The prevalence of malaria in the five districts of Limpopo Province, South Africa, 2015 - 2017

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Background. In South Africa (SA), malaria is endemic in three of nine provinces – KwaZulu-Natal, Mpumalanga and Limpopo. During 2010 - 2014, SA reported that ~47.6% of all malaria cases were imported. Contemporary estimates for the prevalence of malaria in the five districts of Limpopo Province are limited, with unknown proportions of imported malaria cases. We estimated the prevalence of malaria, and the proportion of imported malaria cases in the five districts of Limpopo, from January 2015 to December 2017.
Objective. To measure the prevalence of malaria in Limpopo Province, the proportion of malaria cases that are imported and to determine factors associated with malaria from January 2015 to December 2017.
Methods. We retrospectively reviewed data routinely collected through the Malaria Information System and Laboratory Information System of the National Health Laboratory Services, and assessed associations with age, sex and district, using a multivariable logistic regression model.
Results. From 2015 to 2017, a total of 43 199 malaria cases were reported, of which 3.5% (n=1 532) were imported. The prevalence of malaria in Limpopo Province was the highest in 2017, at 331.0 per 100 000 population. The highest malaria prevalence district was Vhembe, with 647.9 in 2015, 220.3 in 2016 and 659.4 in 2017 per 100 000 population. However, Waterberg had the highest proportion of imported malaria cases 28.5% (437/1 532). In adjusted analyses, ages 15 - 49 years (adjusted odds ratio (aOR) 1.58, 95% confidence interval (CI) 1.48 - 1.68, p<0.001) and <1 year (aOR 1.55, 95% CI 1.37 - 0.74, p<0.001) were at higher odds of having malaria compared with ages ≥65 years.
Conclusion. These findings highlight the significant burden of imported malaria in Limpopo Province. There is a need for strengthened surveillance and control programmes in neighboring countries (such as Mozambique, Zimbabwe and Botswana) to reduce the importation and spread of malaria in this region.

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Malaria is an important public health problem in the world, with nearly half of the world's population at risk.[1] Globally, malaria cases ranged between 212 and 247 million during 2015 - 2022.[1-3] Between 2015 and 2022, malaria cases recorded in Africa ranged between 200 and 234 million.[4] Sub-Saharan African (SSA) countries have a high incidence of malaria infection throughout different seasons, with *Plasmodium falciparum* being the most prevalent malaria species, accounting for 99% of estimated malaria cases.[5,6] However, malaria is also caused by other mosquito-borne parasites of the *Plasmodium* species, namely *P. malariae, P. ovale, P. vivax* and *P. knowlesi*.[5] Imported malaria cases have increased between 2011 and 2016 due to increased air travel over the past decades and population movements worldwide.[7,8] South Africa (SA) has reported an increase in the number of imported malaria cases from neighbouring malaria-endemic countries.[9] Imported malaria is defined as malaria presenting in a country other than that in which it was acquired. During the period 2010 to 2014, imported malaria cases accounted for ~47.6% of malaria cases reported nationally, with the majority originating from Mozambique and Zimbabwe.[7,9-11]

Malaria is endemic in the north-eastern region of SA, namely Limpopo, Mpumalanga and KwaZulu-Natal provinces.[12] It is distinctly seasonal in SA, with the highest risk of transmission during the wet summer months from September to May, and the dominant malaria species is *P. falciparum*.[13,14] In 2012, the National Department of Health (NDoH) developed a Malaria Elimination Strategic Plan 2012 - 2018, to eliminate local malaria transmission by 2018 and reduce morbidity.[15] The World Health Organization (WHO) defines malaria elimination as the interruption of local transmission (reduction to zero incidence of indigenous cases) of a specified malaria parasite species in a defined geographical area. Once the elimination of malaria is achieved, continued measures are required to prevent the re-establishment of the transmission.[16] SA failed to reach the goal of eliminating malaria by 2018, leading to change from the elimination to the management phase due to increased cases.[15] Subsequently, SA published the recent Malaria Elimination Strategic Plan for the period 2019 - 2023, which provides detailed direction to the non-malaria endemic provinces to address the growing problem of imported malaria cases and malaria-related deaths.[17]

Malaria is a category 1 notifiable medical condition (NMC) in SA, which requires immediate reporting by the most rapid means available upon diagnosis, followed by a written or electronic notification to the

NDoH within 24 hours of diagnosis by healthcare providers (HCPs).[18] SA experienced greater than expected malaria cases in 2017 due to an outbreak, which might have been influenced by suitable environmental conditions such as heavy rainfall and increased temperature following 2 - 3 years of below-average precipitation.[19,20] Malaria is endemic in Limpopo Province, causing significant morbidity and mortality. Information on the prevalence of malaria in the five districts of Limpopo Province in recent years is limited, and routine surveillance is suboptimal. Malaria cases have increased and so have malaria control efforts. Therefore, there is a need to measure the disease burden, determine imported cases and understand the factors associated with malaria to inform public health interventions. We conducted a study to measure the prevalence of malaria in Limpopo Province, the proportion of malaria cases that are imported and to determine factors associated with malaria from January 2015 to December 2017.

