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## Existing Biosecurity and Biosafety Frameworks, Policies, and Institutions in ECOWAS Countries: A Review

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### ABSTRACT

This study reviews the current biosecurity and biosafety policies and institutional landscapes in West Africa. Given the increase in biosecurity threats, especially increase in frequency and intensity of emerging and re-emerging infectious diseases in West Africa, it is important to analyse the current policies and institutional landscape and their ability to ensure a biosecured region. Advances in science, technology, and biotechnology, which has improved global practices, bettered our understanding of daily activities, exposed the world to a vast body of knowledge, has at the same time enhanced the frequency of outbreak of biological threats. The capacity of various nations to prevent, detect and respond to emerging infectious diseases has been undermined due to numerous challenges unique to each country, hence the need to study the existence and the extent of biosecurity and biosafety policies, framework, and institutions in ECOWAS states/countries. Data were collected using semi-structured questionnaire, key informant interview and desk study. This study revealed that several legislative instruments and policy responses had been enacted to address biosecurity and biosafety challenges in West African countries; however, the translation of these policies and legislative instruments in documents to practices remains a hurdle owing to multiple challenges including the lack of human capacity to implement policies and lack of specialized institutions that will implement the policies which would not be able to control mishandling and misuse of infectious agents and toxins, disregard for government policy due to absence of oversight of life sciences research of concern, insider and outsider threats at laboratories dealing with biological agents, and poor physical security and materials accountability including transfer and transport of infectious agents and toxins. Conclusively, to promote a safe and secure environment, emphasis must be placed on developing a curriculum for biosafety and biosecurity education that focuses on developing skills to maintain responsible health security practices and human resource incentives to drive a culture of safe and secure science. There is also the need for a clear synchronized framework that governs laboratory and biobanking activities in the West African region.

**Keywords:** Biosecurity; Biosafety; ECOWAS; Laboratories; Policies and Frameworks; WAHO.

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## INTRODUCTION

Extant literature have indicated increasing threats and outbreaks of emerging infectious diseases [1,2]. A 2017 report by CDC, for instance showed that there had been 25 Ebola outbreaks since 1976. The containment strength of the 2014 outbreak led to the loss of 13,000 lives of the infection on 28,000 persons.

The United Nations Food and Agriculture Organisation (FAO) defines biosecurity in the context of a strategic and integrated approach that encompasses the policy, regulatory frameworks, instruments, and activities for analyzing and managing relevant risks to human, animal and plant health, and associated risks to the environment [4]. Biosecurity covers food safety, zoonosis, the introduction of animal and plant diseases and pests, the introduction and release of living modified organisms (LMOs) and their products (genetically modified organisms or GMOs), and the introduction and management of invasive alien species [5]. Thus, biosecurity is a holistic concept of direct relevance to the sustainability of agriculture, and wide-ranging aspects of public health and protection of the environment, including biological diversity [6,7]. Biosecurity measures aim to mitigate, prevent, prepare for, respond to, or recover from natural or manmade biological events that could harm humans, animals, or the environment [8].

Given the increase in the frequency of emerging infectious diseases in recent decades, especially in sub-Saharan Africa [9], coupled with other increasing biosecurity threats caused by climate change, environmental degradation [10] and increased activities of non-state actors in the region; the West African Health organization (WAHO) as part of the development of the regional Biosecurity Policies conducted a detailed review of biosecurity policies and framework in West Africa to effectively prepare the region to tackle emerging biosecurity threats and disease outbreaks.

This review is to put into perspective:

1. Review global narratives on biosecurity and biobanking;
2. Analyze existing policy and institutional landscapes (policies, institutions, and regulatory environments) that regulate biosecurity and biobanking activities in West Africa

## METHODOLOGY

### Study Area

The study was conducted in Economic Community of West African States (ECOWAS) countries

including Senegal, Sierra Leone, Ghana, Togo and Mali. The Economic Community of West African States, founded in 1975, is a regional political and economic union of fifteen countries located in the West of Africa. Collectively, these countries comprise an area of 5,114,162 km<sup>2</sup>, and in 2015 it had an estimated population of 346 million [11].

