A review of malaria trends in South Africa for the 2022-2023 malaria season based on the Notifiable Medical Conditions Surveillance System

Maxwell Mabona[1]*, Ramokone Ednah Baloyi[2], Mbavhalelo Bridget Shandukani[2], Mabatho Mogadime[2], Sadiq Wanjala[3], Jaishree Raman[1, 4, 5]*

[1]Centre for Emerging Zoonotic & Parasitic Diseases, National Institute for Communicable Diseases, a division of the National Health Laboratory Service, Johannesburg, South Africa

[2]National Department of Health, Pretoria, South Africa

[3]Clinton Health Access Initiative, Pretoria, South Africa

[4]Wits Research Institute for Malaria, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, South Africa

[5]UP Institute for Sustainable Malaria Control, University of Pretoria, Pretoria, South Africa

*Authors for correspondence

Summary

In South Africa, where malaria transmission is seasonal, a retrospective review of case data collected throughout a malaria season is crucial. Information on case trends, patterns, and distribution from such reviews allows malaria programmes to make evidence-based decisions on the targeting of control interventions for the upcoming season. This report reviews malaria case notification data from the 2022–2023 season, collected by the Notifiable Medical Conditions Surveillance System (NMC-SS). It also compares these data with data from the endemic provinces' District Health Information System 2 (DHIS2) during the same reporting period.

A total of 5 813 case notifications, 4 137 from endemic provinces and 1 676 from non-endemic provinces, were captured through the NMC-SS between September 2022 and August 2023. The majority of case notifications were among males (61%, 3 574/5 813) aged between 20 and 39 years. Over the review period, 49% of the case notifications came from the malaria-endemic Limpopo Province (2 845/5 813), with the Vhembe (1 280/2 845) and Mopani (1 153/2 845) districts being the most affected. The non-endemic province of Gauteng (19%, 1 095/5 813) reported more cases than the malaria-endemic provinces of Mpumalanga (15%, 868/5 813) and KwaZulu-Natal (7%, 424/5 813). Malaria case notifications peaked in January and late April following the return of people from December and April holiday-related travel, respectively. Severe malaria affected approximately 1 197 of the case notifications, and the recommended first-line intravenous treatment, intravenous artesunate, was used to treat the majority of them (94%, 1 129/1 197).

The NMC-SS only captured 66% (4,137/6,251) of cases from the three endemic provinces compared to DHIS2 for the 2022–2023 season. However, the trends, patterns, and distribution of cases were similar across both sources and to previous malaria seasons. Endemic districts in Limpopo, Mpumalanga, and KwaZulu-Natal provinces, which share borders with neighbouring malaria-endemic countries, continue to account for the majority of case notifications. This highlights the importance of continuing to target these areas for interventions and sustaining malaria surveillance along their borders. The peaks in malaria case notifications following the December and April holidays emphasise the need for increased malaria awareness communication during these periods. The data quality of the NMC-SS needs strengthening to ensure all data fields are completed. As the notification of cases from the endemic provinces to the NMC-SS is currently suboptimal, efforts to merge malaria case data from the NMC-SS and DHIS2 platforms are a priority.

Introduction

Malaria is a mosquito-borne parasitic disease that remains a major public health problem despite being preventable and treatable.[1] The World Health Organization (WHO) has identified several challenges that contribute to this ongoing problem, including climate change, reduced funding, ongoing conflicts, and suboptimal implementation of essential interventions.[2] There were five million more malaria cases in 2022 compared to 2021 globally, bringing the total to 249 million cases in 2022, with Africa accounting for 94% of them.[2,3] South Africa is located on the southernmost edge of malaria distribution in Africa, with endemic transmission restricted to low-altitude border regions of Limpopo, Mpumalanga, and KwaZulu-Natal provinces. Malaria transmission is seasonal in South Africa, with the high transmission period normally commencing in September and ending in May. Malaria case numbers generally peak after the December and April holidays.[4] South Africa is actively working towards eliminating malaria, and one key component of the elimination strategy is the use of accurate case surveillance data to inform the targeting of control and elimination interventions.[5]

The provincial malaria control programmes in the three endemic provinces and communicable disease control (CDC) departments in non-endemic provinces primarily conduct malaria case surveillance. The National Institute for Communicable Diseases (NICD) supports this surveillance by managing the Notifiable Medical Conditions Surveillance System (NMC-SS). Malaria is a category 1 notifiable medical condition in South Africa, requiring healthcare professionals from both the public and private sectors to notify cases within 24 hours of diagnosis.[6] After confirming a malaria infection by a rapid diagnostic test or microscopic examination of a blood smear, healthcare professionals are expected to notify the case through the Notifiable Medical Conditions (NMC) application or the paper-based NMC notification form.

