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Analysis of the Results of Simulation Exercises to Strengthen Preparedness and Response to Public Health Emergencies in Mali

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Abstract

Introduction: From December 2021 to September 2023, to assess Mali Public Health Emergency Preparedness and Response, the Department of Public Health Emergency Operations (DOUSP) conducted simulation exercises (SIMEX) as part of the International Health Regulations (IHR, 2005) evaluation. The aim of this work is to examine the results of the SIMEXs, which assesses Mali's preparedness and response functionality to public health emergencies. **Methods:** Between December 2021 and September 2023, the DOUSP carried out 05 SIMEX which were documented. These SIMEX were conducted respectively in the regions of Koulikoro, Sikasso, Ségou and the district of Bamako. We extracted the information from a database, assigning a unique identifier to each SIMEX report, and a total of 22 variables were extracted. Information on the health district, the region, the year of implementation, the type of SIMEX, the type of health event, the capacities of the 2005 RSI tested and the recommendations were identified. We performed a descriptive analysis and linked the results to the 15 IHR 2005 capabilities. **Results:** Regarding the type of SIMEX, we carried out three tabletop simulation exercises in December 2021, August 2022 and January 2023 respectively; a tabletop simulation exercise coupled with a drill carried out in July 2023 and a functional exercise in September 2023. For the implementation of the 5 SIMEX, 10 (67%) of the 15 capabilities of the RSI, 2005 have been tested globally. Looking closely, C3 and C4 were tested in all the exercises, i.e., 100%, followed by C2, C9 and C10 in 80%. **Conclusion:** SIMEX has enabled the various health dis-

tricts to prepare themselves to meet the challenges of better management of epidemics and disasters in their localities. The primary recommendation for the five (5) SIMEXs focuses on securing funding for activities aimed at enhancing preparedness and response capabilities for public health emergencies.

Keywords

SIMEX, Preparedness, Response, Public Health Emergencies, PHEOC/Mali

1. Introduction

Mali, a country located in West Africa and belonging to the World Health Organization African Region is experiencing epidemics of infectious diseases every year. Between 2020 and 2023, the country recorded the following epidemics: Crimean Congo fever, Covid-19, measles, dengue fever and meningitis [1]-[5]. These epidemics, combined with natural disasters and humanitarian crises, represent situations that could lead to health emergencies threatening the country's health security and the WHO African Region.

It is important to prepare the country's teams to deal with these public health emergencies. In addition to training, the implementation of simulation exercises (SIMEX) is crucial in this preparation [6]. It is in this context that the WHO developed the SIMEX manual for his Member States in 2017 [7]. In September 2022, the country (Mali) benefited from the training of 03 health workers on the implementation of SIMEX in Brazzaville by WHO AFRO teams.

The International Health Regulations 2005 (IHR, 2005) monitoring and evaluation framework enables countries to assess their basic IHR capacities (2005). This framework consists of four elements: State Party Annual Self-Assessment Report (SPAR), Joint External Evaluation (JEE), After Action Reviews (AAR) and Simulation Exercises (SIMEX) [8].

The SPAR and JEE are semi-quantitative monitoring tools with standardized indicators which track capacities over time and allow for comparison. However, these indicators may not adequately reflect the functionality of existing preparedness systems and capacities, and can induce important gaps [7] [9].

After the advent of the Ebola epidemic in 2014, to better prepare for health emergencies, Mali took the initiative of setting up Rapid Response Teams at regional level. The country has 11 health regions in 2022, with 75 health districts and 3234 health facilities. The mission of the DOUSP of the National Public health Institute (NPHI) in Mali is to ensure the application of the International Health Regulations (IHR, 2005), the implementation of the Global Health Security Program in Mali, and to coordinate the implementation of surveillance and response interventions at national level. In 2022, the normative documents for this department were drawn up and a Rapid Response Team (RRT) program was also set up [10]-[12]. As part of its preparation for and response to public health events, the

Mali DOUSP carried out a number of activities between December 2021 and September 2023. These activities are part of the country's emergency preparedness. The aim of this work is to examine the results of simulation exercises (SIMEX) that evaluate the functionality of Mali's preparedness and response to public health emergencies.

