Original research

BMJ Global Health

Enhancing SARS-CoV-2 surveillance in Malawi using telephone syndromic surveillance from July 2020 to April 2022

Godfrey Woelk,[1] Thulani Maphosa ,[2] Rhoderick Machekano,[1] Annie Chauma-Mwale,[3] Lucky Makonokaya,[2] Suzgo B Zimba,[2] Rachel Kanyenda Chamanga,[2] Rose Nyirenda,[4] Andrew Auld,[5] Evelyn Kim,[5] Veena Sampathkumar,[2] Allan Ahimbisibwe,[2] Louiser Kalitera,[2] Lindsay Kim,[5,6] Alice Maida[5]

To cite: Woelk G, Maphosa T, Machekano R, *et al*. Enhancing SARS-CoV-2 surveillance in Malawi using telephone syndromic surveillance from July 2020 to April 2022. *BMJ Glob Health* 2024;**9**:e014941. doi:10.1136/bmjgh-2023-014941

Handling editor Helen J Surana

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/bmjgh-2023-014941).

GW and TM contributed equally. RM and LK contributed equally.

GW and TM are joint first authors.

Received 31 December 2023
Accepted 18 April 2024

For numbered affiliations see end of article.

Correspondence to
Dr Thulani Maphosa; tmaphosa@pedaids.org

ABSTRACT

Introduction Monitoring the SARS-CoV-2 pandemic in low-resource countries such as Malawi requires cost-effective surveillance strategies. This study explored the potential utility of phone-based syndromic surveillance in terms of its reach, monitoring trends in reported SARS-CoV-2-like/influenza-like symptoms (CLS/ILS), SARS-CoV-2 testing and mortality.

Methods Mobile phone-based interviews were conducted between 1 July 2020 and 30 April 2022, using a structured questionnaire. Randomly digital dialled numbers were used to reach individuals aged ≥18 years who spoke Chichewa or English. Verbal consent was obtained, and trained research assistants with clinical and nursing backgrounds collected information on age, sex, region of residence, reported CLS/ILS in the preceding 2 weeks, SARS-CoV-2 testing and history of household illness and death. Data were captured on tablets using the Open Data Kit database. We performed a descriptive analysis and presented the frequencies and proportions with graphical representations over time.

Findings Among 356 525 active phone numbers, 138 751 (38.9%) answered calls, of which 104 360 (75.2%) were eligible, 101 617 (97.4%) consented to participate, and 100 160 (98.6%) completed the interview. Most survey respondents were aged 25–54 years (72.7%) and male (65.1%). The regional distribution of the respondents mirrored the regional population distribution, with 45% (44%) in the southern region, 41% (43%) in the central region and 14% (13%) in the northern region. The reported SARS-CoV2 positivity rate was 11.5% (107/934). Of the 7298 patients who reported CLS/ILS, 934 (12.8%) reported having undergone COVID-19 testing. Of the reported household deaths, 47.2% (982 individuals) experienced CLS/ILS 2 weeks before their death.

Conclusion Telephonic surveillance indicated that the number of SARS-CoV-2 cases was at least twice as high as the number of confirmed cases in Malawi. Our findings also suggest a substantial under-reporting of SARS-CoV-2-related deaths. Telephonic surveillance has proven feasible in Malawi, achieving the ability to characterise SARS-CoV-2 morbidity and mortality trends in low-resource settings.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Before this study, traditional surveillance methods for SARS-CoV-2 in low-resource settings, such as Malawi, faced significant challenges owing to limited resources and access to health facilities, which hindered effective monitoring and response strategies.

WHAT THIS STUDY ADDS

⇒ This study introduced and evaluated a mobile phone-based syndromic surveillance system in Malawi, effectively identifying higher rates of SARS-CoV-2 cases and substantial under-reporting of COVID-19-related deaths compared with official statistics. The system detected trends in COVID-19-like symptoms, testing rates and mortality, thereby offering insights into the actual disease burden.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The study highlights the potential of telephonic surveillance as a feasible and valuable tool for monitoring and responding to infectious diseases, particularly in resource-limited settings. This emphasises the need for enhanced surveillance strategies, accurate reporting and improved public health response systems to better understand and mitigate the impact of infectious diseases, such as SARS-CoV-2.

INTRODUCTION

In December 2019, SARS-CoV-2 was first identified in Wuhan, China.[1] It spread rapidly worldwide, causing significant morbidity and mortality during the COVID-19 (SARS-CoV-2).[1–3] The WHO declared SARS-CoV-2 a pandemic on 11 March 2020, with over 118 000 cases reported in 114 countries.[4] In Malawi, the first cases of SARS-CoV-2 were identified in April 2020[5]; by June 2020, the country faced an initial wave of a substantial number of cases.[6] Given the limited resources of low-income countries such as Malawi[7] and limited access to health facilities, especially in rural areas, traditional surveillance activities such as widespread testing and contact tracing face significant challenges.[8] Thus, there is an urgent need to develop a cost-effective surveillance strategy to monitor the progression of SARS-CoV-2 infection and provide an effective public health response.

