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# Challenges in strengthening sentinel surveillance network during COVID-19 pandemic in Africa

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## Abstract

**Background:** The emergence of variants in the wake of the COVID-19 pandemic has put a strain on healthcare systems in Africa. The Afroscreen project is strengthening national sentinel surveillance systems, combined with sequencing capabilities to identify potentially highly virulent variants of interest at an early stage. The aim of this article is to present the results of this project and discuss the related challenges.

**Methods**: Surveillance was based on national surveillance sentinel systems, either hospital-based or peripheral, and RT-PCR diagnostic capabilities, coupled with sequencing in the event of positivity, from July 2022 to June 2024.

**Results**: In 11 African countries (Senegal, Guinea, Côte d'Ivoire, Togo, Benin, Niger, Cameroon, the Central African Republic (CAR), Burkina Faso, Madagascar and the Democratic Republic of the Congo), it was possible to demonstrate a decline in the circulation of SARS-CoV-2 over the surveillance period, with only the Omicron variant circulating.

**Conclusion**: Setting up and coordinating a multicountry sentinel surveillance system during a pandemic period is a real challenge. This highlights the need to strengthen surveillance

systems during interepidemic and pandemic periods and the question of their sustainability in line with emerging disease preparedness and response programs.

**Keywords:** SARS-CoV-2, COVID-19, Sentinel surveillance, preparedness, detection, Africa

## Introduction

Infectious diseases continue to emerge and re-emerge, leading to unpredictable epidemics and difficult challenges for public health decision-makers[1]. As with the COVID-19 pandemic, disease emergence is usually sudden and nonlinear, making it difficult for policy makers to identify introductions and changes quickly and manage threats appropriately [2]. Thus, key elements in the control of these emerging infectious diseases depend on the early detection and implementation of an early warning surveillance system that combines syndromic surveillance, biological surveillance and surveys of both the population and the environment [3,4]. As surveillance systems are mainly developed for the early detection of the emergence and control of the transmission of infections, epidemiological indicators (reproduction number (R0, Rt), incidence, secondary transmission rate, serial interval, case fatality rate, etc.) are crucial for assessing the risks of propagation.

The COVID-19 pandemic poses a major threat to low-resource countries, and surveillance tools for early detection and response are often inadequate for detecting and monitoring trends. Faced with logistical and budgetary constraints, only a few of these countries, supported by international partners, had set up sentinel surveillance for influenza or other respiratory viruses [5–7] before the COVID-19 health crisis.

In 2022, a sentinel surveillance system combining epidemiological and biological expertise was set up or strengthened in 11 African countries (Senegal, Guinea, Côte d'Ivoire, Togo, Benin, Niger, Cameroon, the Central African Republic (CAR), Burkina Faso, Madagascar and the Democratic Republic of the Congo) with the aim of rapidly identifying changes in the epidemiological profile and potential variants, assessing risks and issuing alerts. Like many other African countries, these countries experienced a relatively benign first wave of the pandemic (up to July 2020), but the risks of an emerging variant pushed them to strengthen both surveillance and sequencing capacities. The aim of this article is to present the issues and

results of this large multicountry surveillance project (acronym AFROSCREEN [8]) funded by the Agence Française de Développement and placed under the responsibility of the health authorities in each country.

**Methods**

All methods were carried out in accordance with relevant guidelines and regulations about surveillance.

The AFROSCREEN project started in July 2022, after the 4th COVID-19 wave (Figure 1).