Methods

Study design

This descriptive study was conducted on malaria data routinely collected through the Limpopo Provincial Malaria Information System (MIS). The MIS data were merged with data from the National Health Laboratory Service (NHLS) to identify laboratory-confirmed cases. The NHLS provides laboratory and pathology services for the public healthcare system, and related public health services to >80% of the population through a national network of laboratories.

Setting

Limpopo Province is the most northern province of SA, and shares borders with Botswana, Zimbabwe and Mozambique. Limpopo also shares borders with the SA provinces of Mpumalanga, Gauteng and North West. The five district municipalities in Limpopo are Capricorn, Greater Sekhukhune, Mopani, Vhembe and Waterberg (Fig. 1). According to the 2018 mid-year population estimates for SA, Limpopo had a population of 5 797 300.[21] The estimated provincial population by district in 2017 was 1.29 million in Capricorn, 1.29 million in Greater Sekhukhune, 1.16 million in Mopani, 1.43 million in Vhembe, and 740 000 in Waterberg.[22]

Study population and sampling

We included all cases captured in the provincial MIS and NHLS Corporate Data Warehouse (CDW) diagnosed with malaria in Limpopo from January 2015 to December 2017.

Case definitions

Confirmed malaria cases were defined as cases with a positive malaria test by blood smear, rapid antigen, and/or polymerase chain reaction (PCR) tests for any *Plasmodium* species, namely *P. falciparum, P. vivax, P. ovale*, *P. malariae* and *P. knowlesi*, and classified as either local or imported malaria cases. Imported malaria cases are due to mosquito-borne transmission and acquired outside of the country. The origin of imported cases can be traced to a known malaria endemic area outside the country to which the patient has travelled.[15] Local malaria cases are due to mosquito-borne transmission and are acquired within the country. These may be indigenous, introduced, or internally imported cases with no history of travel to another malaria-endemic country.[15] Unclassified malaria cases are cases where local transmission is unlikely, but for which travel history cannot be verified.[9]

Data analysis

Data were retrieved and stored using Excel (Microsoft, USA), cleaned by removing duplicates or inconsistencies, and analysed using Stata 15 (StataCorp, USA). The data included the demographics of malaria cases, year (malaria season) of diagnosis, travel history, source sector, source locality and source of infection for the five districts of Limpopo Province captured by the provincial malaria control programme from January 2015 to December 2017. Descriptive statistics were used to summarise the demographic data (sex, age and district) using frequency distributions. Medians and interquartile ranges (IQRs) were used to summarise numerical variables. We estimated the prevalence of malaria by dividing the number of malaria cases by the estimated mid-year population. We used the percentages of each district population from 2011 to estimate the populations in 2015, 2016 and 2017 since the mid-year population estimates for each year were given only for the whole province. We applied the χ^2 test for trend to calculate the *p*-value for the significance of the linear trend in malaria prevalence. To quantify the proportion of malaria cases that were imported, the denominator was all malaria cases.

The number of malaria cases were classified as local, imported, or unclassified, displayed by malaria category per district per year, by sex, and by age groups using a stacked bar chart. Differences in proportions between the groups were compared using the χ^2 test. The Wilcoxon-Mann-Whitney non-parametric test was used for numerical variables (age) due to skewness. Factors associated with malaria in Limpopo were determined using multivariable logistic regression. The outcome variable was malaria, and the independent variables were year, age, sex and district. A manual forward stepwise procedure was used to incrementally include variables, with $p<0.20$ in the bivariate analysis, into the multivariable model. Tests for multicollinearity were performed to ensure that only non-collinear variables were included in the multivariable model, and the Hosmer-Lemeshow test was performed to test the goodness of fit of the final multivariable model. A *p*-value <0.05 was considered statistically significant, with odds ratios (ORs), 95% confidence intervals (CIs) and *p*-values calculated for each risk factor.

Ethical considerations

The study was approved by the Research Ethics Committee, University of Pretoria Faculty of Health Sciences (ref. no. 713/2018). For the MIS data, permission was granted from the Limpopo Health Research Database (ref. no. LP_201812_004). For the NHLS data, permission was requested and granted by the NHLS chief executive officer. Patient confidentiality was maintained by keeping patients anonymous with no identifying information used in the analysis. Data were password encrypted as per protection standards.

Results

A total of 1 867 (7.3%) malaria cases from the MIS and 36 118 (44.5%) from the NHLS records were excluded after de-duplicating and excluding records with missing information. The MIS and NHLS datasets were then merged. A total of 43 199 malaria cases were identified in the final dataset (Fig. 2). The median age of malaria cases was 25 years (IQR 12 - 41 years). Of the 43 199 cases, ages 15 - 49 years were the most affected group, with 56.5% (*n*=24 418) of cases, compared with other age groups. Among the malaria cases, 51.0% (*n*=22 028) were male and 48.8% (*n*=21 079) were from Vhembe district (Table 1).

