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## Disaster preparedness and resilience for hospitals: lessons learned from the COVID-19 pandemic

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### ABSTRACT

Hospital disaster preparedness and resilience are crucial in managing disasters, especially the vulnerabilities of hospitals across the globe revealed by the COVID-19 pandemic, highlighting the need for a robust framework to handle future disasters effectively. This research carries out a comprehensive literature review to identify major weaknesses in current hospital disaster preparedness and resilience strategies and proposes a comprehensive framework to enhance hospital resilience in Lagos state hospitals, Nigeria.

In relation to the existing studies reviewed, key themes were used as an assessment tool: they include the 4S domains, namely, Staff, Stuff, Space and Systems. The proposed framework is centered around six building blocks which includes, governance and leadership, financial stability, workforce competency, flexibility in healthcare delivery, local-level preparedness tools and continuous learning to ensure that hospitals can respond and recover from disaster effectively. By drawing lessons from the COVID-19 pandemic and analyzing comparative studies, this research provides a framework that can help build resilient hospitals capable of adapting to dynamic situations.

### INTRODUCTION

During the COVID-19 pandemic, hospitals worldwide were faced with an unexpected challenge, disclosing the critical importance of hospital disaster preparedness and resilience (Vainieri *et al.*, 2024). According to the International Federation of Red Cross and Red Crescent Societies (Seddighi, 2020). COVID-19 is referred to as a disaster. A disaster can be defined as a serious and unexpected disruption of the functioning of a community or a society at any level due to dangerous events involving widespread human, material, economic and environmental losses and impacts. For example, flood, earthquake, drought, epidemic and pandemic (International Federation of Red Cross and Red Crescent Societies [IFRC], 2022). Throughout history, disasters, both natural and man-made, have inflicted havoc. The effects could be rapid, widespread and last for a lengthy period of time. The impact could stress a community's or government's capacity to manage its resources, requiring assistance from outside sources at national or international levels (Pawar *et al.*, 2024).

According to studies conducted by the Center for Research on the Epidemiology of Disasters (CREDE, 2019). More than 6,800 natural disasters have occurred worldwide in the past 20 years, which have claimed about 1.30 million lives, with an average of 68,000 every year. Moreover, it has affected more than 210 million individuals annually. Based on the CREDE data on the distribution of disaster events by continent during the past ten years, Asia is estimated to be the most affected region (46.7%), followed by the America (24.3%),

Africa (16.9%), Europe (8.2%), and Oceania (3.8%) (Ghanaatpisheh *et al.*, 2019). Hospitals have played a significant role in assisting people who have been affected by these disasters by providing healthcare.

Hospitals, are the most crucial aspect of healthcare organizations as they provide both therapeutic and preventive care. Hospitals are the safest environments for patient care, and they should be well-equipped to manage a range of expected and unforeseen situations. Despite their reputation hospitals are susceptible to both internal (such as fire outbreak, exposure to hazardous materials, etc.) and external disasters (such as flood, mass casualty events or epidemics, etc.) (Hasan *et al.*, 2023). Recently, various kinds of natural disasters have occurred in many countries, including floods in (Nigeria 2015, 2019, Kerala, India 2018 etc.) and earthquakes (Turkey 2023 and Taiwan 2024). A resilient hospital will be able to provide essential services to affected people and can mitigate the risk of injuries during and after disasters. Thus, there is need for hospitals to be prepared in anticipation of extreme cases when their resources (both human and technological) are stretched to an extreme limit (Fallah-Aliabadi *et al.*, 2020).

Disaster preparedness is defined by The World Health Organization (WHO) as a process of continuous anticipation of disaster events, putting preventive measures into place to prevent such events, and building the capacities and resources needed to respond to, mitigate and recover from such events (WHO, 2017). Some examples of preparedness measures include, enhancing outbreak detection services, having a

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good response plan for actions required to lessen a disaster's effects, and setting up mechanisms to allocate manpower, materials, and resources to support the affected individuals and public health infrastructure (Rogers *et al.*, 2023). This can also be achieved through Disaster Risk Reduction measures such as, detection and monitoring techniques, proper communication, facility support and reconstruction measures (Tanguid & Tanguid, 2023)

Many strategies to manage disasters have been proffered by the WHO, such as the Disaster Risk Reduction (DRR) strategy, which has been suggested to be implemented more widely as a way to increase resilience to disasters worldwide (WHO, Health Emergency and Disaster Risk Management Framework, 2019). Additionally, other frameworks such as the Sendai Framework for Disaster Risk Reduction (SFDRR) and the Sustainable Development Goals (SDGs), were recommended by the United Nations to be implemented in every country's Disaster Risk Management initiative in order to strengthened the health sector (Olu, 2017).

