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CORESMA - COVID-19-Outbreak Response combining E-health, Serolomics, Modelling, Artificial Intelligence and Implementation Research

WP 1	**Enhancing public health preparedness and availability of impactful real time data through digital health surveillance with SORMAS**
Deliverable D1.4	**Report**
Title of Deliverable:	**Evaluation of COVID-19 data generated through SORMAS in Côte d'Ivoire and Nepal**
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Deliverable D1.4 - Evaluation of COVID-19 data generated through SORMAS in Côte d'Ivoire and Nepal

With the World Health Organization declaring the COVID-19 outbreak a Public Health Emergency of International Concern (PHEIC) on 30 January 2020, countries initiated the implementation of novel digital solutions to address the pandemic. An excerpt of the work packages within the CORESMA project was dedicated to aiding Côte d'Ivoire and Nepal in their response efforts by facilitating the development and deployment of the Surveillance Outbreak Response Management and Analysis System (SORMAS) software in both nations.

SORMAS is an open-source digital tool that supports disease control and outbreak management procedures (1–5). SORMAS aims to ensure the availability of real-time surveillance data for priority diseases at all administrative levels. SORMAS supports task management, complies with data protection and data security standards, and enhances interoperability with other applications.

This report aims to describe the COVID-19 data generated through SORMAS in Côte d'Ivoire and Nepal.

1.1 **Methods**

Data source

This report utilizes data on documented COVID-19 cases in Côte d'Ivoire and Nepal, captured within the SORMAS system following the deployment in both countries. User training commenced in July and August 2021 in Côte d'Ivoire and in April 2022 in Nepal. The data from each country corresponds to specific regions or provinces — Abidjan 2 and Gbêkê in Côte d'Ivoire, and Gandaki and Sudurpaschim in Nepal (refer to Figures 1 and 2). The information was sourced from the SORMAS database at the Institut National d'Hygiène Publique (INHP) in Côte d'Ivoire and the Epidemiology and Disease Control Division (EDCD) of the Ministry of Health and Population in Nepal. Even though data collection with SORMAS originally started after the initial trainings in July and August 2021, health workers updated SORMAS with previous data collected by other means (when SORMAS was not in use yet) in the piloting region of Gbêke. This allows for the timeline of data collected in Côte d'Ivoire to span from March 2020 to March 2023. In Nepal, it extends from March to November 2023.

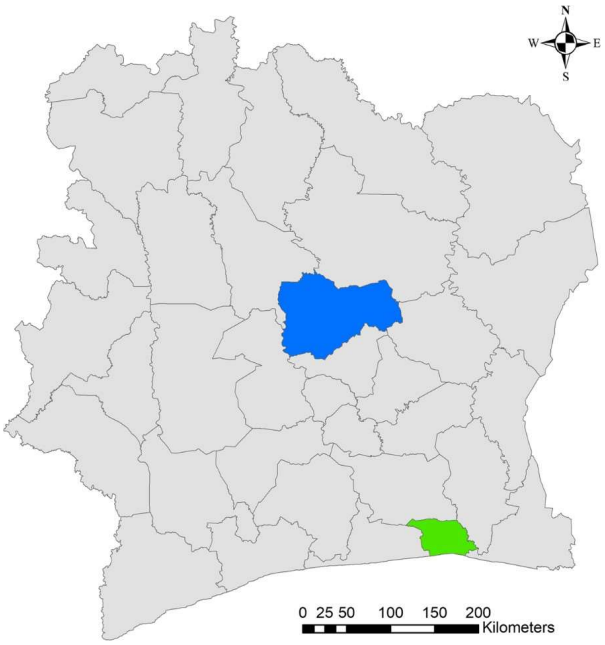

Figure 1. Map of study regions in Côte d'Ivoire, Abidjan (green) and Gbêkê (blue)

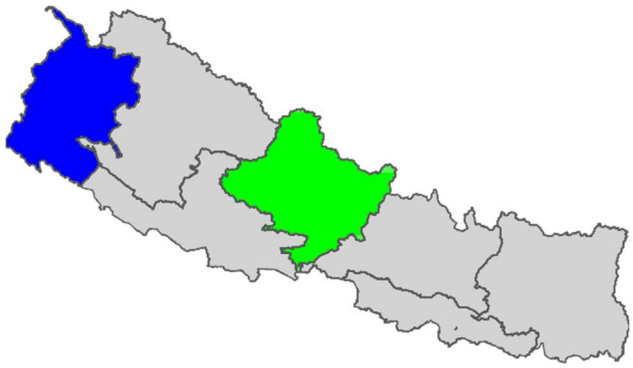

Figure 2. Map of study provinces in Nepal, Gandaki (green) and Sudurpaschim (blue)

Analysis

Our analysis of SORMAS data employed descriptive statistics, graphs, and charts. To assess the effectiveness of the use of SORMAS, we analyzed case counts in different regions or provinces and districts or municipalities, analyzed the ratio of contacts to cases, and examined the distribution of cases by age and gender. We also categorized the samples based on the pathogen test and the reason for the sampling.

