss, chest pain	Cough, fever, muscle or body aches, headache, shortness of breath, chills, abdominal pain, diarrhea, feeling unwell, loss of smell and taste and sore throat; neurological illness.
Morbidity & Mortality	Significant	Very significant
Food Intervention	Food strategy unclear	National strategy developed as virus unfolds to address food and nutrition; distribution of food palliatives
Prevention	Hygiene, Sanitation, Food storage	Hygiene, sanitation, social distancing, isolation, quarantine, masks, PPEs
Vaccine	None; Research in progress	Available (Pfizer, Moderna, Johnson & Johnson, Sputnik V and Sinovac). Paxlovid oral drug by Pfizer.

Source: Authors, 2021

Note: Two LASV cases were reported in the United Kingdom (Gregory, 2022).

LASV (Lassa Virus) vaccine is under development (Arruda et al., 2021) and the COVID-19 vaccine already being administered through COVAX facility has only reached a few. With only 0.2% of the Nigerian population vaccinated (Ogundipe, 2021), Nigeria is still experiencing vaccine inequality or scarcity either in supply, distribution, or vaccine hesitancy. The WHO Regional Director for Africa indicated the double barrier of vaccine scarcity and treatment challenges seriously undermine effective response to the surging pandemic (WHO, 2021d).

6. THE INTERFACE

This section discusses the interface between an epidemic, a pandemic, and the food environment as it relates to food security and nutrition. The COVID-19 pandemic saw food chains disrupted with heightened food insecurity and it accentuated the potential for the deadly zoonotic diseases to impact on socioeconomic factors at a global scale. These zoonotic diseases, affects many people and currently worsens the direct and indirect impact of the COVID-19 pandemic on the food environment (Mardones et al., 2020). About 60% of pathogen found in human originate from wildlife origin and safeguarding food in any environment is vital to anticipate, prevent, observe, and control diseases that can ensue to affect the safety of

food needed for human consumption (FAO, 2022).

Both LASV and COVID-19 have morphed into a subtle food crisis in Nigeria. Food systems have a significant role to play in public health. A 2019 Lancet Commission emphasised the crucial role of food systems in relation to both human and planetary health (Willett et al., 2019). The food environment in Nigeria includes various settings where food is available and accessible to sustain daily living. These include open food markets, produce markets, food kiosks, food hawkers, street food, eateries like Mr Biggs, Fast Food joints like KFC and Domino Pizza, local Bukaterias or food houses (Ilé Oúnje), restaurants, food canteens, grocery stores (e.g., Shoprite, FoodCo), Supermarkets/Food Marts,

smallholders/rural farmers, live animal markets, and school cafeterias. LASV and COVID-19 continue to impact the food environment through the pathways highlighted below.

6.1. Panic Buying and Food Hoarding

The pandemic emergency lockdown announcement led to panic buying; people swamped open markets and supermarkets' shelves were depleted. Locals and foreigners/expatriates patronise these supermarkets. Food hoarding led to artificial scarcity and exorbitant food costs in the days before the full lockdown commenced, especially, in Lagos and Abuja. The lockdown also resulted in an upsurge in the prices of staple foods including bread and sachet water. There were rumors of food items that can help prevent or cure COVID-19 and people scrambled to buy Orógbó (Bitter kola) and lemon. With the stay-at-home lockdown measure in place, many households could not access nutritious food either because they could not go out, or markets closed or unable to store up food due to poor refrigeration or erratic power supply and/or could not afford the cost of food.

6.2. Food Supply Chain Disruption

As a result of the COVID-19 pandemic, market supply chain and trade disruptions have been predicted to limit food accessibility, especially in areas that are already substantially affected by food insecurity (Torero Cullen, 2020). For instance, in Nigeria, transportation of food produce from the north to the south was disrupted due to the pandemic measures put in place by the government that restricted movement; hence, food supply chain was temporarily halted. Trade and foodstuffs coming from neighbouring countries were also disrupted due to cross-border land closures. These all resulted in high prices of food and food inflation. Furthermore, with the pockets of eruptions of Lassa fever outbreaks and deaths in some states of Nigeria, such as Ondo, Edo, Taraba, Bauchi and

Oyo, accompanied by the COVID-19 total lockdown; food entry points were closed, personal determinants of food choices were halted interrupting the food supply chain, disrupting and changing the process of acquiring, preparing and consuming food.