Malaria prevalence estimates

We observed a decrease in malaria prevalence in Limpopo Province from 304 to 115 per 100 000 population from 2015 to 2016. However, there was an increase to 331 per 100 000 population in 2017. Vhembe district had the highest malaria prevalence throughout

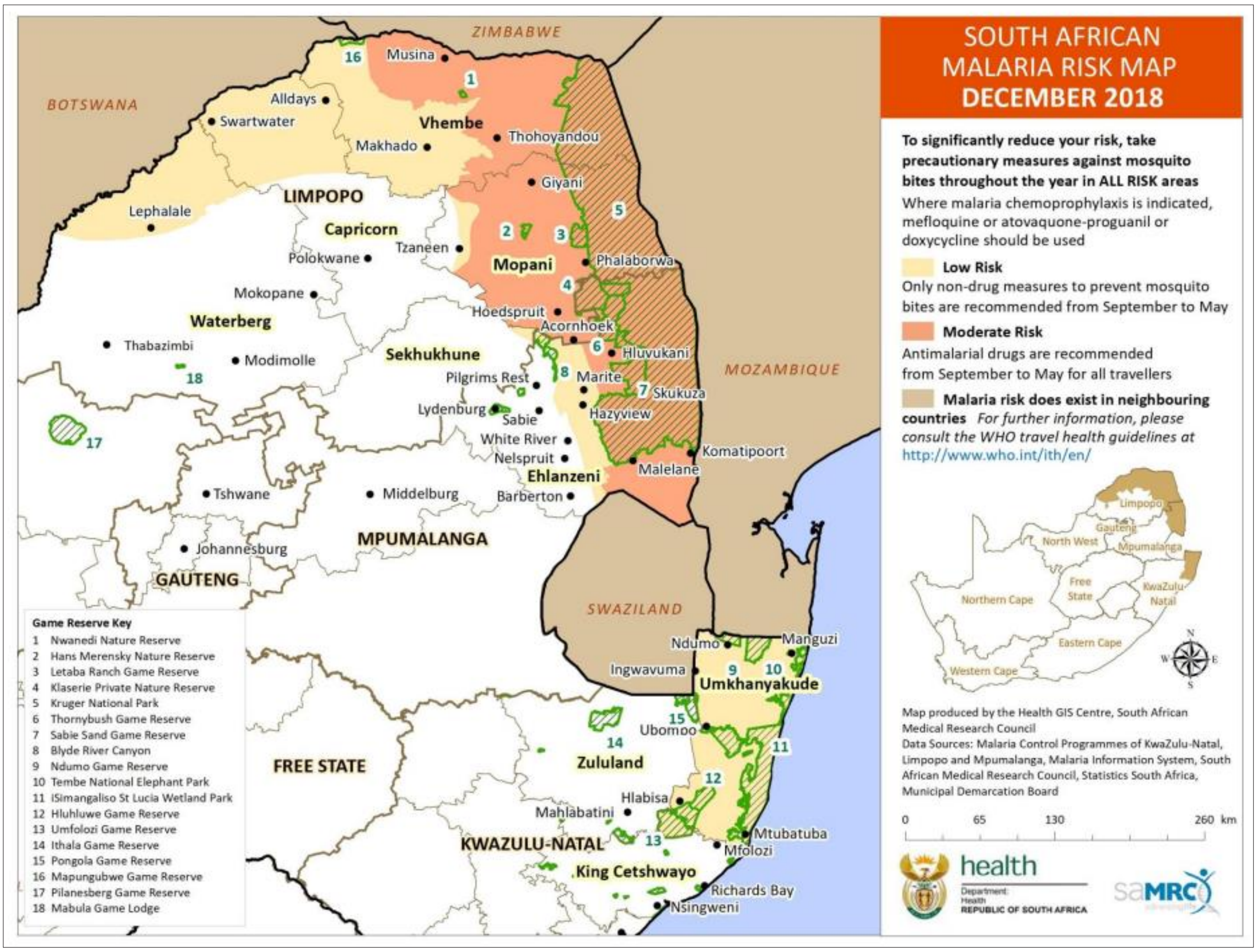

Fig. 1. The distribution of risk of malaria transmission in South Africa, 2018. (Adapted from the National Department of Health: https://www.health.gov.za/malaria/.)

