

Passive Case Findings on Malaria in Yazd as a Central Province of Iran During 2011-2020

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ABSTRACT

Background and Aim: Malaria is considered one of the most serious life-threatening diseases in Yazd, a central province of Iran, which hosts both domestic and foreign immigrants. This study aimed to investigate the trend of Malaria in Yazd during 2011-2020.

Materials and Methods: In this descriptive retrospective study, all episodes of the disease (imported malaria) recorded at Yazd health center in Iran were carefully evaluated and reported. After preparing the peripheral blood smear and fixation with methanol, it was stained with Giemsa and examined with a light microscope by a skilled technician.

Results and Conclusion: A total of 95 confirmed malaria patients were investigated from 2011 to 2020. *Plasmodium falciparum* was the predominant species with 81 cases (85.26%). The highest rate of infection was observed in 49 cases (51.63%) from Yazd city in the age group of 30-39 years with 29 cases (30.53%), and the working class with 69 cases (72.63%). Despite a decrease in Malaria cases through the implementation of the eradication program compared to the last two decades, its imported type is still showing up in the country, especially in the cosmopolitan city of Yazd, where domestic and foreign workers and tourists usually travel; thus it requires to be further monitored and controlled.

Keywords: Malaria, Yazd, Prevalence, *Plasmodium (L) falciparum*, *Plasmodium (p) vivax*

Received: 2022/01/09;

Accepted: 2022/07/13;

Published Online: 2023/01/20

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Fattahi Bafghi A, Minoo Sepehr M, Mozayan M R, Bagheri P, Dehghani A, Rezaee E. Passive Case Findings on Malaria in Yazd as a Central Province of Iran During 2011-2020. Iran J Med Microbiol. 2023; 17(1):117-22.

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1. Introduction

Malaria is one of the most serious life-threatening diseases in the world. It is also the leading cause of death in developing countries, especially in Africa. Approximately 86% of the cases occur in children (1) and it is one of the health problems in 95 countries of the world (2). This parasite is endemic to parts of Asia, Europe, and Africa. The disease is caused by protozoan parasites of the genus *Plasmodium* in humans. Four types of it are known to infect humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale* infection, with each species bearing different clinical results in patients. The most dangerous species of *Plasmodium* in the world is *P. falciparum*, although other species of *Plasmodium* can induce a severe type of disease in humans (3). Generally, more than 90% of deaths around the globe are attributed to *Plasmodium falciparum* (99% in Africa, mainly children under 5 years old) and 7.2% due to *Plasmodium vivax* (4). In Africa, the most common cause of Malaria in humans is *P. falciparum*, and *P. vivax* is the most common species in Southeast Asia (3). Approximately 3,500 species of mosquitoes have been identified worldwide, 60 species of which belong to the Anopheles genus that can transmit the *Plasmodium* parasite to humans (1, 5). Based on the latest WHO report released on 30 November 2020, there were 229 million malaria cases in 2019, with an estimated 409,000 deaths, compared to 228 million in 2018 with estimated deaths of 411,000 (6, 7). Scores of countries have made significant progress towards malaria elimination programs, with 33 countries reporting less than 1000 cases in 2015, while only 13 countries were estimated in 2000 (4, 5). Iran is one of the most malaria-endemic countries in the world so the total number of registered cases in 2015 appeared to be less than 200 cases; also, in 2016 and 2017, less than 90 and 89 cases of local population transmission were observed, which was more than four-fifths. Cases of the disease have been reported in Sistan and Baluchestan and Hormozgan provinces in the southeast and south of the country (8). The beneficial implementation of therapeutic and preventive control strategies through an appropriate healthcare system has led to this remarkable achievement (9). Iran began a malaria eradication effort in 2009 to achieve this by 2025. Since then, there has been tremendous progress, but the persistent possibility of malaria cases being imported from Pakistan and Afghanistan remains a significant political, social, operational, and technological hurdle to malaria eradication in Iran (10, 11). Imported Malaria may occur in travelers or military staff and immigrants from endemic countries entering the region. France is one of the first countries to detect

imported malaria, with approximately 4,000- 5,000 cases detected each year (12). Yazd province and the historical city of Yazd have been known to be a 'world heritage'. This region is located in the center of Iran and enjoys a temperate climate. It is not a malaria-endemic area, but because it is very active in construction projects and is an industrial city, it hosts internal and foreign immigrants, as well as refugee workers from malaria-prone areas who may be in contact with malaria (1, 13). This survey aimed to find out the trend of malaria in Yazd, a central province of Iran in 2011-2020.