Haldane *et al.*, (2021) describes resilience as institutions' and health actors' capacities to adapt to challenges at different systems levels, recover from and absorb shocks, while maintaining high quality care. The COVID-19 pandemic has highlighted the need to the redefinition of resilience in disaster management. Hospital resilience in the context of pandemic or outbreak can be described as the ability of a person, community or health institution to respond and adapt to health hazards in order to mitigate and recover to the pre-outbreak condition (Rogers *et al.*, 2023). EU Expert Group on Health Systems Performance Assessment (2020), describes a resilient health system as its ability to effectively adapt to dynamic situations through prevention, response, recovery and reduce impact across and beyond the system. Hospital disaster preparedness campaign and investment may help build the resilience of public and

healthcare organizations to allow institutions to respond more quickly and mitigate disaster impacts.

The COVID-19 pandemic is the most severe global health emergency since the 1918–19 influenza, causing the worst health emergency that tested the ability of health institutions to manage and respond effectively. Ultimately revealing that the world is not prepared to such health emergency (Paschoalotto *et al.*, 2023). Additionally, the pandemic has necessitated rapid and coordinated response from government, healthcare systems and the community at large (Islam & Kabir, 2024). The Global Health Security Index (GHSI) revealed that, even the countries with the most resilient health systems i.e., the United State and the United Kingdom performed below average in terms of COVID-19 management (Ledesma *et al.*, 2023).

This raises the need to update knowledge on the hospital resilience concept, analytical framework, and implementation of the mechanisms. Also, there are several lessons that are worth considering to make hospitals more resilient to future disasters. Hence, the need, to conduct a comprehensive study in order to identify weaknesses facing the existing approaches to hospital resilience with the aim of proffering framework and strategies that could improve hospital resilience in Lagos State, Nigeria.

Nigeria is the most populous country in Africa with an estimated population of over 227 million people and is expected to continue to grow up to 239 million by 2025 (Pontianus & Oruonye, 2021). Nigeria has been seriously affected by the COVID-19 pandemic, with more than 162,000 COVID-19 cases and more than 2,000 COVID-19 related deaths. Lagos State recorded the highest number of cases due its commercial activities (Okoroiwu *et al.*, 2021).

Lagos State is located in the southwestern part of the country, it's the smallest state by land area and most populous state in Nigeria, with an estimated population

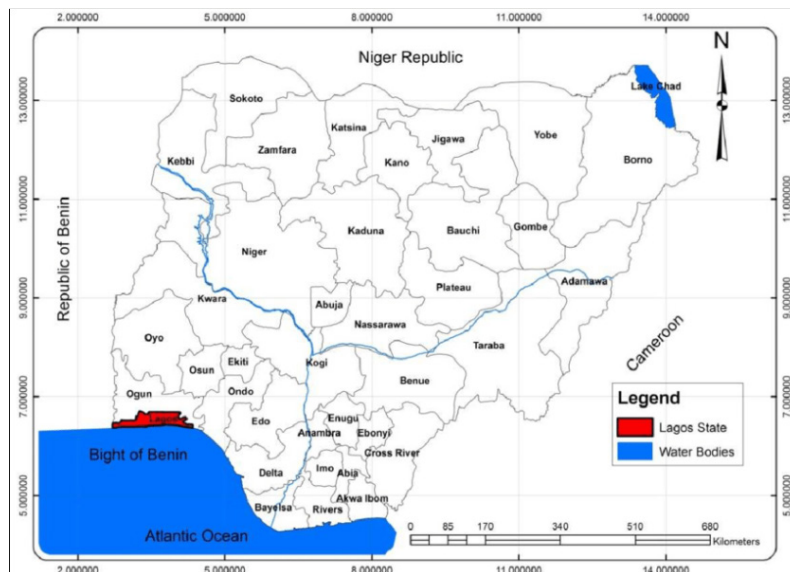


Figure 1: Map of Nigeria showing Lagos state (Adeniran *et al.*, 2020).