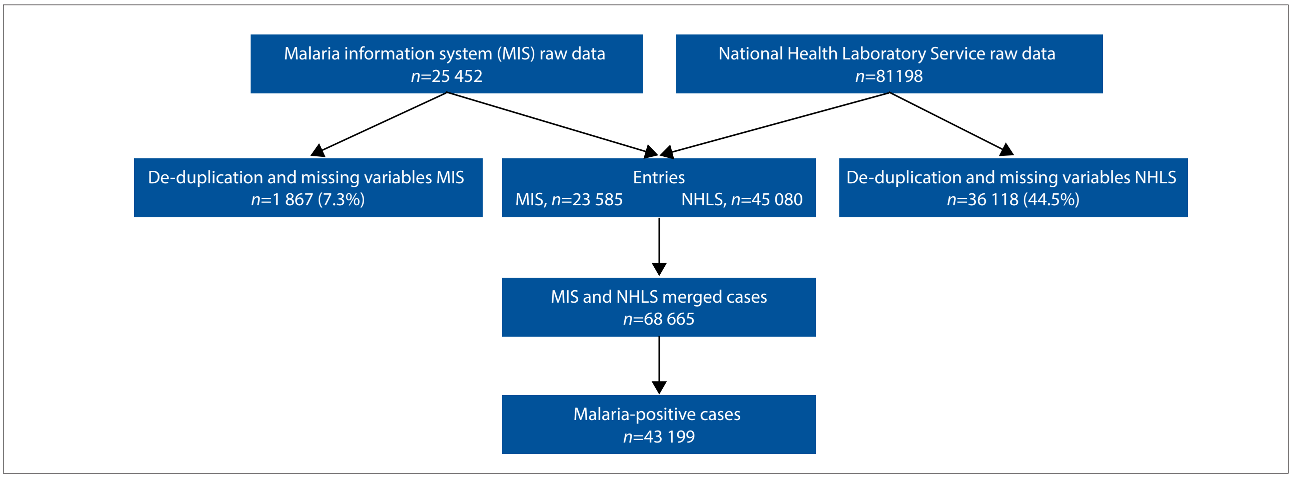

Fig. 2. The eligibility criteria for malaria cases in the five districts of Limpopo Province, South Africa, 2015 - 2017.

the 3 years, having 647.9 in 2015, 220.3 in 2016 and 659.4 in 2017 per 100 000 population, as compared with other districts. Greater Sekhukhune had the lowest prevalence throughout the 3 years, with 47.2 per 100 000 population in 2015, 29.7 in 2016 and 59.8 in 2017, as compared with other districts (Table 2). The percentage change for the Vhembe district was a 199.3% increase from 2016 to 2017 and a 66.0% decrease from 2015 to 2016 (Table 3). Meanwhile, Greater Sekhukhune, the lowest malaria prevalence district, had a percentage increase of 101.4% from 2016 to 2017 and a percentage decrease of 37.1% from 2015 to 2016. Overall, Limpopo had a decrease of 62.3% from 2015 to 2016, followed by an increase of 188.9% from 2016 to 2017.

Comparing malaria prevalence for each year during 2015 - 2017, malaria prevalence among males declined in 2015 from 311.0 per 100 000 population to 138.3 per 100 000 in 2016, then increased to 827.0 per 100 000 in 2017 (Fig. 3).

Infants <1 year old had a general decrease in prevalence throughout the 3-year period, from 73.1 per 100 000 population in 2015, 38.4 in 2016 and 37.1 in 2017, and was the lowest prevalence age group during 2015 - 2017. Comparing age groups, the highest malaria prevalence in 2015 was 390.9 per 100 000 population among those aged 50 - 64 years. In 2016 it was 137.5 per 100 000 among those aged 15 - 49 years, and in 2017 it was 394.7 per 100 000 among those aged 50 - 64 years (Fig. 4).

Table 1. Characteristics of malaria cases in the five districts of Limpopo Province, South Africa, from January 2015 to December 2017 (*N*=43 199)

Demographic variable	*n* (%)
Sex	
Female	21 171 (49.0)
Male	22 028 (51.0)
Age category, years	
<1	1 042 (2.4)
1 - 4	3 921 (9.1)
5 - 14	7 475 (17.3)
15 - 49	24 418 (56.5)
50 - 64	4 141 (9.6)
≥65	2 202 (5.1)
District	
Capricorn	3 323 (7.7)
Greater Sekhukhune	1 571 (3.6)
Mopani	14 509 (33.6)
Vhembe	21 079 (48.8)
Waterberg	2 717 (6.3)

Quantifying the proportions of imported malaria cases

The annual proportions of imported malaria cases in Limpopo were 29.9% in 2015 (458/1 532), 21.1% in 2016 (321/1 532) and 49.2% in 2017 (753/1 532). The district with the highest proportion of imported malaria cases was the Waterberg district, with 28.5% (437/1 532), followed by Greater Sekhukhune with 22.4% (343/1 532) throughout the 3-year period. The proportion of imported malaria cases in Waterberg was 27.5% in 2015 (126/458), 32.1% in 2016 (103/321) and 27.6% in 2017 (208/753), respectively (Fig. 5). Despite having the highest number of malaria cases, only 14.7% (225/1 532) of cases in the Vhembe district were imported. Mopani district had the lowest proportion of imported malaria cases at only 13.5% (207/1 532) throughout the 3 years, and for each year, with 15.1% in 2015 (69/458), 16.2% in 2016 (52/321) and 11.4% in 2017 (86/753).

Factors associated with malaria infection

We report results for the multivariable logistic regression model. Sex was not significantly associated with malaria (Table 4). Compared with people aged >65 years, the odds of having malaria were higher among adults aged 15 - 49 years (aOR 1.58, 95% CI 1.48 - 1.68, p<0.001), followed by infants <1 year (aOR 1.55, 95% CI 1.37 - 1.74, p<0.001). Malaria cases had greater odds of being from Greater Sekhukhune (aOR 1.25, 95% CI 1.11 - 1.41, p<0.001) and Waterberg (aOR 1.24, 95% CI 1.12 - 1.37, p<0.001) districts compared with Capricorn district. Malaria cases had decreased odds of being from Mopani (aOR 0.66, 95% CI 0.61 - 0.71, p<0.001) and Vhembe (aOR 0.55, 95% CI 0.52 - 0.59, p<0.001) districts compared with those from Capricorn district.