2. Materials and Methods

This descriptive-retrospective study was carried out to uncover the epidemiological characteristics of malaria in Yazd province. In general, the patients suspected of malaria, both Iranians and foreigners, all of whom were living in Yazd and had been referred to Yazd Central Health Service (CHS) from 2011 to 2020, were meticulously analyzed and reported. Demographic information of the individuals was recorded through a questionnaire (gender, nationality, age group, residence place, and type of human malaria parasite). This survey was approved by the Ethics Committee of the research group of Yazd University of Medical Sciences, with the ethics code: IR.SSU.MEDICINE.REC.1393.10. A drop of blood was first taken from the patient's middle finger with a sterile needle and placed on a clean slide to prepare a peripheral blood smear. It was spread with another slide, and then each slide was stained with Giemsa after fixation with methanol and examined with a light microscope by a skilled technician. Data were analyzed using SPSS18.

3. Results and Discussion

On the whole, 95 confirmed reported malaria patients were investigated from 2011 to 2020; 90 (94.7%) patients were male and 5(5.3%) were female (Chi-square, $P=0.21$). The mean age of the patients was 33.7 years for men and 21.4 years for women. Species of *Plasmodium (L) falciparum* was isolated from 81 cases (85.26%), but *Plasmodium (p) vivax* was isolated from 14 cases (14.74%). As Figure 1 illustrates, the highest rates of malarial disease were observed in 2013, 2015, and 2018 each with 15 cases (15.8%), but in 2017, there were only 5 cases (5.3%) (Chi-square test, $P=0.021$). Figure 2 displays the malaria cases predicted in the place of living (Yazd & suburbs, Malaria-prone areas of Iran, other regions of Iran, and foreigners), (Chi-square test, $P=0.45$).

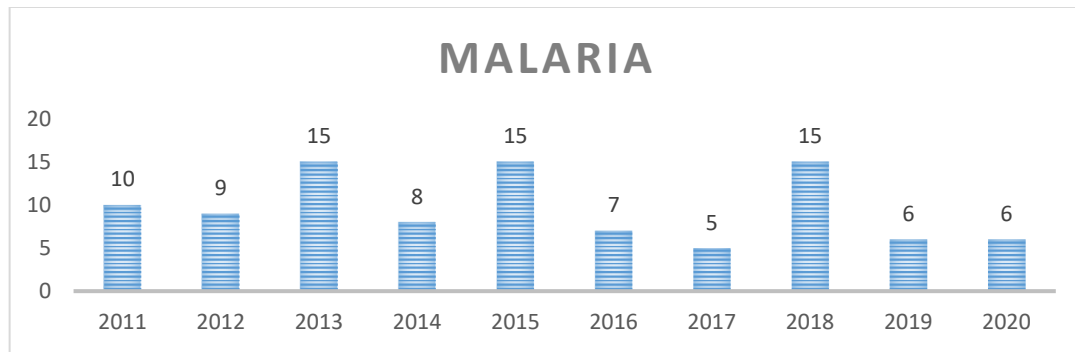


Figure 1. Prevalence of Malaria according to year. Chi-square test, $P < 0.05$.

