Hormozgan Medical Journal
doi 10.34172/hmj.2023.3030
Hormozgan Med J. 2023; 27(2):68-72

Research Article

Analysis of Malaria Situation in Jask County During the Implementation of the Elimination Programme in 2010-2020

Mahmood Hosseinpoor[1], Sajjad Fekrijaski[2], Shahram Zare[3], Moussa Soleimani-Ahmadi[4,5*]

[1]Department of Public Health, Social Determinants in Health Promotion Research Center, Research Institute for Health, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[2]Infectious and Tropical Diseases Research Center, Hormozgan Health Institute, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[3]Department of Community Medicine, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[4]Department of Medical Entomology and Vector Control, Faculty of Health, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[5]Social Determinats in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

***Correspondence to**
Moussa Soleimani-Ahmadi,
Email: mussa.sahmadi@gmail.com

Abstract
Background: Currently, Iran has entered the malaria elimination phase, and no malaria cases have been observed in this country during the last two consecutive years. Continuous monitoring and analysis of the malaria situation are necessary to achieve the elimination goals set to be achieved in 2025. This study aimed to determine the malaria situation analysis during the implementation of the elimination programme in Jask county, one of the most important malaria foci in Iran.
Methods: This descriptive-analytical study was conducted in Jask county of Hormozgan province in the southeast of Iran from 2010 to 2020. Data were collected from the national malaria surveillance system and special forms that were completed by malaria focal points in Jask county. Data were analyzed using SPSS 21 software and descriptive statistics.
Results: A total of 347 confirmed malaria cases were recorded, and the total number of cases was found to decrease from 114 cases in 2010 to 11 in 2020. The mean age of the patients was 23.4 ± 19.6 years, and most cases (74.06%) belonged to 15-year-old or older people. *Plasmodium vivax* was the most prevalent species (83.86%). Based on the results, males were more infected (81.84%) than females, and the majority of the patients were from rural areas (86.4%).
Conclusion: Malaria incidence has significantly decreased during the past eleven years in Jask county. The considerable drop in the incidence of malaria may be related to the implementation of comprehensive malaria control measures and intensive entomological and parasitological monitoring.
Keywords: Malaria, Elimination, Incidence, Iran

Received: April 25, 2021, **Accepted**: May 30, 2021, **Published Online**: March 3, 2023

Background

Malaria is considered one of the concerning health issues in the world, particularly in tropical and subtropical areas (1). Almost half of the world's population is exposed to malaria infection, and approximately 229 million malaria cases and 409 000 malaria deaths occurred in 2019 worldwide (2).

In Iran, the malaria eradication programme was introduced in 1951, and it was altered to malaria control in 1985 because of some complications (3,4). The elimination phase of malaria has been started in Iran in 2010, and it has been planned to become completely malaria-free by 2025 (5).

Despite a significant decrease in malaria transmission in Iran, this disease is still a public health issue in the southeast part of this country, including Sistan-Baluchestan, Kerman, and Hormozgan provinces. Approximately 1% of the total population of Iran (81 million) live in the malarious areas, and about 80% of malaria patients have been found in these regions (6).

Jask county is one of the malarious regions in this county, and its infected population can play a role as mobile reservoirs to spread the disease to other areas (7). The county is facing active malaria transmission, particularly during seasons when the peak of malaria vector proliferation is occurred, frequently in the spring and fall (7). The malaria elimination programme has been started in Jask county in 2010, and larvicides, indoor spraying, and insecticidal bed nets have been applied as the most malaria vector control strategy in the study area (8).

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Jask county is susceptible to malaria epidemics due to several factors such as tropical climate, low socioeconomic conditions, and the existence of four potential malaria vectors, including *Anopheles stephensi*, *Anopheles culicifacies* s.l., *Anopheles dthali*, and *Anopheles fluviatilis* s.l (8,9). Moreover, the vicinity of Jask county to other malarious regions increases the risk of imported cases, probably leading to the reintroduction of new local malaria patients and a serious problem for the elimination of malaria in Jask county. Therefore, constant evaluation and analysis of the malaria situation are required for the elimination goals set to be achieved in 2025.