of over 20 million habitants (National Population Commission, 2019). Several factors contributed to the rapid spread of COVID-19 virus, which includes: population density, high volume of economic and human activities, presence of the Murtala Mohammed international airport, which is the busiest airport in Nigeria and Rapid urbanization (Mogaji, 2020).

According to a survey conducted by the Lagos state government in 2022, the State has numerous amounts of government and private hospitals both in villages and within the state, however the exact number cannot be ascertained. Additionally, the state has numerous amounts of healthcare workers (over 16,000), including doctors, nurses, midwives, and other health personnel. This number has likely increased due to the ongoing efforts to improve healthcare services and infrastructure in Lagos state, Nigeria (Lagos State Health Facility Assessment Report, 2022).

This study aims to identify challenges of existing approaches to hospital resilience during a disaster with the intention to proffer recommendations that could enhance hospital resilience during disasters. The aim of the research is further broken into the following research objectives.

a. To identify the existing weaknesses in Lagos state hospitals using the 4's concept (staff, stuff, system and structure) and to recommend strategies for strengthening hospital resilience to disasters in Lagos state.

b. To propose a comprehensive feasible framework for enhancing hospital resilience ensuring that Lagos state hospitals can respond effectively to disasters.

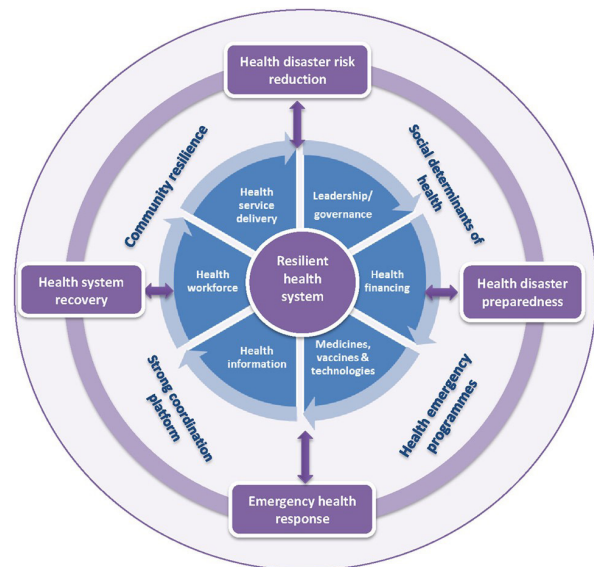
### LITERATURE REVIEW

A comprehensive literature search was conducted using several scientific data bases, including ScienceDirect, google scholar, government reports and PubMed. Important reviews related to hospital disaster preparedness, hospital resilience and lessons learnt from the COVID-19 pandemic were used in this study, irrespective of their study design or geographic location, published between 2017 and 2024, in English and in peer-reviewed journals. Literature on this study emphasizes various strategies for enhancing hospital resilience.

Coronavirus disease (COVID-19) is an infectious zoonotic disease caused by the SARS-CoV-2. It has a positive-stranded Ribonucleic acid (RNA) and belong to the family Coro-naviridae (Center for Disease Control and Prevention, 2020). A novel coronavirus was first identified and reported in Wuhan, China in December 2019 (Gudi & Tiwari, 2020). The coronavirus pandemic has been the biggest calamity of the century and the biggest challenge faced after the Second World War. It has caused a remarkable global crisis, including millions of lives lost, economic and social disruption, disproportionately affecting the most vulnerable (International Federation of Red Cross and Red Crescent Societies [IFRC], 2022). Therefore, highlighting the critical importance of hospital disaster preparedness and

resilience in order to mitigate future disasters.