Discussion

Despite enhanced efforts to prevent and control malaria, it remains a leading cause of morbidity and mortality globally.[16,23,24] This study

Table 2. The prevalence of malaria in the five districts of Limpopo Province, South Africa, per 100 000 per district from January 2015 to December 2017 (*N*= 43 199)

	2015			2016			2017		
District	*n*	Prevalence per 100 000*	95% CI	*n*	Prevalence per 100 000	95% CI	*n*	Prevalence per 100 000	95% CI
Capricorn	1 121	83.9	79.0 - 88.9	760	56.1	52.2 - 60.2	1 442	106.9	101.5 - 112.6
Greater Sekhukhune	539	47.2	43.3 - 51.4	343	29.7	26.6 - 32.9	689	59.8	55.5 - 64.5
Mopani	5 945	513.6	500.6 - 526.8	1 928	164.3	157.1 - 171.8	6 636	568.1	554.6 - 581.9
Vhembe	8 888	647.9	634.4 - 661.5	3 063	220.3	212.6 - 228.3	9 128	659.4	645.9 - 673.1
Waterberg	919	127.7	119.5 - 136.2	558	76.5	70.3 - 83.1	1 240	170.7	161.4 - 180.5
Limpopo Province	17 412	304	299.5 - 308.5	6 652	114.6	111.9 - 117.4	19 135	331.1	326.5 - 335.9

*Prevalence was estimated per 100 000 population using each year's mid-year population estimates from Statistics South Africa and district population estimates from census. Limpopo Province mid-year population stats for 2015 = 5 726 800, 2016 = 5 803 900 and 2017 = 5 778 400.
CI = confidence interval.

Table 3. The percentage difference in the prevalence of malaria in the five districts of Limpopo Province per 100 000 per district from January 2015 to December 2017 (*N*= 43 199)

	Prevalence change 2016 - 2015		Prevalence change 2017 - 2016		Overall
District	Percentage difference	95% CI	Percentage difference	95% CI	*p*-value
Capricorn	−27.8	−34.1 - −21.4	50.8	44.0 - 57.6	<0.001
Greater Sekhukhune	−17.6	−22.7 - −12.5	30.2	24.7 - 35.6	<0.001
Mopani	−349.2	−364.2 - −334.3	403.8	388.3 - 419.3	<0.001
Vhembe	−427.6	−443.1 - −412.1	439.1	423.6 - 454.7	<0.001
Waterberg	−51.2	−61.6 - −40.8	94.2	82.8 - 105.7	<0.001
Limpopo Province	−189.4	−194.7 - −184.1	216.5	211.1 - 222.0	<0.001

CI = confidence interval.

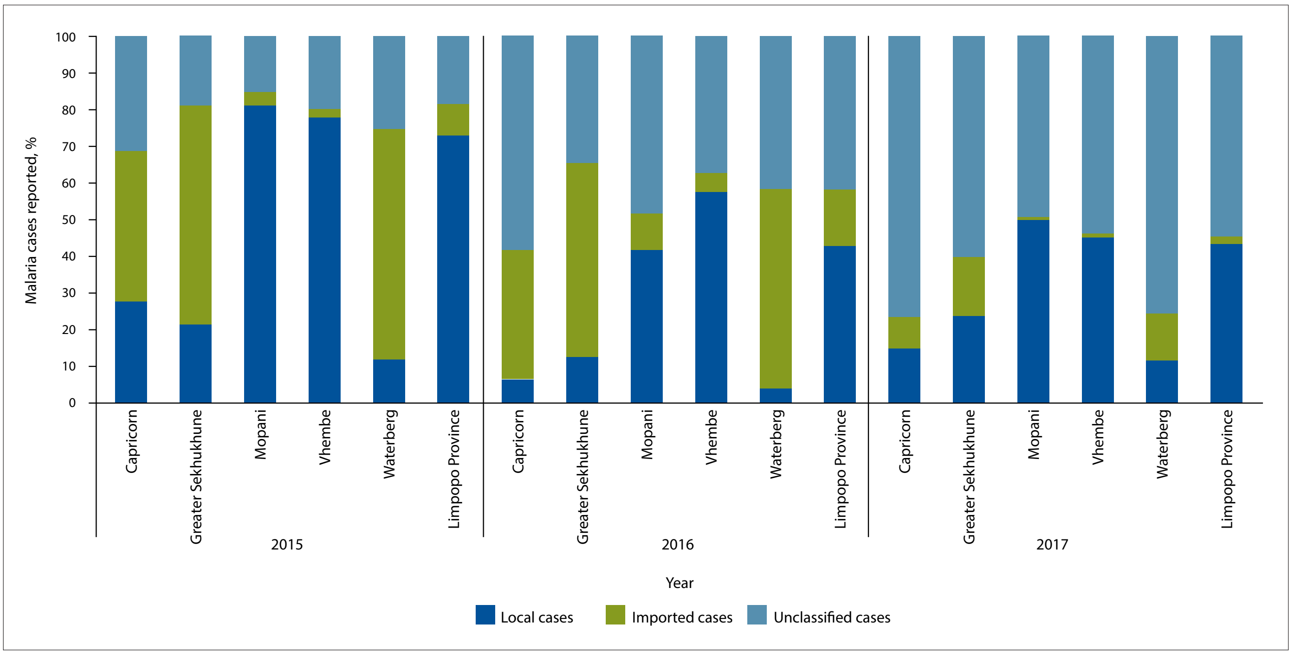

Fig. 3. The prevalence of malaria by sex per 100 000 population in Limpopo Province, South Africa, from January 2015 to December 2017.