As users might have imported data gathered through other conventional methods and predating the deployment of SORMAS in their area into the system, the calendar date utilized in the analysis aligns with when users reported the respective entity to public health authorities. As a result, a subset of cases collected before the deployment of SORMAS was not excluded from the analysis. We used R and the SORMAS Statistical (SORMAS-Stats) module, installed locally on the same server hosting SORMAS, for this analysis.

1.2 **Results**

Analysis from Côte d'Ivoire

Between March 2020 and March 2023, 1585 cases were recorded in SORMAS, with 759 cases (47.89%) originating from Abidjan 2 and 826 cases (52.11%) from Gbêkê. Among these cases, there were 195 (12.30%) confirmed, 15 (0.95%) probable, 1276 (80.50%) suspected, and 99 (6.25%) discarded (not-cases). Figure 3 illustrates the epidemiological curve depicting the daily case counts categorized by case classification. The majority of cases happened between September 2021 and March 2022.

The breakdown of cases by gender revealed 839 (52.94%) males, 739 (46.62%) females, and 7 (0.44%) with missing data. Figure 4 depicts the distribution of cases based on gender and age group within five years. Predominantly, cases occurred among individuals aged 25 to 60 years. The gender-specific distributions show similarities between males and females. Out of the 1549 (97.73%) cases with available data, the mean age was 40.11 years, the median was 39, and the range was 0 to 99.

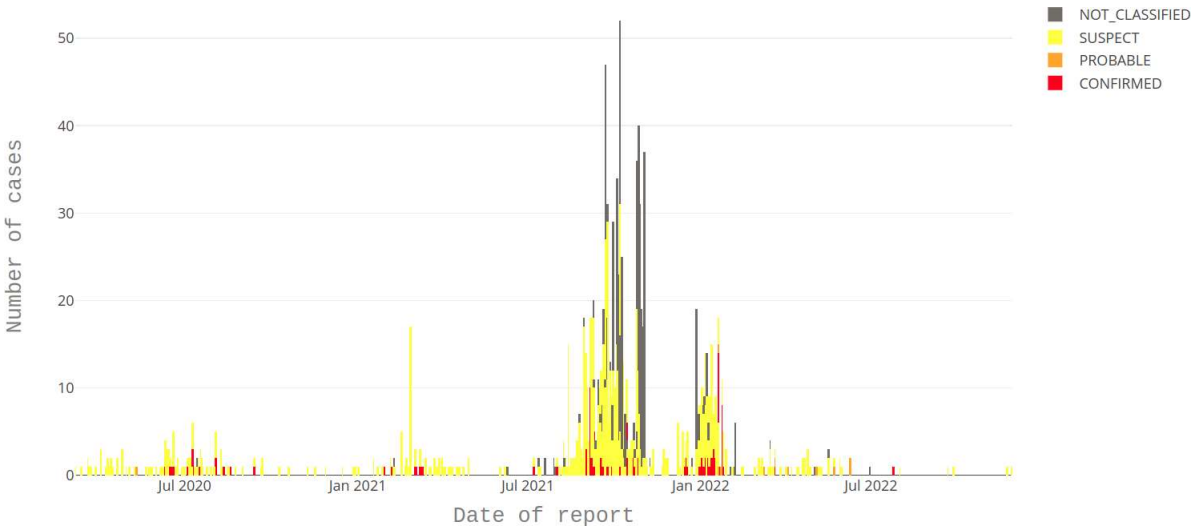

Figure 3. Epidemiological curve for 1585 COVID-19 cases reported in SORMAS between March 2020 and March 2023 in Abidjan 2 and Gbêkê regions in Côte d'Ivoire.

The category NOT_CLASSIFIED, in grey, refers to suspected cases reported in SOR MAS but were not subsequently classified by a disease surveillance officer. Cases reported that were subsequently discarded were omitted.

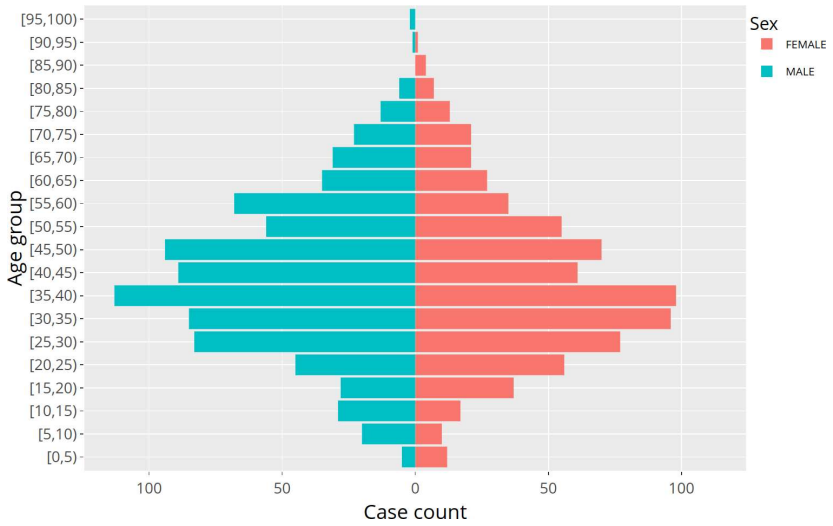

Figure 4. Age-sex pyramid for 1585 COVID-19 cases reported in SORMAS between March 2020 and March 2023 in Abidjan 2 and Gbêkê regions in Côte d'Ivoire.