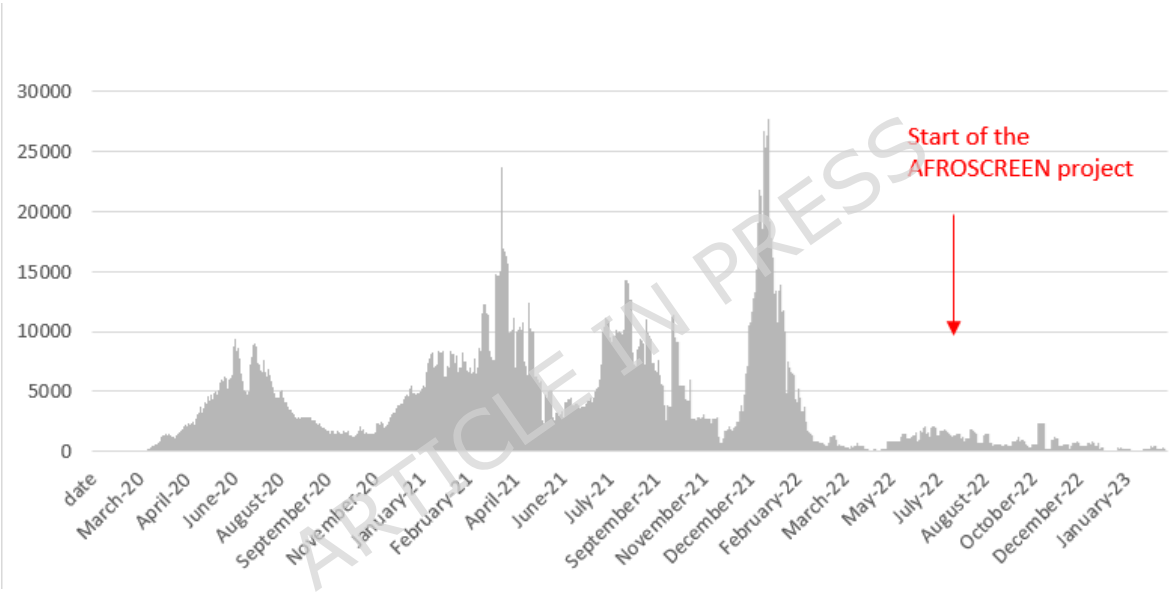



*Figure 1: Daily number of SARS-CoV-2 cases among the 11 AFROSCREEN countries. Source: John Hopkins University*

*Setting*

In each country, sentinel sites were set up in collaboration with health authorities.

Depending on financial and logistical constraints and the presence or absence of a previous national sentinel network, sentinel sites were generally located in or near the capital (Figure 2), except in Burkina Faso, Benin, Togo and Senegal.

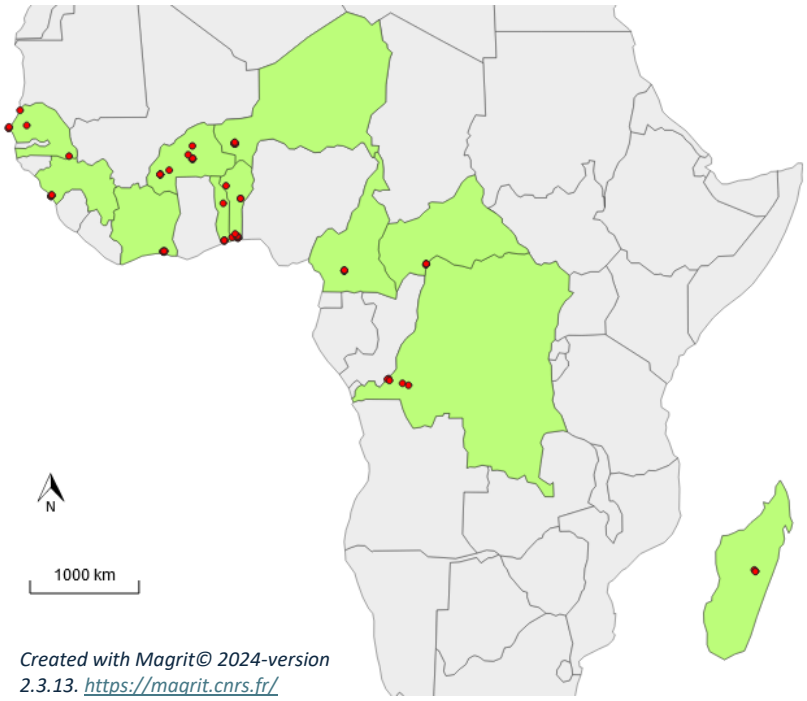



*Figure 2: Countries and sentinel sites of the AFROSCREEN project. July 2022-June 2024.*

A total of 80 sentinel sites have been accredited under the AFROSCREEN project (Table 1). A maximum of 62 sites were active at the same time. The sentinel sites are most often primary health centers (60%) and hospitals (38%).