2. Methods

We created a suitable simulation exercise between December 2021 and September 2023, the DOUSP has carried out 05 SIMEX on diseases with epidemic potential such as Ebola, Rift Valley Fever, Congo Crimea Fever, Cholera, Covid-19, which have been documented. We compiled the information from the SIMEXs carried out in a database and summarized this information descriptively and according to the 15 essential capabilities of the IHR 2005. The scenarios used were based solely on epidemics or pandemics.

The data were gathered from SIMEX reports and the SPAR tool of IHR 2005. The SIMEX reports are developed using evaluation forms and guidelines, and they provide details on the scenarios, proposed recommendations, and the action plan.

We extracted the information from a database, assigned a unique identifier to each SIMEX report and extracted a total of 22 variables. Information related to the health district, the region, the year it has been carried out, the type of SIMEX, the type of health event, the IHR 2005 capabilities tested and recommendations made were identified for the SIMEXs. We performed a descriptive analysis and linked the results to the 15 IHR, 2005 capabilities.

We recorded the existing variables into 22 variables. These new variables included the 15 core IHR capabilities examined or tested and the type of health event examined or tested in the SIMEX databases, which was coded into three categories: 1) epidemics and pandemics, 2) man-made/societal disasters and 3) natural disasters. In order to have information on the capacities of the IHR tested and the recommendations on the capacities of the IHR, two independent experts were requested/ hired to examine the basis. Their role involved analyzing the database of IHR capabilities assessed during the five SIMEXs. This evaluation enabled the identification of both strengths and gaps in the IHR 2005 core capacities tested, and has enabled a consensus reached upon discussion with a WHO expert in public health emergency preparedness and response from the WHO Mali country office. When a tested capacity and a recommendation are presented, they are coded by 1 if they are present and by 0 if they are absent. To obtain the proportion of capabilities tested, we added the scores for the capability for each exercise and multiplied this sum by 20 to obtain the percentage. To obtain the proportion of recommendations tested, we added the recommendation scores for each exercise and multiplied this sum by 20 to obtain the percentage.

We carried out a descriptive analysis and linked the results according to the 15 capabilities of the IHR, 2005. For the categorical data, we presented the results in the form of frequencies and percentages for continuous data.

3. Results

3.1. Characteristics of SIMEX Results

Five simulation exercises were carried out and documented in Mali between December 2021 and September 2023.The SIMEXs were conducted in the capital and in three (03) regions of southern Mali. The Kangaba health district in the Koulikoro region carried out a TTX, the Kadiolo health district in the Sikasso region carried out a TTX, the Ségou health district in the Ségou region carried out a TTX and TTX coupled with a Drill, and Commune IV in the capital, Bamako, carried out a functional SIMEX. For the type of SIMEX: three tabletop simulation exercises carried out respectively in December 2021 on Ebola, August 2022 on HCC fever and January 2023 on Covid-19; a tabletop simulation exercise coupled with a drill carried out in July 2023 on cholera and a functional exercise in September 2023 on a Lassa fever zoonosis. The scenarios used were based solely on epidemics or pandemics (Table 1).

Table 1. Characteristics of SIMEX.

Characteristics	Number
Health district	
Kangaba	1
Kadiolo	1
Ségou	2
Commune IV	1
Region	
Koulikoro	1
Sikasso	1
Ségou	2
Bamako	1
Year of completion	
2021	1
2022	1
2023	3
SIMEX Type used	
TTX	3
TTX coupled to Drill	1
Functional	1

Continued

Category of Public Health Event tested	
Outbreak and Pandemics,	5
Human/societal disasters	0
Natural disasters	0

3.2. IHR 2005 Core Capacities Tested and Reviewed SIMEX

Across the five SIMEX implementations, 10 out of 15 (67%) IHR 2005 capacities were tested. Notably, capacities C4 (Laboratory) and C5 (Surveillance) were assessed in all exercises (100%), followed by C2 (IHR coordination, national focal point functions, and advocacy), C9 (Infection Prevention and Control), and C10 (Risk Communication and Community Engagement), each tested in 80% of exercises (Table 2).