By examining the cumulative daily cases from both regions, as illustrated in Figure 5, it becomes apparent that previous cases dating back as early as March 2020 were documented in the Gbêkê region retrospectively in SORMAS, while Abidjan 2 only recorded cases starting after the SORMAS training in August 2021. However, regardless of the initiation of SORMAS usage in both regions, there appears to be a noticeable rise in case counts between September and November 2021. A bar chart representing the number of cases per district in both regions can be seen in Figure 6. There is a significant variation in the number of cases across districts. The highest number of cases recorded was 517 in Bouaké Nord-Ouest, while the lowest was 11 in Botro.

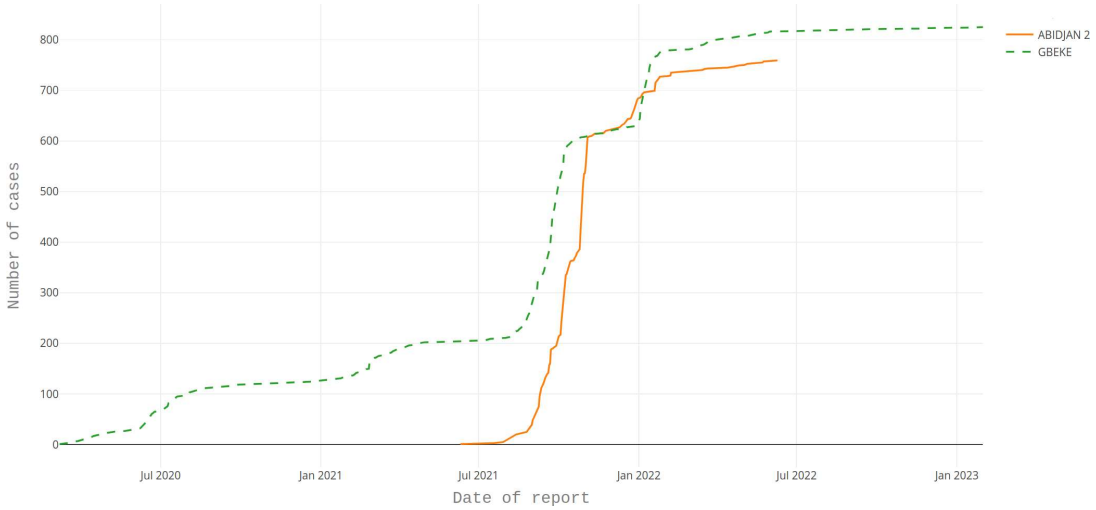

Figure 5. Line plot for 1585 cumulative COVID-19 cases reported in SORMAS between March 2020 and March 2023 in Abidjan 2 and Gbêkê regions in Côte d'Ivoire.

Concerning the management of contacts, users recorded 174 contacts in SORMAS, with 170 (97.70%) originating from Gbêkê and 4 (2.30%) from Abidjan 2. However, the distribution of contacts across districts in Gbêkê did not align proportionally with the number of cases, as depicted in Figure 7. Notably, the Sakassou district reported the highest number of contacts (67) despite having 104 cases, while Botro, with only 10 cases, reported the lowest number of contacts (12). Additionally, the Bouaké nord-ouest district documented 13 contacts for 517 cases.