We implemented a mobile telephone-based syndromic surveillance system to monitor SARS-CoV-2-related symptoms and mortality trends. This system aims to overcome the limitations of traditional surveillance methods, such as under-reporting/ascertainment, lack of timeliness and completeness of data[9] and provide timely and reliable data for decision-making. By leveraging mobile phone technology, we sought to reach a large population quickly and efficiently by collecting information on SARS-CoV-2-like/influenza-like symptoms (CLS/ILS), SARS-CoV-2 testing and mortality. A mobile phone-based syndromic surveillance system for acute public health events has shown that the timeliness and efficiency of public health surveillance could be improved using this approach.[10 11]

In this study, we evaluated our telephone-based surveillance utility in monitoring the COVID-19 pandemic by analysing the number of respondents and trends in reported CLS/ILS, SARS-CoV-2 testing and mortality. By assessing the effectiveness and reach of this innovative surveillance system, we aimed to provide insights into its practical value for monitoring the SARS-Cov-2 pandemic and future pandemics in resource-limited settings. The findings of this study have important implications for public health planning and response efforts and contribute to the global knowledge base for effective surveillance strategies during infectious disease outbreaks.

METHODOLOGY

Study design and sampling

The syndromic surveillance system has been previously described.[11] In summary, we conducted a mobile phone-based survey of the general population of Malawi from July to November 2020 and from April 2021 to March 2022. Adults aged ≥18 years were eligible for inclusion if they resided in Malawi, had access to a mobile phone, could communicate in either English or Chichewa and provided verbal consent to participate in a structured phone interview conducted by a trained nurse or a clinician. We employed a computer-based random digit dialling (RDD) technique to generate random mobile phone numbers based on the 10-digit structure used by Malawi's primary mobile companies. RDD is a method used in telephone survey sampling to select random phone numbers from a database of all possible phone numbers. These phone numbers are typically generated electronically using computer algorithms to ensure randomness.[10 11] Phone numbers were dialled up to three times on the same day at different times and were considered non-responsive if there was no answer. In cases where the participant answered but was busy during the call, the interviewers arranged an alternate time, as suggested by the participant. We anticipated reaching at least 2000 respondents per week, anticipating a 10% refusal rate. The estimated sample size allowed for the estimation of weekly proportions/rates of the outcomes of interest, ensuring a precision of 2.3% in estimating the prevalence of suspected cases of SARS-CoV-2.[10]

The survey included various questions, including age, sex, region of residence, the presence of CLS/ILS within the preceding 2 weeks, SARS-CoV-2 testing history, and details of household illness and death (online supplemental file 1). Respondents were asked whether any deaths occurred in their households between 1 January 2020, and the date of the survey respondent interview. If there was a death, respondents were further questioned about whether the deceased had exhibited CLS/ILS or had undergone SARS-CoV-2 testing. In our study, we defined a household as a group of people living in the same residence or on the same roof (online supplemental file 1).

Data collection and analysis

Interview data were captured using tablets with the Open Data Kit V.2021.2.3 database platform, which is a free and open-source set of software tools for collecting, managing and using data in resource-constrained environments. The collected data were securely transmitted via a virtual private network and stored in a Microsoft SQL server database with stringent security measures. The data entry forms incorporated internal consistency checks and logic validations and were then exported for analysis using Stata V.16. Suspected SARS-CoV-2 cases were estimated based on the reported signs and symptoms using the case definition by the Malawi Ministry of Health (MOH)[i].[12]

We used STATA V.15 to perform descriptive analysis. Age and sex distributions from the survey were visually compared with the corresponding proportions obtained from the Malawi 2018 Population and Housing Census Main Report.[12] To assess trends over time, we calculated the proportion of suspected SARS-CoV-2 cases from the survey (the number of SARS-CoV-2 suspected cases divided by the number of consented participants per epidemiological week) and the proportion of officially confirmed SARS-CoV-2 cases (the number of positive tests divided by the number of tests conducted per epidemiological week) from 1 January 2020 to 30 April 2022.

[i]Suspected SARS-CoV-2 cases: were defined Individuals with acute respiratory illness (fever and at least one sign or symptom of respiratory disease, such as cough or shortness of breath) 1 were classified as suspected cases of COVID-19.

The monthly proportion of reported household deaths was calculated using the following formula.

$$percentage = \left\{ \frac{\text{Number of reported household deaths in that month}}{(\text{Total number of respondents} - \text{Number of respondents interviewed in the prevous month})} * 100 \right\}$$

This proportion was then compared with the monthly number of registered deaths obtained from the MOH Electronic Medical Record System (EMRS) from January 2020 to April 2022. Additionally, the number of MOH-confirmed SARS-CoV-2 deaths was obtained and reported separately from the overall number of registered deaths.

