

DOI: <http://dx.doi.org/10.33846/hn70303>  
<http://heanoti.com/index.php/hn>

**RESEARCH ARTICLE**

URL of this article: <http://heanoti.com/index.php/hn/article/view/hn70303>

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**Epidemiological Study of Malaria Cases 2018-2021 in Bintan District,  
Riau Archipelago Province, Indonesia**

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**ABSTRACT**

Malaria in Bintan Regency is a health problem because several areas are endemic. This study aimed to describe the epidemiology of malaria cases in Bintan Regency in 2018-2021 based on person, place, and time. This type of research was descriptive with a population of all malaria cases recorded at the Bintan District Health Office for the period January 2018 to December 2021. The sample was the total population. Variables collected include trend of malaria cases, annual API, age, sex, plasmodium type, type of case, time, and place. Secondary data was obtained from the SISMAL application of the Riau Islands Province Health Office. Data analysis was performed to describe malaria endemicity. The results of the study showed that the endemicity of malaria in Bintan Regency from 2018-2021 was getting better. The majority of malaria cases for the 2018-2021 period were 15-64 years old and male. Based on the highest time in May and July 2020 with distribution locations in the working areas of Kawal health center and Berakit health center. The type of plasmodium falciparum parasite in 2018-2019 and 2020-2021 was infected with plasmodium vivax. The case type was derived from the original malaria case. The majority of treatments used Artemisinin-Based Combination Therapy (ACT).

**Keywords:** malaria; plasmodium; archipelago

**INTRODUCTION**

Malaria is a public health problem in the world. Where is the World Health Organization (WHO) reported that in 2020 the number of malaria cases was 241 million cases, an increase of 14 million cases from the previous year with 227 million cases. The estimated number of deaths from malaria will reach 627,000 in 2020, an increase of 69,000 deaths compared to the previous year. While around two-thirds of these deaths (47,000) were caused by distraction during the COVID-19 pandemic, another third of deaths (22,000) reflect recent changes in the WHO methodology for calculating deaths from malaria (apart from COVID-19 disruption)<sup>(1)</sup>. Indonesia is one of ten malaria endemic countries in the world<sup>(2)</sup>. Indonesia has succeeded in reducing the API to less than 1 from 2015 to 2020. However, in 2021 the API will increase to 1.1 per 1,000 population. The provinces of Papua, West Papua and East Nusa Tenggara are the provinces with the highest malaria API, in line with the number of districts/cities in these provinces with high endemic status<sup>(3)</sup>.

The malaria morbidity rate (*Annual Paracite Incidence / API*) in the Riau Islands Province in 2018 was recorded at 0.10 per 1,000 population, this figure will continue to fall until 2021. It is reported that there are still several areas that are endemic for malaria in the Riau Archipelago Province including Bintan Regency, Lingga Regency and Anambas Islands Regency. During 2018 to 2021 Bintan Regency ranks first with the most cases of malaria with a total of 304 cases and the highest number of cases recorded in 2020 was 150 cases with API reaching 0.93 per 1,000 population. Topographically, Bintan Regency consists of islands, generally low hills surrounded by swamps. This area is endemic to malaria because there are many swamps in the area and in summer it is a potential breeding ground for Anopheles<sup>(4)</sup>. The spread of malaria is caused by physical and biological environmental factors and behaviors that can support the occurrence of malaria<sup>(5)</sup>. The condition of the home environment of malaria sufferers is related to the incidence of malaria<sup>(6)</sup>, while environmental factors can trigger the occurrence of malaria. Some factors that influence the emergence of malaria in an area are altitude, sunlight, pH, water salinity, dissolved oxygen, wind conditions, plants, climate, temperature, rain intensity, temperature, depth of water sources, water

currents and humidity. Several factors in terms of community behavior are considered to contribute to the emergence of malaria, namely the behavior of people who do not use insecticide-treated nets, the habit of using mosquito coils, and using repellents. All three have a significant relationship with the incidence of malaria<sup>(7)(8)</sup>. Community habits such as closing windows and closing doors in the evening have been shown to reduce the risk of contracting malaria<sup>(9)(10)</sup>. The habit of the people to go out at night is related to the occurrence of malaria<sup>(11)</sup>.