In addition to being captured in the NMC-SS, case notification data should also appear in the main Malaria Information System (MIS), accessed through the District Health Information System 2 (DHIS2) platform. The MIS, managed by the national and provincial malaria control programmes, also includes data on foci investigation, vector control, health promotion, and other key elimination indicators.[5] The NMC-SS malaria data for endemic provinces has some limitations that result from delayed and under-reporting. It is thus important to compare NMC-SS data with DHIS2 data for these provinces to get a more accurate picture of malaria case numbers.

A regular retrospective review of data collected throughout a malaria season enables control programmes to use the information on case trends, patterns, and distribution for evidence-based decision-making in terms of intervention selection and implementation for the upcoming season. This review reports on malaria trends based on case notification data extracted from the NMC-SS for the 2022–2023 malaria season and compares the NMC-SS malaria case notifications with those captured on the DHIS2 platform for the endemic provinces for the same period.

Methods

We extracted a line list of malaria cases for the period 01 September 2022 to 31 August 2023 from the NMC-SS database. STATA statistical software (Version 18) was used to clean and de-duplicate the data. Although the NMC system automatically merges multiple notifications from the same individual into one, manual merging was also performed to further minimise duplicates. A malaria case was defined using the standard NMC case definition as any person who had a malaria diagnosis confirmed through a rapid or laboratory test.[6] Severe malaria cases were identified as those who were admitted to a healthcare facility and treated with an intravenous antimalarial. The data were descriptively analysed using frequency tables, bar graphs, and histograms. Through ArcGIS Pro, the case notifications were mapped using the residential address of the case or reporting facility. Lastly, we obtained DHIS2 data from the National Department of Health for the same review period to compare and quantify the differences in case notifications for the endemic provinces.

Results

A total of 5 813 malaria case notifications, 4 137 from endemic provinces and 1 676 from non-endemic provinces, was received by the NMC-SS between September 2022 and August 2023 (Table 1). The majority of the cases were males (61%, 3 574/5 813) aged between 20 and 39 years (Table 1). Malaria in children under the age of five years (8%, 461/5 813) was reported almost equally to those between five and nine years (8%, 458/5 813). Although a large proportion of case notifications (45%, 2 621/5 813) did not contain information on the diagnostic method used, of the 3 192 notifications that did, cases diagnosed by microscopy (70%, 2 221/3 192) were reported more frequently than those diagnosed by rapid diagnostic tests (30%, 971/3 192). The majority of the case notifications were from public healthcare facilities (91%, 5 311/5 813) (Table 1).

Table 1. Socio-demographic characteristics of malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) in South Africa from September 2022 to August 2023.

Socio-demographic characteristics of case notifications		Frequency (N=5 813)*	Percentage (%)
Endemicity	Endemic province	4 137	71
	Non-endemic province	1 676	29
Sex	Male	3 574	61
	Female	2 237	38
	Unknown**	2	0
Age category	0-4	461	8
	5-9	458	8
	10-14	418	7
	15-19	420	7
	20-24	476	8
	25-29	554	9
	30-34	536	9
	35-39	495	9
	40-44	439	7
	45-49	342	6
	50-54	267	5
	55-59	225	4
	60 and above	336	6
	Unknown**	386	7
Diagnosis method	Rapid diagnostic test	971	17
	Blood smear microscopy	2 221	38
	Unknown**	2 621	45
Notifying sector	Public	5 311	91
	Private	502	9

*The data presented in this table are only case notifications extracted from the Notifiable Medical Conditions Surveillance System (NMC-SS). Data from other sources, such as the District Health Information System 2 (DHIS2), are not included, which might result in some underestimation. NMC data are also continuously cleaned, de-duplicated, and updated, hence subjected to change or variation. All numbers presented are preliminary, unless otherwise stated.
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### Distribution of case notifications by place/malaria status

Over the review period, the three endemic provinces accounted for 71% (4 137/5 813) of total case notifications received, with just under 50% from the Limpopo Province (49%, 2 845/5 813) (Table 2). The non-endemic Gauteng Province (19%, 1 095/5 813) notified more cases than the malaria-endemic provinces of Mpumalanga (15%, 868/5 813) and KwaZulu-Natal (7%, 424/5 813). Malaria-endemic districts collectively accounted for 66% (3 840/5 813) of all notifications (Figure 1).

Table 2. Numbers of malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) in South Africa by province, from September 2022 to August 2023.