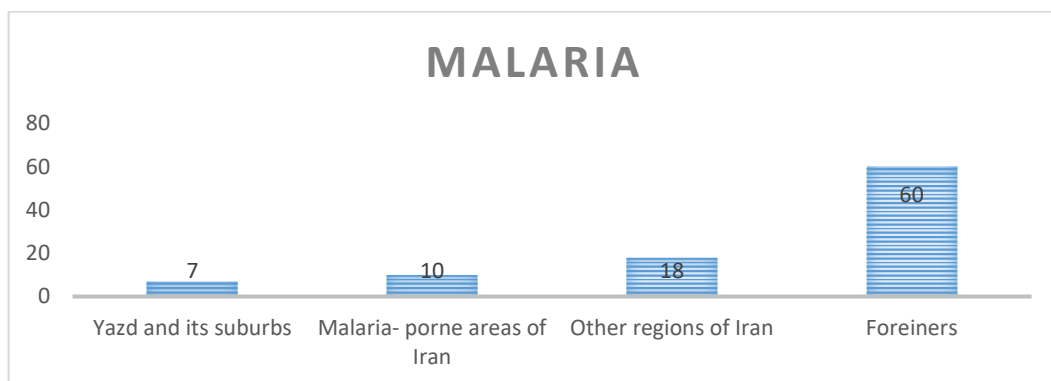


Figure 2. Prevalence of Malaria according to the origin of life. (Chi-square test, $P > 0.45$)

Table 1 reveals the prevalence of malaria according to age group. As shown in Table 1, the highest rate of *Plasmodium (L) falciparum* was seen in the 30-39 years age group with 27 cases (33.3%), and the lowest in the 05-19 years age group with 4 cases (4.94%). The highest rate of *Plasmodium (p) vivax* was observed in the 50≤ years age group with 6 cases (42.86%), and the lowest in the 05-19 and 20-29

years age groups with 1 case (7.14%). As Table 1 further indicates, the highest rate of mixed parasites of both, *Plasmodium (L) falciparum* and *Plasmodium (p) vivax* was seen in the 30-39 years age group with 29 cases (30.53%), but the lowest rate was observed in the 05-19 years age group with 5 cases (5.26%) (Chi-square test, $P < 0.021$).

Table 1. Prevalence of imported malaria according to age groups.

Age group	<i>Plasmodium(L)falciparum</i>		<i>Plasmodium (P)vivax</i>		Total	
	Number	Percent	Number	Percent	Number	Percent
05-19	4	4.94%	1	7.14%	5	5.26%
20-29	15	18.52%	1	7.14%	16	16.8%
30-39	27	33.33%	2	14.29%	29	30.53%
40-49	20	24.70%	4	28.57%	24	25.2%
50≤	15	18.52%	6	42.86%	21	22.1%
Total	81	100%	14	100%	95	100%

Chi-square test, $P < 0.05$.

Table 2 sets out the prevalence of malaria according to the geographical area. As Table 2 displays, the highest rate of malaria was observed in

Yazd City with 49 cases (51.63%), but the lowest rate was seen in Meibod with 4 cases (4.2%). (Chi-square test, $P = 0.041$).

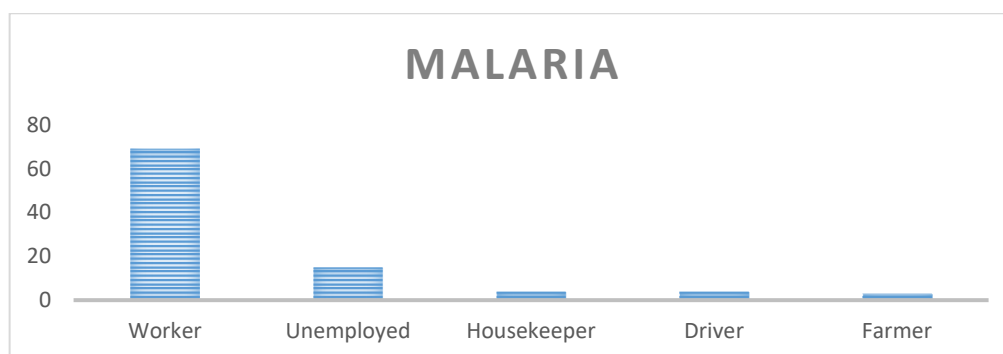
Table 2. Prevalence of imported malaria according to the geographical area

Geographical area	Malaria	
	Number	Percent
Yazd	49	51.6%
Sadoogh	14	14.7%
Mehriz	10	10.5%
Ardakan	6	6.3%
Taft	6	6.3%
Abarkouh	6	6.3%
Meibod	4	4.2%
Total	95	100%

Chi-square test, $P < 0.05$.

