

Malaria in Eswatini, 2012-2019: A Case Study of the Elimination Effort.

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Abstract

Eswatini was the first country in sub-Saharan Africa to pass a National Malaria Elimination Policy in 2011 and later set a target for elimination by the year 2020. This case study aimed to review Eswatini's progress towards malaria elimination by 2020. Coverage of indoor residual spraying (IRS) for vector control and data on malaria cases were provided by the National Malaria Programme (NMP) of Eswatini. The data included all cases treated for malaria in all health facilities. The data was analysed descriptively. Over the eight-year period, a total of 5,511 patients reported to the health facilities with malaria symptoms. Case investigation rate through the routine surveillance system increased from 50% in 2012 to 84% in 2019. Incidence per 1000 population at risk fluctuated between the years but in general increased from 0.70 in 2012 to 1.65 in 2019 with highest incidence of 3.19 reported in 2017. IRS data showed inconsistency in spraying over the eight-year period. Eswatini has fallen short of achieving malaria elimination by 2020. Malaria cases are still consistently reported, albeit at low rates, with occasional localised outbreaks. To achieve elimination, it is critical to optimise timely and well-targeted IRS and to consider rational expansion of tools for an integrated malaria control approach in Eswatini by including tools such as larval source management, long-lasting insecticidal nets (LLINs), screening of mosquito house entry points and chemoprophylaxis. The establishment of rigorous routine entomological surveillance should be among the priorities in order to determine the local malaria vectors' ecology, potential species diversity and the role of secondary vectors and insecticide resistance.

Background

Globally, more countries are moving towards zero indigenous malaria cases. In 2018, 49 countries reported fewer than 10,000 malaria cases [1]. The number of countries with fewer than 100 indigenous cases increased from 17 countries in 2010 to 25 countries in 2017 and 27 countries in 2018 [1]. In 2016, the World Health Organization (WHO) identified 21 countries with the potential to eliminate malaria by 2020 (known as E-2020) and resolved to work with their governments to support their elimination goals [2]. Eswatini is among the E-2020 countries and also part of the Elimination 8 (E-8), a regional initiative established in 2009 by the Southern African Development Community (SADC). The E-8 initiative is coordinating a collaborative effort, led by the Ministers of Health in eight countries; Botswana, Namibia, South Africa, Eswatini, Angola, Mozambique, Zambia, and Zimbabwe to jointly plan and execute a regional malaria elimination strategy. The E-8 aims to mitigate cross border transmission which presents a major threat of re-establishment of infection [3].

In Eswatini, malaria transmission is seasonal and highly influenced by variations in altitude through the corresponding effects of rainfall and temperature levels. The country is divided into four ecological regions distinguished by elevation, climate, soil quality and vegetation: highveld (altitude above 1500 meters); middleveld (average altitude 700 meters); and, lowveld (average elevation 400 meters) [4] (Fig. 1a). Historically, malaria transmission has been confined in the lowveld and lower areas of middleveld regions, where malaria vector breeding is favoured by a range of environmental factors including warm and wet autumn and summer seasons and, availability of suitable mosquito breeding

habitats. Prior to commencement of vector control measures in 1949, malaria was a major health problem in Eswatini, with epidemics reported during the summer and autumn months from December to May [4]. Malaria control measures were extremely limited and prejudicial, whereby the Europeans living in the lowveld regions were advised to put screens on their windows and to avoid walking outdoors in the evenings, while no similar health instructions were given to the native Swazi. In 1946, during the first epidemic, where extensive malaria surveys were carried out; it was estimated that 50,000 cases occurred, which corresponded to 26% of the total population of Eswatini at the time [5]. These epidemics were attributed to heavy rainfall which led to increase in vector breeding sites and colonial economic policies which prevented many Swazi families from producing enough food to meet their subsistence needs [4]. Following the successful control of malaria with IRS using DDT in the 1950s and early 1960s in the lowveld, agricultural activities could now be intensified in these regions. This led to construction of major irrigations schemes for sugar plantation which, unfortunately, resulted in a resurgence of malaria in the areas in which sugar was grown, undermining the effectiveness of the malaria control measures that had been put in place. Autochthonous cases of malaria occurred around the sugar estates in 1960 and larger outbreaks followed in 1967 and 1972 [5]. The number of recorded cases continued to rise during the late 1970s and began to spread out from the sugar estates to other areas of the lowveld and into the lower parts of the middleveld. Ineffective malaria control measures within the sugar estates and more widely in the lowveld, led to the creation of ideal breeding sites for malaria vectors within the irrigation projects. Demographic shifts, with more non-immune populations living near malaria vectors and carriers further contributed to the re-establishment of malaria as a serious health problem in Eswatini in the late 1970s.

However, between 1999 and 2009, Eswatini scaled up vector control, largely using indoor residual spraying (IRS) in the at-risk regions and border areas and established a cross-border collaboration with Mozambique and South Africa for malaria control [7]. As a result, Eswatini greatly reduced the national burden of malaria from 3.9 laboratory confirmed cases to 0.07 cases per 1000 population [6]. The successful control of malaria through national and cross-border efforts, positioned Eswatini to be earmarked for elimination by 2015 by SADC and the African Union [8, 9] and the National Strategic Plan for Elimination (NMESP) of Malaria in Eswatini was initiated [6]. The NMESP for 2008–2015 set the country on a malaria elimination path. In March 2011, Eswatini became the first country in sub-Saharan Africa to approve a National Malaria Elimination Policy [6]. As defined in the NMESP 2015–2020, Eswatini's plan to eliminate malaria focused on four major intervention areas: case management; vector control with indoor residual spraying (IRS); surveillance; and, information, education, and communication on malaria [10]. With the introduction of rapid diagnostic test (RDT) kits to all health facilities in February 2010, laboratory-confirmed cases increased marginally while the number of clinically diagnosed cases decreased significantly, indicating successful uptake of RDT use [11]. Additionally, a surveillance programme has been operationalised nationally to facilitate the investigation of confirmed malaria cases at the household level to determine the source of each infection. Community-based case detection was established to help identify asymptomatic infections that contribute to ongoing local transmission. This has allowed the identification of high-risk groups and areas that can be targeted with additional interventions including vector control using IRS and health promotion messages [10, 11]. At the core of

Eswatini's National Malaria Programme (NMP) vector control strategy is IRS targeted to areas of high malaria transmission/burden. IRS guidelines direct that the entire populations living in those areas have all rooms of their houses sprayed once a year prior to the malaria season. Furthermore, in response to each confirmed local case, and in the event of local malaria epidemic, additional spatially targeted IRS campaigns were to be implemented alongside vector surveillance. However, in recent years, IRS activities were scaled down to a more targeted approach (as opposed to blanket spraying) in malaria hotspots [10].