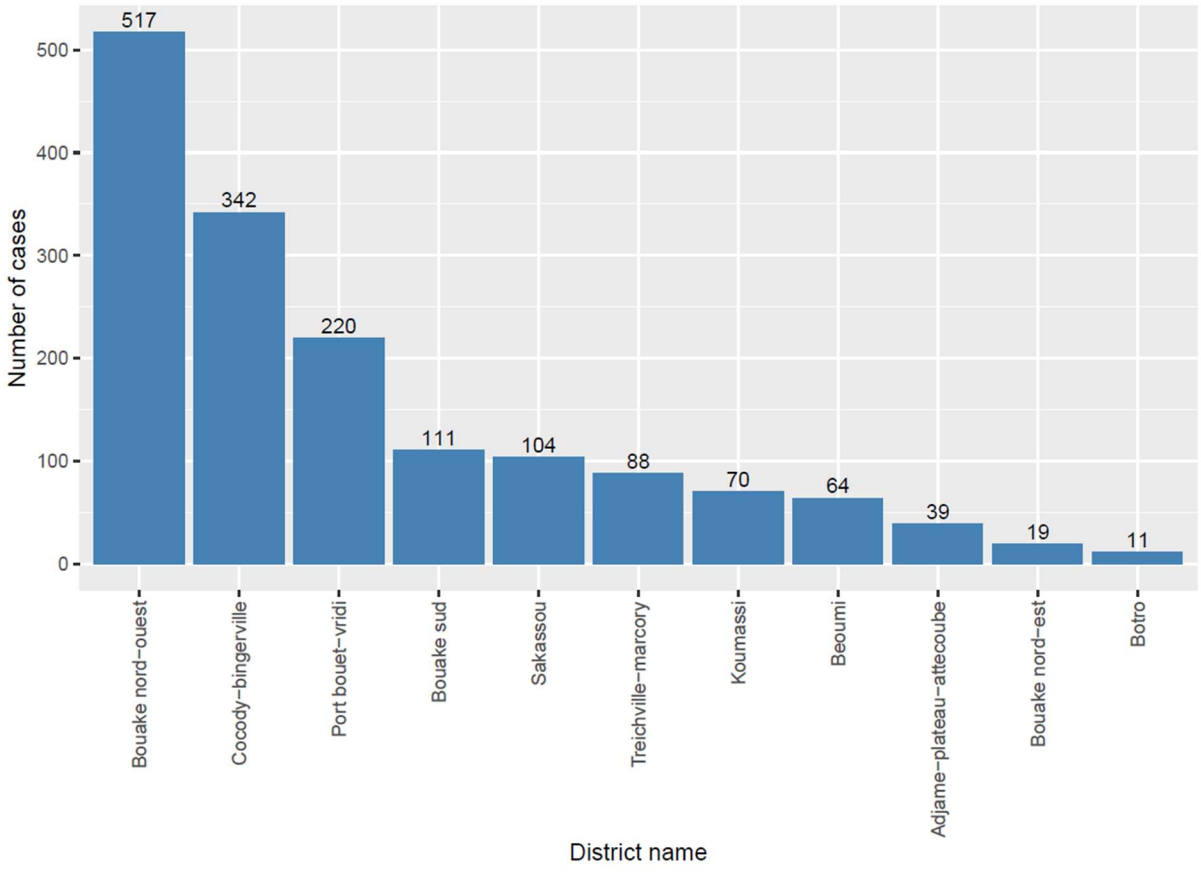

Figure 6. Bar chart for 1585 COVID-19 cases by districts reported in SORMAS between March 2020 and March 2023 in Abidjan 2 and Gbêkê regions in Côte d'Ivoire

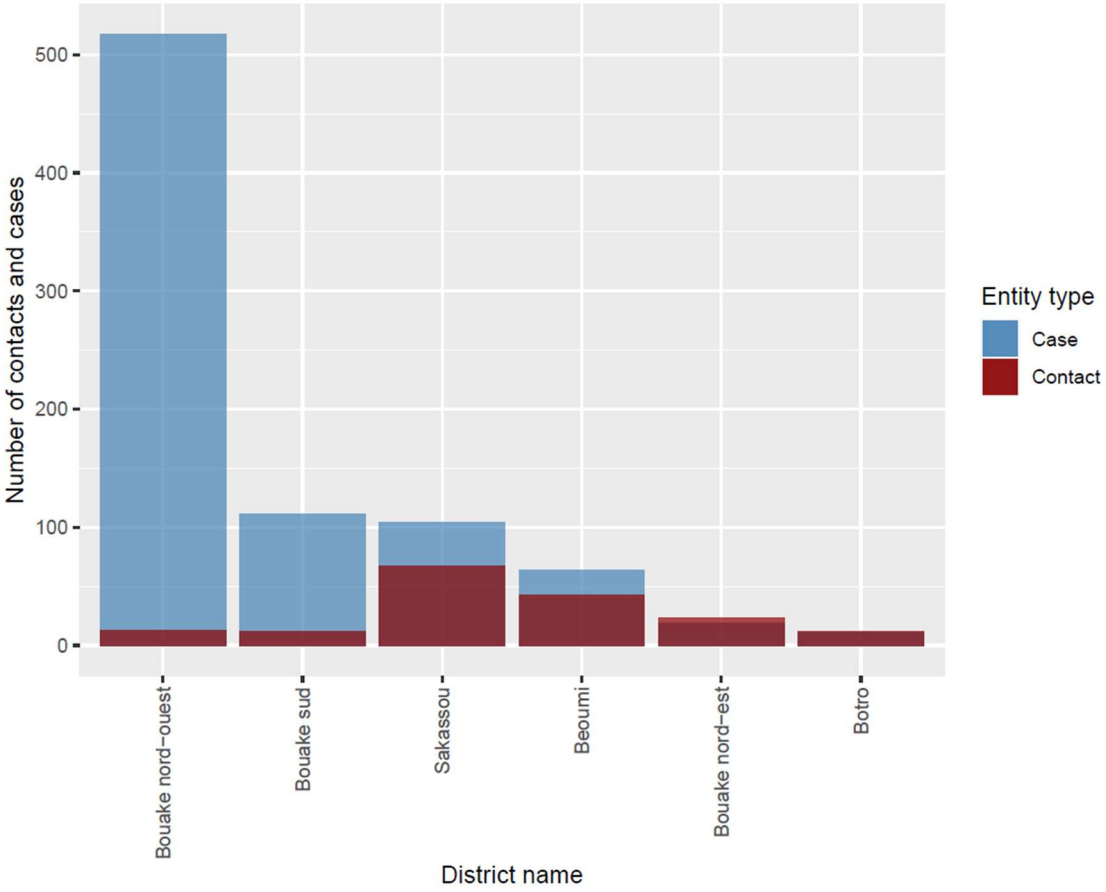

Figure 7. Overlapping bar plot by districts for 826 COVID-19 cases and 170 contacts i
March 2020 and March 2023 in Gbêkê region in Côte d'Ivoire