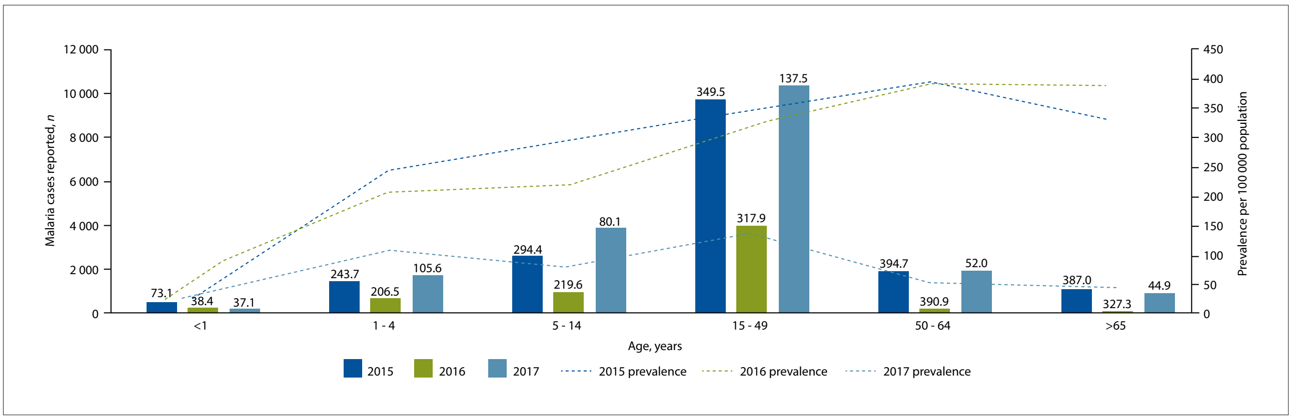

Fig. 4. The prevalence of malaria by age category (in years) per 100 000 population in Limpopo Province, South Africa, from January 2015 to December 2017.

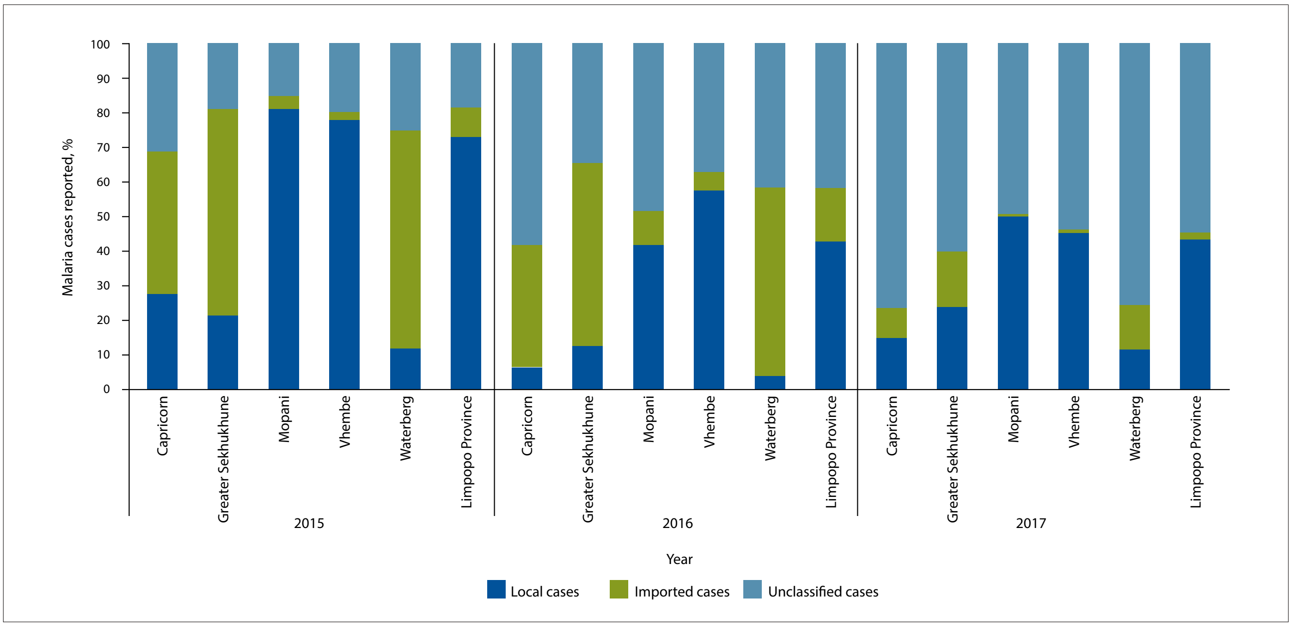

Fig. 5. The contribution of local, imported and unclassified malaria cases in the five districts of Limpopo Province, South Africa, during January 2015 - December 2017.