Recommendations in the SIMEX reports were primarily related to C3 (Financing) (80%), while C5 (Surveillance), C6 (Human Resources), C7 (Health Emergency Management), and C10 (Risk Communication and Community Engagement) each received a 60% score (Table 2).

Table 2. IHR 2005 Core Capacities tested and reviewed SIMEX.

Capacity Title	% Capacities tested	% Capacities reviewed
C.1 Policy, Legal and normative Instruments to implement IHR	0	20
C.2 IHR Coordination, National IHR Focal Point functions and advocacy	80	40
C.3 Financing	20	80
C.4 Laboratory	100	40
C.5 Surveillance	100	60
C.6 Human resources	0	60
C.7 Health emergency management	60	60
C.8 Health services provision	20	20
C.9 Infection prevention and control	80	20
C.10 Risk communication and community engagement	80	60
C.11 Points of entry (PoEs) and border health	40	40
C.12 Zoonotic diseases	60	20
C.13 Food safety	0	0
C.14 Chemical events	0	0
C.15 Radiation emergencies	0	0

4. Discussion

The primary objective of simulation exercises (SIMEX) is to systematically identify and analyze both strengths and gaps in emergency preparedness and response systems, with the ultimate aim of generating concrete recommendations for improvement [7] [13].

In Mali, five SIMEXs were conducted—one in the capital and four in regions located in the southern part of the country. Consequently, other regions did not benefit from such exercises. All five simulations focused on epidemic scenarios involving infectious diseases. It is worth noting that Mali's Ministry of Civil Protection also oversees a specialized national entity dedicated to natural disaster management, whose personnel actively participated in the execution of these exercises. This same structure also conducts SIMEXs on natural disasters, with the involvement of the human health sector.

The implementation of SIMEXs highlighted several areas with significant capacity gaps, notably in: C3: Financing (20%), C8: Health service provision (20%), C11: Points of entry and border health (40%). To address the financial challenges, it is recommended to mobilize national resources to support public health emergency preparedness and response, develop an annual action plan based on national priorities, and establish implementation agreements with relevant stakeholders. To improve health service provision, strategies could include the creation of specialized case management centers for epidemic and disaster response, the assurance of service availability, and the maintenance of essential healthcare services during crises. Regarding Points of entry and border health, it is essential to establish and adequately equip entry points with trained personnel and resources. This includes adopting the "One Health" approach, providing incentives to staff, and engaging border communities in the rapid detection and reporting of suspected cases.

While follow-up on these recommendations has taken place with various stakeholders, the prioritization of specific actions varies by region, particularly for those without PoEs. Priority recommendations include ensuring permanent staffing at points of entry, developing emergency plans, promoting the dissemination and appropriation of multisectoral strategic risk management plans, equipping health districts, conducting additional simulation exercises focused on other epidemic scenarios, and constructing appropriate facilities for the Public Health Emergency Operation Center (DOUSP).

A key ongoing challenge is the limited capacity of implementing structures to operationalize the recommendations due to resource constraints. While the recommendations are relevant and aligned with national priorities, implementation often depends on their integration into institutional work plans and subsequent support from partners.

Despite these challenges, SIMEXs have contributed to improved crisis anticipation, more effective response mechanisms, and reduced impacts on both populations and infrastructure. To ensure the success of a SIMEX, it is critical to apply

standardized methodologies and adhere to common principles throughout implementation.

All reports reviewed were standardized according to the structure and guidelines of the WHO SIMEX manual. The methodology, report format, and key data were consistently documented across the five simulations analyzed.

The effectiveness of a SIMEX is largely dependent on clearly defined objectives, scope, and alignment with national priorities. Participant selection must also be rigorously aligned to ensure accurate assessments of preparedness and response capabilities.

The World Health Organization (WHO) recommends that all countries conduct simulation exercises to test the functional capacity of their International Health Regulations (IHR, 2005) implementation. WHO has developed detailed guidance to support countries in conducting SIMEXs and after-action reviews, incorporating a multi-criteria evaluation framework, standardized templates, and key indicators to facilitate harmonized data collection and analysis.

By adhering to these principles and standardizing data collection and reporting, SIMEX becomes an effective mechanism for enhancing preparedness, strengthening intersectoral coordination, and building organizational resilience.

