The prevalence and distribution of malaria in Mpumalanga Province before and during COVID-19 (2017 - 2022)

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Background. South Africa (SA) has committed to eliminating malaria by 2028. However, the initial target was set for 2023. Additionally, the ongoing COVID-19 pandemic and the emergence of drug and insecticide resistance have been identified as potential stumbling blocks in the achievement of this goal. The impact of COVID-19 on the prevalence and distribution of malaria in SA is unclear.
Objective. To describe the trends and distribution of malaria before and during the pandemic and its associated lockdown strategies in one of the country's malaria-endemic provinces, Mpumalanga Province.
Method. A descriptive, retrospective and cross-sectional study was conducted using Mpumalanga provincial malaria case data extracted from the provincial District Health Information System 2. The impact of COVID-19 on the prevalence and distribution of malaria was assessed in Mpumalanga Province between 2017 and 2022 using descriptive trend analysis. Malaria cases before (2017 - 2019) and post-COVID-19 (2020 - 2022) were cross-tabulated using Stata version 17. We used χ^2 tests to test for significant differences, set at $p<0.05$.
Results. During the study period, 25 380 malaria cases were reported, with the majority men (61%) >26 years old, with reported international travel, primarily to Mozambique. Limpopo Province (93%) accounted for most of the locally imported cases. Headaches and fever were the most common symptoms before and post COVID-19, while asymptomatic malaria carriage was higher during and post COVID ($p<0.05$). Prior to the pandemic reporting of the preferred treatment for uncomplicated malaria, Coartem use was at 53%, declining to 21% thereafter. Although COVID-19-related restrictions on human movement greatly reduced the malaria burden in Mpumalanga Province, the high-risk group (young mobile men) remained unchanged over the study period. Of concern were the marked reduction in the reporting of Coartem doses administered and the increased prevalence of asymptomatic carriage since 2020. The importation of malaria poses one of the biggest challenges to malaria elimination in Mpumalanga Province.
Conclusion. This study highlighted the impact of COVID-19 and its related lockdown restrictions on the delivery of malaria health services in Mpumalanga Province. If malaria elimination is to be achieved, all aspects of the malaria programme must be strengthened urgently. Additionally, the health system and cross-border collaborations must also be strengthened.

Keywords: *Coartem, primaquine, elimination, pandemic, imported, P. falciparum*

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Malaria is a preventable and treatable disease that continues to contribute to high levels of morbidity and mortality, predominantly in sub-Saharan Africa (SSA).[1] Following years of significant advances in the effective control of malaria in Africa, progress has plateaued and, in some cases, reversed since 2015. In 2021 there were an estimated 247 million cases of malaria and 619 000 malaria-related deaths, compared with the 214 million cases and 438 000 reported in 2015, with >90% of cases and deaths occurring in Africa.[2] Inconsistent funding with reallocation of resources towards COVID-19, and the emergence of drug and insecticide resistance, have been identified as key factors that contribute to this progress reversal.[3,4]

With the ongoing COVID-19 pandemic caused by the new coronavirus, SARS-COV-2, placing an increased burden on already severely stretched health systems, there were fears that the delivery of essential malaria services would be adversely affected, reversing the progress made against malaria even further. Mathematical models predicted a sharp increase in malaria cases, with at least a doubling of malaria-related deaths in 2020 compared with 2018.[5] Although COVID-19-linked disruptions in malaria services did not lead to a doubling of malaria-related deaths, they resulted in significant increases in cases and deaths in 2020.[6] The Essential Health Services (EHS) pulse survey (round 3) completed in the World Health Organization (WHO) Africa Region reported that disruptions in diagnoses and treatment failures decreased markedly at the end of 2021 v. the first half of the year, with only 7 countries reporting failures, v. 16 in 2020 and 9 in early 2021.[7]

Worldwide, various public health interventions were implemented to contain and mitigate the morbidity and mortality associated with COVID-19.[8] Unintentional impacts of these mitigation strategies included resource remobilisation toward the pandemic response, and notable disruptions in service delivery and supply chains, especially in low- to middle-income countries within SSA.[8] A systematic review of malaria resurgence between the 1930s and 2000s revealed that resource constraints significantly contributed to malaria rebounding.[8] Globally, malaria-related deaths reduced between 2000 and 2019. However, in 2020 there was a 12% increase in deaths from 558 000 (2019) to 627 000 (2020), with 47 000 of the additional 69 000 deaths attributable to pandemic-related disruptions.[7,9,10] The disruptions caused by the COVID-19 pandemic affected all key priority areas of malaria disease control, including case management and vector control.[7,9,10] The intraperitoneal potential for malaria transmission and vector drug resistance accounted for 59% and 32%, respectively.[8] This highlights the critical role of strengthening post-pandemic malaria control.[8]