This case study aimed to review the malaria surveillance data of Eswatini collected over an eight-year period between 2012 and 2019 so as to evaluate the country's efforts and progress towards the target of malaria elimination by 2020.

Methods

Study setting

Eswatini is a landlocked country in the southern part of Africa bordered by South Africa and Mozambique (Fig. 1b). Malaria transmission is seasonal in Eswatini, due to the country's subtropical climate, and occurs during the warmer and wetter months of November to April. From May to October, it is cooler and drier (winter) and malaria transmission normally ceases with exception of few malaria hotspot in the riverine areas of the lowlands [12]. Of the 1,172,433 population, an estimated 30% of the population live in communities that are prone to malaria transmission (Table 1) [13]. *Plasmodium falciparum*, is responsible for > 99% of malaria cases, while the main vector is reported as *Anopheles arabiensis*, [14] even though there is scarcity of entomological data to support this assertion [3]. Eswatini's mobile population and labour force contributes to sustaining the malaria risk in the country especially across the border with Mozambique, where malaria remains a major public health issue. In 2017, Eswatini had 327 health facilities [15] providing services to most households within an 8 km radius. Facility ownership was distributed between government owned facilities (39%), privately owned facilities by doctors or nurses (29%), mission owned facilities (13%), industry owned facilities (10%), and non-government organizations owned facilities (9%).

Table 1
Population at risk of malaria in Eswatini, 2012–2019

Year	*Total Population	Population at risk (30%)
2012	1,080,337	324,101
2013	1,093,158	327,947
2014	1,106,189	331,857
2015	1,119,375	335,813
2016	1,132,657	339,797
2017	1,145,970	343,791
2018	1,159,250	347,775
2019	1,172,433	351,730

*Total populations are projections from Eswatini population projections, 2007–2030 [13].

Eswatini’s malaria case surveillance

According to national guidelines, all suspected malaria cases need to be confirmed at a health facility using rapid diagnosis test (RDT) and/or microscopy and reported using the electronic Immediate Disease Notification System (IDNS) tool, which is available in all health facilities in Eswatini. This system allows the health care worker to capture demographic details about the patient that assists in patient follow-up. The case notification through the IDNS reaches the NMP surveillance team which then contacts the patient and attempts to conduct a case investigation within 48 hours. The case investigations primary purpose is to establish the case origin (imported or autochthonous) and collect other relevant demographic data such as GPS coordinates, treatment received, age, gender, nationality and occupation of patient.

Furthermore, the NMP surveillance team is required to carry out active case detection (ACD) in malaria receptive communities regardless of whether case has been reported or not. ACD is a process in which malaria infections are identified within the communities through screening using RDTs and blood smear collected for all positive cases for confirmation of positive cases. (Fig. 2).

Review of data

This was a descriptive retrospective study utilising data routinely collected using IDNS from the health facilities and reported to the Eswatini NMP between 2012 and 2019. The data included cases treated for malaria in all health facilities of Eswatini reported to NMP; including confirmed cases (RDT and/or microscopy), investigated cases (followed up at household levels), case origin (autochthonous and imported cases), and demographic data (nationalities, age, gender). Terminology used is as per WHO definitions (Table 1).

Table 2
Definitions of terminology used based on WHO [16, 17]

Type of malaria	Description
Surveillance (elimination programmes)	That part of the programme designed for the identification, investigation and elimination of continuing transmission, the prevention and cure of infections and final substantiation of claimed elimination.
Confirmed cases	A malaria case or infection in which the parasite has been detected in a diagnostic test, i.e. microscopy, a rapid diagnostic test, or a molecular diagnostic test
Presumed cases	A malaria case suspected of being malaria that is not confirmed by a diagnostic test
Active case detection	Detection by health workers of malaria cases at community and household levels, sometimes in population groups that are considered at high risk
Passive case detection	Detection of malaria cases among patients who, on their own initiative, visit health services for diagnosis and treatment, usually for a febrile illness case
Confirmed case	Malaria case (or infection) in which the parasite has been detected in a diagnostic test, i.e. microscopy, a rapid diagnostic test, or a molecular diagnostic test
Indigenous case	A case contracted locally with no evidence of importation and no direct link to transmission from an imported case
Introduced case	A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first-generation local transmission)
Imported case	Malaria case or infection in which the infection was acquired outside the area in which it is diagnosed
Autochthonous	A case locally acquired by mosquito-borne transmission, i.e. indigenous or introduced case (also called 'locally transmitted').

The IRS data for the same period was also reviewed. According to national guidelines, IRS is supposed to be carried out annually in October (one spray cycle) in malaria endemic areas. Over the study period, insecticides used for IRS were DDT, lambda-cyhalothrin and pirimiphos-methyl. DDT was sprayed in mud structures and lambda-cyhalothrin in modern/cement structures. Spray coverage was obtained from the NMP records and was based on the number of structures reported to have been sprayed between 2014–2019. Lack of data for 2012–2013, as reported by NMP, was due to technical malfunction of their servers that led to loss of data records.