*Table 1: Distribution of AFROSCREEN sentinel sites by country and type. July 2022--June 2024*

| | **Health center** | | **Hospital** | | **Airport** | | |
|---|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) | Total |
| Benin | 12 | (100) | 0 | (0) | 0 | (0) | **12** |
| Burkina Faso | 8 | (53) | 7 | (47) | 0 | (0) | **15** |
| Cameroon | 0 | (0) | 6 | (86) | 1 | (14) | **7** |
| Central African Republic | 6 | (75) | 2 | (25) | 0 | (0) | **8** |
| Côte d'Ivoire | 7 | (100) | 0 | (0) | 0 | (0) | **7** |
| Democratic Republic of Congo | 1 | (20) | 4 | (80) | 0 | (0) | **5** |
| Guinea | 3 | (50) | 3 | (50) | 0 | (0) | **6** |
| Madagascar | 0 | (0) | 3 | (100) | 0 | (0) | **3** |
| Niger | 5 | (83) | 1 | (17) | 0 | (0) | **6** |
| Senegal | 5 | (83) | 1 | (17) | 0 | (0) | **6** |
| Togo | 1 | (20) | 3 | (60) | 1 | (20) | **5** |
| Total | **48** | **(60)** | **30** | **(37)** | **2** | **(3)** | **80** |

*Case definitions*

To enable comparisons over time and between different countries, standard case definitions have been used to generate valid surveillance data:

- Acute respiratory infection (ARI): sudden onset of symptoms with fever (>=38°C) and at least one of the following four respiratory symptoms: cough, sore throat, shortness of breath, and coryza.
- Severe acute respiratory infections (SARI): any person suffering from an ARI that requires hospitalization.
- Confirmed cases: ARI or SARI cases with biological confirmation of SARS-CoV-2 infection by RT–PCR (Reverse Transcription-Polymerase Chain Reaction).

*Data collection*

- From July 2022 to June 2024, each national focal point collected data according to the characteristics of its own sentinel system (real-time, daily or weekly) and the recommendations of its health authorities. However, they reported monthly epidemiological data via an interactive Excel spreadsheet shared on a secure collaborative platform.

The following data were collected: number of suspected cases, number of cases sampled, number of ARIs, number of SARIs, and number of cases positive for SARS-CoV-2.

Among these SARS-CoV-2-positive cases, the number of positive cases was linked to sex, the number of confirmed cases by age group ([0--5 years[, [5--15 years[, [15--50 years[ and [50 years and over]), and the number of confirmed cases by severity of illness class (ARI/SARI/death). Number of confirmed cases linked to doses of the COVID-19 vaccine

received (0/1/2 or more). Only patients with ARI or SARI who refused sample collection were excluded from the surveillance.

*Laboratory analysis*

In cases of ARI (maximum 10 per week) or SARI (all cases), nasopharyngeal or oropharyngeal (NP/OP) samples were collected and sent to reference laboratories in each country where they were tested for SARS-CoV-2 via RT–PCR genotyping assays for high-throughput surveillance of variants. The tests were carried out in accordance with the available protocols recommended by the World Health Organization (WHO) and the manufacturer's instructions for use.

A cycle threshold (Ct) value greater than or equal to 33 cycles for the SARS-CoV-2 CFR610 target corresponded to a sample that was below detection limit for mutations and was not considered for sequencing analysis.



*Sequencing analysis*

The genomes of the SARS-CoV-2-positive samples were sequenced to identify and assess the risk of variant spread. Libraries for whole-genome sequencing were prepared using either the Oxford Nanopore Midnight protocol with rapid barcoding or the Illumina COVIDseq Assay. For the Illumina COVIDseq assay, the libraries were prepared according to the manufacturer’s protocol. For Oxford Nanopore sequencing, the Midnight primer kit was used. We assembled paired-end and Nanopore.fastq reads using Genome Detective version 1.132 (https://www.genomedetective.com), which was updated for the accurate assembly and variant calling of tiled primer amplicon Illumina or Oxford Nanopore reads, and the Coronavirus Typing Tool [9]. After verification of the consensus genomes, the sequences were uploaded to the public GISAID repository [10], from which the developers of the Nextstrain.org open-source phylogenetic platform automatically extracted all available SARS-

CoV-2 sequences for global comparison and visualization. In the framework of the Afroscreen project, it was recommended to the national labs to use the GISAID repository [10], recognized by the WHO. We used the results of this surveillance platform to identify the circulating variant in each country during our period survey.

*Statistical analysis*

The first step in processing the data, was to map the countries and locate the sentinel sites via Magrit software (https://magrit.cnrs.fr/). Next, the aggregated data are presented as proportions. The evolution of suspected and confirmed cases was described as an average per site. The positivity rate was calculated by dividing the monthly number of SARS-CoV-2-positive patients by the total number of sampled patients. Tables and graphs were produced via R software. The monthly data are presented for the period from July 2022 to June 2024 (24 months).