Bintan District has established several malaria prevention strategies and conducts periodic assessments to eliminate this disease. As an endemic area, it is clear that identifying patterns of malaria cases in Bintan District requires an appropriate strategy. One of them is by early detection of malaria cases, by strengthening the role of surveillance as an early warning system for malaria. This system is implemented by collecting malaria case data based on place, person and time every month by public health centers (Puskesmas) and hospitals throughout Indonesia. In addition, the collection of data on malaria cases can be used to see trends in malaria cases from year to year as material for recommendations for malaria control programs. Therefore the aim of this study is to describe the epidemiology of malaria cases in Bintan Regency in 2018-2021 based on the variables of person, place and time.

**METHODS**

This research was a descriptive study with all residents recorded in Bintan Regency in 2018-2021. Descriptive studies were used to describe disease distribution patterns and disease determinants based on person, place and time, as well as the endemicity of malaria cases in each working area of the Health Center, the type of *Plasmodium* that infects it, the type of cases, and the type of treatment. The population used in this study were all malaria cases in Bintan Regency from 2018 to 2021. The sample in this study was the entire population. This study used secondary data obtained from the application of the Malaria Surveillance Information System (SISMAL) at the Riau Islands Province Health Office and collected from 2018-2021 as a *retrospective study*.

The data was presented in a frequency chart and analyzed descriptively to provide an overview of malaria endemicity and incidence based on the person, place and time variables in Bintan Regency in 2018-2021. Data collected included trends in malaria cases, malaria endemicity map, number of malaria cases by age and sex, number of malaria cases by month and year, number of malaria cases per working area of the health center, types of Plasmodium that infect, number of types of malaria cases and types of *treatment* malaria.

**RESULTS**

**Overview of Bintan Regency**

Geographically, Bintan Regency is located between 1° 00' North Latitude, 1° 20' South Latitude, 104° 00' East Longitude, 108° 30' East Longitude. The boundaries of Bintan Regency are to the north by East Malaysia and Natuna Regency, to the south by Tanjungpinang City and Daik Lingga Regency, to the west by Batam City, to the east by West Kalimantan Province. The number of sub-districts in Bintan Regency is 10 sub-districts with 36 villages and 15 sub-districts. The availability of health facilities itself is 2 hospitals and 14 health centers<sup>(12)</sup>. In general, Bintan Regency has a tropical climate with an average temperature of 23.9 °C - 31.8 °C and humidity around 88%.

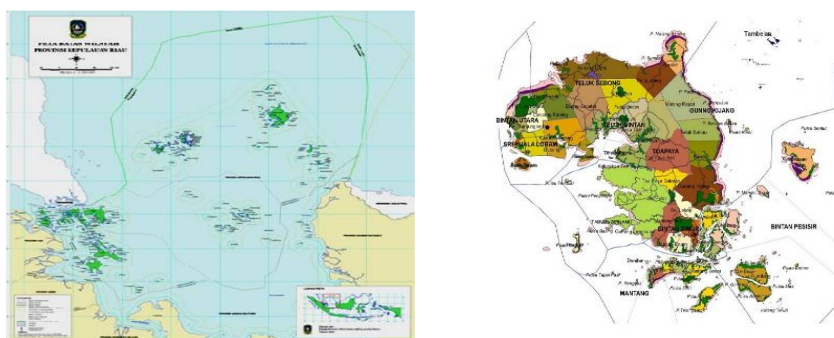


Figure 1. Location map of Bintan Regency, Riau Archipelago Province – Indonesia

**Malaria Cases**

Laboratory-confirmed positive malaria cases in Bintan Regency from 2018 to 2021 totaled 304 cases. Malaria cases in Bintan Regency was fluctuate every year.