Olu (2017), conducted a study to analyzed and advocate for the practical application of resilient health system frameworks into disaster management to improve disaster preparedness, response, and recovery. The methodology of the Olu's study involves a comprehensive analysis and review of existing literatures, frameworks, and case studies related to health system resilience and their applicability to disaster management. Figure 2 below presents a conceptual framework proposed by Olu towards a resilient health system. This framework includes, Leadership and governance, health financing, medicines, vaccines & technologies, health information, health workforce and health service delivery. Olu's study emphasizes that a resilient health system can significantly enhance the ability to manage disasters of all kind.



**Figure 2:** Conceptual framework for health system resilience (Olu, 2017).

A study conducted by the WHO-Health Emergency and Disaster Risk Management (2019), proposes a framework that emphasizes the critical importance of disaster prevention, preparedness, response and recovery as an effort to reduce the consequences of disasters on human health. The framework consists of six elements which includes, Surveillance, Early Warning, and Alert Systems, Emergency Preparedness for Response Across All Hazards, Resilient Hospitals and Health Facilities, Strong Advocacy and Participation, Operational Coordination, and Support for International Frameworks (International Health Regulations, Sendai Framework for Disaster Risk Reduction, Sustainable Development Goals and the Paris Agreement). The framework also aims to achieve the WHO's triple billion goals: universal health coverage, health security, and health for all. Figure 6 below shows a pictorial view of the proposed framework.

Note: The two sets of frameworks above reflects two complementary but different frameworks related to health system strengthening and emergency



**Figure 3:** WHO H-EDRM framework (2019)

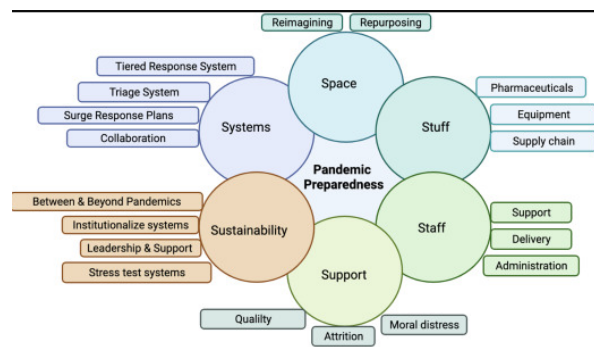
management. However, both frameworks are centered around preparing for and responding to emergencies and disasters, ensuring that health systems are resilient enough to continue functioning in the face of disasters. Haldane *et al.* (2021) carried out a comprehensive study to review the COVID-19 responses across 28 countries using a novel health systems resilience framework. The methodology used by Haldane *et al.* (2021) includes, review of existing literatures, national government submissions, and interviews with experts. From this extensive analysis, the study identified six critical elements that underlie the most effective national response which includes, governance and financing, health workforce, medical products and technologies, public health functions, health service delivery, and community engagement aimed at preventing and mitigating the spread of COVID-19. These elements are similar to that of Olu (2017) and WHO H-EDRM framework (2019). Except that, Haldane *et al.* (2021) emphasized more on community engagement. Figure 4 below depicts a pictorial view of the proposed frameworks.



**Figure 4:** Determinant of health systems resilience framework (Haldane *et al.*, 2021).

A study conducted by Mer *et al.* (2022), which aims to evaluate the effectiveness of various strategies employed by hospitals and government during the COVID-19

pandemic, an analysis of preparedness and response measures were conducted using existing literatures and reports. The study shows that countries that implemented strict lockdown, extensive testing and maintained robust contact tracing were able to controlled the virus spread. The result of the study also identifies six crucial elements for effective management of pandemics and other disasters, these includes: staff, stuff, space, systems, support, and sustainability. By addressing these identified weaknesses adequately, countries can be able to enhance hospital resilience to outbreaks and other disasters. Figure 5 shows the proposed framework as proffered by Mer *et al.* (2022).



**Figure 5:** Key component of disaster preparedness: the six S's (Mer *et al.*, 2022)

Similarly, Karreinen *et al.* (2023) conducted a comprehensive literature review of existing studies and government reports related to the COVID-19 preparedness and response in Finland. The study aims to identify the weaknesses and strengths in Finland's hospitals to handle emergencies in order to improve future preparedness to emergencies. The study emphasized the critical importance of 6'S (staff, stuff, space, systems, support, sustainability) in disaster management.