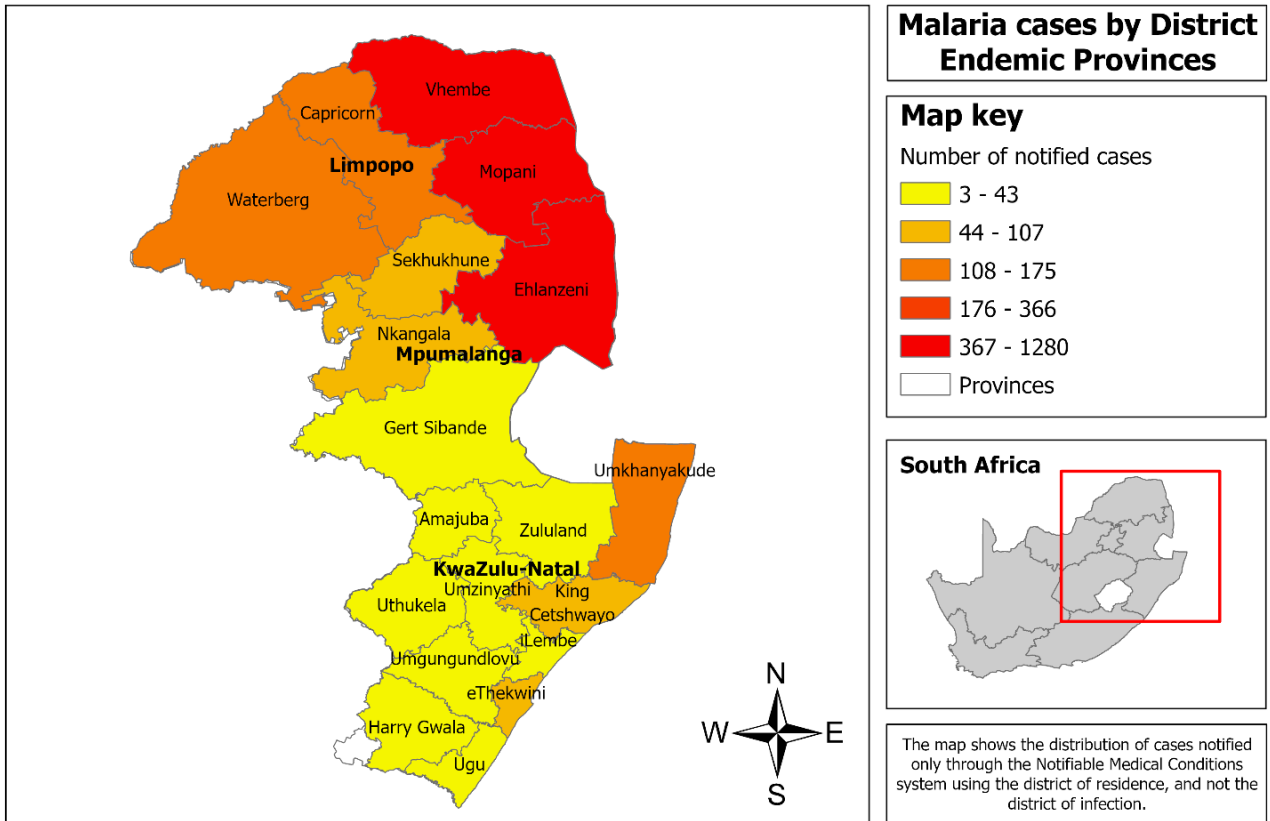| Year	Month	Endemic provinces				Non-endemic provinces							Grand Total
		LP	MP	KZN	Total	GP	WC	FS	EC	NW	NC	Total	
2022	**Sep**	208	73	23	304	64	10	1	0	12	1	88	392
	Oct	238	74	30	342	67	11	3	5	6	6	98	440
	Nov	74	23	20	117	58	17	4	3	5	2	89	206
	Dec	188	63	19	270	76	21	6	5	12	1	121	391
2023	**Jan**	264	90	85	439	230	42	12	17	20	5	326	765
	Feb	166	48	47	261	110	21	3	10	9	2	155	416
	Mar	145	47	38	230	89	18	0	2	14	0	123	353
	Apr	506	91	37	634	104	24	21	6	20	3	178	812
	May	729	222	54	1 005	116	29	17	3	30	2	197	1 202
	Jun	240	70	37	347	79	24	9	6	10	4	132	479
	Jul	63	41	19	123	70	17	3	3	10	1	104	227
	Aug	24	26	15	65	32	19	5	3	5	1	65	130
	Total	2 845	868	424	4 137	1 095	253	84	63	153	28	1 676	5 813*