Table 4. Assessment of factors associated with malaria in Limpopo Province from January 2015 to December 2017

	Malaria		Bivariate analysis		Multivariate analysis	
Variable	Positive, *n* (%)	Negative, *n* (%)	Odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value
Sex						
Female	21 171 (62.4)	12 758 (37.6)	Reference	-	-	-
Male	22 028 (63.4)	12 708 (36.6)	1.04 (1.01 - 1.08)	0.006	1.02 (0.99 - 1.05)	Not significant
Age category						
<1	1 042 (64.2)	581 (35.8)	1.55 (1.38 - 1.75)	<0.001	1.55 (1.37 - 1.74)	<0.001
1 - 4	3 921 (62.1)	2 388 (37.9)	1.42 (1.31 - 1.54)	<0.001	1.43 (1.32 - 1.56)	<0.001
5 - 14	7 475 (61.1)	4 763 (38.9)	1.36 (1.26 - 1.46)	<0.001	1.38 (1.28 - 1.48)	<0.001
15 - 49	24 418 (54.4)	12 895 (34.6)	1.64 (1.53 - 1.75)	<0.001	1.58 (1.48 - 1.68)	<0.001
50 - 64	4 141 (58.6)	2 929 (41.4)	1.22 (1.13 - 1.32)	<0.001	1.20 (1.11 - 1.29)	<0.001
≥65	2 202 (53.5)	1 910 (46.5)	Reference	-	Reference	-
District						
Capricorn	3 323 (72.6)	1 253 (27.4)	Reference	-	Reference	-
Greater Sekhukhune	1 571 (77.0)	470 (23.0)	1.25 (1.11 - 1.42)	<0.001	1.25 (1.11 - 1.41)	<0.001
Mopani	14 509 (63.3)	8 410 (36.7)	0.66 (0.60 - 0.69)	<0.001	0.66 (0.61 - 0.71)	<0.001
Vhembe	21 079 (60.2)	14 514 (40.8)	0.56 (0.51 - 0.58)	<0.001	0.55 (0.52 - 0.59)	<0.001
Waterberg	2 717 (76.8)	819 (23.2)	1.25 (1.13 - 1.38)	<0.001	1.24 (1.12 - 1.37)	<0.001

P-value is for *z*-test results. Post-regression (final model) area under receiver operating characteristic curve = 0.57; Hosmer-Lemeshow goodness-of-fit test *p*=0.26.
CI= confidence interval.

shows a substantial burden of malaria over 3 years in Limpopo Province, with a high prevalence of 304 per 100 000 population in 2015, 115 per 100 000 in 2016 and 331 per 100 000 population in 2017. In 2016 compared with 2015, all districts of Limpopo Province had a significant decline in malaria prevalence, which is likely owing to drought conditions, thus improving chances of a successful malaria elimination as targeted by the NDoH. The NDoH malaria elimination was aimed at achieving zero local malaria transmission in a defined geographical area, with the interruption of local malaria transmission by mosquitoes despite the continued presence of malaria vectors and the importation of parasites from abroad through international travel and migration.[15,25]

However, following the decline in malaria prevalence from 2015 to 2016, in 2017, Limpopo Province experienced a malaria outbreak, resulting in a substantial increase in the prevalence of malaria cases.[19] It is likely that climatic changes such as high rainfall, humidity and a rise in ambient temperatures, as well as unusually mild winter temperatures in the malaria-endemic areas around Africa, the Southern African Development Community (SADC) region, and SA (especially in the malaria-endemic provinces including Limpopo), contributed towards increased breeding of malaria-carrying mosquitoes (*Plasmodium* species) and parasite development.[26-28] Despite malaria being distinctively seasonal in SA, with the seasonal peaks occurring during the rainy months from September to May (the highest transmission months are January - April), these factors contributed towards an overall increase in cases.[27] The general increase in malaria cases was also aggravated by the suboptimal coverage of vector control interventions due to insufficient funds for indoor residual spraying (IRS), long-lasting insecticide-treated nets (LLNs) and larval source management throughout the SADC region.[28]

Although children <5 years are known to be more affected by malaria, our study shows that adults aged 50 - 64 years had the highest malaria prevalence compared with other age groups. These results might be influenced by the consistency in tackling malaria and prioritisation of malaria control among children <5 years old. Individuals 15 - 49 years are likely to travel to malaria-endemic areas as migrant workers, hence the high prevalence of malaria in this age group. The WHO identifies infants <1 year as one of the age groups at high risk of malaria infection.[29] This study shows that all age groups were at significantly high risk of malaria infection when compared with those ≥65 years, with the highest likelihood of malaria among adults aged 15 - 49 years, followed by infants <1 year. Although infants and young children are biologically at high risk of acquiring malaria, previous studies have found that the risk of being infected with malaria declines with age between childhood and adulthood, signifying that protective immunity may be acquired with increasing age up to adulthood in malaria-endemic areas.[30,31]