In line with the Global Technical Strategy for Malaria, all malaria-endemic countries, irrespective of transmission intensity, are working towards malaria elimination.[5,9,11] However, challenges such as emerging antimalarial drug resistance are threatening the success of these efforts.[5,9,12] To address these concerns, new antimalarial drugs are being developed; however, the process of getting these novel products to market is very time-consuming.[6,10,12] It is, therefore, crucial that current, accurate information on the prevalence, distribution and resistance status of the malaria parasite is available, to guide effective case management interventions' selection and implementation.

South Africa (SA) was one of the African countries most affected by the COVID-19 pandemic, accounting for ~48% of all cases in Africa, reporting 4 045 262 cumulative cases and 102 568 deaths.[13,14] The pandemic and its associated restrictions compromised the delivery of essential HIV and tuberculosis health services.[15-17] However, the impact of COVID-19 on the prevalence of malaria in the three malaria-endemic provinces, KwaZulu-Natal, Limpopo and Mpumalanga (Fig. 1),[20] and the country's elimination aspirations, are less clear. SA officially transitioned from a control to an elimination agenda in 2012, intending to eliminate malaria in 2018, but owing to several challenges, the elimination target date was moved to 2028.[18-21]

Strategic goals in the 2019 - 2023 Strategic Elimination Plan include effective management, leadership and co-ordination for the implementation of malaria elimination interventions at all levels by 2020, strengthening and maintaining malaria surveillance to facilitate 100% case reporting within 24 hours by 2020. The goals also included ensuring that 90% of the population living in endemic areas receive information and educational communication messages by 2023, protecting at-risk populations by ensuring at least 95% coverage of vector suppression strategies and interventions between 2019 and 2023, and finally ensuring universal access to diagnosis and treatment in endemic and non-endemic areas according to guidelines.[18,20,21]

This study aimed to describe the prevalence and distribution of malaria in Mpumalanga Province before and during COVID-19 and its associated lockdown restrictions, at a district level, from 2017 to 2022, with the ultimate objective of informing policy-makers on targeted post-COVID-19 malaria control strategies.

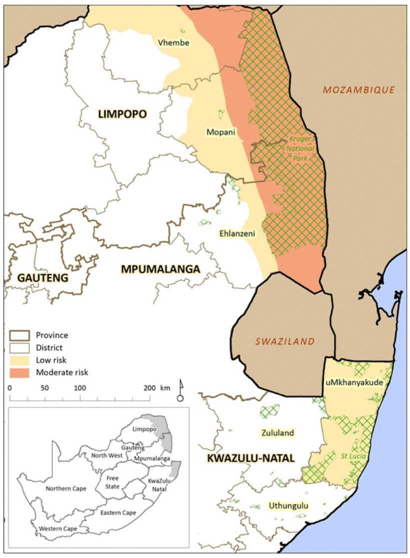

Fig. 1. Distribution risks of malaria transmission in South Africa.

Methods

Study setting

SA has three malaria-endemic provinces, Mpumalanga, KwaZulu-Natal and Limpopo[20] (Fig. 1). They are low-altitude regions with an estimated 10% of the country's population residing in these endemic areas.[20,21] Malaria is seasonal, peaking during the hot wet months from September to May (highest between December and February). Previously, *Anopheles arabiense* was the dominant vector, with *Plasmodium falciparum* responsible for most malaria infections in the country. However, a recent malaria vector surveillance report revealed that a secondary vector, *A. merus*, was now the dominant vector species in Mpumalanga Province.[21-23]

The study was conducted using malaria data from Mpumalanga Province. The province has three districts, Ehlanzeni, Gert Sibande and Nkangala, with the Ehlanzeni district most affected by malaria due to its proximity to malaria-endemic neighbouring countries, Mozambique and Eswatini.[24] Ehlanzeni District is located in the north-east part of the province and shares a provincial border with Limpopo Province. Currently, the first-line regimen for the treatment of malaria in Mpumalanga Province is artemether-lumefantrine, more commonly known as Coartem.[25,26]

Study population and sample

The study population was all available malaria cases reported to the District Health Information System 2 (DHIS2) between January 2017 and December 2022. This is routinely collected data of all patients who tested positive for malaria. DHIS2 is the malaria information system (MIS) used by the malaria control programmes in the three malaria-endemic provinces.