Patient and public involvement

The research question and outcome measures for this survey on monitoring the SARS-CoV-2 pandemic in Malawi's low-resource context were shaped by insights gained from community members' experiences and priorities through radio channels. While respondents were not directly involved in study design due to logistical constraints, community leaders and healthcare providers contributed to crafting culturally sensitive and accessible methodologies. Throughout the study, community engagement remained central, facilitated by local healthcare workers and leaders, ensuring widespread dissemination of information and encouraging participation. The results of the study will be shared through diverse channels accessible to participants and the wider community, including community meetings, radio broadcasts and informational materials, to inform both local stakeholders and broader public health strategies.

RESULTS

Enrolment

From July 2020 to April 2022, 527 278 unique calls were made to the general population as part of the survey. Approximately 67.6% (n=356 525) of calls reached active phone lines. Among the reached lines, approximately 38.9% (n=138 751) of the calls were answered by individuals. Of the respondents, 104 360 (75.2%) were aged ≥18 years and were eligible for the survey. Among the eligible respondents, 98.6% (n=101 617) consented to participate in the structured phone interview and 99.0% (n=100 160) completed the interviews. The survey completion rate was 28.1% (100 160/356 525).

Demographic distribution of respondents

This manuscript presents the demographic distribution of the participants according to age group and sex. A total of 101 277 individuals participated in this study, with varying representations across age categories. Among participants aged 18–24 years, 11 221 (17.0%) were male and 8096 (22.9%) were female. In the 25–34 age group, 20 309 (30.8%) were male and 12 175 (34.5%) were female. Participants aged 35–44 years included 17 914 (27.2%) males and 8660 (24.5%) females. Among individuals aged 45–54 years, 10 627 (16.1%) were male and 4183 (11.8%) were female. In the 55–64 age group, 3697 (5.6%) were male and 1486 (4.2%) were female. The oldest age group, 65 years and above, comprised 2192 (3.3%) males and 717 (2.0%) females. Overall, male participants accounted for 65.1% of the total, whereas female participants constituted 34.9%.

Figure 1 illustrates the proportions of the population distributed by age group and sex, comparing the survey results with corresponding data from the population census. Notably, a higher percentage of survey respondents was found in the 25–54 age group compared with the overall distribution in the Malawi population. Furthermore, the survey sample displayed a higher proportion of males than females.

The reported regional distribution of respondents was consistent with the regional census results. The distribution of respondents by region was 44.9% in the southern region, 40.9% in the central region and 14.2% in the northern region, compared with census estimates of 44.1%, 42.8% and 13.0%, respectively.

In figure 1, we compare the demographic distribution of respondents in syndromic surveillance with the 2018 National Census.[13] Notably, the age group 18–24 exhibits fewer respondents in syndromic surveillance compared with the majority representation in the census data. Additionally, our surveillance data displayed variance by sex, in contrast to the census data, which demonstrated a pyramid-shaped distribution with nearly equal representation of males and females.

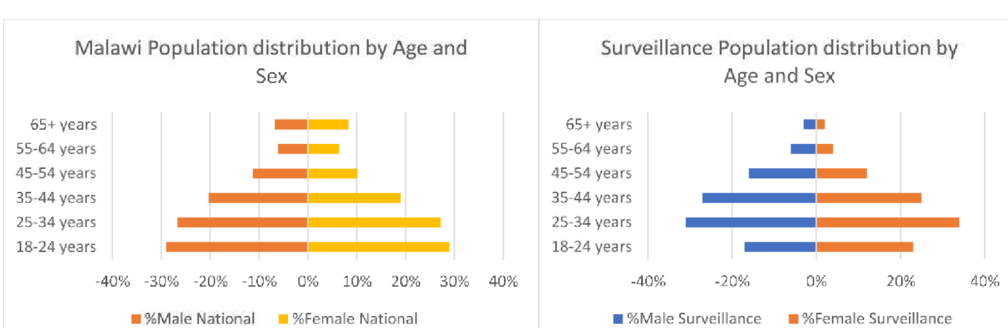


Figure 1 Age and sex distribution of survey respondents and Malawi population.