6.3. Farming Season Disruption

Movement restrictions occurred during the key planting period for rice and maize in March and April 2020, disrupting agricultural activities and potential crop yields (Ayanlade and Radeny, 2020). Farmers complying with restricted movements and lockdown were forced to stay off their farms. This resulted in harvest losses, delayed harvesting and missing out completely on the planting season. Consequently, leading to food scarcity, shortages, and increasing costs of the available food produce.

6.4. Food Contamination

Rats eat and destroy food and agricultural crops, which increases risk of Lassa virus contamination and generally can lead to food insecurity and hunger due to available food losses. Contamination of food or food staples such as Gàrí (cassava flour/flakes) by infected rats can occur in households, food markets and during agricultural or commercial production and storage and these can cause disruptions in food availability. Lassa virus impacts on how certain food staples are processed, stored and consumed. For example, Gàrí, an affordable staple food in Nigeria, is usually spread on paved surfaces to dry and this exposes the food staple to rat excrement or droppings. The ways by which foods like Gàrí, Locust bean (Irú), yams are processed predispose these food items to rodent excrement. These raw foods are sun-dried in any available open space (open air drying) or spread on open surfaces along roadside, or any concrete surface outdoors. However, knowledge, perceptions, and practice gaps still remain in effective methods to avoid viral contamination during food processing and storage.

6.5. Food Loss

Food loss from contamination by infected rats or their faecal matter/urine was notable with the Lassa virus outbreak while food loss due to transportation delays, movement restrictions and poor refrigeration were prevalent during COVID-19 lockdown. Transportation delays, poor storage facilities, poor hygiene and sanitation practices, inadequate infrastructures, erratic electricity supply and poor refrigeration in food produce markets like Mile 12 in Lagos also led to food loss and waste because many perishable food items were left to rot in the trucks. Infrastructure that supports good hygienic handling of food in these markets, such as potable water and refrigeration, is normally lacking (Mutua et al., 2021).

6.6. Poverty and Hunger Protests

The COVID-19 lockdown and containment measures exacerbated already existing poverty, food and nutrition insecurity, hunger, vulnerabilities, inequities, and inequalities in the Nigerian society. Sova (2020) asserts hunger feeds on crisis, when disaster strikes, hunger often follows, this time, it is caused by a global pandemic. Lassa virus and COVID-19 pandemic have significant effects on the Nigerian economy, food environment and health sectors. Hunger, starvation, and malnutrition have since increased and reached crisis levels in many communities in Nigeria. For example, the full lockdown in Lagos and Abuja gave rise to hunger protests and the palpability of poverty, suffering and starvation in the cities. Covid-19 food hunger protests were prevalent during the lockdown because about 70% of the population work in the informal sector, earning low wages. About 40.1 percent (82.9 million excluding Borno State; 4 out of 10 individuals) of the total population were classified as poor (NBS, 2020).

Residents, market women and informal sector workers, food vendors, food retailers took to the streets to protest the poverty and hunger unleashed by the COVID-19 full lockdown. COVID-19

pandemic lockdown negatively impacted the population who live day-to-day and subsist on daily livelihoods from the informal sector. Many people earn and depend on daily income and spend the day's wage on subsistence and caring for their families and their survival depends on living day-to-day and eating from hand-to-mouth. People did not have money to buy food due to incomes drying up, and the cry of hunger and food distress prevailed due to restricted access and closure of food markets. Hunger was palpable and poverty-laced hunger or pandemic-induced hunger became more compelling. The economies of food hunger varied from State to State depending on the social safety nets available like food cooperatives, food emergency handouts, bailouts, palliatives, and food parcels.

6.7. Food Insecurity

Nigeria is one of the 20 countries identified as a food insecurity hotspot which is attributed in part to the ongoing Boko Haram conflict in the northeastern part of the country. About 13 million people are projected to be in high acute food insecurity due to conflict in northern Nigeria (WFP and FAO, 2021). The food insecurity situation has been further worsened by Lassa virus and COVID-19. The poorest of the poor are the most vulnerable to the compounding impact of COVID-19 on the global food system, including its effects on food production (planting and harvest), transport, processing, and safe distribution to and from local markets (Lambert, Gupte and Fletcher et al., 2020). Informal sector workers and the unemployed are the most vulnerable to the food insecurity impacts of COVID-19. Nigeria's unemployment rate is 33.3 percent and half of Nigeria's population currently live below the poverty line ₦137,430 (US\$331.156) per year (NBS, 2020). World Bank (2021) notes the COVID-19 situation and recession is likely to push an additional 5 million Nigerians into poverty in 2020, bringing the total of newly poor to 7 million. Kassa and Grace (2020:3) asserts "while lockdown is intended as a measure to reduce

the outbreak of COVID-19 and prevent its transmission in the affluent world, it represents a race against death to survive among many in Africa, where life has become an 'avoidance— avoidance' conflict situation; be locked in at home and die of starvation, or violate the lockdown regulations to work and collect food and die from the disease. Whatever citizens choose to do, the race is against death, from starvation, or the virus".