Data collection

The secondary malaria case data from the DHIS2 were requested from the Mpumalanga Province Malaria Control Programme. For trend comparison, COVID-19 case data were requested from the National Institute for Communicable Diseases (NICD). The COVID-19 data spanned from March 2020 to December 2022. The malaria data were received as a line list in Excel (Microsoft, USA) format, while the COVID-19 data were received as aggregated daily case counts, also in Excel format.

Data management and analysis

Data, de-identified, cleaned and coded in Excel 2016 were imported into Stata 17 statistical software (StataCorp., USA) for downstream analysis. Descriptive analysis using summary statistics was performed to describe the sociodemographic characteristics of the malaria cases. Malaria cases in the pre- and post-COVID-19 periods were cross-tabulated, and tests of association were used to see if there were statistically significant differences between the pre- and post-COVID-19 periods. The Pearson χ^2 test was performed using each sociodemographic characteristic (e.g. district or case classification) as the independent variable, and the number of cases in the pre- and post-COVID-19 period as the dependent variable. $P<0.05$ was considered a statistically significant difference. Owing to the unavailability of population denominator data, the prevalence of malaria was inferred (using inferential statistics) as the actual number of reported malaria cases.

Pre- and post-COVID-19 trend analysis

Descriptive trend analysis was conducted by comparing malaria cases reported before COVID-19 (January 2017 and February 2020) to those reported during and post COVID-19 (March 2020 - December 2022), from here on referred to as post COVID-19, taking the different lockdown restrictions (Table 1) into consideration. Lockdown levels ranged from 5 (most stringent) to 1 (least stringent). During this period, wearing of masks was mandatory, and hand washing was encouraged. Trends were descriptively analysed using line graphs to identify major changes (increase or decrease) corresponding to events such as the first case of COVID-19, a surge in COVID-19 cases, or changes in lockdown restrictions. To enhance the reliability of the trend analysis, the expected seasonal case trends were also considered when estimating the impact of the aforementioned events.

Ethical clearance

The study was conducted with ethical approval from the University of Pretoria Faculty of Health Sciences Research Ethics Committee (ref. no. 718/2023), the University of the Witwatersrand Human Research Ethics Committee (Medical) (ref. no. M2011124) and Mpumalanga Province Health Research Ethics Committee (ref. no. MP_202402_003).

Results

A total of 25 380 malaria cases were reported in Mpumalanga Province over the study period, 19 625 before the COVID-19 pandemic (January 2017 - February 2020) and 5 755 during and after the COVID-19 pandemic (March 2020 - December 2022). The majority of cases were notified in Ehlanzeni district both before (19 027/19 625, 97%) and post COVID-19 (5 604/5 755, 98%) and managed as outpatients (15 460/19 625; 79%; 5 157/5 755, 90%) with favourable survival outcomes (19 359/19 625, 99%; 5 704/5 755, 99%). Additionally, men (11 994/19 625, 61%; 3 560/5 755. 62%) >26 years of age (9 861/19 625, 50%; 2 784/5 755, 48%), with a history of recent travel (13 294/19 625, 68%; 4 557/5 755, 79%) were the population most at risk both before and post COVID-19 (Table 2).

Table 1. Travel restrictions imposed during the different lockdown levels during COVID-19 in South Africa

Level	Relevant restrictions
Level 1	Some restrictions on international travel
Level 2	Closed land borders except for some, domestic flights allowed
Level 3	Restricted domestic air travel
Level 4	Closed borders for international travel, domestic air travel prohibited
Level 5	Travel between provinces, metropolitan areas and districts prohibited unless proven essential