Data analysis

The study variables included case status (investigated or not investigated), case origin (autochthonous, imported), demographics of patients (age, gender, and nationalities), and IRS coverage (coordinates of sprayed structures). Data was entered into Microsoft Office Excel 2010 (Microsoft Corp., Redmond, WA)

and SPSS 19.0 software (IBM) for analysis. Incidence rate was calculated from the confirmed number of cases per 1000 population at risk for each year (Table 1).

Results

A total of 5,511 patients reported to health facilities between 2012 and 2019 with malaria symptoms. The case investigation rate increased from 50% in 2012 to 84% in 2019, with a record high of 92% in 2017 (Fig. 3a). The number of cases fluctuated in these eight years, with an upward trend, from a total of 460 cases in 2012 to 693 in 2019 and a peak in 2017 with 1198 cases. As the cases increased so did the malaria incidence per 1000 population at risk, from 0.70 in 2012 to 1.65 in 2019 (Fig. 3b). The highest malaria incidence, of 3.19 was recorded in 2017

Malaria remains a major public health problem in Eswatini, with significant transmission occurring in the local communities as shown by the number of autochthonous cases over the years. Most of investigated cases were Swazi ($n = 2,895$) and Mozambican ($n = 1,315$), few were of other nationalities ($n = 67$) (Fig. 4). Whilst in 2012 only 13% (58 out of 460 cases) of the cases were autochthonous, in 2019 over 33% (234 out of 693 cases) were autochthonous (Fig. 5a). Furthermore, as malaria transmission in Eswatini is seasonal, annual data showed a peak in malaria cases in January due to imported rather than autochthonous cases, whilst the local cases peaked later and especially in years with higher transmission (2014 and 2017), peak transmission being observed from September to December. In 2017, a year with exceptionally high number of cases, over 57% of the cases were autochthonous (686 out of 1198 cases). Most autochthonous malaria cases were located along the borders with Mozambique and South Africa and in the Hhohho (middleveld) and Lubombo (lowveld) regions (Fig. 6). Imported malaria cases were found in naturally low malaria risk areas like the central region of Manzini, but also in the southern part of Hhohho region and along the borders with Mozambique and South Africa (Fig. 6). The geographical distribution of cases indicates that local cases were associated with the areas supporting transmission (lowveld and lower middleveld), whilst the imported cases to a large extent seen to occur in the highland areas (highveld and upper middleveld).

There was no IRS data for 2012 and 2013, while in 2014 the data indicates limited application of IRS and a high number of malaria cases with an increased proportion of autochthonous cases (Fig. 6). In 2015 IRS was very focal, targeting primarily areas that had local transmission in 2014. In 2016, IRS efforts were even more reduced and targeted at the few local transmission hotspots, while in 2017, the year with the highest case incidence rate over the observation period, hardly any IRS was done. In response to increase in malaria incidence, the areas targeted with IRS in 2018 significantly increased, and focussed especially at Eswatini's border with South Africa. In 2019 targeted IRS was maintained, keeping cases controlled, with 693 cases reported compared to 847 cases reported the previous year (Fig. 6).

Discussion

Eswatini has made major investments in improving malaria control and surveillance, including significant policy changes enabling the NMP to rapidly respond to cases. Despite all the efforts to make Eswatini malaria-free by 2020, there has been little change over the past decade and the overall elimination strategy has fallen short of its target. Eswatini has managed to keep malaria controlled with relatively low annual incidence rates compared to its neighbor Mozambique and other E-2020 countries in the region [1, 18]. However, outbreaks could still not be prevented within the case study's observation period. The reviewed data suggest that higher case numbers are associated with decreased vector control efforts. This is especially well illustrated in 2017 when hardly any structures were sprayed, and local malaria transmission increased rapidly, reaching an unprecedented high over the study observation period. Whilst an excellent surveillance system has been established in the country, and investigation rates have improved over the years, there still remains around a fifth of the reported cases that are uninvestigated, an area which must be improved if elimination is to be achieved. Reviewing the NMP databases highlighted significant missing demographic data (GPS coordinates, case origin data) which limited the mapping of malaria cases and IRS coverage. This missing information is pertinent for a country that is aiming for elimination, as all cases need to be identified and mapped for proper and effective deployment of vector control interventions [19].

IRS remains one of the most powerful vector control interventions for reducing/interrupting malaria transmission in terms of its immediate impact. Its use in the last seven decades has played a major role in the elimination of malaria from southern Europe, the Mediterranean region, Russia, large parts of Asia and Latin America, as well as many parts of South Africa [20]. In Eswatini, IRS is supposed to be implemented annually in October, marking one spray cycle before the start of the major local malaria season. This strategy aims to target the local cases that seem to peak later in the year as observed in this case study. In 2016, the IRS effort was reduced and targeted at the few local transmission hotspots observed in the previous year when IRS was more widely applied. In 2017 hardly any IRS was done. This reduced vector control effort correlated with major outbreaks of local cases in an expanded area of lowveld and lower middleveld regions. The exploration of the data suggests that IRS applications were frequently targeted in areas seen to be persistent malaria hotspots in the previous year. However, this targeted approach might have not considered that the higher coverage with IRS in the previous year prevented most of the cases that would have been seen without intervention. The increase of the IRS efforts in 2018 was associated with reductions in malaria incidence.

The mapped locations receiving IRS from the data provided by the NMP surveillance, highlights significant gaps in strategic deployment of this vector control tool to targeted malaria hotspots in some of the studied period (years). Studies have shown IRS to be an effective strategy for preventing malaria infection and mortality across a range of transmission settings [21–26]. However, low coverage and poor quality of IRS can limit the impact on malaria transmission [27]. The reasons of Eswatini's low coverage in 2017 was attributed to challenges in the procurement of insecticide, hence only limited amounts of insecticide (lambda-cyhalothrin) that remained from the previous season was used and targeted at outbreaks rather than prior transmission season hotspots. In 2018, IRS coverage maps show much more spraying. However the challenges in procurement extended to 2018 and hence whilst there was increased

coverage, the timing of IRS was not adhered to and was done late in many targeted regions [14]. In summary, challenges experienced by the NMP due to procurement and resource allocation led to poor planning and execution of IRS which led to insufficient coverage. Since IRS is at the core of Eswatini's vector control strategy, this delay had major impact on malaria control. To get on track with the elimination effort, it is necessary for the NMP to clearly identify and address the challenges in the implementation of IRS in order to sustain vector control.