Our study shows that the prevalence of malaria per 100 000 population and proportions of imported malaria cases were higher in males than females throughout the 3-year period. Previous studies found that males had higher proportions of imported malaria cases compared with females.[32-42] This is probably due to males being less likely to seek pre-travel advice (or delayed health-seeking behaviour among males), or less likely to adhere to appropriate personal vector avoidance and suffer more mosquito bites compared with females.[43] Additionally, males are more likely to be migrant workers, or malaria symptoms are more severe in males than females, forcing males to seek healthcare despite several studies showing that males are less likely to seek healthcare than females.[32-38] Previous studies found that men have a greater occupational risk of being infected by malaria than women because they work in mines, fields, or forests at peak biting times, or migrate to areas of high endemicity for work.[39] Lastly, a large number of male expatriates work as labour from malaria-endemic countries such as Mozambique, Zimbabwe and other African countries. The districts such as Greater Sekhukhune, Mopani and Waterberg serve as employment attraction to people, especially the male population, owing to several mining sectors.

Although the general population of Limpopo Province is regarded as at risk of malaria, there is significant heterogeneity in malaria risk and prevalence by and within district. Waterberg, Capricorn and Greater Sekhukhune are considered non-endemic malaria districts in Limpopo. Vhembe and Mopani are known malaria-endemic districts and have both low- and moderate-risk areas. Vhembe was the highest malaria prevalence district throughout the 3 years, followed by Mopani district. Vhembe district is known to have contributed >60% of the national malaria burden.[40] Vhembe district borders three countries, Botswana, Zimbabwe and Mozambique; therefore, the high malaria prevalence might be influenced by the location of the district in relation to neighbouring malaria-endemic countries. Mopani district borders Mozambique, while Capricorn and Waterberg border Botswana.

Our results demonstrate that the highest proportion of imported malaria cases was in Waterberg district, followed by Greater Sekhukhune. Waterberg district has more farms and mines, followed by Greater Sekhukhune district; these attract migrant workers seeking jobs. As such, Waterberg and Greater Sekhukhune districts had the most imported malaria cases. Those aged 15 - 49 years accounted for 55% of imported malaria cases throughout Limpopo. Previous studies have shown that those aged 15 - 49 years have contributed to a higher proportion of imported malaria cases compared with the other age categories, most likely due to the working age group migrating to or from malaria-endemic areas for occupational reasons.[41] The large number of adults within the working age group might have influenced the high proportions of imported malaria cases in this age group.

Our study shows that although Vhembe and Mopani districts have the highest number of malaria cases, these districts had a lower prevalence of malaria infection. However, the two districts are known (historically and currently) to experience the highest malaria transmission, and border Zimbabwe to the north, Botswana to the west, Mozambique to the east and SA's Kruger National Park.[42,43] Meanwhile, the other three districts (Waterberg, Sekhukhune and Capricorn) experience very little local transmission.[15]

Study limitations

Our study is based on old data, which may affect timely application of recommendations to the malaria surveillance system. However, considering that there have not been new malaria prevention strategies implemented in these areas, it is likely that the situation may be worse. Our study location has many mines and farms; however, we could not verify the type of occupation that males and females are exposed to. The high proportions of unclassified cases, which resulted from the lack of follow-up of cases during surveillance data collection, may have led to biased results. The linkage rates between the MIS and laboratory data reflect more cases being missed clinically and later diagnosed or detected by laboratory. However, the data do not record information on the severity of malaria. The incompleteness of the data from the NHLS in which the de-duplicated and missing values contributed to 44.5% is also another limitation.

Recommendations

Our findings highlight the need for the following:

- targeted interventions among the high-risk populations identified
- strengthening control programmes in neighbouring countries (cross-border collaborations)
- malaria rapid testing in symptomatic people at high-risk borders
- local control during malaria peak seasons such as seasonal IRS and insecticide-treated bed net (ITN) administration with or without confirmed malaria cases
- introduction of the malaria vaccine in highly endemic areas
- malaria control strategies focused on migrant workers or travellers where they are given free malaria prophylaxis before they return to their home country
- training of healthcare providers on data quality issues, as evidenced by data exclusion of 7.3% from the MIS and 44.5% from the NHLS, and improved measures and methods to tackle issues related to loss to follow-up, which resulted in higher proportions of unclassified cases.

Conclusion

We identified a high burden of malaria in Limpopo Province, with higher prevalence in Vhembe and Mopani districts, which border malaria-endemic countries. Waterberg district had the most imported malaria cases; however, local transmission is more evident in Vhembe district. The whole of Limpopo Province had a general decline in malaria prevalence in 2016. During 2017, there was a three-fold increase in cases compared with 2016, highlighting the need for more targeted malaria control interventions and adequate funding for prevention measures. Older age groups had a higher prevalence of malaria compared with those aged <1 year, which may reflect the prioritisation of malaria control interventions among children under five years.

Declaration. None.

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