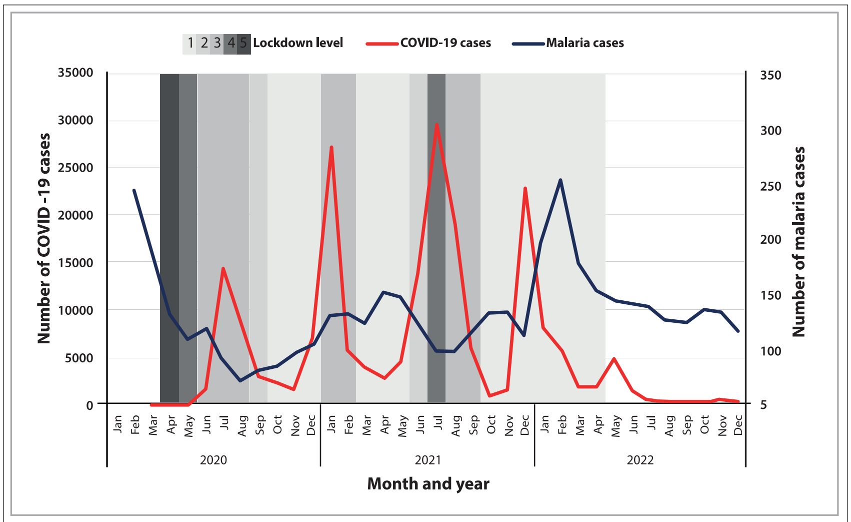

Fig. 2. Malaria and COVID-19 cases, n, in Mpumalanga Province between 2020 and 2022 across the different lockdown restriction levels.

Headaches (2 877/19 625, 49%; 2 264/5 755, 41%) and fever (559/19 625, 10%, 501/5 755, 9%) were the most common symptoms before and post COVID-19, while asymptomatic malaria carriage was higher post COVID-19 (965/5 755, 18%). The recommended first-line treatment Coartem (10 307/19 625, 53%) was reported more frequently pre COVID-19 compared with during and post COVID-19 (1 234/5 733, 21%). Reporting on the administration of the transmission-blocking drug primaquine increased from 10% (2 033/19 625) pre COVID-19 to 36% (2 047/5 755) post COVID-19. More detailed sociodemographic characteristics are reported in Table 2.

The COVID-19-related restrictions impacted the number (Fig. 2) and types (Fig. 3) of malaria cases reported in Mpumalanga Province over the study period. The implementation of the most stringent restrictions on movement in March 2020 prevented the expected post-Easter uptick in malaria case numbers (Fig. 2). As COVID-19 case numbers surged during the first wave in the winter months of 2020, malaria cases in the province dropped to their lowest level for that year (Fig. 2). Throughout the pandemic, the number of malaria cases fluctuated in response to the varying levels of lockdown restrictions and changes in COVID-19 case numbers. An unprecedented decline in malaria cases was seen when higher levels of lockdown measures were enforced, or when there was a surge in COVID-19 cases, or both. Conversely, noticeable increases in malaria cases coincided with lower lockdown restrictions or a decline in COVID-19 cases. For instance, after the easing of lockdown restrictions between December 2021 and March 2022 (Fig. 2), there was an upswing in malaria cases. This period, however, also coincided with the expected seasonal increase associated with wet summer months.

During the COVID-19 pandemic and its associated lockdown restrictions, a distinct disparity emerged between the trends of imported malaria cases and local malaria cases (Fig. 3). Following the imposition of level 5 restrictions in March 2020, numbers of both imported and local cases declined (Fig. 3). However, as the lockdown restrictions eased from late 2020 to mid 2021, the number of imported cases increased (Fig. 3). Throughout the pandemic, the number of imported malaria cases was consistently higher than the number of local cases. The largest upswing in imported cases was observed between December 2021 and March 2022. Subsequently, following this peak in imported cases, a decline was

Table 2. Sociodemographic characteristics of malaria cases reported in Mpumalanga Province, South Africa, between 2017 and 2022