Analysis from Nepal

From March to November 2023, SORMAS documented a total of 794 cases. The highest proportion, 576 cases (72.54%), originated from Sudurpaschim province, while Gandaki province accounted for 218 cases (27.46%). Among these cases, 785 (98.87%) were confirmed, and 9 (1.13%) were suspected. Figure 8 illustrates the epidemiological curve depicting the daily case counts categorized by case classification. The peak of cases occurred primarily between April and June 2023.

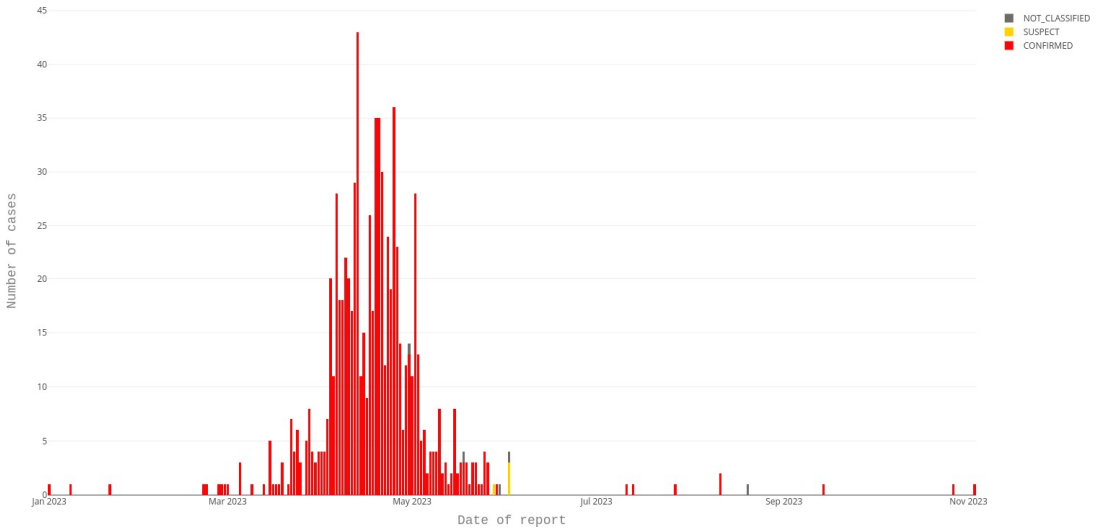

Figure 8. Epidemiological curve for 794 COVID-19 cases reported in SORMAS between January to November 2023 in Sudurpaschim and Gandaki provinces in Nepal. The category NOT_CLASSIFIED, in grey, refers to suspected cases reported in SORMAS but were not subsequent

The analysis of cases by gender revealed 476 (59.95%) males, 316 (39.80%) females and 2 (0.25%) others. Figure 9 depicts the distribution of cases based on gender and age group within five years. The sex-specific distributions show similarities between males and females. Notably, within the age range of 20 to 35 years, there are higher case counts for males compared to females. Out of the 712 (89.67%) cases with available data, the mean age was 35.20 years, the median was 31 and the range was 0 to 90. Concerning the case outcome, 88 recovered, 1 deceased and 705 had missing data.

Upon analyzing the cumulative daily cases from both regions, as shown in Figure 10, it is evident that both regions started reporting cases around the same period, with an increase in April 2023. Furthermore, there appears to be a higher spike in new cases in the Sudurpaschim

province compared to Gandaki from April to May 2023. However, the curve for both provinces flattens out nearly at the same time, in June 2023. Figure 11 displays a bar chart illustrating the number of cases per district in both regions. There is a notable difference in the number of cases reported in various districts, with Kailali reporting the highest number of cases at 228, while Parbat reported only one case in SORMAS.