Table 1 Percentage of signs and symptoms by sex and age among respondents reporting selected CLS/ILS and Suspected SARS-CoV-2 cases

	Selected CLS/ILS signs and symptoms					
Age group (years)	Fever n (%)	Cough n (%)	Headache n (%)	Muscle ache n (%)	Runny nose n (%)	Suspected COVID-19 case* n (%)
Male (total)	2892 (63.3)	3291 (72.0)	1113 (24.4)	1085 (23.7)	1871 (41.0)	859 (17.8)
18–24	434 (61.9)	491 (70.0)	141 (20.1)	147 (21.0)	290 (41.9)	147 (19.4)
25–34	969 (64.6)	1067 (71.1)	378 (25.2)	334 (22.3)	603 (40.2)	285 (18.1)
35–44	790 (64.2)	881 (71.6)	315 (25.6)	330 (26.8)	545 (44.3)	234 (18.3)
45–54	462 (62.9)	525 (71.4)	193 (26.3)	181 (24.6)	288 (39.2)	125 (16.2)
55–64	164 (62.2)	211 (79.9)	58 (22.0)	58 (22.0)	98 (37.1)	46 (16.9)
65+	73 (52.5)	116 (83.5)	28 (20.1)	35 (25.2)	47 (33.8)	22 (13.6)
Female (total)	1510 (65.1)	1762 (75.9)	612 (26.4)	597 (25.7)	940 (40.5)	425 (17.3)
18–24	314 (63.6)	361 (73.1)	117 (23.7)	107 (21.7)	182 (36.8)	99 (18.8)
25–34	517 (67.6)	565 (73.9)	208 (27.2)	200 (26.1)	323 (42.2)	134 (16.4)
35–44	399 (66.1)	467 (77.3)	163 (27.0)	183 (30.3)	247 (40.9)	109 (17.4)
45–54	193 (62.3)	250 (80.7)	82 (26.5)	77 (24.8)	123 (39.7)	54 (16.4)
55–64	65 (61.3)	83 (78.3)	33 (31.1)	24 (22.6)	50 (47.2)	23 (20.4)
65+	22 (53.7)	36 (87.8)	9 (21.9)	6 (14.6)	15 (36.6)	6 (12.8)
Total	4402 (63.9)	5053 (73.3)	1725 (25.0)	1682 (24.4)	2811 (40.8)	1284 (17.7)
18–24	748 (62.6)	852 (71.3)	258 (21.6)	254 (21.2)	472 (39.8)	246 (19.1)
25–34	1486 (65.6)	1632 (72.0)	586 (25.9)	534 (23.6)	926 (40.9)	419 (17.5)
35–44	1189 (64.8)	1348 (73.5)	478 (26.1)	513 (28.0)	792 (43.2)	343 (18.0)
45–54	655 (62.7)	775 (74.2)	275 (26.3)	258 (24.7)	411 (39.3)	179 (16.3)
55–64	229 (61.9)	294 (79.5)	91 (24.6)	82 (22.2)	148 (40.0)	69 (17.9)
65+	95 (52.5)	152 (84.0)	37 (20.4)	41 (22.7)	62 (34.3)	28 (13.4)

*Suspected COVID-19 cases were defined by the MOH as having fever plus at least one sign or symptom of respiratory disease.
CLS/ILS, SARS-CoV-2-like/influenza-like symptoms; MOH, Ministry of Health.

Reported CLS/ILS signs and symptoms

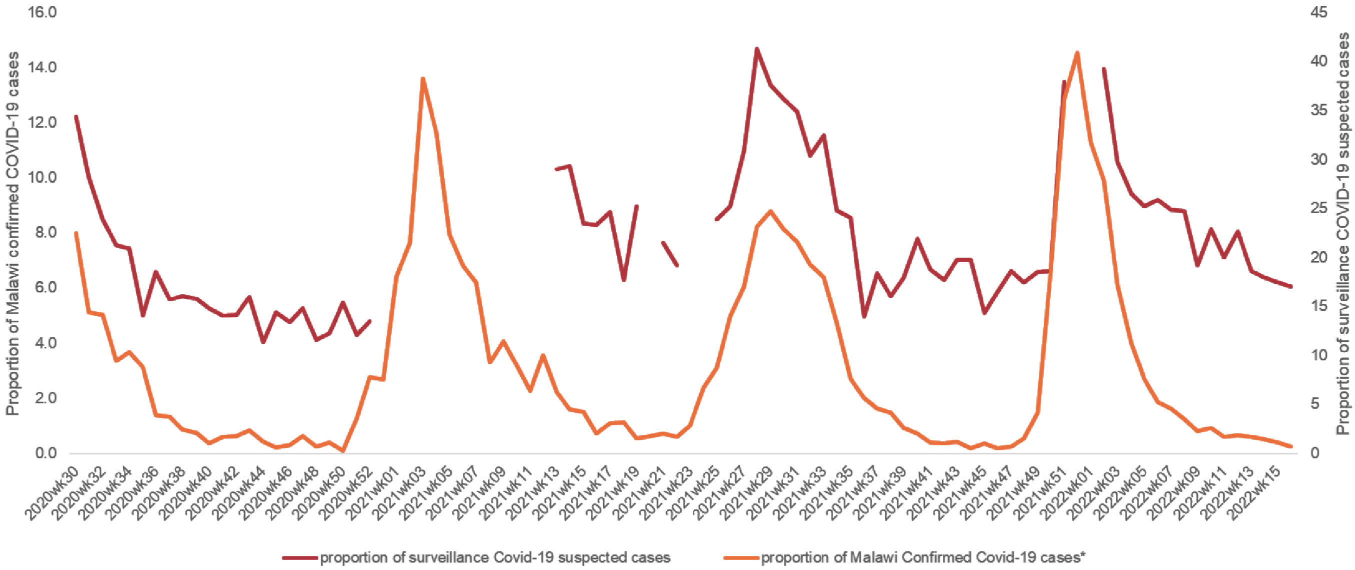
Among males, fever was reported by 63.3% of respondents while cough was prevalent in 72.0% of cases. Headache was reported by 24.4% of the respondents, and muscle aches were reported by 23.7%. A runny nose was noted in 41.0% of the cases. Suspected SARS-CoV-2 cases accounted for 17.8% of the reported cases in males (table 1).