Characteristic	Overall patients enrolled, *n* (%) 2017 - 2019 (*n*=19 625)	2020 - 2022 (*n*=5 755)	*p*-value
District			
Ehlanzeni	19 027 (97)	5 604 (98)	<0.001
Gert Sibande	317 (2)	60 (1)	
Nkangala	249 (1)	82 (1)	
Age group (years)			
≤5	2 332 (12)	678 (12)	<0.001
>5 - 25	7 423 (38)	2 197 (38)	
≥26	9 861 (50)	2 784 (48)	
Unknown	9 (0)	96 (2)	
Sex			
Male	11 994 (61)	3 560 (62)	<0.001
Female	7 631 (39)	2 195 (38)	
Admission status			
Inpatient	3 943 (20)	571 (10)	<0.001
Outpatient	15 460 (79)	5 157 (90)	
Unknown	222 (1)	27 (0)	
Outcome			
Died	149 (1)	44 (1)	<0.001
Survived	19 359 (99)	5 704 (99)	
Unknown	117 (1)	7 (0)	
Travel history			
No	6 331 (32)	1 198 (21)	<0.001
Yes	13 294 (68)	4 557 (79)	
NMC class-based classification			
Imported	12 394 (63)	4 436 (77)	<0.001
Local	6 020 (31)	1 105 (19)	
Locally imported	806 (4)	93 (2)	
Unknown	405 (2)	121 (2)	
Pregnancy status			
No	4 563 (27)	1 312 (26)	<0.001
Yes	329 (2)	114 (2)	
Unknown	73 (0)	57 (1)	
n/a	11 998 (71)	3 563 (71)	
Citizenship			
South Africa	1 660 (8)	1 353 (24)	<0.001
Mozambique	4 191 (21)	3 654 (63)	
Other	13 774 (70)	748 (13)	
South African citizen/permanent resident			
Yes	1 817 (9)	1 523 (26)	<0.001
No	4 491 (23)	4 133 (72)	
Unknown	13 317 (68)	99 (2)	
Symptoms			
Asymptomatic	441 (8)	965 (18)	<0.001
Body pain (abdominal/rigors/joints)	374 (6)	285 (5)	
Chills/shivering	33 (1)	30 (1)	
Diarrhoea	62 (1)	28 (1)	
Dizziness	50 (1)	36 (1)	
Febrile illness/hot body	111 (2)	100 (2)	
Fever	559 (10)	501 (9)	
Flu-like symptoms	39 (1)	27 (0)	
Headache	2 877 (49)	2 264 (41)	
Loss of appetite	182 (3)	230 (4)	
Other	134 (2)	133 (2)	
Tiredness/body malaise	510 (9)	406 (7)	
Vomiting	441 (8)	496 (9)	
Unknown	0 (0)	0 (0)	

...continued

Table 2. (continued) Sociodemographic characteristics of malaria cases reported in Mpumalanga Province, South Africa, between 2017 and 2022

Characteristic	Overall patients enrolled, *n* (%) 2017 - 2019 (*n*=19 625)	2020 - 2022 (*n*=5 755)	*p*-value
Treatment given			
ACT/Coartem	10 307 (53)	1 234 (21)	<0.001
Artemether-lumefantrine	44 (0)	14 (0)	
Artesunate (IV)	1 007 (5)	271 (5)	
No primaquine, no coartem	1 (0)	8 (0)	
Panado	540 (3)	457 (8)	
Primaquine	2 033 (10)	2 047 (36)	
Quinine (IV)	2 433 (12)	50 (1)	
Quinine (oral) and Doxycycline	10 (0)	2 (0)	
Other	249 (1)	1 029 (18)	
Unknown	3 001 (15)	643 (11)	
Source of imported case (country)			
Mozambique	12 040 (61)	4 236 (74)	<0.001
Other	7 585 (39)	1 519 (26)	
Source of local imported case (province)			
Gauteng	2 (0)	1 (2)	<0.001
KwaZulu-Natal	4 (0)	2 (5)	
Limpopo	799 (98)	38 (88)	
Mpumalanga	7 (1)	2 (5)	
Western Cape	1 (0)	0 (0)	

NMC = notifiable medical condition; IV = intravenous, ACT = artemisinin-based combination therapy.

observed from March 2022 to October 2022, before the seasonal increase in cases began (Fig. 3).

Following the onset of COVID-19, there was a notable reduction in the average number of reported malaria cases across all three districts of Mpumalanga Province (Fig. 4). The trend clearly demonstrates a sharp decline in case numbers immediately after SA's first COVID-19 case was diagnosed in March 2020. Particularly noteworthy is the larger drop in malaria cases in Ehlanzeni district during this period. Subsequently, the decreased number of cases persisted in Ehlanzeni district until the end of 2021, after which a minor upsurge was observed. Although all three districts experienced sharp increases in malaria cases during the post-COVID-19 period, these sharp increases were considerably smaller than those observed in the pre-COVID-19 period. Even though the Nkangala and Gert Sibande districts report much lower numbers of cases compared with Ehlanzeni district, both of these districts experienced larger spikes in malaria cases during the post-COVID-19 period in comparison with Ehlanzeni District (Fig. 4).