### Data Collection and Analysis

This study employed both primary and secondary sources of data. This approach allows for effective triangulation of data to ensure that findings can be corroborated and any weaknesses in the data can be compensated for by the strengths of other data, thereby increasing the validity and reliability of the results.

Firstly, a content analysis of scientific literature, national policy documents, biosecurity and action plans, global biosecurity databases, web content, conference documents, summit reports and national reports, among others, were analyzed. Secondly there was engagement and consultation with experts and stakeholders in West African countries. For this, a semi-structured questionnaire was designed and employed to obtain information from West African state parties in respect of harmonization of standardized information about the progress of its national core capacities and confidence-building measures (CBM) within a biosecurity, biosafety and biobanking context. Thirdly, key informant interviews and stakeholder engagement were conducted in Senegal, Sierra Leone, Ghana, Togo and Mali to verify information obtained through the questionnaire and desk analysis.

### Framework for Analysis

Before venturing into biosecurity related policies and institutional landscape in West African countries, it is essential to provide an analytical lens through which this review was undertaken (Figure 1). The emergence of national policies, action plans and institutions governing biobanking and biosecurity have been driven by these narratives: (1) the rise of multiple international agreements, protocols and conventions to compel countries to commit themselves towards ensuring biosecurity and safety of biological materials[12,13,14]; (2) the increase in the frequency and severity of emerging infectious diseases (EID) in recent decades[15]; (3) the increase in biological and genomics research coupled with increasing valuable biological materials generated from research and also as disease pathogen samples [16]; and. (4) Changes caused by emerging environmental issues such as

climate change, deforestation and environmental degradation [10]. The important question is to understand how policies, legislations, and institutions function with a wide array of actors to influence biosecurity in West Africa. Understanding how these processes function, their impacts and implications requires a framework that can assist in looking at how biosecurity related policies, legislations and institutions shape the agenda of ensuring a biosecured environment in West Africa.

## RESULTS AND DISCUSSION

### **Biosecurity and Biosafety: Component of Global Health Security Agenda**

Disease outbreaks could significantly impact global security by undermining the economy of countries, international trade and travel, public health and safety, and the trust of the populace in its government [8]. The risk of a disastrous biological event is increasing, and this risk is amplified by global travel and trade, urbanization, terrorist interest in weapons of mass destruction, and rapid advances in technology that can create and manipulate pathogens with pandemic potential [17]. Achieving an effective biosecured environment that prevents unauthorized possession, loss, theft, misuse, diversion, or intentional release of biological agents and toxins is a shared responsibility at the international level since infectious diseases know no borders [8]. While the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (Global Partnership) and the Global Health Security Agenda (GHSa) have both emphasized the need for countries to improve biosecurity capability, 69% of assessed countries still do not have the adequate capability in place [18]. The Global Health Security Agenda was launched in 2014 to foster global security from emerging infectious disease threats and prioritize global health security at regional and national scales [19]. The capacity of various nations to prevent, detect and respond to emerging infectious diseases has been undermined due to numerous challenges unique to each country [20]. Through a conglomeration of countries, international organizations and relevant non-governmental stakeholders, various capacity-building efforts is currently facilitated by GHSa to achieve specific and measurable targets around biological threats together with core capacities required by the World Health Organization's (WHO) International Health Regulations (IHR), Joint External Evaluation (JEE),

the World Organization of Animal Health's (OIE), Performance of Veterinary Services Pathway (PVS), and other relevant global health security frameworks.

### **Some Global Biosecurity and Biosafety Treaties to Which ECOWAS States are Parties**

#### *Biological Weapons Convention (BWC)*

Biological weapons are complex systems that disseminate disease-causing organisms or toxins to harm or kill humans, animals, or plants [21,22]. Biological weapons consist of a weaponized agent and a delivery mechanism. In addition to either strategic or tactical military applications, biological weapons can be used for political assassinations, the infection of livestock or agricultural produce to cause food shortages and economic loss, the creation of environmental catastrophes, and the introduction of widespread illness, fear, and mistrust among the public [23]. A rapid surge of global terrorism activities has necessitated state parties to sign a bilateral agreement to effectively prohibit the development, production, acquisition, transfer, retention, stockpiling and use of biological and toxin weapons as weapons of mass destruction [24].