Across the age groups, the prevalence of fever, cough, headache, muscle ache and runny nose generally followed a consistent pattern. Suspected SARS-CoV-2 cases varied across age groups, with the highest percentage observed in the 35–44 age group (18.3%). Among females, fever was reported by 65.1% of respondents, and cough was prevalent in 75.9% of cases. Headache was reported by 26.4% of the respondents, and muscle aches were reported by 25.7%. A runny nose was noted in 40.5% of the cases. Suspected SARS-CoV-2 cases accounted for 17.3% of reported cases among females. Similar to males, the prevalence of symptoms generally followed a consistent pattern across age groups among females. The number of suspected SARS-CoV-2 cases varied across age groups, with the highest percentage observed in the 35–44 age group (17.4%) (table 1).

When considering both sexes combined, fever was reported by 63.9% of respondents and cough was prevalent in 73.3% of cases. Headache was reported by 25.0% of the respondents, with a muscle ache in 24.4%. A runny nose was noted in 40.8% of the cases. Suspected SARS-CoV-2 accounted for 17.7% of the reported cases. Overall, the prevalence of symptoms remained consistent across the age groups when both sexes were combined. Suspected SARS-CoV-2 cases varied across age groups, with the highest percentage observed in the 35–44 age group (18.0%) (table 1).

Trends in surveillance of SARS-CoV-2 suspected cases

Figure 2 presents suspected SARS-CoV-2 cases identified through syndromic surveillance compared with confirmed SARS-CoV-2 cases reported in the Malawi National Data from the Public Health Institute of Malawi (PHIM).[13] In general, the surveillance trends in suspected cases mirrored the trend in confirmed cases, indicating a decline in cases after a June 2020



NB: *The gaps in the proportion of surveillance COVID-19 suspected cases were due to interruptions in data collection*

Figure 2 Proportion of suspected cases (syndromic surveillance) compared with the proportion of confirmed cases (national data): July 2020–April 2022.

peak when telephone surveillance started in July, and an increase in cases with what became the fourth wave in December 2021. During the data collection period, we experienced data collection interruptions at the selected time points due to protocol amendments in 2020, week 50 to 2021, week 7, 2021 and week 51, 2022 week 1, as observed in figure 2.

Of 7298 respondents who reported experiencing CLS/ILS, 12.8% (n=934) reported undergoing SARS-CoV-2 testing. Among them, 12.1% (581 of 2460) were male and 14.3% (353 of 4818) were female. Among those tested, 11.5% (107 of 934) tested positive for SARS-CoV-2. It is important to note that respondents awaiting test results were not included in these findings.

Reported household deaths

Survey respondents reported 2080 household deaths while the total national registered deaths in nationally registered deaths were 42 974, and of the reported deaths, 1093 (52.5%) in the survey and 26 099 (60.7%) in the EMRS were in males. Approximately one-third of the reported deaths (31.3%) in the survey and approximately a quarter (25.6%) in the EMRS occurred in individuals aged ≥65 years. Among the female deaths, 34.3% (n=339) in the survey vs 25.9% (n=4377) in the EMRS were aged ≥65 years, whereas among the male deaths, 28.6% (n=313) vs 25.4 (n=6628) were aged ≥65 years. We also noted varying distributions of deaths in all other age groups (0–4, 5–14, 15–34, 35–49 and 50–64) between the reported survey-reported household deaths and EMRS nationally registered deaths in 2022 (table 2).

Among the reported household deaths in the survey, 982 (47.2%) of the deceased household members were reported to have experienced CLS/ILS in the 2 weeks preceding their death (table 2). Of these individuals, 411/982 (41.9%) were tested for SARS-CoV-2, with 34.1% (140/411) reported to have tested positive.