Many factors have been shown to contribute to malaria outbreaks in various settings in Eswatini including, rainfall, temperature, population movement, and the lack of sufficient or appropriate control tools or timings of vector control strategies [18]. Control of malaria transmission in border areas, together with the importation of cases, presents a major threat to successfully eliminating malaria in Eswatini. Population movement, especially from the malaria-endemic neighbouring Mozambique, have been previously recorded as an important factor contributing to persistence of malaria cases in Eswatini [28]. The reviewed data supported these international border movements contributing to malaria cases

Eswatini can be described as low transmission and high importation case, similar to what is described in a study in Ethiopia where the local transmission risk was apparently very low, but many cases likely originated from other countries [29]. The high numbers of imported cases that were observed in this Eswatini study during the first few months of the year are likely caused by workers from Mozambique returning to Eswatini in January following the Christmas and New Year holidays [30]. Additionally, high case importation rates have been credited to sugar plantation workers whose travel patterns are well known between Eswatini and Mozambique [28]. Currently, Eswatini's NMP carry out malaria screening at the Eswatini/Mozambique border where they do not treat the positive cases but rather refer them to a nearest health facility. The data in this study clearly indicates the outbreaks are due to local transmission, which calls for two different responses: for cases imported to areas where transmission is unlikely, it is more a medical treatment case, so border check and treatment; whilst for local cases there needs to be more emphasis on vector control. Elsewhere it has been previously demonstrated in Eastern Myanmar that early diagnosis and prompt onsite treatment of confirmed cases is effective in achieving malaria elimination (14). In addition, it has been observed in southern Iran, that the presence of foreign immigrants could cause malaria outbreaks (15). Therefore, there is need for Eswatini to strengthen its cross-border surveillance, form collaborations with its neighbouring countries and learn from past lessons such as the cross-border initiative Lubombo Spatial Development Initiative (LSDI) [7]. This initiative represented collaborative efforts between Eswatini, Mozambique and South Africa to reduce each country's malaria importation risk and achieve elimination. LSDI led to success towards malaria elimination in both South Africa and Eswatini, with IRS as the core intervention [6, 7]. However, the termination of LSDI resulted in an upsurge of malaria cases in these countries, mainly as a result of migration from high transmission areas to low transmission ones [7]. The LSDI focus on vector control with IRS, further demonstrates the importance role of vector control in elimination efforts, and in particular, IRS.

This case study has programmatic implications. IRS has in the past successfully proven to work in Eswatini to manage cross-border transmission via the LSDI regional malaria control collaboration [7] and has for over 70 years contributed to eliminating malaria from various countries when integrated with other measures [20]. Integrated vector management (IVM) is the rational decision-making process to maximize the impact of resources allocated for vector control for long-term sustainability [31]. It might be timely for Eswatini to consider an integrated approach for malaria control adding tools such as long-lasting insecticidal nets (LLINs) [32], screening of house entry points [33] and targeted larviciding [34] along with chemoprophylaxis in their malaria control toolbox. Operational research should support such efforts towards IVM [35] which has been demonstrated in other countries including Zambia [36], and Tanzania [37, 38]. In Zambia, the interventions include IRS, LLINs, larviciding and environmental management implemented in eligible urban and rural areas [36]. In Tanzania, integrated control of urban mosquitoes in Dar es Salaam using community sanitation supplemented by larviciding was successful in managing mosquitoes [37, 38].

Furthermore, there is need to improve the entomological surveillance in Eswatini to clearly identify and monitor malaria vectors. Despite the country's emphasis on vector control, surprisingly little is known about the local vector species and population dynamics, the role of secondary vectors in malaria transmission and the status of insecticide resistance. Equally, implementation of resistance management strategies and alternative approaches including natural-based interventions will be pivotal for effective IVM and attainment of the objectives of the Stockholm Convention [39]. A review of procedures and challenges at programme level might help to improve vector control implementation including routine entomological surveillance in sentinel sites in the different ecological zones. Overall, the review of the malaria control effort over the past 8 years highlights the need to invest in strengthening human resources and infrastructural capacity. These include training and retaining of personnel with the necessary skills, laboratories, an insectary, establish systems for timely procurement, appropriate storage, and adherence to standard operating procedures.

Conclusion

This case study has presented a descriptive analysis of Eswatini's malaria elimination effort over the past eight years. Whilst overall malaria incidence rates have remained low, sporadic outbreaks could not be prevented and set back Eswatini's malaria elimination goal of eliminating malaria by 2020. The country needs to review the malaria elimination strategic plan and set a more realistic goal for achieving a malaria-free Eswatini. An integrated vector management approach with a more diverse set of tools and strong community engagement and participation is recommended for higher impact and sustainability.

List Of Abbreviations

ACD- Active Case Detection

E8- Elimination 8

GTS – Global Technical Strategy for Malaria 2016–2030

IRS- Indoor Residual Spraying

IVM- Integrated Vector Management

LLINs- Long lasting insecticide nets

NMESP- National Malaria elimination Strategic Plan

NMP- National Malaria Programme

WHO- World Health Organization

Declarations

Authors' Contribution

TEN, CM and UF conceived the idea for this manuscript. TEN conducted literature review and wrote the first draft. UF helped with writing. ZZ, QD and MD provided data. CM, POS, RM and EC critically reviewed the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Relevant data included in the manuscript.