The BWC is the first multilateral disarmament treaty banning the development, production and stockpiling of bacteriological and toxin weapons [25]. The BWC was opened for signature on 10th April 1972 and became effective on the 26th of March 1975 [25]. A second review conference held in 1986 agreed that all States Parties were to implement specific confidence-building measures (CBM) to reduce the occurrence of ambiguities and suspicion to foster international cooperation in the field of peaceful biological activities [25]. Then a third review conference held in 1991 further helped identify and examine potential verification measures from a scientific and technical standpoint [26].

Under these agreements, the States Parties undertook to provide annual reports – using agreed forms – on specific activities related to the BWC such as data on appropriate research centres and biobanking laboratories; details on vaccine production facilities; information on national biological defence research and development programmes; declaration of past activities in offensive and/or defensive biological research, eventual publication of results and promotion of the use of knowledge and contacts;

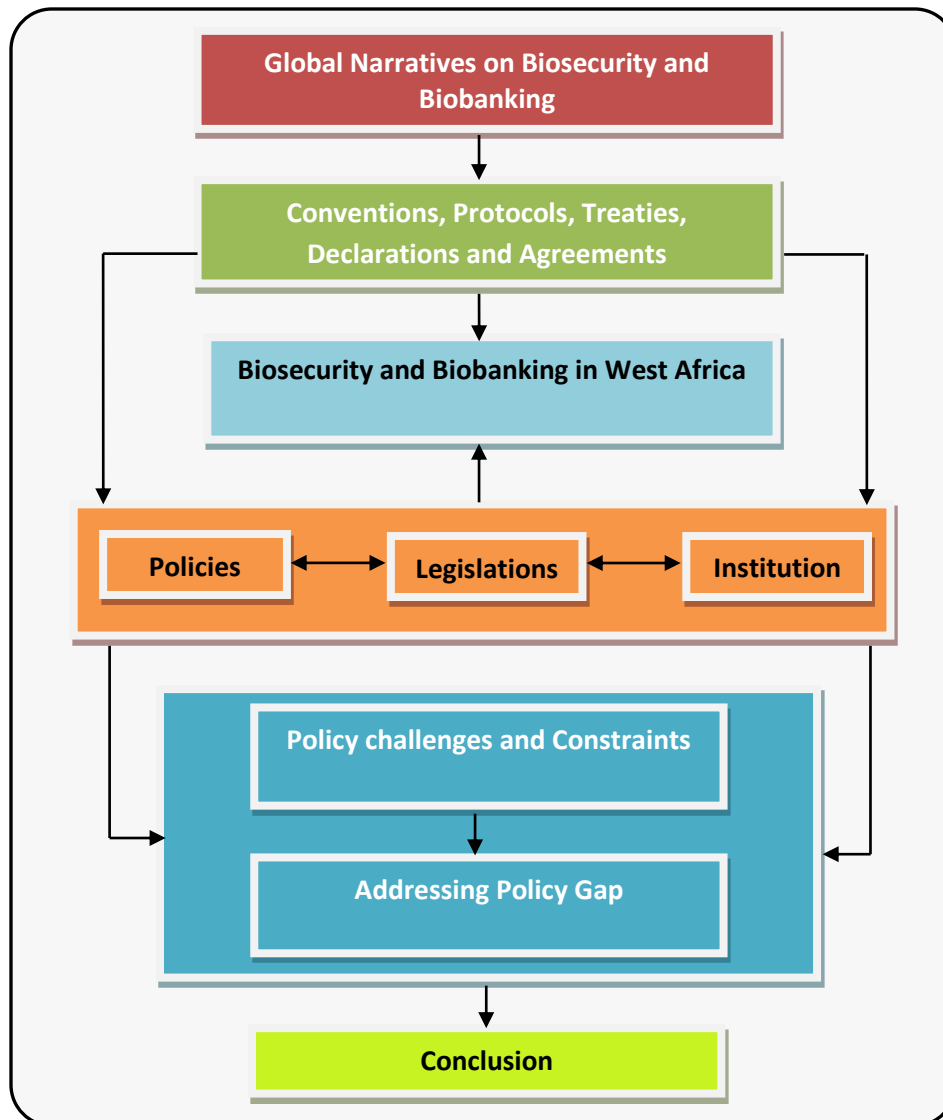


Figure 1: Framework for Analysis

existing information on legislation, regulations, frameworks, protocols and other measures (Table 1).