Objectives

As mentioned earlier, continuous monitoring and malaria situation analyses are necessary for achieving the elimination goals set to be obtained in 2025. Hence, this descriptive-analytical study was designed to investigate the malaria situation during the implementation of the elimination programme in Jask county, one of the most important foci in Iran.

Methods

Study Area

This study was conducted in Jask county, which is located in Hormozgan province, southeast Iran. The area of the county is about 10,702 km^2 and is situated between latitudes 25°23'-26°13'N and longitudes 57°10'-59°16'E, with 58,884 populations (Figure 1). The study area has hot weather, and the rainfall happens from December to May with an annual average of 213.1 mm (10). This is an agricultural region, and rivers are its main irrigation water which are also the main breeding places for malaria vectors. The main occupations in this area include fishing, livestock herding, agriculture, and trading.

Study Design and Data Collection

This survey was designed to assess eleven-year trends of the malaria situation in Jask county from 2010 to 2020. Detailed information related to malaria status was collected from epidemiological recording forms completed by malaria focal points and physicians in Jask county and the national malaria surveillance system of Iran. Data included malaria patient's information such as gender (male and female), age groups (0-4, 5-14, and ≥15 years old), residence place (rural and urban), and malaria indicators (annual blood examination rate [ABER], slide positivity rate [SPR], and annual parasitic incidence [API]). The other collected data were related to parasite species (*Plasmodium vivax*, *P. malariae,* and *P. falciparum*) and the transmission method (imported, indigenous, relapse, and introduced). Finally, demographic and epidemiological data were recorded in a checklist and analyzed by SPSS 21 software and descriptive statistics.

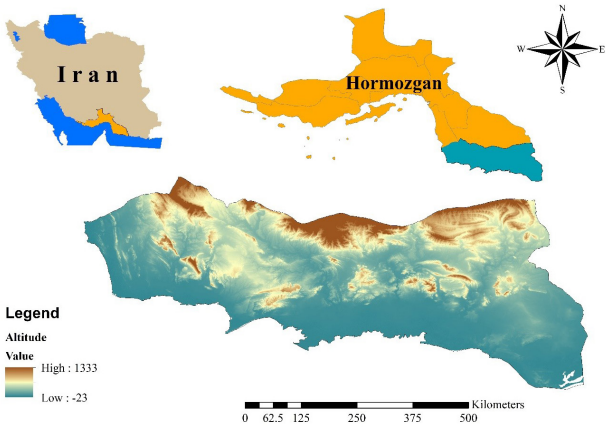

Figure 1. Map of Iran Showing Hormozgan Province and the Location of Jask county, Southeastern Iran

Results

In the present study, 347 confirmed cases were reported in Jask county. The highest number of patients (114 cases) was recorded in 2010, while the lowest number (7 cases) was recorded in 2015 (Table 1). Moreover, the API showed a decreasing trend from 2.79 to 0.18 per 1000 people (Table 1).

In this study, the SPR and ABER also decreased from 1.44% and 19.34% in 2010 to 0.20% and 8.82% in 2020, respectively. This decrease has nearly the same trend as API and the number of malaria patients. Detailed malaria information is provided in Table 1.

The gender distribution of patients demonstrated that malaria was most common in men (81.84%), while only 18.16% of cases occurred in women (Table 2).

The average age of patients was 23.4±19.6 years,

Table 1. Frequency and Incidence Rate of Malaria in Jask county During 2016-2020

Year	Population	Total Slides	Total Cases	Malaria Indicators		
				API	SPR	ABER
2010	40836	7899	114	2.79	1.44	19.34
2011	42155	8066	86	2.04	1.07	19.13
2012	43580	6903	37	0.84	0.54	15.83
2013	44034	5166	12	0.27	0.23	11.73
2014	52157	5864	15	0.28	0.26	11.24
2015	55247	5644	7	0.12	0.12	10.21
2016	55747	4389	10	0.18	0.23	7.87
2017	56559	2171	25	0.44	1.15	3.83
2018	58011	3716	18	0.31	0.48	6.40
2019	63043	3658	12	0.19	0.33	5.80
2020	62212	5488	11	0.18	0.20	8.82
Total	-	58964	347	-	-	-

Note. API: Annual parasitic incidence=Total No. of positive slides for parasite in a year×1000/total population; SPR: Slide positivity rate=Total positive×100/total examined slides; ABER: Annual blood examination rate=Smears examined in a year×100/total population.

