

Epidemiological Trends of Malaria Infection in Saudi Arabia from 2020 to 2021: A Retrospective Study

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Abstract

Background: Malaria infection is a highly serious vector-borne protozoan blood disease that affects all human ages and poses a major public health risk worldwide. This retrospective study aimed to determine the epidemiological trends of malaria cases that were reported in the different regions of the Kingdom of Saudi Arabia (KSA) from 2020-2021.

Methods: The analyzed data were based on surveillance and registry database of the Saudi Ministry of Health and included the reported regions, patients' age groups, and the causative *Plasmodium* species. Overall, a total of 6274 confirmed cases of malaria infection were reported in KSA; divided as 3658 and 2616 cases in 2020 and 2021, respectively.

Results: The highest number of the reported cases were from Jazan region (N = 3022/6274, 48.2% in 2020; and N = 1657/6274, 26.4%) in 2021), while the lowest number was reported in Al-Jouf and Al-Qurayyat regions (for each N = 1 case/year). Infection with *P. falciparum* was the most frequently reported species (N = 5254/6274, 83.7%), while infection with *P. vivax* and/or *P. ovale* were 899/6274 (14.3%) cases, and infection with *P. malariae* and mixed *Plasmodium* species accounted 0.16% (N = 10/6274) and 1.79% (N = 112/6274), respectively. In relation to patients' age group, the majority of the reported malaria cases were in ≥15 years age group.

Conclusion: Taken together, the present findings indicate the persistency of malaria infection endemicity, particularly *P. falciparum*, in KSA and Jazan region is the most affected one. Thus, sustainable monitoring of malaria and improving its control measures is warranted.

Keywords: Malaria; Epidemiological Trends; Saudi Arabia

Abbreviations

KSA: Kingdom of Saudi Arabia; *P.*: *Plasmodium*; WHO: World Health Organization; *A.*: *Anopheles*; MOH: Ministry of Health; NMCP: The National Malaria Control Program

Introduction

Malaria is still a potential life-threatening vector-borne protozoan disease with a major public health problem affecting all human ages worldwide, particularly in in tropical and sub-

tropical countries [1,2]. Based on a report from the World Health Organization (WHO), over 3.4 billion people worldwide are at risk of malaria infection, and about 409,000 malaria-related deaths have been reported worldwide in 2019 [3]. The disease is caused by protozoan parasites from genus *Plasmodium*; subdivided to four species: *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae* [3]. At that regard, *P. falciparum* is the most virulent and prevalent type among *Plasmodium* species and accounts for approximately 99.7, 69 and 62.8% of malaria cases in the African, Southeast Asia and Eastern Mediterranean regions, respectively [4,5]. Likewise, *P. vivax* has also a wide distribution, and ~14.3 million cases of its worldwide infection were reported in 2018 [6]. In contrary, *P. malariae* has a low prevalence rate [7]. A fifth species, nominated as *P. knowlesi*, was also recently discovered [8], and the incidence of its zoonotic infections in humans is rising [9]. Most importantly, malaria cases caused by mixed infections with two or more *Plasmodium* species have been also reported worldwide, and this phenomenon has been attributed to vector factor (e.g., female *Anopheles* mosquitoes can carry more than one species), *Plasmodium* species factors (e.g. *P. vivax* and *P. ovale* can form hypnozoites in liver), and human factors (e.g., residing in or travel to endemic areas, and non-proper treatment of previous malaria infection) [10,11].

Saudi Arabia is still a country in the Arabian Peninsula that is yet to achieve malaria elimination, despite the successful efforts of its malaria control programs and elimination strategy that have been established in 2004; including The National Malaria Control Program (NMCP) [5]. Even though these programs have markedly reduced the overall burden of malaria in KSA, a significant number of malaria foci and residue remain in some regions of the country [12-14]. Several types of *Anopheles* species; the main vector for malaria, have been detected in Saudi Arabia and include *A. arabiensis*, *A. sergentii*, *A. fluviatilis*, *A. dthali*, *A. stephensi*, and other *Anopheles* mosquitoes that are known to transmit *Plasmodium* species [15,16]. Furthermore, millions of people from different countries, including those endemics with malaria, are annually come to KSA for Hajj or employment seeking [17-19]. Therefore, a continues screening implement and an epidemiological monitoring of the status of malaria infection in KSA is warranted. Coherently, the present study aimed to determine the epidemiological trends of malaria cases in the different regions of KSA during the period from 2020 to 2021.