#### *UN Security Council Resolution (UNSCR) 1540 (2004)*

This international treaty "Resolution 1540 (2004)" was adopted by the Security Council at its 4956th meeting, on 28 April 2004, which states that "All states shall refrain from providing any form of support to non-State actors that attempt to develop, acquire, manufacture, possess, transport, transfer or use nuclear, chemical or biological weapons and their means of delivery, particularly for terrorist purposes [27]. The resolution further

requires all States to adopt and enforce necessary National laws to this effect, as well as other effective measures to prevent the proliferation of these weapons and their means of delivery to non-State actors, especially for terrorist purposes. In cooperation with the 1540 Committee and relevant regional and sub-regional organizations, UNODA assists member states in their efforts to fully implement the key requirements of resolution 1540 (2004), including the preparation of voluntary national implementation and capacity building plans. Regionally coordinated approaches are one of the most efficient means of bolstering National implementation. The 1540 committee called upon

all states to promote the universal adoption and full implementation, and where necessary, strengthening of multilateral treaties to which they are parties, whose aim is to prevent the proliferation of nuclear, biological or chemical weapons; secondly to adopt national rules and regulations, where it has not yet been done in order to ensure compliance with their commitments under the key multilateral non-proliferation treaties; thirdly to renew and fulfil their commitment to multilateral cooperation within the framework of the International Atomic Energy Agency (IAEA), the Organization for the Prohibition of Chemical Weapons and the Biological and Toxin Weapons Convention (BWC), an essential means of pursuing and achieving their common objectives in the area of non-proliferation and of promoting international cooperation for peaceful purposes; and finally to take cooperative action to prevent illicit trafficking in nuclear, chemical or biological weapons, their means of delivery, and related materials in accordance with their national legal

authorities and legislation, and consistent with international law [28]. The International Federation of Biosafety Associations (IFBA) recognized through ongoing deliberations that widespread and lasting results can only be realized by harnessing the power of multiple stakeholders [29]. The IFBA also believed that the 1540 Committee could match UN member States' requests for assistance in implementing UNSCR 1540 to their Local/National or Regional biosafety associations [29]. Domestic biosafety associations are usually equipped with the appropriate expertise to help states meet such requirements.

#### *Global Health Security Agenda: GHSA*

The GHSA was launched in 2014 to foster global security from emerging infectious disease threats and prioritize global health security at Regional and National scales [3]. The capacity of various nations to prevent, detect and respond to emerging infectious diseases has been undermined due to numerous challenges unique to each country [20].

**Table 1:** An Overview of the BWC Status of ECOWAS Countries

	Country	Signatory	Action type: Date
1	Benin	Yes: 4/10/1972	Ratification: 4/25/1975
2	Burkina Faso	Yes: N/A	Accession: 4/17/1991
3	Cape Verde	N/A	N/A
4	Gambia	Yes: 8/8/1972	Ratification: 11/21/1991
5	Ghana	Yes: 4/10/1972	Ratification: 6/6/1975
6	Guinea	Yes: 11/10/2016	Accession: 11/10/2016
7	Guinea Bissau	Yes: N/A	Accession: 8/20/1976
8	Cote d'Ivoire	Yes: 5/23/1972	Ratification: 3/23/2016
9	Liberia	Yes: 4/14/1972	Ratification: 11/4/2016
10	Mali	Yes: 4/10/1972	Ratification: 11/25/2002
11	Niger	Yes: 4/21/1972	Ratification: 6/23/1972
12	Nigeria	Yes: 4/10/1972	Ratification: 7/9/1973
13	Senegal	Yes: 4/10/1972	Ratification: 3/26/1975
14	Sierra Leone	Yes: 11/24/1972	Ratification: 6/29/1976
15	Togo	Yes: 4/10/1972	Ratification: 11/10/1976