Figure 3 compares the proportion of surveillance-reported household deaths based on the date of death with confirmed COVID-19 deaths from 1 January 2020 to 30 April 2022, as well as nationally registered deaths during the same period. The pattern of household deaths closely aligns with confirmed SARS-CoV-2 deaths from the Public Health Institute of Malawi (PHIM),[13] except from January to April 2020. Furthermore, the nationally reported all-cause-specific mortality largely approximates the pattern of confirmed SARS-CoV-2 deaths, with notable peaks observed in July 2020, January 2021, and July and August 2021.

DISCUSSION

This study shows that telephone syndromic surveillance is valuable for identifying the trends and peak phases of SARS-CoV-2 cases and deaths. Our survey yielded three key findings. The remote survey conducted via telephone successfully gathered essential data on the SARS-CoV-2 pandemic while adhering to social distancing guidelines. Second, the telephonic surveillance system effectively detected and characterised the second, third and fourth waves of SARS-CoV-2 infection by identifying increases

Table 2 Reported survey household deaths January 2020–April 2022 and EMRS national registered deaths in January 2020–April 2022 by age group, sex and CLS/ILS

Age group (years)	Survey reported household deaths January 2020–April 2022								EMRS national registered deaths January 2020–April 2022					
	Male		Female		Total		Reported CLS/ILS		Male		Female		Total	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
0–4	63	(5.8)	64	(6.5)	127	(6.1)	71	(7.2)	4970	(19.0)	4427	(26.3)	9397	(21.9)
5–14	54	(4.9)	51	(5.2)	105	(5.0)	49	(5.0)	1359	(5.2)	1002	(5.9)	2361	(5.5)
15–34	231	(21.1)	175	(17.7)	406	(19.5)	162	(16.5)	3479	(13.3)	2263	(13.4)	5742	(13.4)
35–49	230	(21.0)	183	(18.5)	413	(19.9)	213	(21.7)	6532	(25.0)	3229	(19.1)	9761	(22.7)
50–64	202	(18.5)	175	(17.7)	377	(18.1)	199	(20.3)	3131	(12.0)	1577	(9.3)	4708	(11.0)
65+	313	(28.6)	339	(34.3)	652	(31.3)	288	(29.3)	6628	(25.4)	4377	(25.9)	11 005	(25.6)
Total	1093	(52.5)	987	(47.5)	2080	(100.0)	982	(47.2)	26 099	(60.7)	16 875	(39.3)	42 974	(100)

CLS/ILS, SARS-CoV-2-like/influenza-like symptoms; EMRS, Electronic Medical Record System.

in self-reported CLS/ILS and trends in household deaths. Finally, a substantial proportion of reported household deaths exhibited CLS/ILS before death, indicating the potential under-reporting of SARS-CoV-2-related deaths.

We achieved a completion rate of 28% among active phone numbers, which aligns with a similar completion rate of 30% reported in an Australian study.[14] Furthermore, our survey demonstrated a high degree of representativeness, with a completion rate of 95% among eligible respondents aged 18 years and above who answered the calls. Although most respondents were male, this finding is consistent with the higher prevalence of mobile phone ownership among males in Malawi.[15] The regional distribution of the respondents mirrored the overall regional distribution of the Malawi population, further supporting the representativeness of the sample. We further assumed that there was a possibility that the respondents were concentrated in urban areas to align with the patterns of SARS-CoV-2 clusters observed in densely populated urban regions; however, we did not collect a variable to stratify our data by rural and urban areas.[16 17]

Our study findings demonstrated concordance between suspected SARS-CoV-2 cases identified through syndromic surveillance and confirmed cases reported by the Public Health Institute of Malawi (PHIM). These trends indicate a decline in the post-June 2020 peak, coinciding with the commencement of telephone surveillance in July, followed by a resurgence during the fourth wave in December 2021. However, it is important to acknowledge intermittent data interruptions during certain phases of data collection because of the protocol amendments that potentially influence surveillance accuracy and continuity. The syndromic surveillance system serves as a valuable proxy measure and predictor of SARS-CoV-2 wave cycles. Suspected cases based on surveillance also indicated that there may have been at least 10 times as many possible cases as the reported cases in the MOH system. During the surveillance period, there were 82 931 MOH-confirmed SARS-CoV-2 cases in a population of 19.89 million, resulting in an incidence of 417 per 100 000 population (0.42%). Applying the survey, an 11.5% estimated positivity rate to the symptomatic respondents gave 839 positive cases, suggesting an incidence rate of 0.84% (839/100 160), which is twice the official rate. Notably, our findings indicate a potentially higher incidence of SARS-CoV-2 than officially reported, consistent with worldwide assessments.[18–20] The availability of test kits, national testing guidelines and testing uptake influenced SARS-CoV-2 testing rates, and the limited availability of test kits during the surveillance period may have contributed to under-reporting.[21–24]