However, the research of Munasinghe *et al.* (2023), which conducted a pivotal study to develop a comprehensive hospital disaster preparedness evaluation tool, focuses on the 4S domains of preparedness: space, stuff, staff, and systems. This tailored toolkit stands out as a critical resource for enhancing the disaster resilience of hospitals.

Research of Hasan *et al.* (2023) aimed to identify, review, and analyzed preparedness activities and gaps related to hospital surge capacity during disasters and emergencies. A systemic literature review was conducted, several weaknesses related to surge capacity were identified and a comprehensive strategy was proposed, these includes the 4S domain: staff, stuff, space, and systems. This comprehensive strategy will help in improving hospital preparedness and resilience to various challenges faced in boosting surge capacity during disaster and emergency situations.

Note that: all the above four studies emphasize on critical elements (S elements) as vital for hospital preparedness and response.

## MATERIALS AND METHODS

This research employed a comprehensive literature review methodology approach to Identifying weaknesses in hospital disaster preparedness and to suggest strategies for enhancing preparedness and resilience, that can be applied to Lagos hospitals in Nigeria, ensuring that hospitals can effectively respond to and

recover from various disasters, thereby safeguarding community health. The process flow diagram below depicts the steps that was taken in conducting literature analysis. This process involves systemically reviewing and synthesizing existing research to identify patterns, themes, gaps, providing comprehensive insights and proffering actionable strategies and recommendations.



**Figure 6:** Conceptual approach

### Data Extraction and Synthesis

Relevant information from the selected articles and journals including science direct, google scholar and government reports were extracted and synthesized to identify common themes, trends, and gaps in the literature. Keywords used in the search included COVID-19 pandemic, Disaster preparedness, Hospital resilience, Lagos state Nigeria. This approach allows a comprehensive understanding of the current state of hospital disaster preparedness and resilience.

### Data Analysis and Interpretation

The synthesized data which is presented in section 4 was interpreted for better understanding of the vulnerability of hospitals to disasters and the effectiveness of existing strategies and frameworks. The study established that the 4S concept which includes, staff, stuff, space and system and the six building blocks were the major pillars for having an improved preparedness and a resilient hospital. The findings were interpreted to inform the development of evidence-based recommendations aimed at enhancing hospital preparedness and resilience.

## RESULTS AND DISCUSSION

This discussion synthesizes the findings from the conducted comprehensive literature review, identifying key weaknesses, strategies and framework for enhancing hospital resilience, framed within the 4S concept: Staff, Stuff, Space, and System and the six building blocks (framework). The following subsections discusses its application to the use case.

### Feedback 1. Hospital Resilience and Preparedness in Lagos state, Nigeria

The COVID-19 pandemic has brought unprecedented challenges to healthcare systems in Lagos state, Nigeria, highlighting critical weaknesses in hospital disaster preparedness and resilience. Practical application of resilient hospital as a framework for strengthening public health DRM is, therefore essential. This requires the strengthening and use of the proposed six building blocks as elements in the implementation of public health DRR, preparedness, response and post-disaster recovery

interventions at the individual, community, and hospital levels. Apart from weak health systems in Lagos state, Nigeria, poor status of the social determinants such as poverty, lack of good housing, inadequate access to good nutrition, clean water, improved sanitation, education, and social protection could reduce individual and community resilience and increase the risk of disasters. Thus, optimal social determinants of health and resilient communities are also required for mitigating the public health risks and impacts of disasters.

Adopting and applying the 4S concept which consist of Staff, Stuff, Structure, and System, revealed significant weaknesses that hampered Lagos State's ability to effectively handle the COVID-19 pandemic as elucidated below.

a. Staff: Despite the numerous numbers of existing health care personnel in both government and private hospitals in Lagos State (Lagos State Health Facility Assessment Report, 2022). The state lacked healthcare workers that are specifically trained to handle outbreaks like the COVID-19 pandemic and other unanticipated disasters, this resulted in inefficient management and increased spread of the infection among the Staff. Therefore, addressing the issue of Manpower including continuous training of healthcare personnel on disaster response should be organized by the Lagos State ministry of health in order to handle future disasters effectively.