Source: <https://www.getafrica.org/bio-security/bwc/>

The Global Health Security Index assessed the quality of and access to health services populations have during an emergency [30]. Using an assessment range of 0-100, countries were sorted into three bands: (1) low band scores 0-33.3; (2) middle band scores 33.4-66.7; and (3) upper band scores 66.8-100. As indicated in Table 2 for the health system category, of the 16 Member States in West African region, Benin, Burkina Faso, Guinea, Guinea-Bissau and Togo scored 10 and under; Cote d'Ivoire, Cabo Verde, Liberia, Mali, Nigeria and Senegal scored between 10-20; and Gambia, Ghana, Niger and Sierra Leone scored in the lower 20s. Sierra Leone scored the highest at 25.3 out of a 100 for the quality of and public access to their hospitals and clinics. Overall result for the GHSA as presented in Table 2 shows that eight (8) countries (Benin, Burkina Faso, Carbo Verde, Guinea, Guinea-Bissau, Mali, Niger and Togo) scored below 33 which is the lower band score, seven (7) countries (Cote d'Ivoire,

Gambia, Ghana, Liberia, Nigeria, Senegal and Sierra Leone) scored between 33 and 38.2 which falls within the middle band scores with Sierra Leone having the highest score of 38.2.

#### *Joint External Evaluation (JEE)*

Joint external assessments (JEE) are essential instruments/tools used to assess a country's capacity to combat global biological threats towards the goals of the GHSA. The GHSA Steering Group developed a voluntary assessment process that independently assesses the health security of each member country, as well as offering assistance in identifying indicators necessary for improving health security. These evaluations could be used to assess the strengths of member countries' efforts in the detection, prevention, and control of emerging diseases and biological threats, as well as provide frameworks to match gaps in capacity to available resources.

Table 2: Global Health Security Index Overall Score and Health Systems Score for West African Countries

Country	Overall	Health Systems
Benin	28.8	5.6
Burkina Faso	30.1	5.6
Côte d'Ivoire	35.5	17.1
Cabo Verde	29.3	16.1
Gambia	34.2	23.5
Ghana	35.5	23.4
Guinea	32.7	8
Guinea-Bissau	20	4.6
Liberia	35.1	19.9
Mali	29	13
Niger	32.2	21.9
Nigeria	37.8	19.9
Senegal	37.9	18.5
Sierra Leone	38.2	25.3
Togo	32.5	10

Source: <https://www.ghsindex.org/>

A total of 40 out of 47 countries in the WHO Africa region have conducted their JEEs as of October 2020 [31]. This makes the WHO African continent the leading region in the number of JEEs conducted, with over 42% (40 of 95) of the conducted globally. Results from the JEE show that no African country has all the required IHR capacities [31]. For the biosecurity and biosafety technical area, over 70% of countries had either no capacity or limited capacity. JEE scores for biosecurity and biosafety scores for West African countries are presented in Figure 2. The Figure shows that six countries (Ghana, Guinea, Ivory Coast, Liberia, Senegal, and Togo) scored 2 out of the possible 5 points for the indicator referencing the implementation of a whole-of-government biosafety and biosecurity one-health system for human, animal, and agriculture facilities, the remaining nine countries scoring 1 point out of the possible 5. The achieved scores for indicator 2 (Biosafety and biosecurity training and practices) had 10 countries (Benin, Burkina Faso, Ghana, Guinea, Ivory Coast, Liberia, Mali, Mauritania, Senegal and Sierra Leone) achieve 2 points out of the possible 5. The other five countries scored 1 point. Generally, the WHO JEE scores for biosecurity and biosafety technical areas for West African countries are low, with none of them rising above 2. Globally, this is not unusual. The countries with the lowest average score of 1 are Gambia, Guinea Bissau, Niger, Nigeria, and Togo. The overall average point for West Africa is 1.4 out of the possible 5 for indicator 1 (whole-of-government biosafety and biosecurity system in place for human, animal, and agriculture facilities) and 1.7 out of the possible 5 for indicator 2 (Biosafety and biosecurity training and practices).