Our data suggest that SARS-CoV-2 deaths in Malawi are under-reported. Assuming that 6.7% of the reported deaths may have been SARS-CoV-2 related

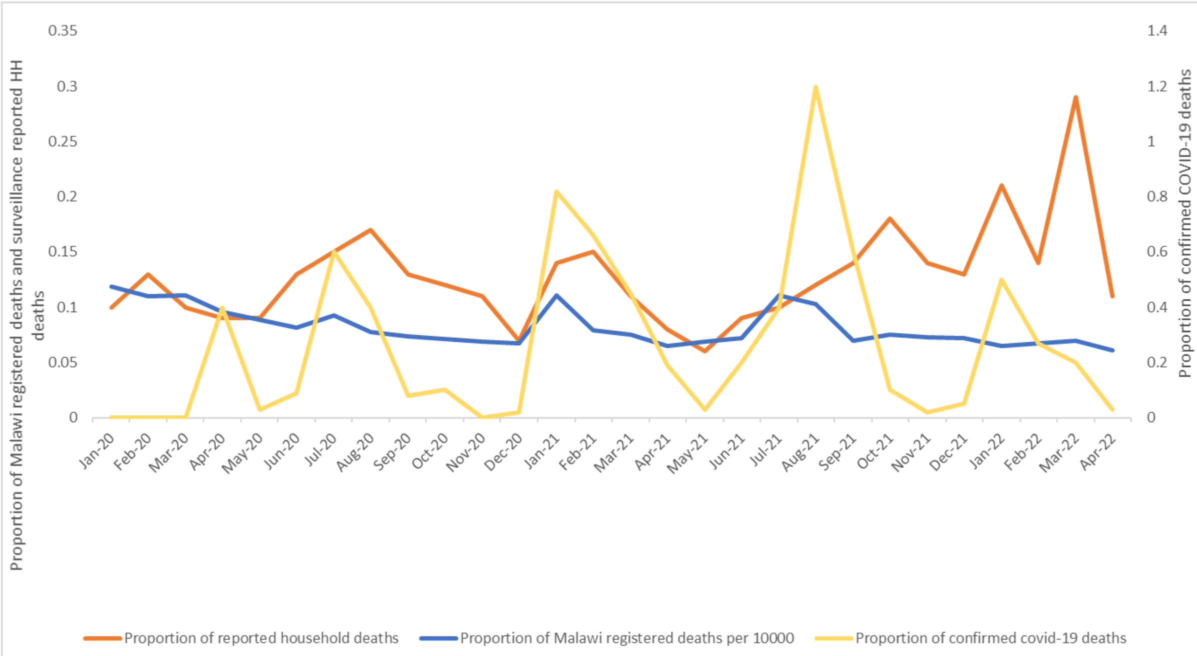


Figure 3 The proportion of surveillance-reported household deaths, nationally registered deaths per thousand and national COVID-19 confirmed deaths by month of death, January 2020–April 2022.[13]

(from our survey (140 reported testing positive of the 2080 reported deaths), we estimated that approximately 21 135 deaths from January 2020 to April 2022 may have been associated with SARS-CoV-2. However, this method has several limitations. Aside from the fact that this estimate is based on reported data from a population that may not be representative of the population of Malawi as a whole, the percentage estimated to have died from SARS-CoV-2 is based only on the number of persons with symptoms that were tested. This number excludes symptomatic patients who were not tested, a number that is likely to be larger than those tested given the constraints around testing and does not account for asymptomatic patients who may have died.[25] Therefore, our estimates may have underestimated the true number. In addition, respondents may not have been aware that the decedent was tested or of the results of the test.

With these considerations, our estimated deaths were nearly eight times higher than the 2634 confirmed SARS-CoV-2 deaths reported by April 2022.[26] A study in Zambia found that 19.2% of decedents at a university teaching hospital tested positive for SARS-CoV-2 postmortem. This was measured during the first (relatively small) SARS-CoV-2 wave in that country, and subsequent waves were much larger, which could have resulted in even higher proportions of deaths.[27] Under-reporting of SARS-CoV-2-related deaths has also been reported in Brazil, India, Turkey and the USA, with India under-reporting by a factor of six for the second wave.[28–31] The likelihood of under-reported SARS-CoV-2 deaths has also been reported in Kenya.[32] Our findings underscore the utility of telephonic surveillance as a feasible approach to better assess the mortality burden of SARS-CoV-2 in low-resource settings.[33]

We acknowledge the limitations of telephone surveillance for SARS-CoV-2. One significant limitation is the requirement for respondents to have access to a mobile phone, which may introduce a bias towards more economically active, urban and male populations.[34] This limitation may affect the generalisability of our findings to the entire population. Furthermore, including suspected cases involving other non-SARS-CoV-2 illnesses could lead to the overestimation of SARS-CoV-2 cases. The reliability of self-reported data, particularly regarding household deaths, CLS/ILS before death and SARS-CoV-2 testing, is uncertain and subject to potential reporting bias. Additionally, the completeness and comparability of the national death data with survey data may be compromised. National death data encompass all deaths from all causes, including SARS-CoV-2, making it challenging to accurately differentiate between SARS-CoV-2-related deaths. The interruption of data collection due to project suspension caused by resource constraints resulted in missing data during a significant wave of SARS-CoV-2 cases. This limitation may have affected the ability to capture the full extent of the pandemic's impact during that period.