6.8. Malnutrition

Malnutrition and the increased risk of certain types of chronic diseases are directly influenced by access to balanced food diets. The lockdown resulted in limited access to food and its supply chains leading to restriction in the availability of and people's access to sufficient/diverse and nutritious food (FGN, 2020). Nigeria's Agricultural Sector Food and Nutrition Strategy 2016-2025 highlights the importance of agriculture and, consequently, food systems are being deliberately and strategically harnessed to bear on nutrition.

Lassa virus and the COVID-19 pandemic has threatened the food environment and brought about unprecedented socio-economic and health challenges that have hindered the translation and implementation of the strategy. Nutrition indicators show at least 5% of the global burden of undernutrition in Nigeria with more than 14 million malnourished children (GLOPAN, 2017). Over 37% of children (under 5) are stunted and 22% are underweight (National Population Commission, 2019) which means they are at risk of dying or not developing to their full potential. These poor health outcomes and unsustainable diets were significantly influenced by limited government investments in nutrition; and LASV and COVID-19 further exacerbated the strained food environment.

Sustainable diets are key to nutritional well-being and health while ensuring food system sustainability for future food security (Berry et al., 2015). The stay-at-home measure compromised

the diets of many households and resulted in many relying on unsustainable food options. The lockdown restricted school feeding programs and many adults are consequently at increased risk of obesity and chronic disease because they are making less healthy food choices - prioritizing carbohydrates and skipping consumption of fruits and some vegetables (WHO, 2020c). Food insecurity and low-quality diets cause undernutrition, micronutrient deficiencies, rising overweight and obesity rates, which in turn are notable risk factors for admission to hospital and death due to complications from COVID-19 (Stefan et al., 2020).

6.9. Food Environment Fragility

LASV and COVID-19 continue to have significant impact on the 5 As of food security as shown in Table 4. The fragility of the food environment and the intersectionality (hunger, poverty, unemployment, contamination, loss) of these impacts cannot be overemphasised. The four pillars of food security (availability, access, utilization, and stability) are being threatened LASV and COVID-19. Weakened purchasing power, limited food preferences, restricted food production and distribution, and unsustainable diets continue to plunge the vulnerable into food insecurity in Nigeria. Hundreds of millions of people were already suffering from hunger and malnutrition before the virus hit and, unless immediate action is taken, we could see a global food emergency (UN, 2020). The impacts of the COVID-19 pandemic on food security are expected to linger on after social-distancing policies are lifted and the health system stabilizes, resulting in increased risk for chronic disease development, morbidity, and mortality among food-insecure households in the long-term (Leddy et al, 2020).

Table 4: Food Environment during an Epidemic and Pandemic in Nigeria

5 As of Food Security	LASV Epidemic	COVID-19 Pandemic
Availability (Sufficient supply)	<ul style="list-style-type: none"> Contamination during domestic production and processing of food staples. Scarcity of certain food items High cost of specific food items like Gàrí 	<ul style="list-style-type: none"> Production, Procurement, distribution disrupted Disrupted domestic agriculture production Disrupted imported food supply due to inter-country border closures Disrupted flow of local produce due to restricted inter State movement Disrupted local harvest and planting seasons Food scarcity High prices of food staples
Accessibility (Effective distribution; equal access)	<ul style="list-style-type: none"> Increased hunger Loss of affordable staple food due to high contamination risk Rats are high risk food source 	<ul style="list-style-type: none"> Increased hunger, starvation Restricted food market access Erratic income sources Non-affordability Food hoarding Food protests Inability to acquire and consume nourishing diet Lack of access to secure adequate food through purchase or distribution Poor access to farms Delayed planting and harvesting
Acceptability/Utilization (Culturally acceptable and nutritionally adequate)	<ul style="list-style-type: none"> Food loss Food safety risk Consumption of rats Poor food storage (food containers not rodent-proof) Insanitary food handling Food-borne illness 	<ul style="list-style-type: none"> Food loss Reduced Income Weak purchasing power Undernourishment Poor refrigeration
Appropriateness/Stability (Ecologically sustainable)	<ul style="list-style-type: none"> Inadequate food assistance Poor food supplements 	<ul style="list-style-type: none"> Inadequate food assistance Slow food system recovery
Agency (Enables action)	<ul style="list-style-type: none"> Intersection of Policy: food, health, transportation, local environment Urban planning (Land use) Infrastructures 	<ul style="list-style-type: none"> Intersection of Policy: food, health, trade, transportation, environment Infrastructures Spatial distribution of food baskets Palliatives, Food relief programs