Discussion

In this study, we found that Mpumalanga Province reported a significant decrease in malaria cases during the COVID-19 pandemic. Most of the malaria cases reported during the study period were among men >26 years of age with a travel history outside the province, and were classified as imported. Before the COVID-19 pandemic malaria cases were imported from a number of different African countries, but after the COVID-19 pandemic, the majority of the imported cases were from Mozambique. Throughout this study, locally imported cases were predominately from Limpopo Province, SA's highest malaria-burdened province.[23]

The COVID-19 pandemic had far-reaching effects on already weakened health systems, particularly in low- and middle-income countries.[27,28] Malaria elimination efforts across the globe were adversely affected by human resources, medicines and products, and funding limitations. A study from Uganda reported a modest decline in the proportion of rapid diagnostic tests (RDT) used for malaria diagnosis, and a decrease in the mean proportion of cases prescribed artemether-lumefantrine in the second half of the pandemic year.[29]

Furthermore, a 10% increase in malaria prevalence was associated with a 28% decrease in the cumulative incidence of COVID-19.[30]

Throughout the study, men of working age were more affected by malaria compared with females. Other studies in Africa have shown that men are at a higher risk for malaria than women.[31] This could be because men are more involved in outdoor activities than women in many communities, and their activities often progress into dusk or night, which are high-risk times for malaria exposure through mosquito bites. Many women stay home to take care of the house. Furthermore, males are mobile and often travel to areas, including malaria-endemic areas, in search of work.[32]

SA's government had an urgency in responding to the pandemic once the first case of COVID-19 was diagnosed on 5 March 2020. Strict lockdowns followed from 26 March 2020, with varying levels ranging from 5 (most stringent) to 1 (least stringent), which governed both international and interprovincial travel and increased port health services. This had a marked impact on the number of malaria cases in the study, as the vast majority of the cases in Mpumalanga Province are imported from other countries, including Mozambique. Although this remained true throughout the pandemic, the cumulative incidence declined between 2020 and 2022. These findings can be supported by similar studies reporting a decline in the number of imported cases during and after the pandemic in the three endemic provinces, with a notable decrease in cumulative cases in Mpumalanga and Limpopo provinces.[33] Similar findings were also described in a study in Cabo Verde where the cessation of international travel reduced the risk of imported cases and undetected transmission.[34] Furthermore, SA's malaria season is generally between September and May, leading to an expected decline in malaria cases outside this season.

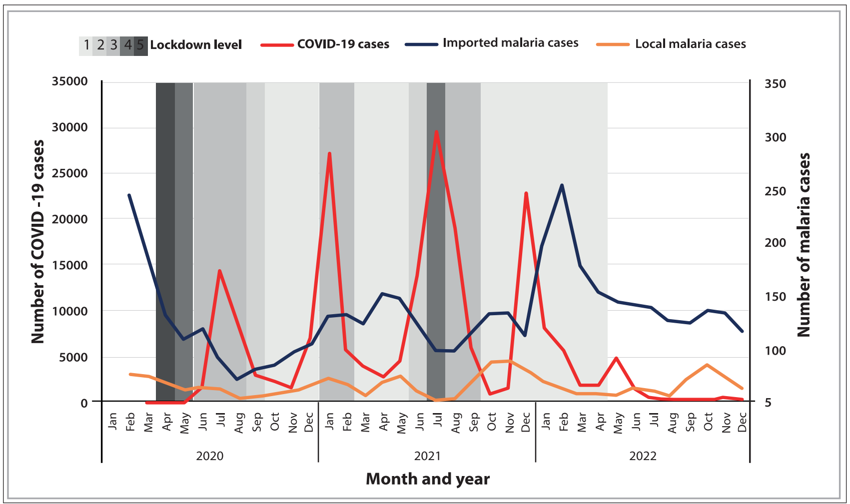

Fig. 3. Malaria and COVID-19 cases, n, *in Mpumalanga Province between 2020 and 2022, by case classification (imported v. local) across the lockdown restriction levels.*