*The data presented in this table are only case notifications extracted from the Notifiable Medical Conditions Surveillance System (NMC-SS). Data from other sources, such as the District Health Information System 2 (DHIS2), are not included, which might result in some underestimation. NMC data are also continuously cleaned, de-duplicated, and updated, hence subjected to change or variation. All numbers presented are preliminary, unless otherwise stated. LP: Limpopo; MP: Mpumalanga; KZN: KwaZulu-Natal; GP: Gauteng; EC: Eastern Cape; FS: Free State; NC: Northern Cape; NW: North West; WC: Western Cape.
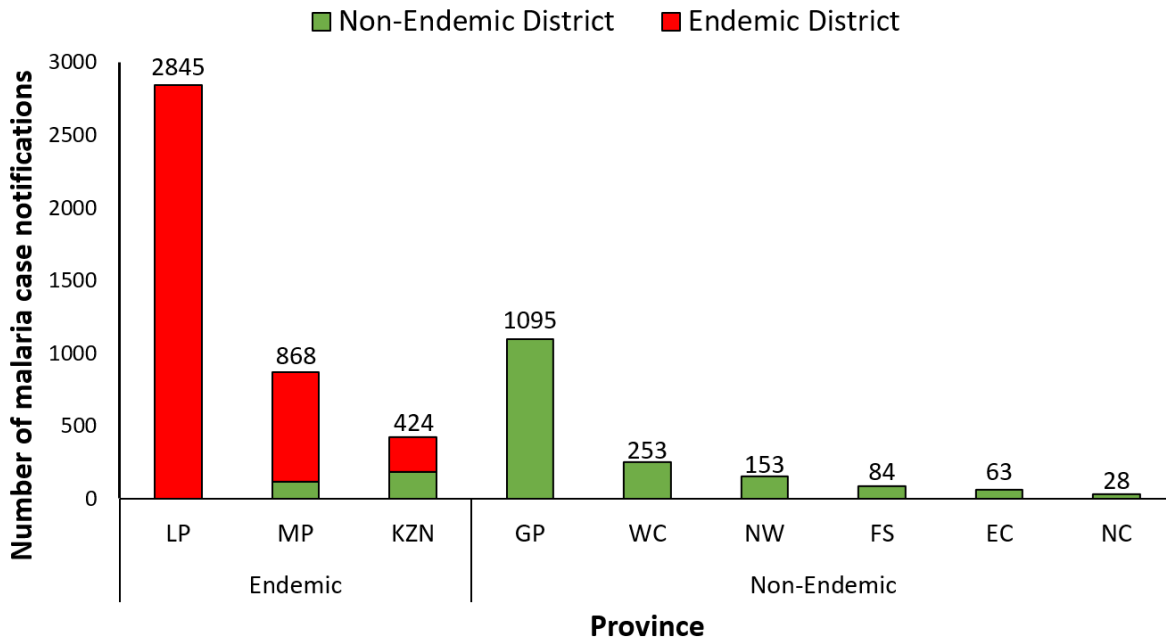
Figure 1. Malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) by province and district in South Africa, from September 2022 to August 2023.
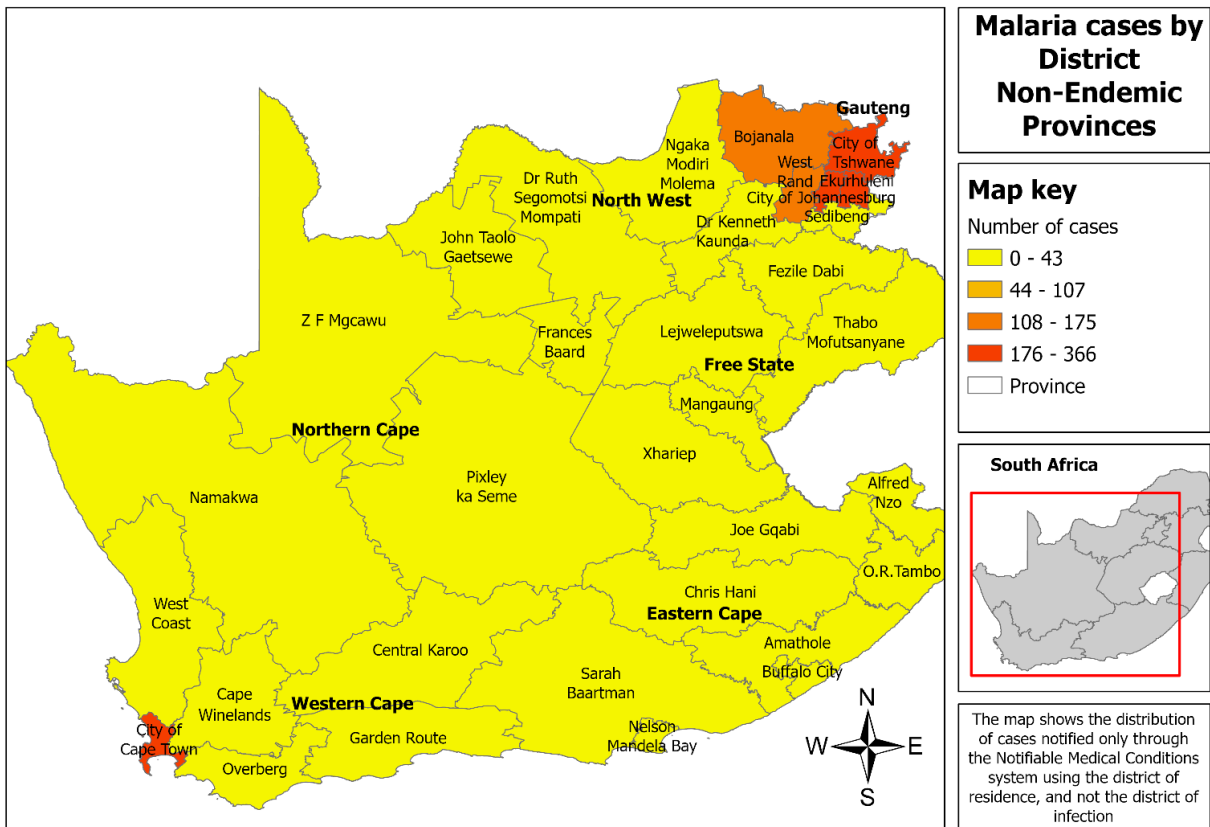
Endemic provinces