Table 2. Frequency of Malaria Infections in Terms of Gender and Age Group in Jask county During 2016-2020

Year	Gender				Age Groups						Total Cases	
	Male		Female		<5		5-14		>14			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2010	90	78.95	24	21.05	12	10.53	22	19.30	80	70.18	114	32.85
2011	63	73.25	23	26.75	11	12.79	23	26.74	52	60.47	86	24.78
2012	31	83.78	6	16.22	4	10.81	9	24.32	24	64.86	37	10.66
2013	12	100.00	0	0.00	0	0.00	1	8.33	11	91.67	12	3.46
2014	11	73.33	4	26.67	0	0.00	1	6.67	14	93.33	15	4.32
2015	5	71.42	2	28.58	0	0.00	1	14.29	6	85.71	7	2.02
2016	8	80.00	2	20.00	1	10.00	1	10.00	8	80.00	10	2.88
2017	25	100.00	0	0.00	0	0.00	0	0.00	25	100	25	7.20
2018	18	100.00	0	0.00	0	0.00	2	12.50	16	87.50	18	5.19
2019	11	91.67	1	8.33	1	8.33	1	8.33	10	83.34	12	3.46
2020	10	90.90	1	9.10	0	0.00	0	0.00	11	100.00	11	3.17
Total	284	81.84	63	18.16	29	8.36	61	17.58	257	74.06	347	100

ranging from 1 to 79 years. The highest number of malaria cases occurred in people aged more than 15 years old, and the least cases were observed in children within the age range of 0-5 years (Table 2).

Based on the obtained data (Table 3), *P. vivax* (83.86%) and *P. falciparum* (16.14%) were the main parasite species, respectively.

Malaria epidemiological classification in Jask county indicated that most patients (69.74%) were imported, while the indigenous cases consisted of about 30% of the total cases (Table 3).

In this study, most malaria infection cases (86.4%) were observed in rural regions, and about 13% of cases were found in urban regions.

Table 3. Frequency of Malaria Infection in Terms of Parasite Species and Transmission Type in Jask county During 2016-2020

Years	Plasmodium Species				Transmission Type			
	P. vivax		*P. falciparum*		Indigenous		Imported	
	No.	%	No.	%	No.	%	No.	%
2010	97	85.08	17	14.92	34	29.82	80	70.18
2011	76	88.37	10	11.63	44	51.16	42	48.84
2012	36	97.30	1	2.70	13	35.13	24	64.86
2013	11	91.67	1	8.33	1	8.33	11	91.67
2014	14	93.33	1	6.67	3	20.00	12	80.00
2015	6	85.71	1	14.29	1	14.29	6	85.71
2016	8	80.00	2	20.00	1	10.00	9	90.00
2017	16	64.00	9	36.00	6	24.00	19	76.00
2018	13	72.22	5	27.78	0	0.00	18	100.00
2019	7	58.33	5	41.67	0	0.00	12	100.00
2020	7	63.63	4	36.37	2	18.18	9	81.82
Total	291	83.86	56	16.13	105	30.26	242	96.74

Note. P. vivax: Plasmodium vivax; P. falciparum: Plasmodium falciparum.

Discussion

The results of this study confirmed a dramatic reduction in the frequency of malaria cases and incidence rate of disease in Jask county over the past 11 years. In this regard, the frequency of malaria cases decreased from 114 in 2010 to 11 in 2020. These results indicated the relative achievement of malaria control plans to succeed in the malaria elimination goal in Jask county. This reduction in malaria cases may be due to the intensification of malaria preventive activities by the national malaria control programme (6). Moreover, improving socio-economic parameters such as an increase in access to electricity and safe drinking water, climate change, and consecutive drought can be considered the main reasons for the decrease in malaria disease (11,12).