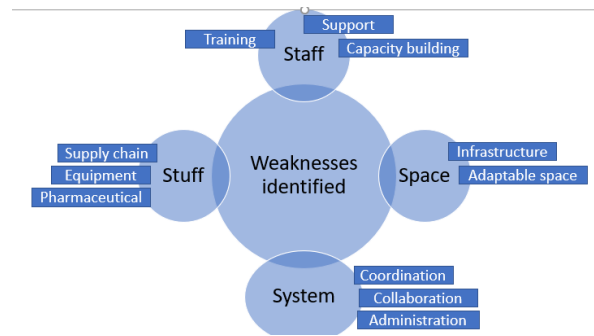
b. Stuff: During the COVID-19 pandemic, hospitals in Lagos State has faced logistical difficulties due to the sudden total lockdown and lack of store up of essential medical equipment such as, testing instruments, mechanical ventilators, face mask and PPE needed for the effective treatment of affected patients ((Mogaji, 2020). These contributed to the rapid spread of the infection among healthcare personnel, limiting ability of the workers to manage the disaster efficiently. Therefore, adequate and continuous supply and storage of essential stuff is encouraged in order to manage future outbreaks effectively and to increase the resilience of Lagos State hospitals to disasters.

c. Space: Lagos State, Nigeria is one of the states with high number of hospitals both in villages and within the state (Lagos State Health Facility Assessment Report,

2022). However, during the COVID-19 outbreak, the hospitals were unable to accommodate patient due to lack of knowledge on surge capacity. Additionally, there are inadequate isolation centers and intensive care units, which contributed to the ineffective management of patients. Therefore, hospitals in Lagos are encouraged to be designed with sufficient spaces that can be used for different purposes during disasters.

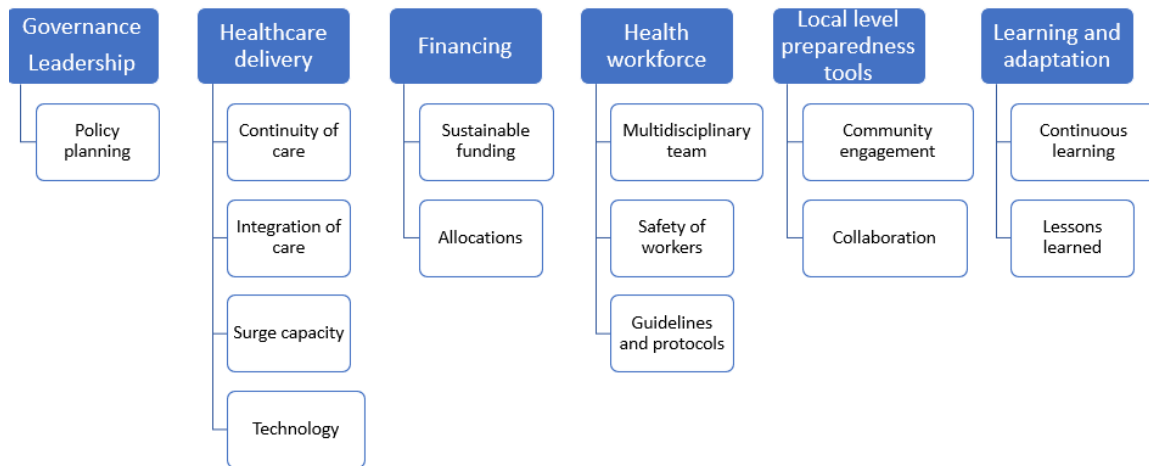
d. System: Hospitals in Lagos State, Nigeria are managed by different levels of government, from the federal government down to the state level (Lagos State Health Facility Assessment Report, 2022). This long chain of management contributed to mis-management, lack of coordination and corruption among workers, making it difficult to manage the COVID-19 pandemic effectively. Therefore, strengthening governance and leadership is vital for effective coordination during disasters.