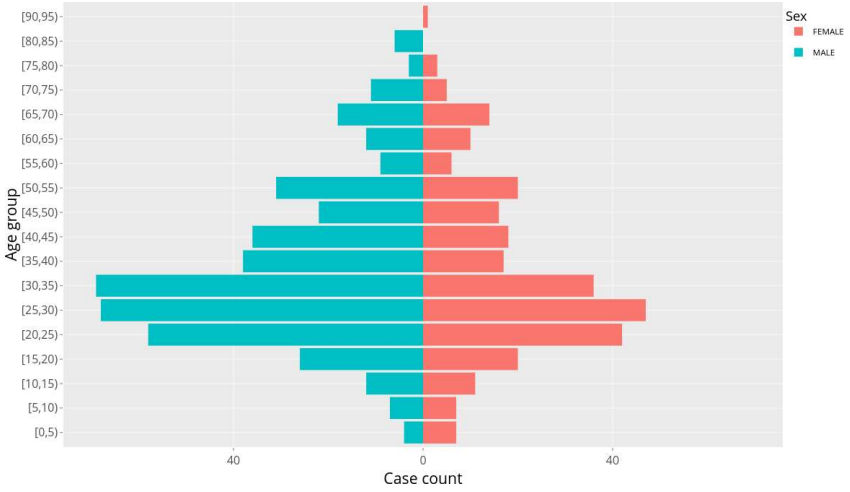

Figure 9. Case pyramid by sex and age for 794 COVID-19 cases reported in SORMAS between January to November 2023 in Sudurpaschim and Gandaki provinces in Nepal.

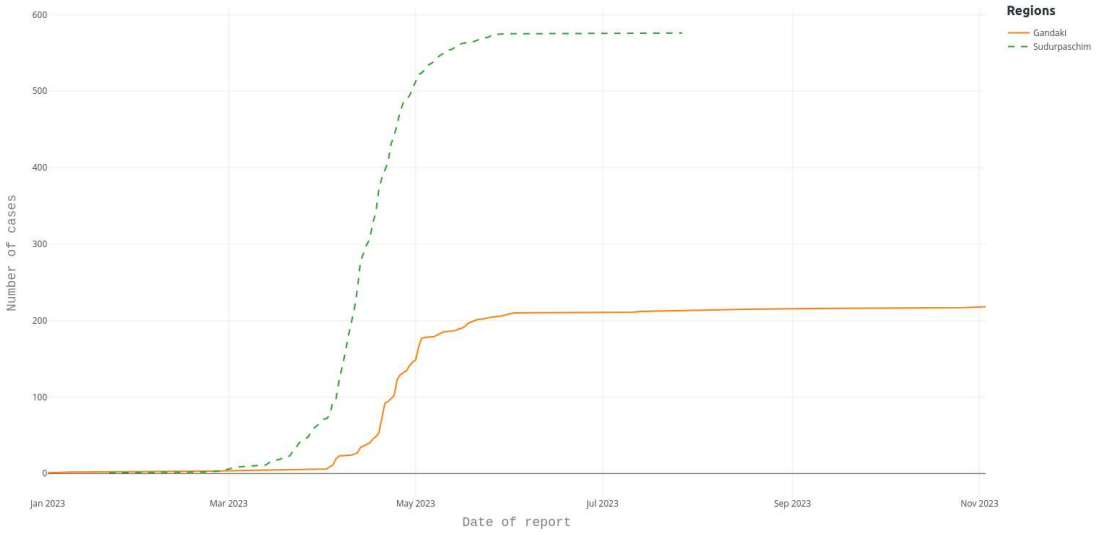

Figure 10. Line plot for 794 cumulative COVID-19 cases reported in SORMAS between January to November 2023 in Sudurpaschim and Gandaki provinces in Nepal.