The malaria-endemic districts Vhembe (1 280/2 854) and Mopani (1 153/2 854) accounted for 82% of all cases notified by the Limpopo Province, while Ehlanzeni District, the only malaria-endemic district in the Mpumalanga Province, accounted for 87% (754/868) of the provincial total. The KwaZulu-Natal Province notified the least number of cases among the three endemic provinces (10%, 424/4 137). The malaria-endemic uMkhanyakude District (33%, 141/424) had the highest number of case notifications in KwaZulu-Natal Province, followed by King Cetshwayo (20%, 84/424) and Zululand districts (4%, 16/424), respectively. The eThekwini District (25%, 107/424) notified most of the cases from the non-endemic districts in the KwaZulu-Natal Province (Figure 2).

Figure 2. Distribution of malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) by district in the three malaria-endemic provinces, South Africa, from September 2022 to August 2023.

Non-endemic provinces

Among non-endemic provinces, the Gauteng Province (65%, 1 095/1 676) had the highest number of case notifications, followed by the Western Cape Province (23%, 253/1 676) and the North West Province (9%, 153/1 676). Most districts in non-endemic provinces notified less than 43 cases during the review period (Figure 3). Over 80% of case notifications in the Gauteng Province were from metropolitan municipalities: the City of Johannesburg (33%, 366/1 095), the City of Tshwane (24%, 266/1 095), and Ekurhuleni (24%, 266/1 095). Similarly, most case notifications in the Western Cape Province were from the province's metropolitan municipality, the City of Cape Town (70%, 188/253). In the North West Province, Bojanala District (71%, 108/153) notified the highest number of cases, followed by Dr. Kenneth Kaunda District (19%, 29/153) (Figure 3).
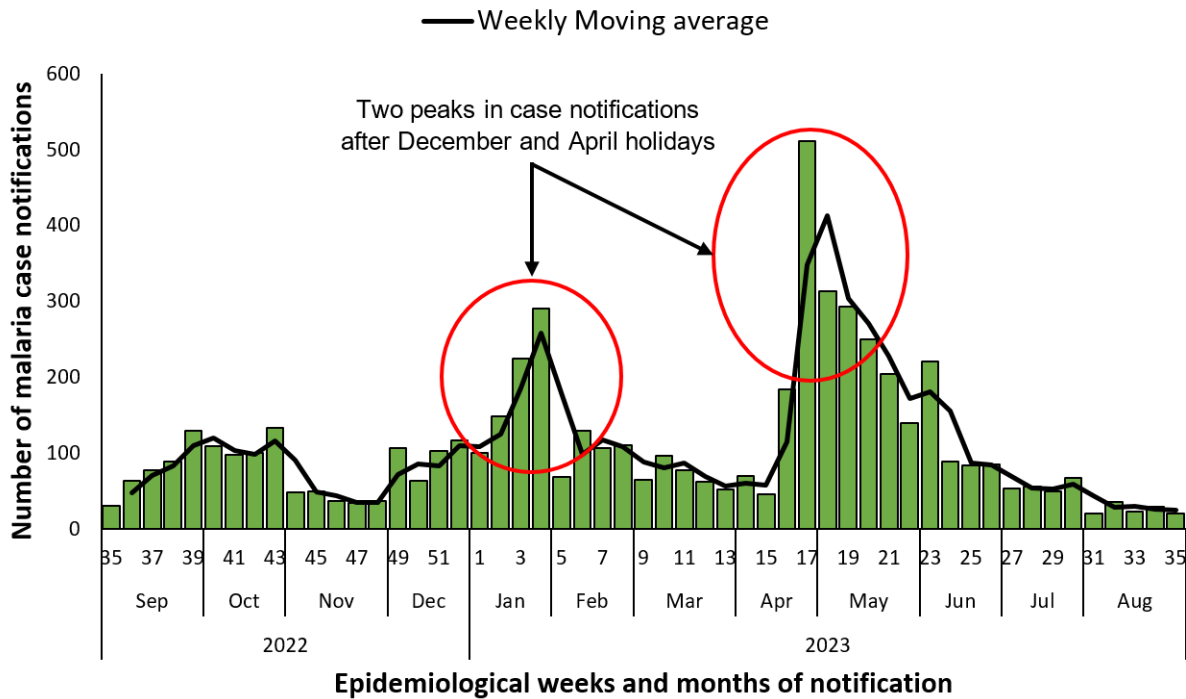
Figure 3. Distribution of malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) by district in the malaria non-endemic provinces, South Africa, from September 2022 to August 2023.