Source: Authors, 2021

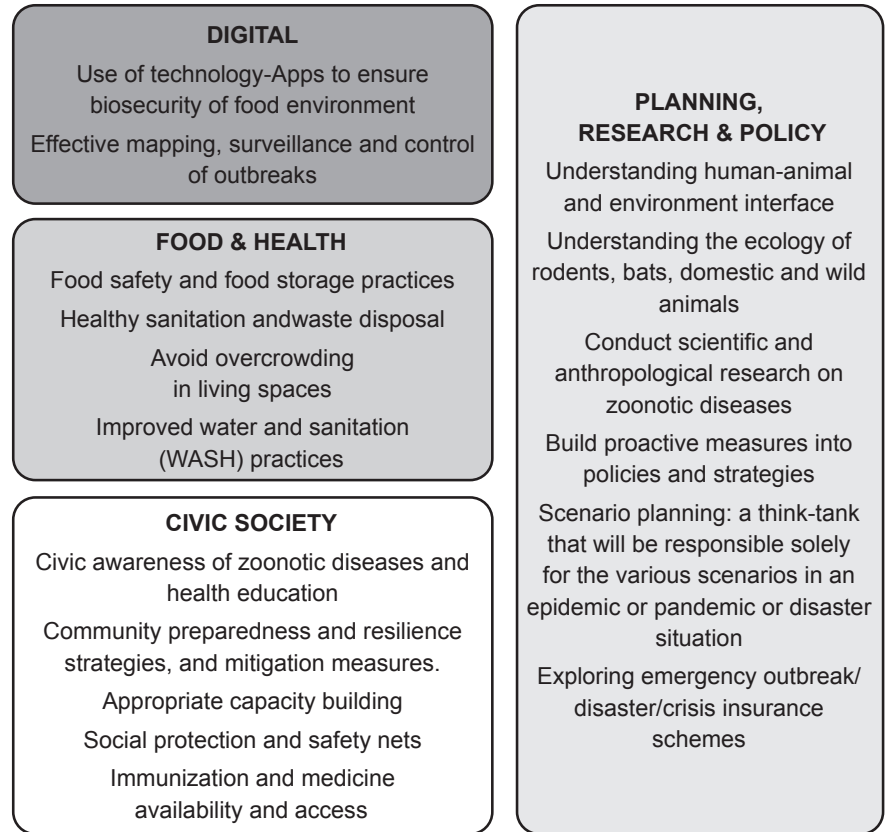
6.10. Policy Response

The Nigeria Centre for Disease Control (NCDC) in collaboration with the Federal Ministry of Environment and Federal Ministry of Agriculture and Rural Response leads Lassa fever response activities across the country. This is done in close collaboration with State Ministries of Health, and with support from partners coordinated by WHO. Deratization and fumigation of open markets have been adopted in addition to practicing good personal hygiene (hand washing with soap and water), keeping the environment clean (environmental sanitation) and rodent free to prevent the spread of Lassa fever. The COVID-19 Pandemic Response plan (FGN, 2020) proposed mitigation measures to limit the impact of COVID 19 on the nutritional status of the vulnerable groups, mitigate the impact of the COVID-19 pandemic on the food system and develop guidance for actions for ensuring safe, resilient markets and food supply chains. The introduction of palliatives by the different levels of government to the poorest of the poor, including women, was received with mixed reactions. For example, palliatives distributed to residents included food items like Gari, Semovita, bread, vegetable oil and some cash ranging from ₦2000-₦5000 (US\$4.8-US\$12.04). Palliatives distributed was not enough and, at a point, became politicized by politicians who wanted to appease their constituencies or political allies through stomach infrastructure. "COVID-19 is potentially catastrophic for millions who are already hanging by a thread. It is a hammer blow for millions more who can only eat if they earn a wage..." (WFP's Chief Economist, Arif Husain, WFP, 2020).