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Figures

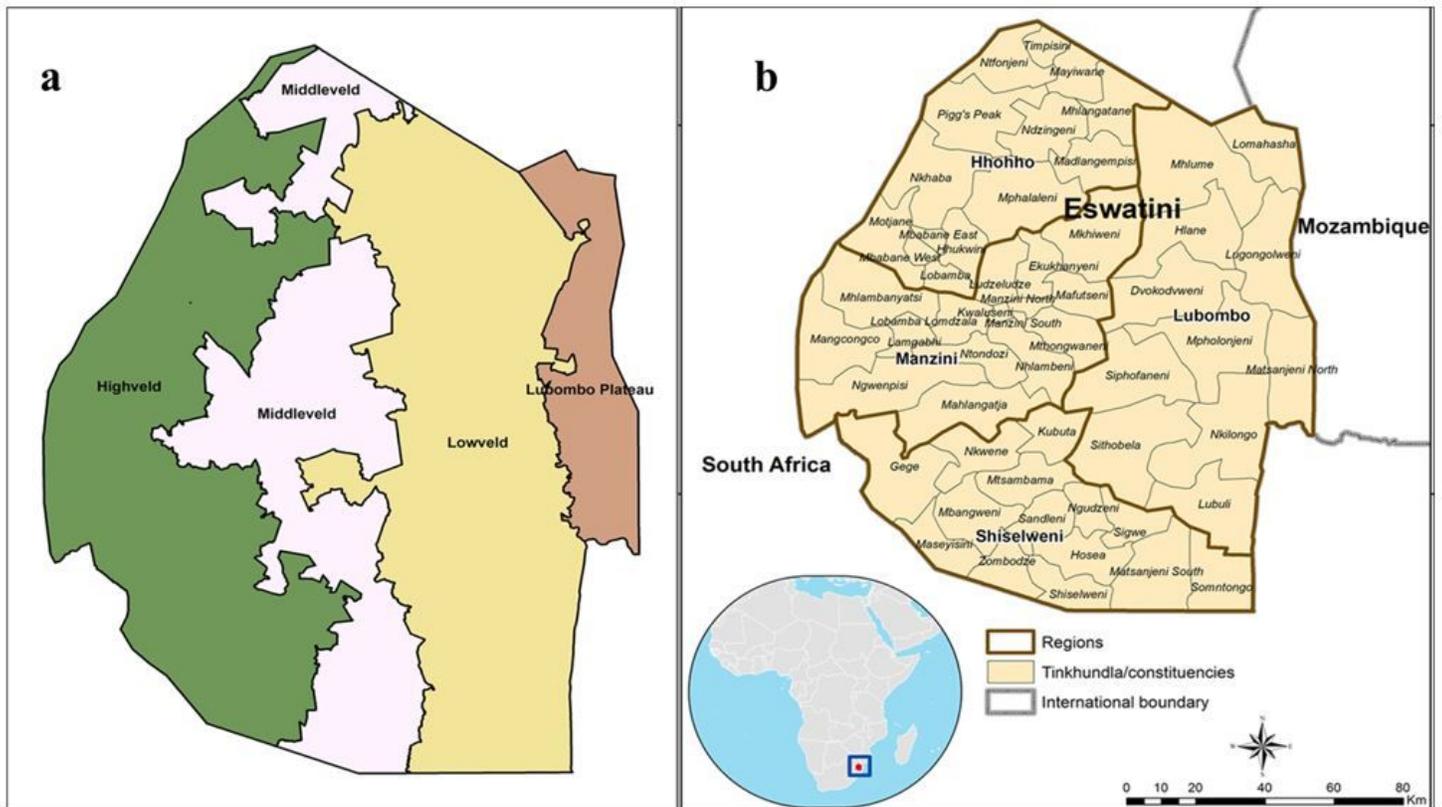


Figure 1

Map of Eswatini is a landlocked country surrounded by South Africa and Mozambique. a) ecological regions; highveld, middleveld, and lowveld. b) Eswatini showing regions, constituencies, and international borders. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