Distribution of case notifications over time

Case notifications during the 2022–2023 malaria season followed the traditional epidemiological trend, with the number of notifications increasing week-on-week from mid-September. The first peak in case notifications occurred in January after people returned from December holiday-related travel. The second larger peak in case notifications occurred in the latter two weeks of April after people returned from April holiday-related travel (Figure 4). The number of weekly case notifications was at a seasonal high between epidemiological weeks 17 and 18 of 2023, with at least 300 notified cases per week. The number of case notifications started to decrease in May 2023 and remained relatively low until the end of August 2023 (Figure 4).
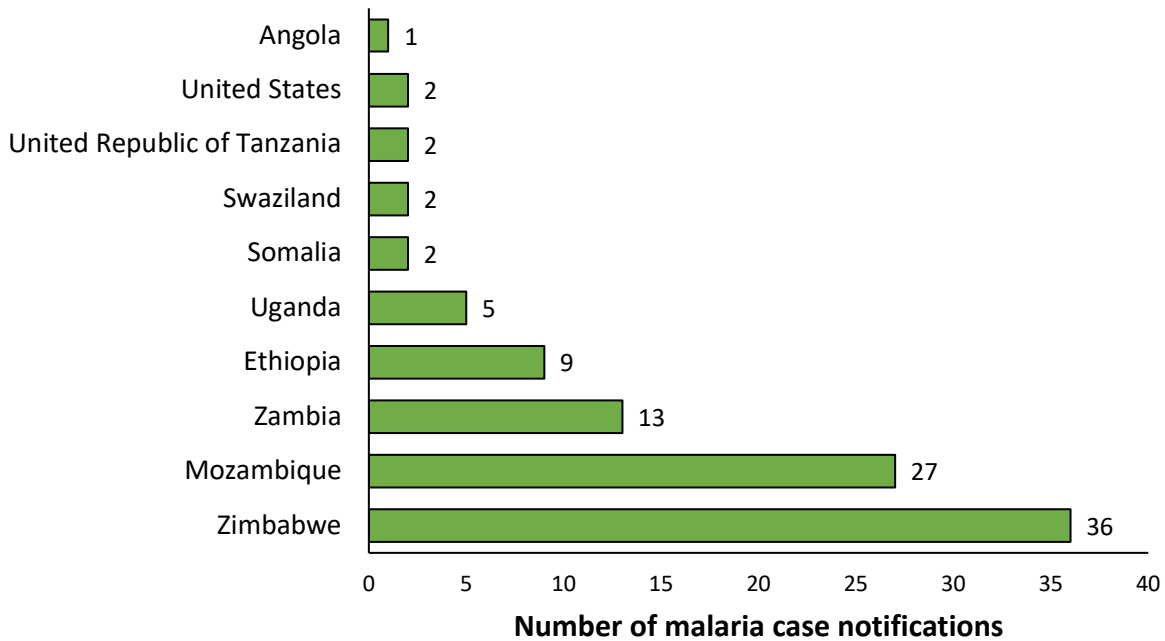
Figure 4. Malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) by epidemiological week in South Africa, from September 2022 to August 2023.

### *Travel history, prophylaxis, and citizenship*

Only 38% (2 228/5 813) of the case notifications contained any travel information. Among the cases with travel history information, just under 50% (1 083/2 228) reported recent travel (three months prior to the date of diagnosis) to an endemic area, province, or country. Information on the use of chemoprophylaxis was also very limited, with only 122 case notifications having valid information available. About 49% (2 832/5 813) of the case notifications had citizenship captured, with only 4% (110/2 832) reporting non-South African citizenship. Zimbabwean (33%, 36/110) and Mozambican (25%, 27/110) citizens constituted the largest proportion of non-South African citizens (Figure 5).

Figure 5. Citizenship of malaria case notifications received via the Notifiable Medical Conditions Surveillance System (NMC-SS) originating outside of South Africa from September 2022 to August 2023.

