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 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).

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
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 km² 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.

**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**

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

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.
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rangings 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.

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.

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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).

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Informed Consent
Information privacy was considered in all steps of the research.

References