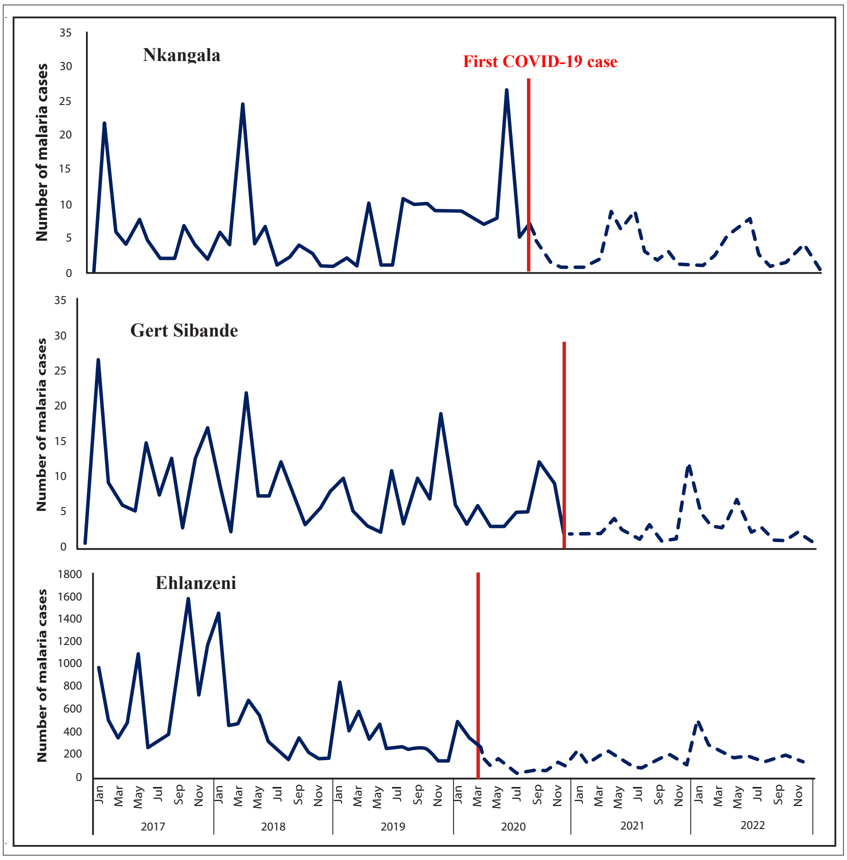

Fig. 4. Malaria cases, n, *in the three districts of Mpumalanga Province, before and after the start of COVID-19 in South Africa, 2017 - 2022.*

The study revealed that the most common symptoms for those with malaria between 2017 and 2022 were fever and headaches. This is in line with other studies in SSA which have found that fever, headaches, chills, myalgia and vomiting are the most common symptoms that individuals will usually present with.[35] Due to the similarity of symptoms between malaria and COVID-19, especially fever, fatigue and acute-onset headache, a malaria patient may be misdiagnosed based on clinical suspicion at the time as COVID-19, and vice versa.

Due to the similarities in the symptom profile of malaria and COVID-19, it is important to understand the respective case definitions and diagnostic criteria for each disease. The suspected case definition for malaria is an acute febrile flu-like illness in a person with a history of travel to or who resides in a malaria-endemic area, while a case is confirmed by a malaria antigen RDT or microscopic examination of thick and thin blood smears.[36] Malaria treatment can only be administered following parasitological confirmation by RDT or microscopy.[37]

The suspected case definition for a symptomatic COVID-19 patient is any person presenting with an acute (≤10 days) respiratory tract infection or other clinical illness compatible with COVID-19.[38] Other symptoms may include headache, fever, rhinorrhea, weakness, myalgia and diarrhoea.[38] The recommended diagnostic criteria for COVID-19 included a real-time reverse transcription polymerase chain reaction test or a COVID-19 RDT.[38,39] In the case of lower resource settings where no COVID-19 diagnostics are available, the decision to treat the patient for COVID-19 should be made clinically, and appropriate monitoring, follow-up and referral should be considered.[38,39]

During the peak of the COVID-19 pandemic, a high index of suspicion was skewed toward COVID-19 (especially during a wave of COVID-19 cases), leading to the possibility of fewer cases of malaria being diagnosed if symptoms alone were used to define a case without following up with appropriate tests.[35,40] Therefore, the availability of appropriate diagnostic capacity is essential for accurate surveillance and clinical management of cases.[40] Interestingly, the proportion of asymptomatic malaria carriers increased significantly from 8% in 2017 - 2019 to 18% in 2020 - 2022. Despite this increase, the overall value was still much lower than the proportions of asymptomatic carriers found in other endemic regions of the SSA.[41] This is less than the prevalence of asymptomatic malaria found in a study[41] carried out in Cameroon, where 27% of the participants were found to be asymptomatic carriers. Fewer people might have reported to health facilities during the pandemic, and studies found that patients were less likely to report symptoms such as fever and headache owing to disrupted access to healthcare facilities and fear of stigmatisation.[42]