Severe malaria cases and treatment

Over the reporting period, 1 197 case notifications were of individuals with severe malaria. The Limpopo Province reported the majority of the severe malaria cases (57%, 677/1 197), followed by Gauteng Province (18%, 212/1 197) (Figure 6). The recommended first-line treatment for severe malaria, intravenous artesunate, was used to treat 94% (1 129/1 197) of the cases. Intravenous quinine was used to treat about 5% (54/1 197) of cases, while the remaining 14 cases were reportedly treated with both intravenous antimalarials. The use of intravenous quinine was more common in private healthcare facilities (14%, 24/170) compared to public healthcare facilities (3%, 30/1 027).
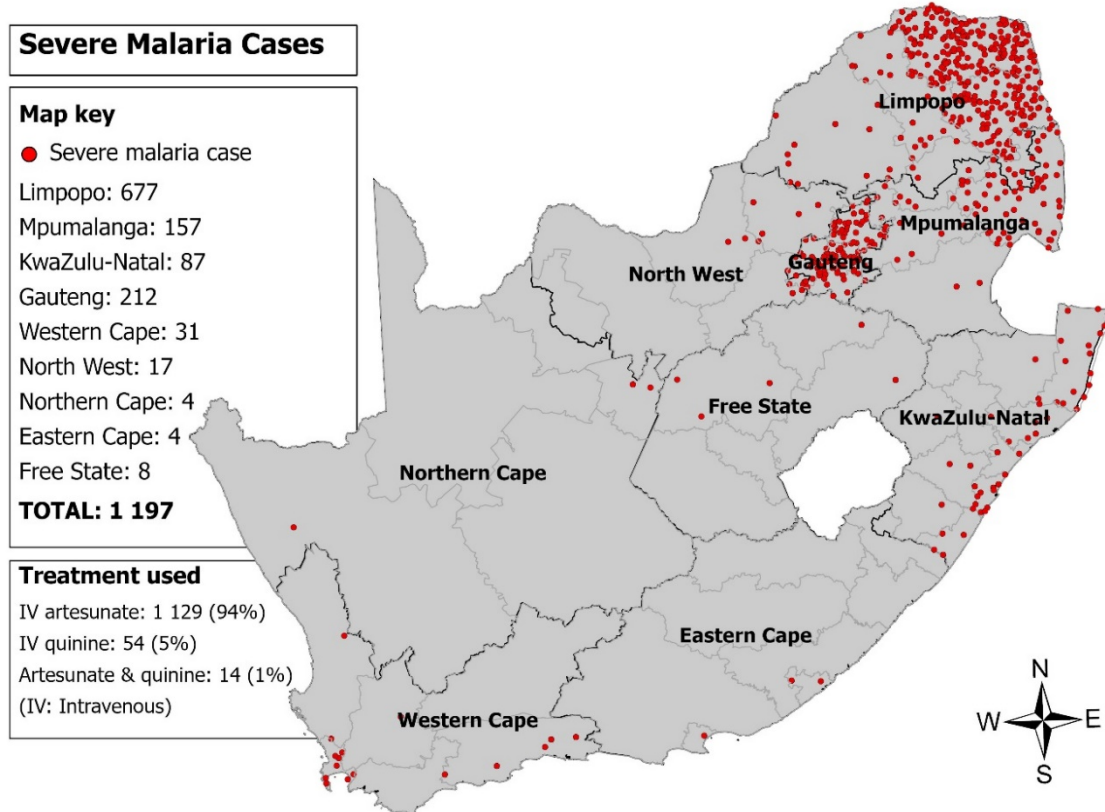
Figure 6. The distribution of severe malaria case notifications (red dots) received via the Notifiable Medical Conditions Surveillance System (NMC-SS) in South Africa from September 2022 to August 2023.

Comparison of NMC-SS and DHIS2 case numbers

During the review period, the NMC-SS recorded 4 137 cases across the three endemic provinces, while DHIS2 recorded 6 251 cases. Using the DHIS2 cases as a benchmark for the total number of cases notified, the NMC-SS recorded two-thirds (66%, 4 137/6 251) of the total notifications. The NMC-SS captured 68% (2 845/4 189) of the cases notified in the Limpopo Province, 53% (868/1651) of the cases notified in the Mpumalanga Province, and more than 100% (424/411) of those notified in the KwaZulu-Natal Province. Although monthly notifications in the NMC-SS were generally lower than those in the DHIS2, there were months when the NMC-SS captured more notifications (Table 3).

Table 3. Numbers of malaria cases received via the Notifiable Medical Conditions Surveillance System (NMC-SS) compared to the District Health Information System 2 (DHIS2) by province, South Africa, from September 2022 to August 2023.

Year	Month	Limpopo			Mpumalanga			KwaZulu-Natal		
		NMC	DHIS2	%	NMC	DHIS2	%	NMC	DHIS2	%
2022	**Sep**	208	259	80%	73	128	57%	23	24	96%
	Oct	238	280	85%	74	133	56%	30	17	176%
	Nov	74	98	76%	23	103	22%	20	14	143%
	Dec	188	299	63%	63	88	72%	19	19	100%
2023	**Jan**	264	407	65%	90	305	30%	85	75	113%
	Feb	166	206	81%	48	108	44%	47	36	131%
	Mar	145	193	75%	47	100	47%	38	41	93%
	Apr	506	909	56%	91	123	74%	37	48	77%
	May	729	1171	62%	222	289	77%	54	63	86%
	Jun	240	299	80%	70	136	51%	37	38	97%
	Jul	63	48	131%	41	96	43%	19	22	86%
	Aug	24	20	120%	26	42	62%	15	14	107%
Total (overall %)		2 845	4 189	68%	868	1651	53%	424	411	103%

The data presented in this table from both sources are continuously cleaned, de-duplicated, and updated, hence subjected to change or variation. All numbers presented are preliminary, unless otherwise stated. % = Percentage of NMC-SS cases from the DHIS2 total, percentages above 100 indicate that the NMC-SS had more cases than the DHIS2.