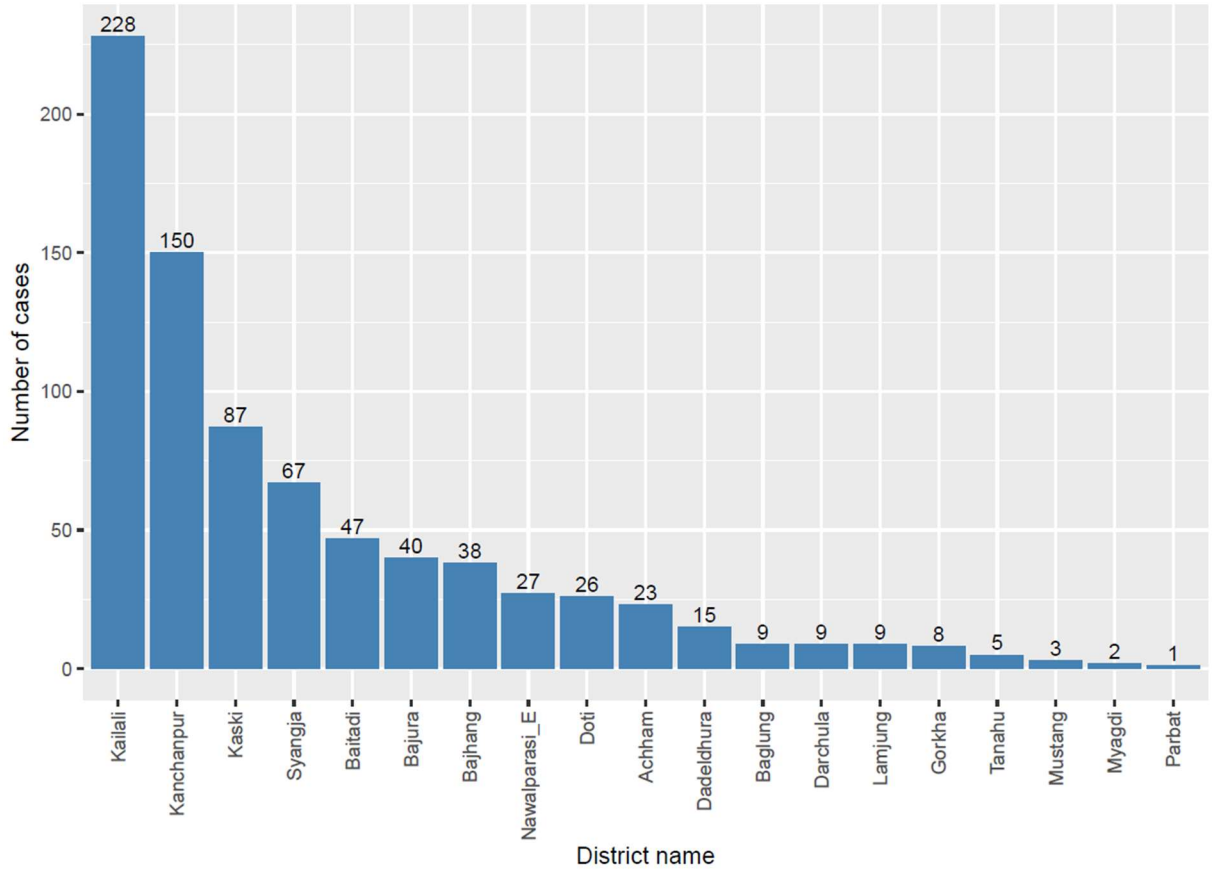

Figure 11. Bar chart for 794 COVID-19 cases reported in SORMAS between January to November 2023 in Sudurpaschim and Gandaki provinces in Nepal.

Regarding sample management, users entered a total of 726 samples into SORMAS. Out of these, 149 (20.52%) yielded positive pathogen test results, 3 (0.41%) negative, and 574 (79.06%) were pending. The sample material included 698 (96.14%) nasal swabs, 21 (2.89%) throat swabs, and 7 (0.96%) other types. Examining the reasons for sample collection, 355 (48.90%) were collected for screening purposes, 167 (23%) due to the presence of symptoms, 4 (0.55%) for other reasons, and 200 (27.55%) had missing data.

Discussion

This report delves into the COVID-19 data generated through SORMAS in piloted regions or provinces of Côte d'Ivoire and Nepal. In both countries, SORMAS successfully managed COVID-19 data, including cases, samples, and contacts. A study conducted by Barth-Jaeggi et al. also concluded that users and decision-makers in Côte d'Ivoire accepted SORMAS for responding to outbreaks (5).

The visualization of the time series of case counts in the two piloted regions or provinces of each country indicates a positive correlation. Additionally, the distribution of cases across districts or municipalities appears skewed, with a few districts/ municipalities reporting a high proportion while others show a lower proportion. This disparity suggests a non-uniform infection proportion or potential under-reporting in certain districts. The reported cases demonstrate a proportional relationship with the number of samples collected in Nepal. However, some of the cases categorized as confirmed relied on clinical diagnostics, lacking corresponding positive pathogen test records. Furthermore, the utilization of SORMAS' contact tracing module was sub-optimal, with a limited number of recorded contacts relative to cases. This discrepancy may be attributed to a delayed deployment of SORMAS in the piloted regions and provinces. Further to this, it has to be noted that the recorded number of contacts were very low especially since the COVID-19 was no longer declared a Public Health Emergency of international concern as there exists no mandatory contact tracing mechanism in Nepal. Initially, also during the Delta and Omicron waves (in 2022 and early 2023), contact tracing was not yet functioning well in Nepal, making it a low priority for local health care workers.

The results presented in this report may not correspond to the true epidemiological situation in the

countries at this time since other systems besides SORMAS were used in parallel. There may have been data that was notified using other conventional methods but not subsequently transferred to SORMAS.

References

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[5] Tanja Barth-Jaeggi, Clarisse A Houngbedji, Marta S Palmeirim, Daouda Coulibaly, Aboubakar Krouman, Cordula Ressing, and Kaspar Wyss. Introduction and acceptability of the surveillance outbreak response management and analysis system (sormas) during the covid-19 pandemic in côte d'ivoire. BMC Public Health, 23(1): 2189, 2023.