*Ethics approval and consent to participate*

All experimental protocols were approved by a named institutional and/or licensing committee.

Although surveillance data were used, requests for ethics committees were made in each country: *Le Comité National d'Ethique pour la Recherche en Santé* (CNERS*)* in Benin (n°82/MS/DC/SGM/CNERS/SA), le *Comité d'éthique pour la recherche en santé (CERS) in* Burkina Faso (CERS-2022-04-74), le *Comité national d'éthique pour la protection des personnes dans la recherche medical* (CRERSHC) in Cameroon (CE n°00360/CRERSHC/2022), *le Comité Scientifique de Validation des Protocoles et Résultats de la Recherche en Santé* (CSVPRS) in Central African Republic (n°09/UB/FACSS/IPB/CES/2022), *le Comité National d'Ethique des Sciences de la Vie et de*

*la Santé (CNESVS)* in Côte d'Ivoire (n°035-22/MSHPCMU/CNESVS-km), *le Comité National de l'Éthique de la Santé (CE) in* Democratic Republic of Congo (ESP/CE/47/2025), *le comité national d'éthique pour la recherche en santé (CNERS) in* Guinea (n°199/CNERS/23), *the National Biomedical Research Ethics Committee* (CERBM) in Madagascar (n°13/MSANP/SG/AMM/CERBM), le C*omité National Ethique pour la Recherche en Santé* (CNERS) *in* Niger (n°020/2022/CNERS), *le Comité National Ethique pour la Recherche en Santé* (CNERS) Senegal (032/MSAS/CNERS/SP) and *le Comité de Bioéthique pour la Recherche en Santé (*CBRS*)* Togo (018/2022/CBRS).

Informed consent was obtained from all subjects and/or their legal guardian(s).



**Results**

A total of 91,631 suspected cases were reported by sentinel sites between July 2022 and June 2024, of which 14,100 ARI cases (15%) and 5,355 SARI cases (6%) were reported and sampled. We observed that the average number of suspected cases reported per site varied over the study period, with a peak in the first few months and a gradual decrease in the number of confirmed cases from July 2022 to December 2022 (Figure 3).