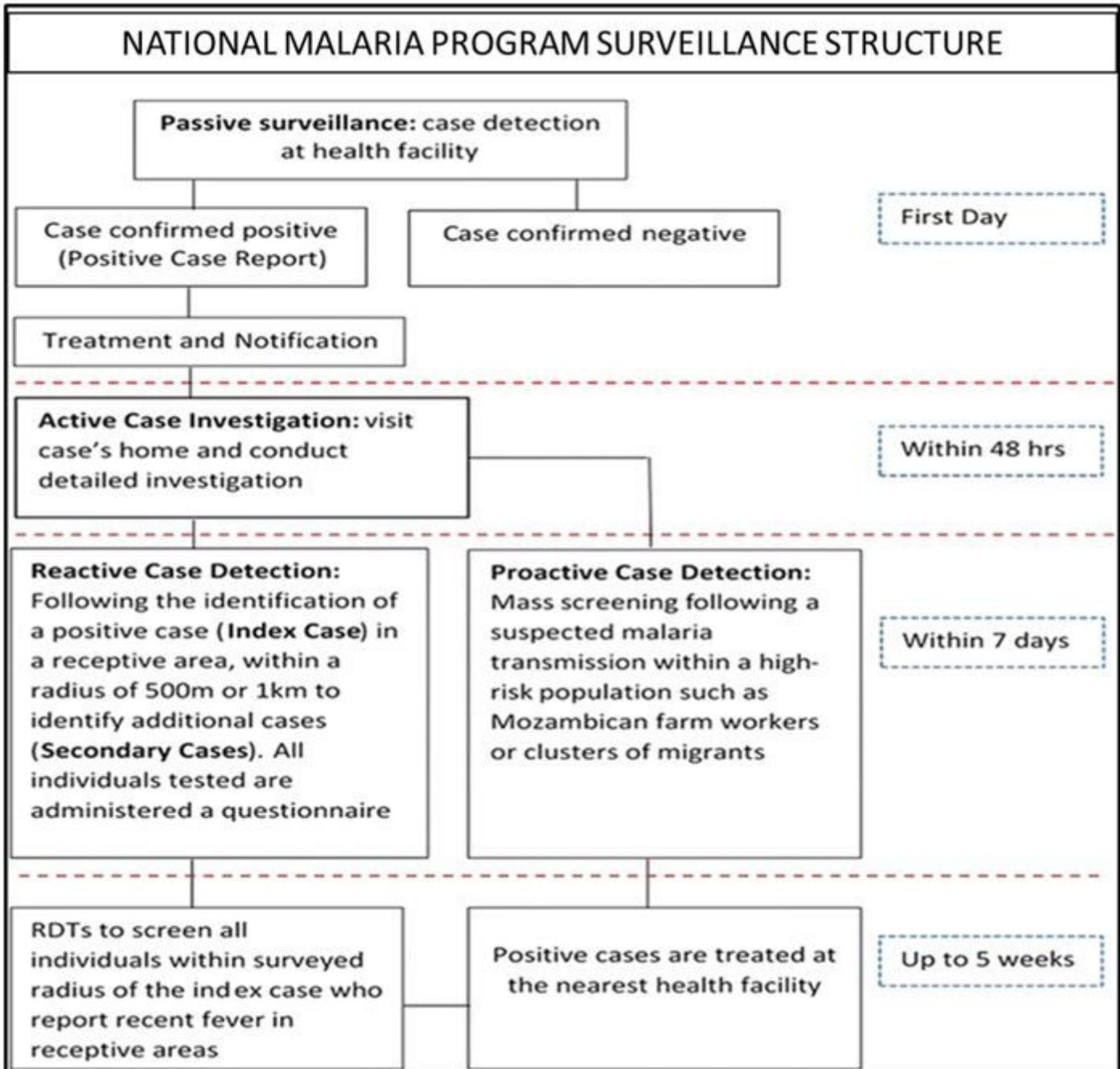


Figure 2

Eswatini's National Malaria Program Surveillance Structure.

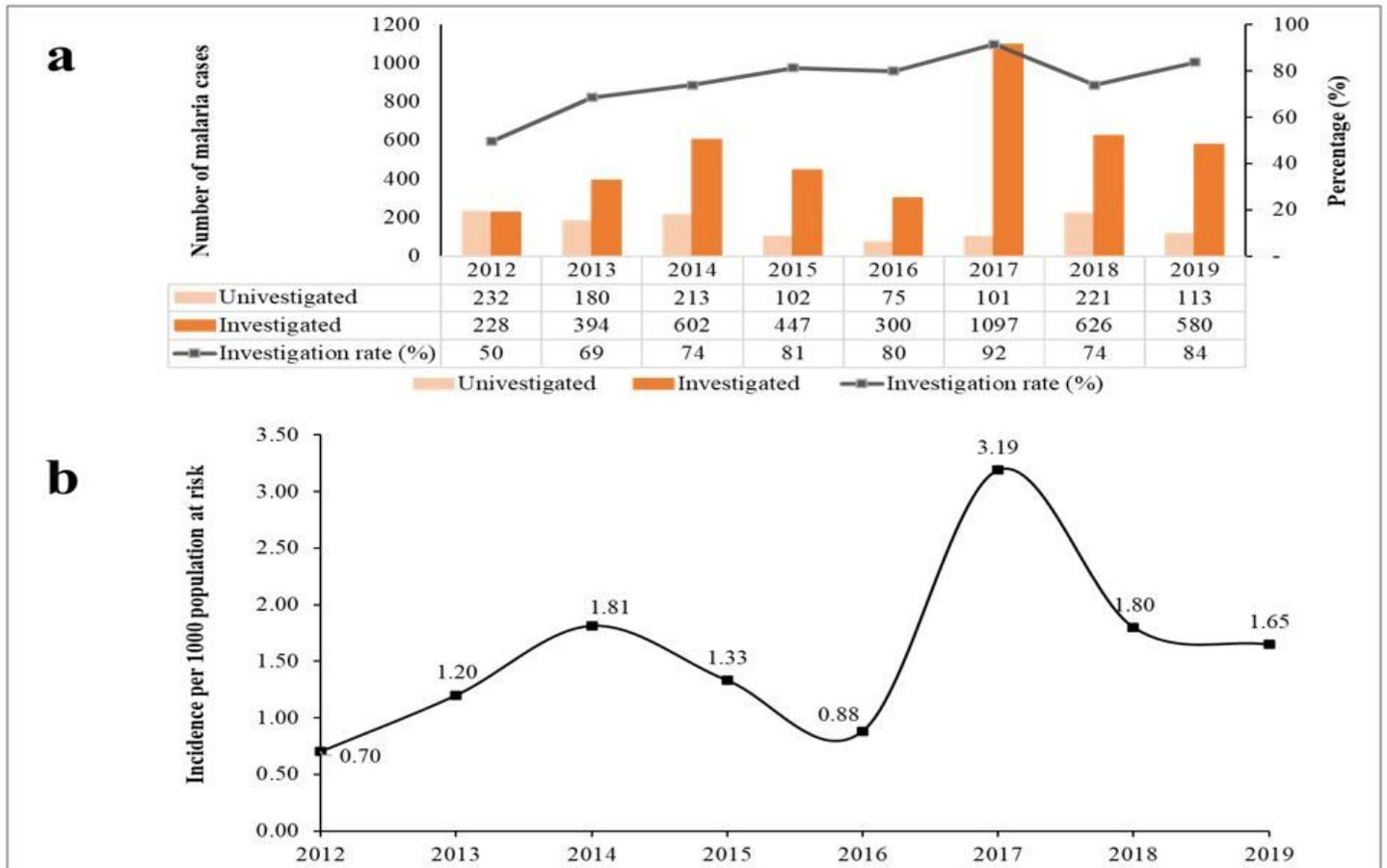


Figure 3

Malaria case numbers and incidence in Eswatini, 2012-2019. a) Investigated cases, uninvestigated cases, and investigation rate. b) incidence per 1000 population at risk of contracting malaria.