7. WAY FORWARD

Practical integrative stages to prevention, preparedness and response to epidemic or pandemic such as Lassa virus and COVID-19 will comprise technology, proactive civic participation, and research (Figure 3).

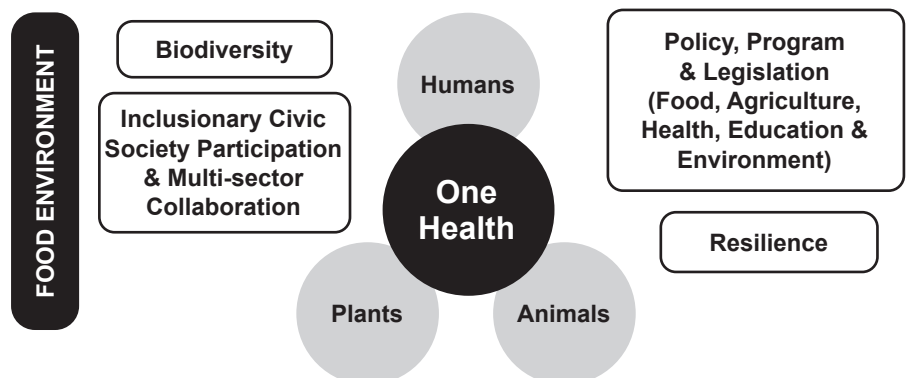
Figure 3: Integrative Stages to Epidemic/Pandemic Preparedness



Source: Authors, 2021

The ecology of Lassa virus and COVID-19 or any zoonotic disease that impacts on humans and their food environment requires a One Health, holistic approach that emphasises inclusionary participation, prevention, and preparedness for future occurrences; incorporates environmental, community and veterinary health; and an interdisciplinary collaboration of professionals at all levels in the health, planning, environment, food, education, and agriculture sectors (Figure 4).

Figure 4: One Health Approach to Epidemic/Pandemic in the Food Environment



Source: Authors, 2021

8. CONCLUDING THOUGHTS

The food environment in Nigeria is faced with a rugged terrain ahead amidst the recovery from COVID-19 and the continued outbreak of Lassa virus. There is a need to build sustainable, and resilient public health and comprehensive food environment in Nigeria such that can withstand disruptions from emerging disease outbreaks and ensure food security of its population. It is important that the government at all levels have strategic plans to protect the food environments to ascertain uninterrupted access to food by all, including the most vulnerable, and avert food disruptions during an epidemic, a pandemic, or a disaster. Protecting the food environment entails intentionally safeguarding food workers, truckers, wholesalers, retailers, consumers, small holders' farmers (family farms) and food retail vendors in the informal economy. Lassa virus and COVID-19 measures - which include hand washing, sanitizing, physical distancing - are flouted and crowding is almost inevitable in the food environment (family farms, open markets) and other public spaces/ places in Nigeria. A sustainable and resilient food environment is contingent on uninterrupted clean water and food access, accessible public health, and practising safe hygiene and sanitation. While many have inadvertently died of hunger during the outbreak of Lassa virus and COVID-19 and/or due to inequities of health care system and lack of access to basic needs, the efforts of many food workers, small scale farmers, food heroes and food front-liners, who worked tirelessly to keep the food supply chain going, need to be celebrated.

Both the epidemic and pandemic have highlighted significant weaknesses and opportunities to strengthen the food environment for better food security and nutrition in Nigeria. Priority should be placed on strengthening local food production to encourage better food diversity and affordable options and promote regulation of food prices. Implementing systems and software

applications to monitor and map food security in real-time will also provide an avenue to understand the long-term effects of the epidemic and pandemic on nutrition and will inform targeted interventions. In applying the One Health approach to Lassa Virus and COVID-19, it is important to focus on the links between human, domestic and wildlife health and the threats posed on food security. A One Health approach to addressing an epidemic, a pandemic or any other health disaster, is contingent on informed, inclusive, community-driven and sustainable infrastructure. It is also significantly pertinent to recognize that healthy biodiversity and functioning ecosystems are crucial to the sustainability of the food environments and their infrastructure, the people they serve and overall planetary health.

Note: US\$1 = ₦415 (April 7, 2022, rate)

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