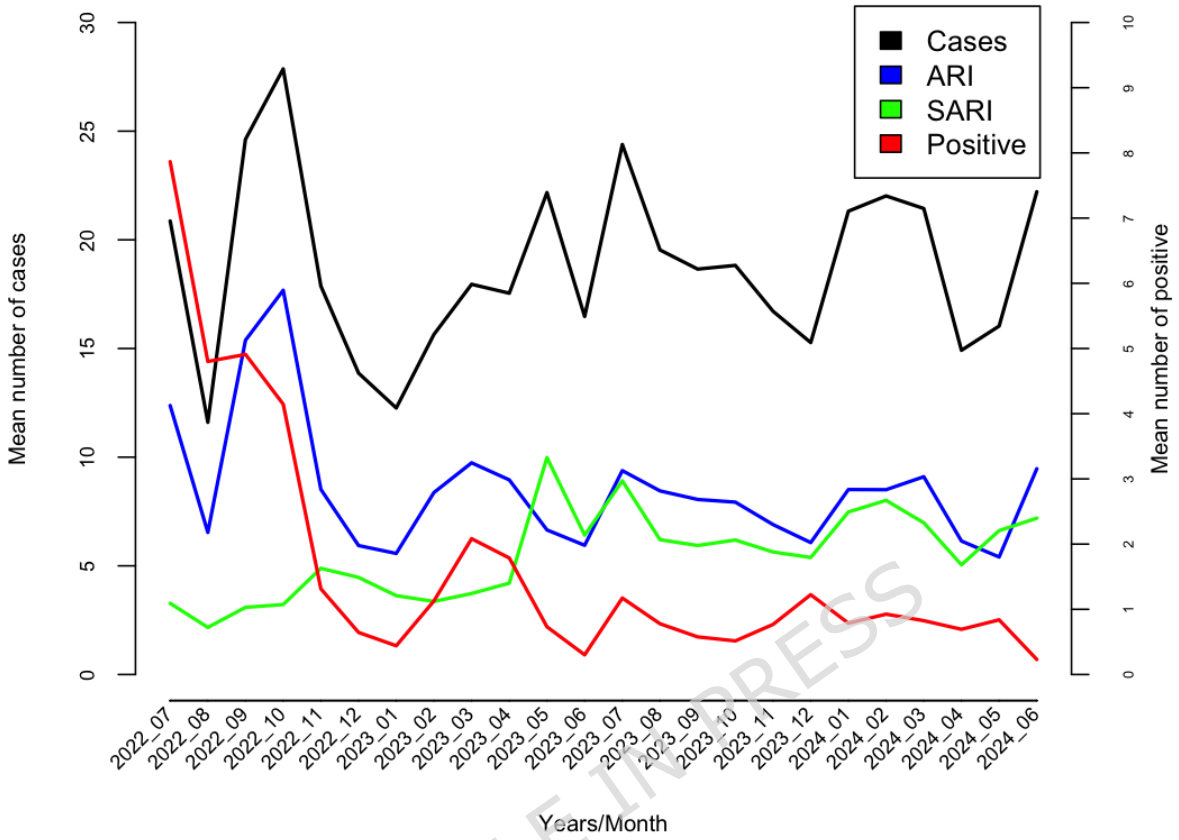



*Figure 3: Average number of suspected cases of ARI (Acute Respiratory Infections), SARI (Severe Acute Respiratory Infections) and positive cases per site, AFROSCREEN project. July 2022 to June 2024.*

During the period under review (Table 2), 19,455 patients were sampled, including 14,100 for ARI (72%) and 5,355 for SARI (28%). A total of 1,505 positive cases were reported (7.7% of the sample).

*Table 2: ARI, SARI and positivity cases and rates by country, AFROSCRENN project. July 2022 to June 2024.*

| Countries | Total ARI + SARI cases | ARI cases | ARI rate (%) | SARI cases | SARI rate (%) | Positive cases | Positive rate (%) |
|---|---|---|---|---|---|---|---|
| Benin | 2,052 | 2,052 | (100.0) | 0 | (0.0) | 148 | (7.2) |
| Burkina Faso | 3,615 | 3,151 | (87.2) | 464 | (12.8) | 129 | (3.6) |
| Cameroon | 1,632 | 1,159 | (71.2) | 473 | (29.0) | 215 | (13.2) |
| Central African Republic | 1,052 | 475 | (45.2) | 577 | (54.8) | 85 | (8.1) |
| Côte d'Ivoire | 532 | 532 | (100.0) | 0 | (0.0) | 66 | (12.4) |
| Democratic Republic of Congo | 2,059 | 2,044 | (99.3) | 15 | (0.7) | 61 | (3.0) |
| Guinea | 1,521 | 1,229 | (80.8) | 292 | (19.2) | 139 | (9.1) |
| Madagascar | 1,275 | 0 | (0.0) | 1,275 | (100.0) | 49 | (3.8) |
| Niger | 1,015 | 355 | (35.0) | 660 | (65.0) | 12 | (1.2) |
| Senegal | 2,121 | 1,328 | (62.6) | 793 | (37.4) | 300 | (14.1) |
| Togo | 983 | 177 | (18.0) | 806 | (82.0) | 301 | (11.7) |
| **Total** | **19,455** | **14,1** | **(72.5)** | **5355** | **(27.5)** | **1,505** | **(7.7)** |

ARI: Acute Respiratory Infections. SARI: Severe Acute Respiratory Infections.

In Benin, where surveillance was based on primary health centers, only patients with ARI were reported, whereas in Madagascar, where surveillance was based on hospitals, only patients with SARI were reported.

The positivity rate varies from country to country. The highest rates were observed in Senegal (14.1%), Cameroon (13.2%) and Côte d'Ivoire (12.4%) but also over time (Figures 3 and 4), with higher rates occurring between July 2022 and November 2022 (Table 2).

Among the positive cases, 817 (54%) were male and 684 (46%) were female. This distribution between males and females was significantly different across countries (p value=0.02). The percentage of positive cases was greater for males in CAR (67%) and Senegal (61%) and for women in Côte d'Ivoire (55%) and Guinea (54%) (Additional file 1).