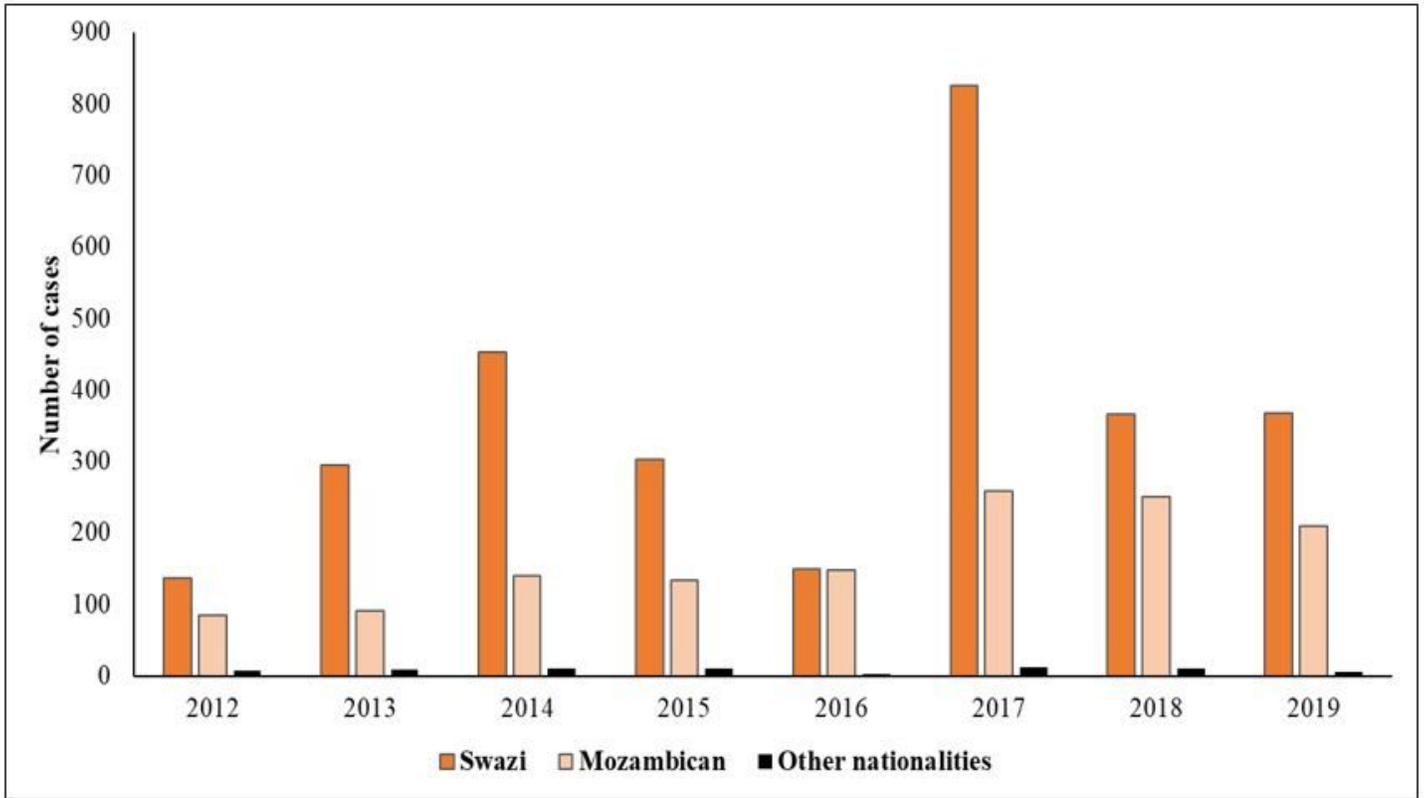


Figure 4

Distribution of malaria cases by nationality in Eswatini, 2012-2019.