[Figure 3](#) indicates the prevalence of malaria based on the job. As shown, the highest rate of the disease was identified with 69 cases (72.63%) in workers, but

the lowest rate was observed with 4 cases in the farmers (4.21%) (Chi-square test, $P = 0.041$).

**Figure 3.** Prevalence of malaria according to the job (Chi-square test, $P < 0.05$)

Malaria is one of the dominant causes of death in the world by imposing varying adverse effects on populations. It is a real menace in developing countries with more than 3000 deaths every day (14). Malaria has been widely prevalent in Iran for a long time, with a total risk of 2,714,648 persons with mainly 60% of this population living in endemic centers including Kerman, Hormozgan, as well as Sistan, and Baluchestan provinces; before starting any anti-malarial campaign, about 30 to 40% of the total mortality was due to malaria (15). Despite reports of high morbidity and death in previous decades, the current malaria condition in Iran demonstrates a victorious eradication in most divisions of the country. The malaria outbreak has been lowered from 333/1000 cases in 1921 to 0.01/1000 in 2017 (15). In our study, the overall of 95 confirmed reported malaria patients were investigated from 2011 to 2020; Of these, 90 (94.7%) were male and 5 (5.3%) were female. The mean age of the patients was 33.7 years for men and 21.4 years for women. Species of *Plasmodium (L) falciparum*

were mainly isolated from 81 cases (85.26%), but *Plasmodium (p) vivax* was isolated from only 14 (14.74%) cases. The highest rate of malarial disease was identified in the years 2013, 2015, and 2018. The highest rate of *Plasmodium (L) falciparum* was observed in the 30-39 years age group with 27 cases (33.3%), but the lowest rate was seen in the 05-19 years age group with 4 cases (4.94%) as compared to 58.17% cases in Khan *et al.*'s study (16). The highest rate of *Plasmodium (p) vivax* was seen in the 50≤ years age group with 6 cases (42.86%), but the lowest rate was observed in the 05-19 and 20-29 years age groups with 1 case (7.14%) as compared to 40.81% in Khan *et al.*'s study (16). In our study, the prevalence of malaria was higher in men than in women; our result is in line with that of Khan *et al.*, Sheikh *et al.*, and Yang *et al.* (16-18). In this study, the highest rate of malaria was identified in the workers with 69 cases (72.63%), but the lowest in the farmers with 4 cases (4.21%); this is in line with the results of Yang *et al.* (18).

4. Conclusion

Overall, the results demonstrated that although malaria has been drastically reduced in comparison with the last two decades through the implementation of the malaria eradication program, its imported type is still prevalent in the country, apparently introduced from some high-traffic areas, especially the neighboring countries of Afghanistan and Pakistan. Border entry and exit laws and residence in cities, especially in the cosmopolitan city of Yazd, where domestic and foreign seasonal workers and tourists travel, need to be further reviewed and controlled.

Acknowledgment

The authors would like to thank Yazd Central Health Service (CHS) for providing the data.

Funding

This research has received a grant from Yazd Shahid Sadoughi University of Medical Sciences.

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Ethical Approval

The Ethics Committee of Yazd Shahid Sadoughi University of Medical Sciences approved the study protocol under the code: IR.SSU.MEDICINE.REC.1393.10.

Availability of Data and Materials

The data used during the current study would be available from the corresponding author.

Ethics Approval and Consent to Participate

Ethical approval to perform this study was obtained by the Ethical Review Board of Yazd Shahid Sadoughi University of Medical Sciences.

Conflict of Interest

The authors declared no competing interests.

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