2 Annex

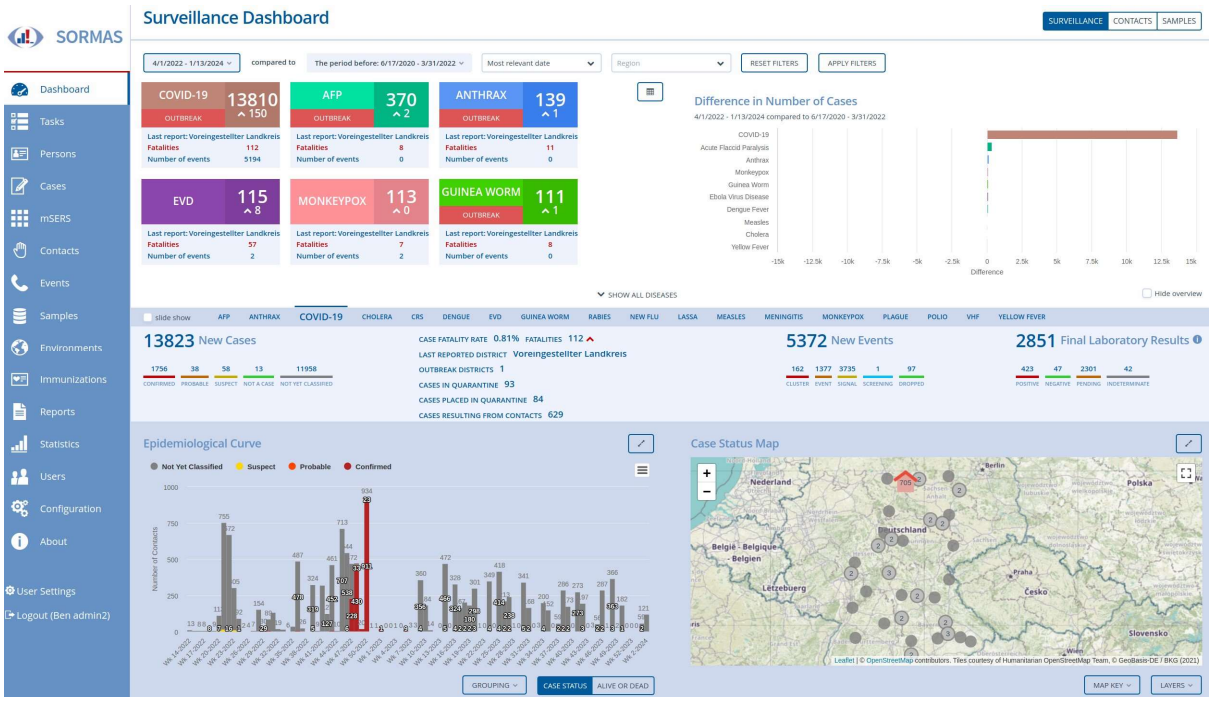

Figure 12. A surveillance dashboard of SORMAS showing demo cases created during testing. The demonstration server is available online at https://demo.sormas.org/ sormas-ui/login

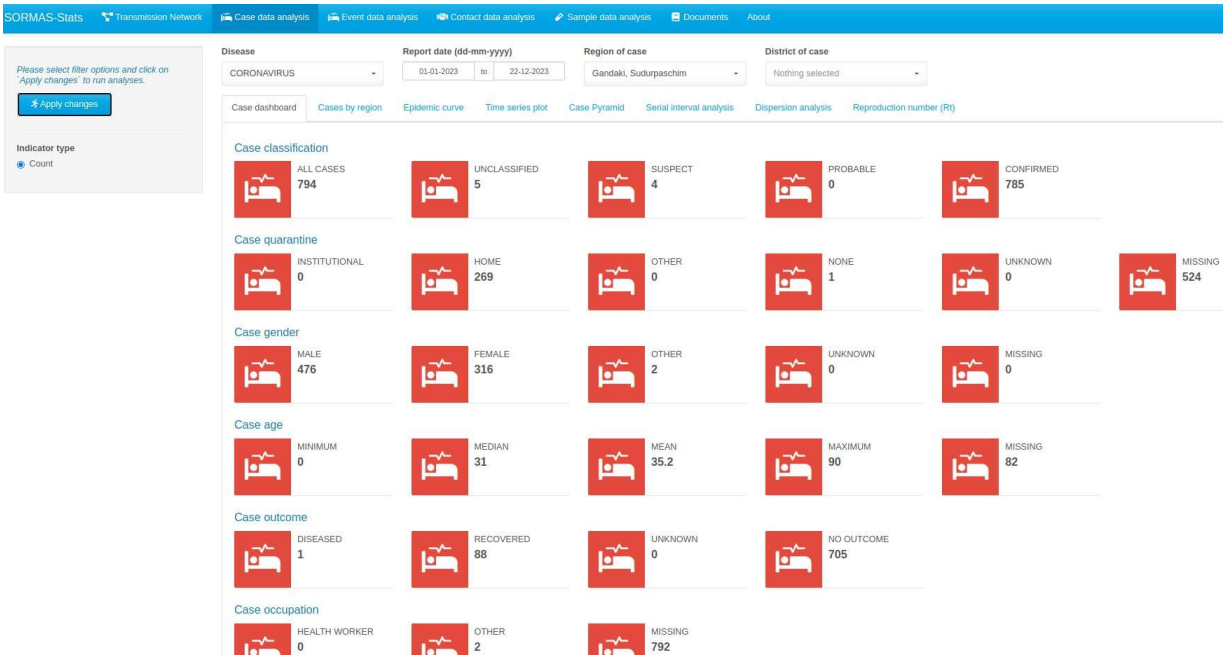

Figure 13. A dashboard of SORMAS Statistical (SORMAS-Stats) module showing COVID-19 cases reported in SORMAS between January to November 2023 in Sudur- pashchim and Gandaki regions in Nepal.