### **Assessment of West African States Parties Biosecurity Core Capacities**

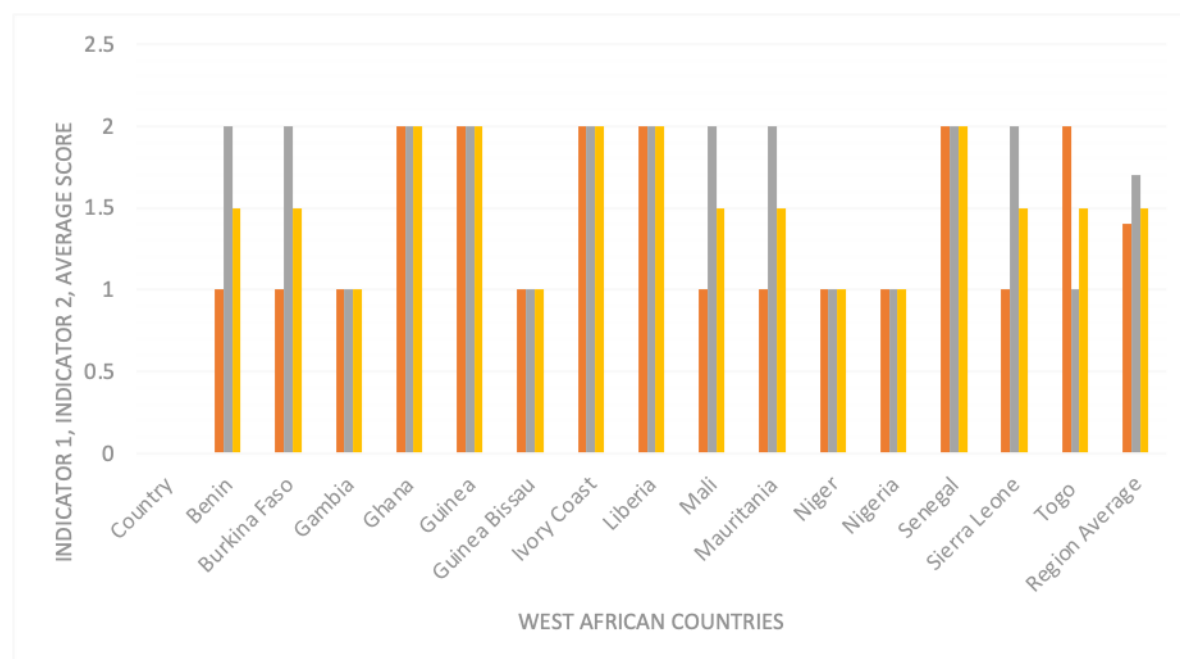
Biosecurity policies, frameworks and practices are holistic and protect a community from any form of biological, toxic, or environmental threat [32,33]. These include outbreaks of epidemic disease, inadvertent, inappropriate, or intentional use of potentially dangerous biological or toxic agents, misuse of biotechnology and threats emerging from animal and plant life or the abnormal manipulation of the ecosystem [34,22]. Biosecurity encompasses much more than physical controls and requires the coordination of national governments and the support of various disciplines, scientists, law enforcement officials, policymakers, and the civil society at large [35]. Potential challenges, vulnerabilities and rapidly expanding ideologies of federalism and

communalism in the sub-region continue to make biosecurity a sector requiring special attention by law enforcement agencies.