In the study area, *P. vivax* was the most predominant parasite. These results are in agreement with those of a study from Khuzestan Province, representing that *P. vivax* was the most prevalent species found in 88% of patients, and the next abundant species was *P. falciparum* with 63 (12%) patients (13). Additionally, the results of a recent study by Vatandoost et al revealed that *P. vivax* was a predominant parasite species in different malarious areas (14). In other studies conducted in Middle East countries and other neighboring countries, including Turkey, Armenia, Azerbaijan, Tajikistan, Afghanistan, and Pakistan, *P. vivax* was reported as the prevalent species (14,15). *P. vivax* is a persistent parasite that finally results in dormant liver-stage hypnozoites, causing recurrent cases of malaria in non-endemic regions (16). Therefore, imported *P. vivax* infections from Pakistan as a malarious region remain a major challenge for the elimination of malaria from Jask county.

According to the results, males were more likely than females to be infected by malaria, which is in line with the results of previous research in this county (7). Moreover,

studies conducted in Konarak and Bashagard, the counties neighboring the study area, have shown a higher prevalence of malaria in men (17,18). The difference in the risk of malaria infection between women and men is not attributed to biological characteristics associated with gender, but to differences in gender roles (19). In this regard, social activities, type of clothing, and the working men in the outdoor environment raise their exposure to malaria vectors. Additionally, low parasite densities of asymptomatic cases among men play an important role in producing outbreaks (20).

Based on the results of the present study, the frequency of malaria infection was higher in rural areas compared to urban areas, which conforms to the findings of several studies conducted in malaria-endemic regions, indicating a higher prevalence of malaria infection in rural regions (4,14,19).

The results of previous studies in some malaria-endemic countries also demonstrated that malaria is prevalent in rural areas, where there are many favorable sites for vector breeding (21,22). In the current study, an explanation for the higher malaria frequency in rural regions may be related to the presence of many rivers in this area, serving as favorable proliferation habitats for malaria vectors. The other reason for the higher incidence of malaria in rural regions is that the majority of the population of Jask county resides in rural parts.

A limitation of this study may be misreporting of malaria cases due to asymptomatic infections and the limited capacity of malaria testing and healthcare facilities.

Conclusion

Overall, the frequency of malaria cases has represented a considerable decrease in the past eleven years in Jask county. The significant reduction in the incidence of malaria can be related to the implementation of comprehensive malaria prevention measures and intensive entomological and parasitological surveillance and evaluation. Current interventions and strategies should be followed to attain the goal of malaria elimination which is no indigenous malaria infections for at least three sequential years in the county.

Acknowledgments

The authors would like to appreciate the collaboration received from Mr. M. Irvani, the vice-chancellor of Jask Health Center for providing facilities for the implementation of this investigation. We also thank Mr. K. Rafiee and M. Mousavi personnel of the Jask Health Center for their cooperation in the field and data collection.

Authors' Contribution

Conceptualization: Moussa Soleimani-Ahmadi and Mahmood Hosseinpoor.
Data Curation: Sajjad Fekrijaski.
Formal Analysis: Shahram Zare.
Investigation: Moussa Soleimani-Ahmadi.
Methodology: Moussa Soleimani-Ahmadi and Shahram Zare.
Project Administration: Moussa Soleimani-Ahmadi.
Resources: Moussa Soleimani-Ahmadi.
Supervision: Moussa Soleimani-Ahmadi.
Validation: Shahram Zare.
Visualization: Moussa Soleimani-Ahmadi.
Writing – Original Draft: Moussa Soleimani-Ahmadi.
Writing – Review & Editing: Shahram Zare.

Competing Interests

The authors declare that they have no competing interests.

Ethical Approval

This study was confirmed by the Ethics Committee of Hormozgan University Medical Sciences (Code number: 1398.285).

Funding

There was no funding for this research.

Informed Consent

Information privacy was considered in all steps of the research.

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