Materials and Methods

Study design and setting

The present retrospective study was designed to disclose the epidemiological trends of infections with different malaria species that were reported among the individuals who were resident in the Kingdom of Saudi Arabia (KSA) during 2020 and 2021. Febrile patients who were diagnosed as positive cases of malaria infections and registered at the General Administration of Statistics and Information of the Ministry of Health, KSA, during the said period were included and analyzed here.

Geographically, KSA is located in Southwest Asia with estimated land area of 2,217,949 km² and 35.95 million population; making it the fifth-largest country in Asia, the largest one in Western Asia and the Middle East, and represent 80% of the Arabian Peninsula. KSA is annually attracting millions of visitors (pilgrims) and workers from different nations including those from malaria endemic regions. Moreover, climate changes, rainfall seasons in different regions (with an average ranging from 9 mm to 12 mm), and abundance of wild herbs and groundwater, make collectively KSA a good environment for the breeding of insects and dissemination of vectors-borne diseases including malaria [20].

Study participants, data sources/measurement

In this retrospective study, two-year malaria data (January 2020 to December 2021) were obtained from the surveillance database of malaria at the Registry of the Ministry of Health (MOH), KSA. The available data included regions, patient's age, and the underlying causative type of *Plasmodium* species. However, some important data such as patient's sex and their nationality (Saudis and Non-Saudis) and treatments were not provided. Notably, there is a Vector-borne Diseases Control Unit at each province of KSA, and its reported cases are constantly raised to be registered in MOH of KSA. In addition, the diagnosis of malaria infection in KSA and determination of the underlying *Plasmodium* species is a hospital-based process and follows the gold standard microscopic examination methods of blood smears in conjunction with rapid diagnostic serological tests and PCR (optional) as per the WHO protocol [11,21].

Ethics considerations

An ethical approval (IRB # TU-077-022-127) was obtained from the Institutional Review Board of Local of Health Affairs, KSA.

Statistical analysis

Data analyses were done using SPSS (Statistics software package version 20.0; SPSS Inc. Chicago, Illinois, USA) and Microsoft Excel 2010. The Chi-square (χ^2) test and Student “t” test or Mann-Whitney test were used for the categorical data and continuous variables as appropriate. P-value of <0.05 was considered statistically significant.

Results and Discussion

Results

A total of 1,345,866 febrile individuals, who were resident in KSA during the period of 2020 to 2021, were subjected to malaria diagnosis and among them a total of 6274 cases (0.46%); 3658 (0.27%) and 2616 (0.19%) cases in 2020 and 2021, respectively, were reported as positive-malaria infected patients (Table 1). Furthermore, as shown in Tables 1 and 2, the region distribution showed that the highest number of the reported positive cases ($p < 0.5$) was in Jazan region (3022/6274 (48.2%) in 2020; and 1657/6274 (26.4%) in 2021), while the lowest number (one case per year) was reported in Al-Jouf and Al-Qurayyat regions of KSA.

Region	Examined Patients	Malaria Positive Cases	Causative <i>Plasmodium</i> Species			
			<i>Pf</i> Cases	<i>Pv</i> and <i>Pov</i> Cases	<i>Pm</i> Cases	Mixed infection Cases
Riyadh	120164	47	17	30	0	0
Makkah	19530	36	24	10	0	2
Jeddah	4981	147	91	53	0	3
Taif	76754	41	18	22	0	1
Medina	38146	28	18	9	0	1
Eastern	95085	107	58	49	0	0
Al-Ahsa	46855	21	17	3	0	1
Hafr Al-Baten	120	9	9	0	0	0
Al-Qaseem	45817	20	7	13	0	0
Aseer	8734	112	93	19	0	0
Bishah	667	20	3	17	0	0
Tabouk	3514	2	2	0	0	0
Hail	1680	5	2	3	0	0
Northern	889	5	4	1	0	0
Jazan	187819	3022*	2841*	181*	0	0
Najran	18263	13	9	4	0	0
Al-Bahah	13733	15	12	3	0	0
Al-Jouf	14003	1	1	0	0	0
Al-Qurayyat	3738	1	1	0	0	0
Al-Qunfudah	2556	6	4	2	0	0
Total	703048	3658	3231#	419	0	8

Table 1: The distribution of reported malaria cases and their causative *Plasmodium* species in different regions of Saudi Arabia during 2020.