Biosecurity is everyone's business. There are people all over West Africa intentionally working for or against a biosecured environment [36]. Protecting the region from biological threats is a continuous challenge because the risk factors this region faces are growing in scale and complexity [37]. Rapidly changing risk pathways, demographic growth/porosity in trade routes and population movements, climate change, advancing technology, pressure from existing and new and invasive pests/pathogens and shrinking natural resources are a few red flags that point to the looming crisis ahead [38]. A sound biosecurity system should protect a nation's way of life, natural productive resources, and biodiversity from harmful effects of pests, diseases, toxins, and biotechnology that threaten to corrode the wellbeing of society [39]. Biosecurity has long expanded beyond the focus on small individually motivated bio-attacks by criminals to include compromising both global food and environmental quality, unethical utilization of natural resources and unprecedented pressures with potentially greater economic and public health impacts to existing nations. This section uses the information from the questionnaire filled by experts from West African state parties and key informant interviews to provide the status of biosecurity, biosafety, biobanking and biocontainment core capacities in the region.

### **Policies and Legislations on Biosecurity in West Africa**

Most countries in West Africa have developed policies and legislations for biosecurity related issues [40]. Most West African countries have policies and legislations that support human, animal, plant, and environmental health [41]. The enactment of these policies and laws has been enhanced by the emergence of several international biosecurity and health agreements, protocols, and conventions. Most West African countries are signatories [41]. There is need to domesticate and operationalize these instruments with a clear understanding of the One Health approach. Most West African countries currently have several sectoral policies, legislations and institutions that have various aspects of biosecurity, biosafety and one health [42]. The WHO Guidance on implementing regulatory requirements for biosafety and biosecurity in biomedical laboratories reported that, majority of West African countries had created separate



**Figure 2:** Biosafety and Biosecurity Country JEE Scores for West African States

Note: Scores: 1 = No Capacity; 2= Limited capacity; 3= Developed capacity; 4 = Demonstrated Capacity; 5= Sustainable Capacity

policies and legislative instruments such as human health policy, environmental policy, biosecurity policy, biosafety framework, environment management act, among others, which are being implemented by different institutions with sometimes overlapping and duplications in responsibilities [12]. There is a need for an integrated biosecurity and One health policy that will synergize biosecurity and biosafety governance and regulation in the region.

#### Laboratory Capacity in West Africa

Laboratory capacity in West Africa has progressively improved due to a heightened awareness of the need for laboratory capacity in detecting increasing emerging infectious diseases such as Ebola and COVID-19 in the region [43]. The Ebola virus disease outbreak (2014-2016) highlighted significant gaps in regional laboratory capacity [44]. In the West African region, only a few countries have the capacity, in terms of technical ability and laboratory infrastructure, to diagnose viral haemorrhagic fever viruses (VHF) [44]. Developing laboratory capacity, including investment in national laboratory services, systems, and infrastructure, is critical to stemming the tide of infectious diseases like Ebola [45,46]. Laboratories

are complex and have different levels of capacity and safety to keep lab personnel safe [47]. Scientists who study extremely contagious and deadly pathogens, such as Ebola, need to work in specialized laboratories termed biosafety laboratories (BSL) which not only protect them from contamination but also prevent these contagious materials from entering the environment [48,49]. As of 2007, the United States had 13 BSL-4 laboratories and 1,356 BSL-3 laboratories registered with the Centre for Disease Control and Prevention (CDC) [50,51]. By comparison, we found that Africa, with a population of 1.078 billion people (2018), only has two BSL- and about 25 BSL-3 laboratories, many of which are modular labs, prefabricated and shipped to the desired location [52]. Although modular BSL laboratories have many advantages, they are mobile, rapidly deployable, suitable for resource-limited, remote areas, and are often less expensive than traditional labs, they do not offer a permanent solution to the infrastructural gap in the West Africa region when it comes to laboratory capacity [52]. Table 3 below shows the list of BSL3 laboratories in West Africa. Most of these laboratories are modular labs, and they are constructed after the 2014-2016 Ebola outbreak.