Discussion

The frequency of malaria case notifications received through the NMC-SS for the 2022–2023 malaria season followed the expected seasonal trend, with two seasonal peaks. These peaks followed periods of increased national and international travel to malaria-endemic regions. Economically active young males, especially those aged between 20 and 39 years, appeared to be the most at-risk population group. Previous studies in low-transmission areas found that this population is at a higher risk of infection as their travel and work habits increase their exposure to mosquito vectors.[7,8] The Limpopo Province continued to notify the highest number of malaria cases (49%), with Vhembe and Mopani districts being the most affected. The Ehlanzeni District, which shares a border with Mozambique, continued to be the primary contributor to malaria case notifications in the Mpumalanga Province. In KwaZulu-Natal Province, most notifications originated from uMkhanyakude District, the northernmost district of the province and closest to Mozambique.

The periods following the December and April holidays saw a significant increase in malaria case notifications. This underscores the importance of targeting these specific periods for malaria-related communication aimed at increasing malaria awareness among clinicians and travelers. Although the NMC-SS data do not contain case classification information (that shows the origin of infection), several notifications, particularly during the upsurges, indicated citizenship in neighbouring countries such as Mozambique and Zimbabwe, where malaria is also prevalent. In most instances, these non-South African nationals are migrant workers involved in mining and agricultural activities in South Africa.[7,9] This highlights the importance of sustained test-and-treat activities along shared international borders to target this population group before possibly seeding malaria in South Africa.

Even though malaria is both preventable and treatable, it is concerning that 1 197 individuals were diagnosed with severe malaria during the period under review. Intravenous artesunate, the recommended first-line intravenous treatment, was used in most instances. However, certain healthcare facilities, particularly in the private sector, frequently used intravenous quinine, although intravenous artesunate provides roughly 23–35%

better treatment outcomes.[10] It is advised to only consider intravenous quinine when intravenous artesunate is contraindicated or unavailable.[11]

Some data fields, such as the method of diagnosis, travel history, and citizenship were frequently not captured on the NMC-SS notifications. The absence of these data hinders comprehensive retrospective analysis of case notification data to inform control strategies and identify areas where re-training of healthcare workers might be required. Healthcare workers who notify cases need reminding of the importance of completing all data fields, with additional training provided to underperforming healthcare facilities. Despite the limitations of the NMC-SS malaria data, which include delayed and under-reporting, predominately from the endemic provinces, the NMC-SS data provided valuable insights on malaria case trends, patterns, and distribution. However, for the three endemic provinces, DHIS2 data remain the most reliable for reporting and retrospective analysis. There are ongoing efforts to integrate these two data sources, but in the interim, this NMC-SS data-based review should be interpreted with these limitations in mind.

Conclusion

Analysis of the malaria case notification data from the NMC-SS for the 2022–2023 season revealed case trends and distribution, consistent with previous seasons. Endemic districts in Limpopo, Mpumalanga, and KwaZulu-Natal Provinces that share borders with neighbouring malaria-endemic countries continue to account for the majority of case notifications. There were significant spikes in malaria case notifications following the December and April holidays, highlighting the importance of targeted malaria awareness communication around these holidays and the need for sustained malaria test-and-treat activities along shared international borders. Certain data fields, including the method of diagnosis and travel history, were missing from most case notifications. Healthcare workers should be alerted to the importance of reporting these and offered retraining where necessary. For the treatment of severe malaria, healthcare facilities, particularly within the private sector, are encouraged to administer intravenous artesunate followed by a full course of artemether-lumefantrine once the patient is able to swallow, in line with national treatment guidelines.

We recommend

- The issuing of malaria-awareness communications and materials before peak malaria periods to raise the index of suspicion for malaria and encourage chemoprophylaxis use, the use of protective long-sleeved clothing, especially when outdoors during dusk and dawn, and early healthcare seeking upon the onset of flu-like symptoms after travel.
- Continued and strengthened test-and-treat activities along border regions through mobile malaria border surveillance units.
- The use of intravenous artesunate followed by a full course of artemether-lumefantrine for the treatment of severe malaria as per national treatment guidelines, particularly in the private sector.
- Improvements to NMC-SS data quality by encouraging comprehensive completion of fields, especially for informative variables like travel history and the method of diagnosis. Continuous training, supportive supervision, and mandatory inclusion of certain critical data fields in the NMC application could achieve this.
- Enhancement of the sensitivity of the automatic merging function within the NMC system to reduce duplicates.
- Establishment of alert and action malaria incidence thresholds, specifically for the non-endemic provinces.

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