Pf: *Plasmodium falciparum*; *Pv*: *Plasmodium vivax*; *Pov*: *Plasmodium ovale*; and *Pm*: *Plasmodium malariae*.

* $p < 0.5$ vs other reported regions; # $p < 0.5$ vs other *Plasmodium* species.

Region	Examined Patients	Malaria Positive Cases	Causative <i>Plasmodium</i> Species			
			<i>Pf</i> Cases	<i>Pv</i> and <i>Pov</i> Cases	<i>Pm</i> Cases	Mixed infection Cases
Riyadh	19202	121	105	12	3	1
Makkah	34093	32	21	9	0	2
Jeddah	5209	156	95	52	2	7
Taif	73892	67	44	23	0	0
Medina	40832	55	48	5	1	1
Eastern	114944	206	142	64	0	0
Al-Ahsa	46629	32	23	7	0	2
Hafr Al-Baten	200	24	7	17	0	0
Qaseem	52553	52	28	23	1	0
Aseer	10043	86	66	20	0	0
Bishah	3105	16	5	10	1	0
Tabouk	3627	7	7	0	0	0
Hail	3434	20	8	12	0	0
Northern	114	6	5	1	0	0
Jazan	165023	1657*	1375*	190*	2	90*
Najran	21860	38	16	21	0	1
Al-Bahah	14546	32	25	7	0	0
Al-Jouf	28525	1	0	1	0	0
Qurayyat	3968	1	0	1	0	0
Qunfudah	1019	7	3	4	0	0
Total	642818	2616	2023#	480	10	104

Table 2: The distribution of reported malaria cases and their causative *Plasmodium* species in different regions of Saudi Arabia during 2021.

Pf: *Plasmodium falciparum*; *Pv*: *Plasmodium vivax*; *Pov*: *Plasmodium ovale*; and *Pm*: *Plasmodium malariae*.

* p < 0.5 vs other reported regions; # p < 0.5 vs other *Plasmodium* species.

As shown in Figure 1, in regards to the underlying *Plasmodium* causative species, the highest incidence rate of the reported cases was caused by *P. falciparum* infection (5254/6274 (83.7%; p < 0.5), followed by cases infected with *P. vivax* and/or *P. ovale* (899/6274 (14.3%)), and the lowest incidence rate was caused by *P. malariae* (10/6274 (0.16%)). More interestingly, cases of mixed infections with *Plasmodium* species was also reported (112/6274 (1.79%)), and its majority was seen in 2021 in Jazan region (90/112 (80.36%; p < 0.5) (Tables 2).

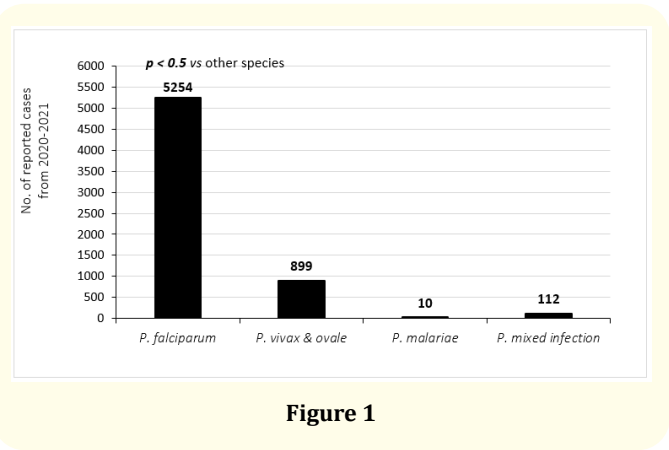


Figure 1

Age group distribution among the reported malaria cases showed that 98.52% of all reported cases were in patients with age group of ≥15 years (p < 0.5), and the lowest percentage (0.25%; p < 0.5) was in age group of <5 years (Table 3).