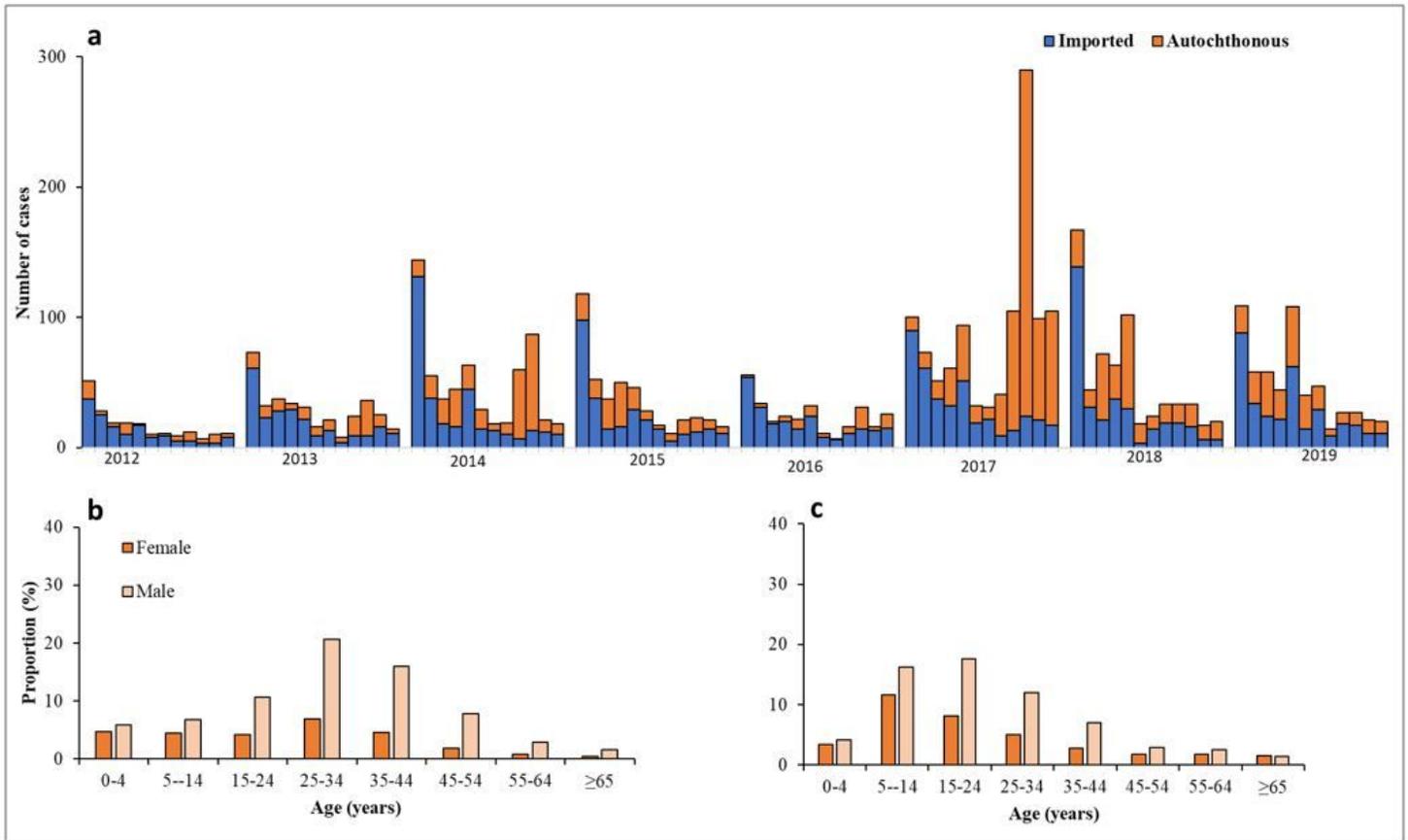


Figure 5

Epidemic curve and demographic features of malaria in Eswatini. a) Epidemic curve of autochthonous and imported malaria (n = 4,173) in Eswatini, 2012–2019. b) Age of autochthonous male (n =1,194) and female cases (n =677) in 2012–2019. c) Age of imported male (n = 1,662) and female cases (n = 640) in 2012–2019

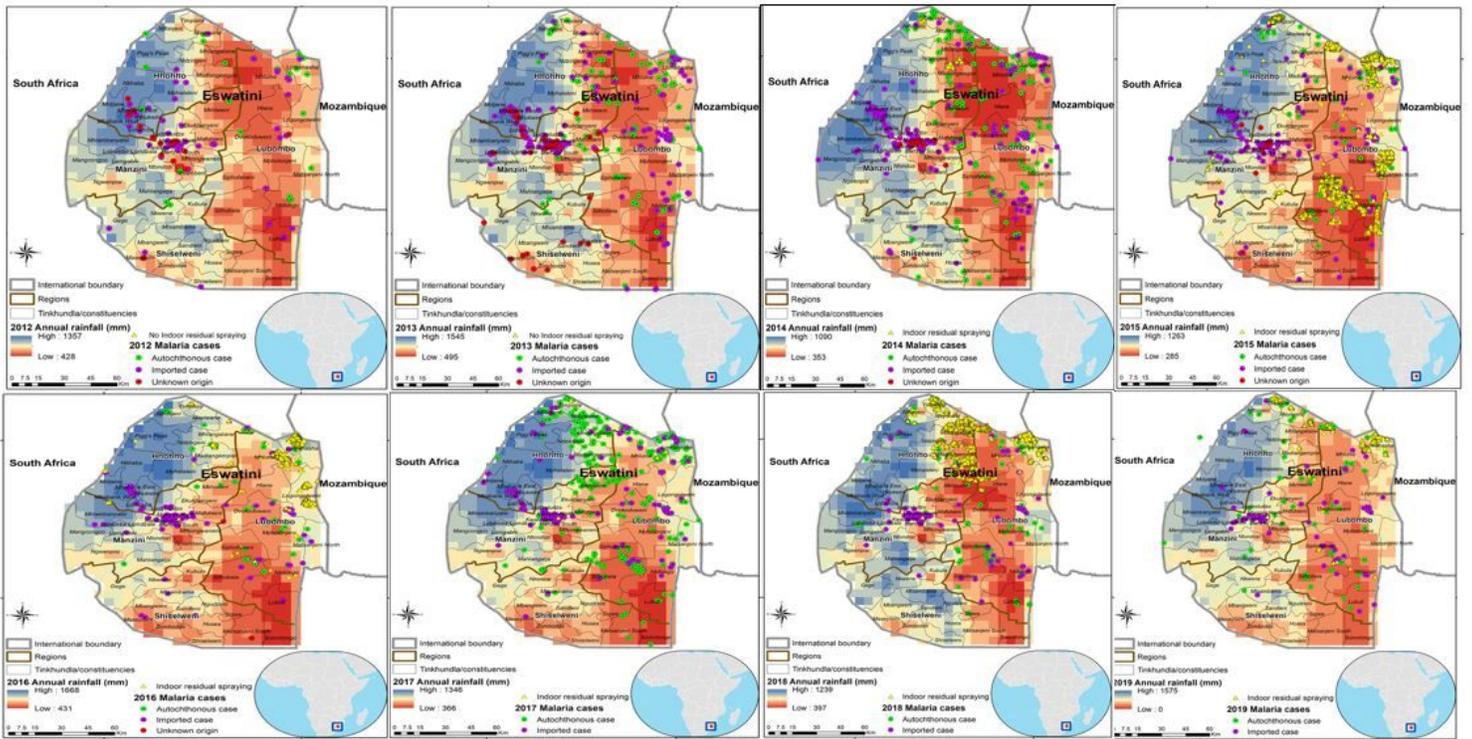


Figure 6

Geographic distribution of malaria cases origin (autochthonous, imported, and unknown), and indoor residual spraying (IRS) in Eswatini, 2012-2019. There was lack of data for 2012 and 2014 even though IRS was done. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.