**Feedback 2. Proposed Framework for Enhancing hospital Resilience in Lagos state, Nigeria**



**Figure 7:** Summary of weaknesses identified in Lagos state hospitals using the 4'S concept

The comprehensive framework proposed in this study comprises of six building blocks namely, governance and leadership, financial stability, workforce competency, flexibility in healthcare delivery, local-level preparedness tools, and continuous learning and adaptation.



**Figure 8:** Proposed framework for enhancing disaster preparedness and resilience in Lagos hospitals

Response toward COVID-19 by the Lagos state government has underscored the critical importance of good governance and strong leadership that are willing to learn from past experience and can be able to protect the wellbeing of their people at all times. Several studies reviewed have highlighted the importance of governance in disaster preparedness and response (Thomas *et al.*, 2020; Haldane *et al.*, 2021). This study emphasized that healthcare systems in Lagos state would benefit from a whole of government approach. Securing sustainable funding sources and implementing financial contingency plans are vital for managing economic disruptions during crises. Lagos state, being the commercial hub of the country is known for its economic activity and has a good revenue. However due to the high level of corruption and mis priority by the government, most of the budgets is not directed to the health sector, which contributed to the poor health infrastructure in the state, therefore the government must increase its expenditure to the health sector to build a resilient hospital that can handle future

disaster and protect population health. Healthcare workers are the most important aspect of a resilient hospital (Olu, 2017). Despite the numerous numbers of healthcare personnel in Lagos State hospitals, the state faced difficulties in managing patients during the COVID-19 pandemic due to the diverse population of Lagos (23 million habitants). The study therefore strongly proposed that, Lagos State government should invest in both quality and quantity of healthcare personnel. Additionally, continuous training on hospital disaster preparedness and management can enhance the ability of workers to manage future disasters effectively. Granting flexibility in healthcare delivery is crucial for enhancing the resilience of the health system (Marmo *et al.*, 2022). Lagos State government needs to design hospitals with adequate spaces that can be easily converted for different uses, depending on the need and type of disaster. This flexibility can enable hospitals to function effectively in all situations. Developing Local-level preparedness tools such as telephone chain, social media group and text

messages can enhance effective communication among various stakeholders (Rogers *et al.*,2023). This strategy can enhance not only resilience of health systems but overall community resilience to disaster situation and can help in inform policy and decision making. The COVID-19 pandemic has highlighted the need for continuous learning, learning from past experience and continuous training through simulation exercises and frequent drills. This approach is particularly difficult in Lagos state due to the large population in the state.

This proposed framework is designed to enhance hospital preparedness and resilience in Lagos State, Nigeria which aligns well with the Health Emergency and Disaster Risk Management framework developed by the World Health Organization in 2019 and encouraged all countries to implement as part of their disaster management initiative.

### Feedback 3. Possible hitches that could be faced in the implementation of the proposed framework

#### Resource restraint

This proposed solution involves sufficient and consistent funding from the Lagos state government. However, due to the recent inflation and insecurity in the country, the state may face difficulty in implementing this framework within a short period of time.

#### Infrastructure challenges

Lagos state is the smallest state by land in Nigeria. Therefore, there may be no adequate land to build big hospitals with enough spaces that can be easily be converted according to need.

#### Corruption issues

Implementation of the proposed framework will require strong governance and good leadership that can limit corruption among workers.

#### Cultural differences

Lagos is a state with divers' culture and large population. Therefore, involving this large number of people in disaster preparedness activities such as training exercises and drills might be difficult and challenging.

### CONCLUSION

Globally, the COVID 19 pandemic has primarily stretch facilities of healthcare systems. With an estimate of over 6 million deaths worldwide and great effects on social and economic activities, the pandemic should serve as a learning point for improved preparedness and resilience in hospitals globally. Thus, the need for mechanisms that can adapt to dynamic times and assist mitigate the effect of disasters. Hence DRM programs should place hospital preparedness at the heart of improved resilience.

By addressing the identified weaknesses and implementing the proposed framework in this study, we can build a resilient hospital that can withstand future disasters in Lagos State, Nigeria. The proposed framework in this study could be achieved through the use of the

six elements proposed in this study. Additionally, it is important to learn from past experience and continuously refined preparedness strategies.

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