However, several limitations were encountered during this study. These include challenges in mobilizing relevant stakeholders, difficulties in intersectoral coordination, and the prevailing security situation. Additionally, the implementation and follow-up of SIMEX recommendations remain limited due to structural and operational constraints.

5. Conclusion

Simulation exercises are essential tools for crisis management and preparedness. In Mali, their implementation has been constrained by structural, security, and financial challenges, limiting their effectiveness and long-term impact. Nevertheless, the SIMEXs conducted have enabled health districts to better prepare for epidemic and disaster scenarios within their respective jurisdictions. The main recommendations emerging from the five SIMEXs focused on key thematic areas, including C3: Financing, C5: Surveillance, C6: Human resources, and C7: Health emergency management. The implementation of these recommendations is crucial for enhancing Mali's capacity to meet the core requirements of the International Health Regulations (IHR, 2005) and to respond more effectively to public health emergencies.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Temur, A.I., Kuhn, J.H., Pecor, D.B., Apanaskevich, D.A. and Keshtkar-Jahromi, M. (2021) Epidemiology of Crimean-Congo Hemorrhagic Fever (CCHF) in Africa—Underestimated for Decades. *The American Journal of Tropical Medicine and Hygiene*,

104, 1978-1990. https://doi.org/10.4269/ajtmh.20-1413

[2] Boly, A., Dembélé, A.Y., Diarra, S.S., Berthé, I., Koné, B., Koné, A., *et al*. (2021). Etude sur les caracteristiques cliniques et epidemiologiques des 1030 premiers cas de covid-19 au Mali. *Le Mali medical*, **36**, 27-31.

[3] Camara, M.F., Diallo, B.A. and Ripoll, S. (2019) L'Afrique Contre Les Epidemies: Principales Considerations en Matiere de Preparation et de Riposte aux Epidemies au Mali. http://www.socialscienceinaction.org/wp-content/uploads/2021/09/TDDA_TechnicalBrief_Mali_Final-version_FR.pdf

[4] Amaguiré Sy, E.H.I., Barry, D., Traoré, B., Boly, A., Koné, B., Dembélé, A., *et al*. (2021) Profil épidémiologique de la rougeole au Mali de 2009 à 2018. *Journal of Interventional Epidemiology and Public Health*, **4**, 8. https://doi.org/10.37432/jieph.supp.2021.4.3.03.8

[5] Reliefweb (2023) Mali: Dengue Outbreak. https://reliefweb.int/disaster/ep-2023-000268-mli

[6] World Health Organization (2016) International Health Regulations (2005). 3rd Edition, World Health Organization. https://www.who.int/publications/i/item/9789241580496

[7] World Health Organization (2017) WHO Simulation Exercise Manual. World Health Organization. https://www.who.int/ihr/publications/WHO-WHE-CPI-2017.10/en/

[8] World Health Organization (2018) International Health Regulations (2005) Monitoring and Evaluation Framework. World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/276651/WHO-WHE-CPI-2018.51-eng.pdf

[9] Bartolini, G. (2021) The Failure of 'Core Capacities' under the Who International Health Regulations. *International and Comparative Law Quarterly*, **70**, 233-250. https://doi.org/10.1017/s0020589320000470

[10] INSP Mali (2022) Missions du Département des Opérations d'Urgence en santé publique. https://insp.ml/departements/ousp/

[11] INSP Mali (2002) Concept des Operations (Conops) du Departement des Operations d'Urgence de Sante Publique (Dousp) du Mali. https://insp.ml/concept-des-operations-conops-du-departement-des-operations-durgence-de-sante-publique-dousp-du-mali/

[12] INSP Mali (2022) Manuel du Département des Opérations d'Urgence de Santé Publique (DOUSP). https://insp.ml/manuel-du-departement-des-operations-durgence-de-sante-publique-dousp/

[13] Copper, F.A., Mayigane, L.N., Pei, Y., Charles, D., Nguyen, T.N., Vente, C., *et al*. (2020) Simulation Exercises and after Action Reviews—Analysis of Outputs during 2016–2019 to Strengthen Global Health Emergency Preparedness and Response. *Globalization and Health*, **16**, Article No. 115. https://doi.org/10.1186/s12992-020-00632-w