Nevertheless, the strengths of this study include its large sample size and national approach, with calls made across the country. Over 138 000 calls were answered, and a high completion rate of 97% was achieved among eligible respondents who participated in the interviews.

This large-scale and comprehensive approach enhanced the robustness and reliability of the findings.

In conclusion, telephone surveillance for SARS-CoV-2 in Malawi demonstrated the feasibility and potential utility of this approach in responding to the SARS-CoV-2 epidemic in a low-resource setting. These findings provide valuable insights into the trends and burden of COVID-19 and emphasise the need for improved surveillance and reporting systems to ensure a more accurate estimation of the impact of the disease.

Author affiliations
[1]Elizabeth Glaser Pediatric AIDS Foundation, Washington, District of Columbia, USA
[2]Elizabeth Glaser Pediatric AIDS Foundation, Lilongwe, Malawi
[3]Public Health Institute of Malawi, Ministry of Health, Lilongwe, Malawi
[4]Ministry of Health Department of HIV and AIDS, Lilongwe, Central Region, Malawi
[5]US Centers for Disease Control and Prevention, Division of Global HIV and TB, Lilongwe, Malawi
[6]US Public Health Service Commissioned Corps, Rockville, Maryland, USA

X Thulani Maphosa @maphosat2011

Acknowledgements The work described in this poster was supported by the US President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC) under Cooperative Agreement U2UGH002010. The authors are grateful to the Government of Malawi for providing a platform for this syndromic surveillance system. We also gratefully acknowledge the support from the Malawi Ministry of Health Department of HIV/AIDS, the PEPFAR/CDC team in Malawi and Atlanta, and EGPAF Malawi for their technical role and leadership in establishing the syndromic surveillance system. We would like to express our sincere gratitude to all the survey respondents whose invaluable participation made this research possible. Additionally, we extend our thanks to the patient advisers for their valuable insights and contributions to this study.

Contributors GW made substantial contributions to the conception or design of the study, analysis or interpretation of data, critically revised the manuscript and approved the final version to be published. TM is the guarantor of the overall content of this publication, and he made substantial contribution to the conception or design of the study, analysis and interpretation of data. He critically revised the manuscript and approved the final version to be published. RM made substantial contributions to the study, including its conception, data collection or analysis, manuscript revision, and approval of the final version. AC-M contributed to the study process, including its conception, data interpretation, manuscript drafting and final approval of the manuscript. LM played a substantial role in the research, including the data interpretation, manuscript preparation or revision and final approval of the manuscript. SBZ made substantial contributions to the study process. He supported the design, manuscript drafting and revision and final approval of the manuscript. RKC contributed significantly to the study process, including its conception, manuscript revision, and final approval of the manuscript. RN made contributions to the study, manuscript preparation, revision and final approval of the manuscript. AA contributed significantly to the study, including its conception, manuscript drafting or revision, and final approval of the manuscript. EK made substantial contributions to the study, such as its design, manuscript preparation or revision and final approval of the manuscript. VS contributed significantly to the study, including its conception and final approval of the manuscript. AA made substantial contributions to the research, including its design and final approval of the manuscript. LoK contributed significantly to the study process, including data analysis and interpretation, manuscript drafting or revision, and final approval of the manuscript. LiK made substantial contributions to the study, including its design, data analysis or interpretation, manuscript preparation or revision, and final approval of the manuscript. AM contributed significantly to the research process, including its conception, data analysis or interpretation, critical manuscript revision and final approval of the manuscript.

Funding This surveillance work was supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC) under the Cooperative Agreement Number U2UGH002010.

Disclaimer Its contents are solely the responsibility of the authors and do not necessarily represent the CDC's official views. Its contents are solely the authors' responsibility and do not necessarily represent the official views of PEPFAR, the CDC or the US Public Health Service.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The survey was approved by the Malawi National Health Sciences Research Committee and Advarra Institutional Review Board (Protocol #20/06/2537). The Centers for Disease Control and Prevention reviewed and approved this project and determined that it would comply with all requirements of surveillance research. Verbal informed consent was obtained from all participants before conducting interviews to ensure that ethical standards were met throughout the surveillance.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data may be obtained from a third party and are not publicly available.

ORCID iD
Thulani Maphosa http://orcid.org/0000-0001-5164-8913

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