*Additional file 1: Distribution of positivity and comparison by country according to sex. AFROSCRENN project. July 2022 to June 2024.*

| Countries | Positive cases N | Male n (%) | Female n (%) | p-value |
|---|---|---|---|---|
| Benin | 148 | 79 (53) | 69 (47) | |
| Burkina Faso | 129 | 66 (51) | 63 (49) | |
| Cameroon | 215 | 114 (53) | 101 (47) | |
| Central African Republic | 85 | 57 (67) | 28 (33) | |
| Côte d'Ivoire | 61 | 26 (39) | 36 (55) | |
| Democratic Republic of Congo | 61 | 29 (48) | 32 (52) | **0.02** |
| Guinea | 139 | 64 (46) | 75 (54) | |
| Madagascar | 49 | 29 (59) | 20 (41) | |
| Niger | 12 | 7 (58) | 5 (42) | |
| Senegal | 300 | 183 (61) | 117 (39) | |
| Togo | 301 | 163 (54) | 138 (46) | |
| **Total** | **1501** | **817 (54)** | **684 (46)** | |

Among the positive cases, 841 (56%) were included in the 15–50 years age group, 339 (23%) were included in the 50 years and over age group, 238 (16%) were included in the 0–5 years age group, and 85 (6%) were included in the 5–15 years age group. This distribution differed statistically between countries (p value <0.001). (Additional file 2).

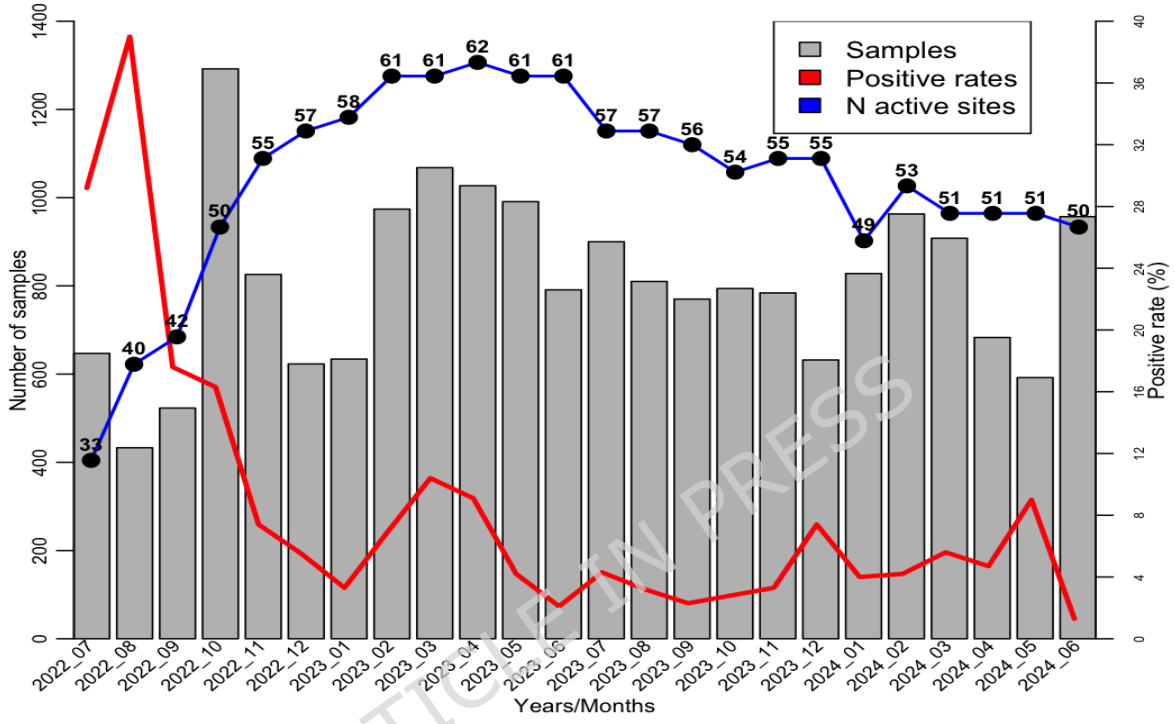
*Additional file 2: Positivity distribution and comparison by country according to age group. AFROSCREEN project. July 2022 to June 2024.*