Region	Malaria Positive Cases	Age Group (years)		
		<5 years	5-15 years	≥ 15 years
Riyadh	168	0.0	3.0	165
Makkah	68	1.0	2.0	65
Jeddah	303	3.0	4.0	296
Taif	108	0.0	7.0	101
Medina	83	0.0	0.0	83
Eastern	313	2.0	3.0	308
Al-Ahsa	53	0.0	2.0	51
Hafr Al-Baten	33	0.0	0.0	33
Al-Qaseem	72	1.0	0.0	71
Aseer	198	3.0	11.0	184
Bishah	36	0.0	1.0	35
Tabouk	9	0.0	0.0	9.0
Hail	25	0.0	1.0	24
Northern	11	0.0	0.0	11
Jazan	4679*	5.0*	41*	4633*
Najran	51	0.0	2.0	49
Al-Bahah	47	1	0.0	46
Al-Jouf	2	0.0	0.0	2.0
Al-Qurayyat	2	0.0	0.0	2.0
Al-Qunfudah	13	0.0	0.0	13
Total	6274	16 (0.25%)	77 (1.23%)	6181 (98.52%)#

Table 3: Age group distribution of malaria cases in different regions of Saudi Arabia from 2020-2021.

* p < 0.5 vs other reported regions; # p < 0.5 vs other age group sets.

Discussion

The present study was designed to reveal the epidemiological trend of malaria cases that were reported in KSA from 2020-2021. A total of 6274 confirmed cases of malaria (3658 cases in 2020 2616 cases 2021) were reported in KSA, and the highest number of these cases was reported in Jazan region; reflecting the disease endemicity in this region Moreover, *P. falciparum* was the most frequently reported type among malaria species, and the majority of the reported patients with malaria infection were in ≥15 years age group. These findings are constant with the previous and recent reports described the distribution and prevalence patterns of malaria in KSA [5,13,20,22].

The present study showed a varying trend in the number of malaria cases related to the region, where the highest number of the reported cases was recorded in Jazan region. In support, [20,23,24] have also reported that Jazan region has the highest frequent rate of malaria infection compared to other studied regions of Saudi Arabia; reflecting its endemicity with malaria [22]. Regions-related variations in the prevalence of malaria cases was also reported worldwide [25-27], and such variations have been attributed to various ecological factors including diversity in the rainfall status, humidity, temperature, groundwater, and plants; which collectively affect the breeding of insect vectors (*Anopheles* mosquito) and the prevalence of malaria infection [5,14,26,28]. In addition, influx and immigrants of people from countries with known malaria endemicity to KSA for either Hajj or for employment might have a role in spectrum of malaria infection [17-19].

Next, the majority of malaria cases that were reported here was due to infection with *P. falciparum* infection, followed by those caused by *P. vivax* and/or *P. ovale* infections, while the lowest number of the cases was due to *P. malariae* infection. These findings have also been reported previously in Saudi Arabia [13,17,20,29]. In support, infection with *P. falciparum* has been revealed as the most virulent and prevalent type among *Plasmodium* species and accounts for approximately 99.7, 69 and 62.8% of malaria cases in the African, Southeast Asia and Eastern Mediterranean regions, respectively [4,5]. In a constant line, *P. vivax* has also a wide worldwide distribution [6], while *P. malariae* has a low prevalence rate [7]. Cases of mixed infections with two or more types *Plasmodium* species was also reported here and support those reported worldwide [10,11].

Lastly, most of malaria-infected patients reported here were those who had ≥ 15 years age, while the lowest number was in < 5 years age group. These findings are in constancy with those reported in Saudi Arabia [29] and other world countries [25,26]. This observation may be attributed to the fact that individuals with age of 15 years and above are the most productive and involved in different activities, and this in turn may increase their chances for bitten by malaria infected *Anopheles* mosquitoes. However, the present study revealed that there were malaria cases among children with < 5 years age. This observation was also reported in the world malaria report [3] as well as in KSA [19], and attributed to the low immune defense status among these infected children.

Conclusions

Data of the present study reveal that despite the efforts exerted for controlling malaria infection in KSA, it remains endemic and represents a major public health concern in some regions of KSA particularly Jazan region. Furthermore, infection with *P. falciparum* was the predominant type of the reported malaria cases in KSA during 2020 and 2021, and the > 15 years age group was the most vulnerable during the period of the study. Further screening implements and continuous epidemiological monitor of the status of malaria infection in KSA are thus warranted to improve its controlling activities and eradicate its endemicity in the country.

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Conflict of Interest

The author declares that there is no conflict of interests. The author also declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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