The recommended treatment for patients with uncomplicated malaria in SA is the fixed-dose artemisinin-based combination therapy, artemether-lumefantrine, trade-name Coartem, with intravenous artesunate recommended for complicated malaria.[25,27,43] In eliminating districts, the gametocytcidal, single-low dose primaquine is prescribed with Coartem to reduce the chances of onward transmission. There was a notable decrease in the reported use of Coartem over the study duration. In contrast, reported primaquine use increased. It is likely that this was a result of a reporting bias, as primaquine use must be reported to the SA Health Products Regulatory Authority as part of section 21 approval for its use.

Strengthening and improving resilience are critical in the post-COVID-19 era to ensure that the impacts on health systems are not as significant as they were during the COVID-19 pandemic.[44,45] Pandemic preparedness and response planning are important components of epidemic preparedness.[44,45] In December 2021, the World Malaria Report reflected on the unique challenges in the global malaria community and the impact of the pandemic on the progress towards malaria elimination. Across the world, resource-limited countries, including SA, had to redistribute valuable resources to meet their pandemic response needs.[46] The 2023 World Malaria Report found 249 million malaria cases in 2022 (5 million higher than 2021), with Africa still accounting for 94% of cases globally.[47] Owing to the slow progress in malaria elimination, the WHO Global Malaria Programme released a departmental operational strategy for the period 2024 - 2030 to strengthen global malaria elimination efforts.[47]

The pandemic affected the foundations of effective health systems.[42] Service delivery was negatively impacted by lockdown measures, psychosocial barriers and accessibility challenges.[3,42,45,48] The healthcare workforce was reallocated and redistributed in accordance with the pandemic response plan. This may have reduced communities' access to healthcare while increasing the perceived risk of contracting COVID-19.[3,42,45,48] Lockdown measures adversely affected the manufacturing and distribution of medicines, medical consumables and vaccines, and delayed turnaround times for essential medical tests.[3,42-49]

The unauthorised use of antimalarial drugs for the prevention and treatment of COVID-19 also influenced the availability of antimalarials, and could have potentially contributed to the emergence of antimalarial drug resistance.[3,50] The redistribution of funds from other health programmes, including malaria, towards the pandemic response negatively impacted some malaria control programmes.[3,42,46] Vector control activities in SA, particularly indoor residual spraying activities, were reduced due to the perceived heightened risk of contracting and transmitting COVID-19.[51] However, the use of health information to address malaria in the middle of the pandemic proved valuable in many countries where targeted communication, social networks and text messaging were successful in reminding communities of the risk of malaria in endemic areas, including health education provided by community healthcare workers, which led to an increase in health-seeking behavior in some countries such as Rwanda and Cambodia.[41,52]

Limitations

The study had a few limitations that must be taken into consideration when interpreting the findings. Firstly, the unavailability of data on the population at risk for malaria in Mpumalanga Province, which needs to be used as the denominator, restricted the ability to calculate the actual disease prevalence. As a result, prevalence estimates were derived solely from the reported case numbers, which might not provide the most accurate representation. Secondly, the analysis was limited to testing statistical differences between the pre- and post-COVID-19 periods and conducting descriptive trend analysis. The use of interrupted time series analysis, which could have provided more robust insights, was not done owing to dataset constraints. Furthermore, it is important to acknowledge that the study's exclusive focus on Mpumalanga Province limits the generalisability of the findings to other malaria-endemic provinces in SA. Lastly, potential bias cannot be excluded owing to the uncertainty of the number of malaria cases that might have been missed due to the nature of the public health emergency at the time, which could have affected clinical suspicion.

Conclusion

The restrictions on cross-border movement greatly reduced the number of malaria cases reported in Mpumalanga Province. Case numbers began increasing as the restrictions on travel eased. If Mpumalanga Province is to eliminate malaria, the healthcare system must be strengthened to detect and effectively treat imported cases before they seed secondary local transmission. Strengthening all facets of the health system, from surveillance to prompt accurate reporting, is essential for the resilience and sustainability of the malaria control programme towards the goal of elimination. Cross-border and intersectoral engagement are necessary to address the issue of malaria importation, and strengthening border malaria control through port health services will greatly impact the control of malaria in SA.

Data availability. The datasets generated and analysed during the current study are not publicly available; however, they can be made available by the corresponding author on reasonable request.

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