| Age groups / Countries | Pos.* N | [0-5yrs) n (%) | [5-15yrs) n (%) | [15-50yrs) n (%) | 50yrs and more n (%) | p-value |
|---|---|---|---|---|---|---|
| Benin | 148 | 3 (2) | 2 (1) | 126 (85) | 17 (11) | |
| Burkina Faso | 127 | 90 (70) | 13 (10) | 17 (13) | 7 (5) | |
| Cameroon | 215 | 26 (12) | 7 (3) | 122 (57) | 60 (28) | |
| Central African Republic | 85 | 14 (16) | 1 (1) | 44 (52) | 26 (31) | |
| Côte d'Ivoire | 66 | 2 (3) | 7 (11) | 46 (70) | 11 (17) | |
| Democratic Republic of Congo | 61 | 11 (18) | 2 (3) | 35 (57) | 13 (21) | **<0.001** |
| Guinea | 139 | 2 (1) | 7 (5) | 99 (71) | 31 (22) | |
| Madagascar | 49 | 21 (43) | 2 (4) | 9 (18) | 17 (35) | |
| Niger | 12 | 0 (0) | 3 (25) | 5 (42) | 4 (33) | |
| Senegal | 300 | 58 (19) | 31 (10) | 145 (48) | 66 (22) | |
| Togo | 301 | 11 (4) | 10 (3) | 193 (64) | 87 (29) | |
| **Total** | **1503** | **238 (16)** | **85 (6)** | **841 (56)** | **339 (23)** | |

*Positive cases

Figure 4 shows monthly data on the number of patients sampled and SARS-CoV-2 positivity rates from July 2022 to June 2024.

*Figure 4: Number of patients sampled and positivity rate for COVID-19. AFROSCREEN project. July 2022 to June 2024*






The number of deaths was low throughout the study period. A total of 12 deaths were recorded among the 1,513 patients who tested positive for SARS-CoV-2, corresponding to a case fatality rate of 0.8%.

**Sequencing:**

From July 2022 to June 2024, the laboratories from the AFROSCREEN project collected samples from the surveillance sentinel system. Omicron was the only variant identified in this period, with XBB and JN.1 subvariants in circulation, as in other parts of the world.

**Discussion**

Our results revealed low circulation of SARS-CoV-2 in all countries during the period from July 2022 to June 2024. The implementation of the AFROSCREEN project aimed to identify new variants of SARS-CoV-2 and to strengthen laboratory platforms with sequencing equipment and capacity building through sharing and training activities [8]. On the basis of sentinel surveillance, the network should be able to monitor trends in the epidemiology of COVID-19 in each country. However, as it was implemented at the end of the spread (Figure 1), the results were less interesting than expected. In the second half of 2022, sentinel surveillance was able to detect the latest waves in countries where sentinel surveillance was already operational and in place before the COVID-19 pandemic (Senegal [6], Cameroon [11], Côte d'Ivoire [12], and Burkina Faso[7]). It is important to note that the project was set up at the end of the pandemic, and the countries were not faced with another epidemic wave until the end of the project.

With respect to sequencing, no new variants were identified by the surveillance network. All the sequences have already been described in other parts of the world [10]. However, today's success is linked to the fact that all these countries have developed technical capabilities in terms of surveillance, combining syndromic surveillance with traditional biological surveillance via RT–PCR and new tools such as sequencing.

The number of countries involved in the AFROSCREEN project and the different levels of progress in respiratory disease surveillance have presented major challenges in terms of harmonizing practices, case definitions, testing procedures, data collection, storage and processing. Furthermore, in Africa, the seasonality of respiratory viruses varies from one country to another [13], and their circulation seems to have been affected by the SARS-CoV-2 pandemic, the seasonality of which is not well known [14].

The data presented in Table 1 and the results of the comparisons by sex and age highlight the variability in the number and types of sites per country, as well as the heterogeneity at the site

level. This highlights the fact that the definition of surveillance strategies specific to each country is obviously the responsibility of health authorities and could explain and lead to the differences observed in the epidemiological profiles.

However, after initial difficulties, the number of samples collected remained relatively stable between November 2022 and June 2024, so that a resurgence of the virus, or the appearance of a variant, would probably have been detected by the surveillance system in place in each country.

Creating a sentinel surveillance system from scratch in the context of an epidemiological emergency is a challenge. The AFROSCREEN project has overcome these pitfalls by drawing on the experience and sentinel networks of certain members who had already activated influenza and other respiratory pathogens surveillance systems [6,11,12].

In its simplest form, sentinel surveillance of ARI or influenza-like illness (ILI) and SARI in outpatients and hospitalized patients can provide early evidence of respiratory virus spread and information on where activity is increasing, track changes in virus activity over time and act as a source of samples for virus isolation.

When the population under surveillance is known, it is possible to calculate rates of ARI, SARI or other syndromes on the basis of the population [15]. Alternatively, total consultations should be collected to calculate proportional morbidity. If, in addition, samples are routinely collected from sentinel sites, it is possible to determine the proportion of ARIs due to SARS-CoV-2 or other viruses to calculate rates of SARS-CoV-2 infection requiring medical attention and to estimate the burden of SARS-CoV-2 in terms of outpatient consultations.