**Table 2:** Legislative acts supporting Biosecurity and Biobanking in West Africa

Country	Human Health Act	Plant Health Act	Animal Health Act	Biodiversity Act	UNFCCC Communication Report
Benin	2	2	2	3	3
Burkina Faso					
Gambia					
Ghana	2	-	2	3	3
Guinea	3	3	3	2	2
Guinea Bissau	1	1	2	2	1
Ivory Coast	2	3	3	3	3
Liberia					
Mali	3	3	3	3	-
Mauritania					
Niger	3	3	3	3	3
Nigeria					
Senegal	1	-	-	-	-
Sierra Leone	3	1	2	3	3
Togo	2	-	-	-	-

Scores: 1 = Nonexistence; 2= Drafting stage; 3= Implementing/Enforced

**Table 3:** List of Laboratories Identified in West African Countries

Country	BSL2/3/4	Status	Location	Capacities
Burkina-Faso	BSL2 Container	Operational	Centre Muraz	Research and diagnostics/PCR; limited sequencing capacity
Cote D' Ivoire	BSL3 (Lassa Virus) BSAT (Lassa Fever)	Operational	Institut Pasteur Cote d'Ivoire (IPCI)	Regional AI, reference Lab, human diagnostic test
	BSL 4	Under construction and certification		

Ghana	BSL3 No BSAT	Operational	Noguchi Memorial Institute for Medical Research	Reference Lab/Culture collection, antiviral research, molecular epidemiology of polioviruses, HIV and others
	Other BSL3/2 with BSAT.	Operational	Located in Accra, Tacoradi and Tamale	Government veterinary services labs, human and animal disease surveillance (b. Anthracis and avian influenza)
Guinea	BSL3	Institute of Microbiology, University of Conakry	Operational	Equipped lab for VHF and YF diagnostics
Liberia	BSL3	Liberia Institute for Biomedical Research, Min of Health	Operational	National Lab for diagnosis of hepatitis B, Cholera, Ebola, limited Lassa fever PCR Capacity.
MALI	BSL3 No BSAT	FMPOS; Ministry of Health	Operational	Reference Lab/culture collection
Nigeria	9 BSL3/BSL2 Labs with numerous academic BSAT (e.g., Ebola, Lassa)	Academic institutes, Lagos State Ministry of Health	Operational	Isolation, diagnostics, characterization, and research. Capacity to handle unknown pathogens; PCR, sequencing
Senegal	BSL3 BSAT unknown	Institute Pasteur in Dakar, Min Health	Operational	Diagnosis, treatment, Reference Lab/Culture collection
	BSL3	National Public health laboratory and IRESSEF (Research Institute for Epidemiological surveillance and	Operational	Diagnosis, treatment and reference lab diseases

		training) Diamniadio		
Sierra Leone	BSL2  No BSAT  BSL3  BSAT unknown	Central public Health Reference Laboratory  Chinese Mobile container BSL3 Lab (3 containers)	Operational         Operational	Reference Lab/ Culture collection for HIV and others    VHF diagnosis

## CONCLUSION

Several legislative instruments and policy responses have been put in place to address biosecurity and biosafety challenges in West African countries. Most of the new policies, legislations and institutions established were prompted by several multilateral global health security agreements, protocols, and conventions which West African countries are parties to. The domestication and operationalization of these policies and legislative instruments remains quite a hurdle owing to multiple challenges, including the lack of human capacity to implement policies and lack of specialized institutions that will implement the policies.

There are major gaps in biosecurity and biosafety in West Africa with limited capacities in all countries in the region. There is an urgent need to build biosecurity and biosafety systems in the region. The increase in the frequency of emerging infectious diseases coupled with environmental degradation and climate change, increasing population, weak states and increasing presence of non state actors is increasing biosecurity threats in the region.

Furthermore, biosecurity threats are likely to arise from mishandling and misuse of infectious agents and toxins, disregard of government policy due to absence of oversight of life sciences research of concern, insider and outsider threats at laboratories dealing with biological agents, and poor physical security and materials accountability including transfer and transport of infectious agents and toxins. Capacity building is also very imperative in the tackling and containing these biosecurity threats. Finally, to promote a safe and

secured environment, emphasis must be placed on developing a curriculum for biosafety and biosecurity education that focuses on developing skills to maintain responsible health security practices and human resource incentives to drive a culture of safe and secured science. There is also the need for a clear synchronized framework that governs laboratory and biobanking activities in the West African region.

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