Our results faced several limitations. The selection of sentinel sites was based on country priorities but lacked clearly defined criteria (e.g., population density, healthcare infrastructure, geographic diversity) to contextualize the data analysis. Additionally, some healthcare

facilities have low patient volumes for ARI/SARI, limiting potential analyses at sentinel sites or by subgroups. The number of deaths during the project was low. This is probably due to an underreporting of mortality in the countries involved in the project, as already observed in developing countries for influenza [16].

While the AFROSCREEN project developed a secure database, delays in its implementation limited real-time data analysis and sharing. Future systems should prioritize integrated data platforms that allow for real-time data entry, analysis, and sharing across sentinel sites and laboratories, supported by digital tools (e.g., DHIS2, REDCap, SORMAS, EWARS). From a governance perspective, the project faced challenges in establishing clear communication channels for coordination and resource sharing at the regional and national levels, despite engagement with the Africa CDC and Ministries of Health in each country.

In conclusion, sentinel surveillance systems and networks must be designed and implemented during the interpandemic period with sufficient flexibility to respond to changing needs and be robust enough to be sustainable during the interpandemic and pandemic periods. It is essential to support the development and sustainability of sentinel surveillance networks linking syndromic and biological targets [13]. Dealing with health crises is an incredible challenge for health systems in low-income countries, so their ability to detect threats early and monitor their trends over time should be one of the key awareness-raising messages in preparedness and response programs.

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**Ethics approval and consent to participate**
All experimental protocols were approved by a named institutional and/or licensing committee.
Although surveillance data were used, requests for ethics committees were made in each country: *Le Comité National d'Ethique pour la Recherche en Santé* (CNERS*)* in Benin (n°82/MS/DC/SGM/CNERS/SA), le *Comité d'éthique pour la recherche en santé (CERS) in* Burkina Faso (CERS-2022-04-74), le *Comité national d'éthique pour la protection des personnes dans la recherche medical* (CRERSHC) in Cameroon (CE n°00360/CRERSHC/2022), *le Comité Scientifique de Validation des Protocoles et Résultats de la Recherche en Santé* (CSVPRS) in Central African Republic (n°09/UB/FACSS/IPB/CES/2022), *le Comité National d'Ethique des Sciences de la Vie et de la Santé (CNESVS)* in Côte d'Ivoire (n°035-22/MSHPCMU/CNESVS-km), *le Comité National de l'Éthique de la Santé (CE) in* Democratic Republic of Congo (ESP/CE/47/2025), *le comité national d'éthique pour la recherche en santé (CNERS) in* Guinea (n°199/CNERS/23), *the National Biomedical Research Ethics Committee* (CERBM) in Madagascar (n°13/MSANP/SG/AMM/CERBM), le C*omité National Ethique pour la Recherche en Santé* (CNERS) *in* Niger (n°020/2022/CNERS), *le Comité National Ethique pour la Recherche en Santé* (CNERS) Senegal (032/MSAS/CNERS/SP) and *le Comité de Bioéthique pour la Recherche en Santé (*CBRS*)* Togo (018/2022/CBRS). Informed consent was obtained from all subjects and/or their legal guardian(s).

**Consent for publication**
Not applicable.

**Data Availability**
The data are provided within the manuscript or supplementary information files.
The datasets generated and analyzed during the current study are available in the Zenodo repository: https://zenodo.org/records/15050557.

Concerning SARS-CoV-2 sequencing, no new data were analyzed in this study. Data sharing about sequencing is not applicable to this article. SARS-CoV-2 genomes analyzed by Afroscreen partners (On 17th December 2025, n=10957 ; https://www.afroscreen.org/en/sequence-data-management-and-sharing/) are available on the global initiative on sharing avian influenza data (GISAID) database (https://gisaid.org/).

**Competing interests**
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

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**Authors' contributions**
Concept, design, protocol writing: VR and MA. Epidemiological data collection: KJJOK, RHL, PH, MCT, ITi, RR, SC, JN, MAB, RK and ITr. Technical support and coordination: JP, EG, VR and MA. Epidemiological data cleaning, analysis and drafting of the manuscript: JP, VR and MA. Manuscript revision: KJJOK, RHL, PH, ITr
All the authors read and approved the final manuscript.

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