Table 1. Positive cases of malaria based on population of Bintan Regency in 2018-2021

Year	Number of population	Positive cases	IR (per 1.000 population)
2018	80.525	74	0.92
2019	153.915	60	0.39
2020	160.921	150	0.93
2021	160.921	20	0.12

The highest malaria cases in Bintan Regency in 2018-2021 occurred in 2020 with 150 cases with an incidence rate (IR) of 0.93 per 1,000 population (Figure 2).

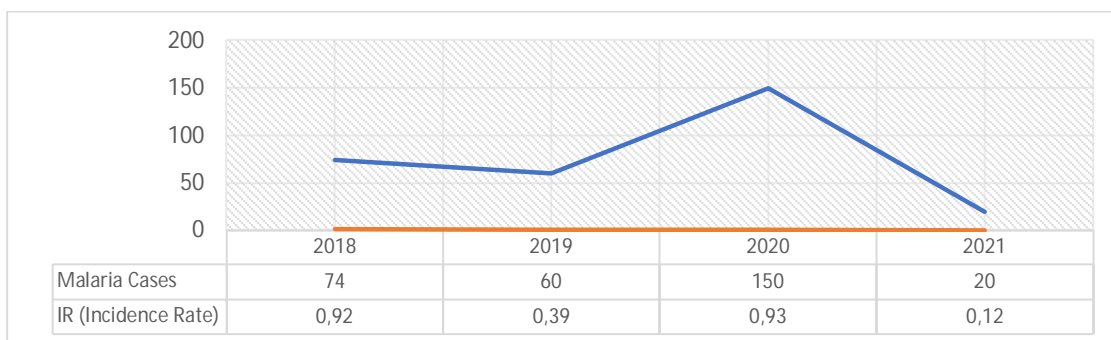


Figure 2. Trends in malaria cases in Bintan Regency in 2018-2021

### Malaria Endemic Level

An area was categorized as low endemic if API <1 (green), medium endemic if API is 1-5 (yellow), and high endemic if API >5 (red)(3). Malaria endemicity in Bintan Regency from 2018 to 2021 with a high category occurs in the working areas of the manggar health center (2018, 2019), Berakit health center and Kawal health center (2020). The current category was occurred in the working area of the Berakit Health Center (2021). The low category occurs in the work area of Berakit Health Center (2018), Kawal Health Center (2019, 2021), Sei Lekop Health Center and Kelong Health Center (2021). The malaria morbidity rate (*Annual Paracite Incidence / API*) and the endemicity map in Bintan Regency for the 2018-2021 period are as attached (Figure 3 and Figure 4).

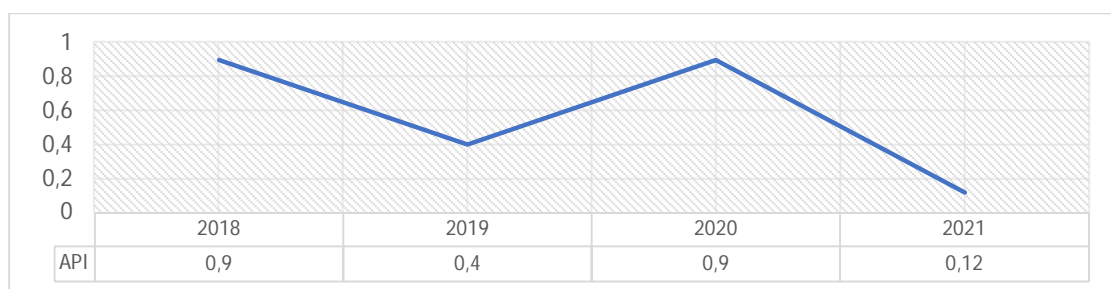


Figure 3. API Indicators for malaria cases in Bintan Regency in 2018-2021

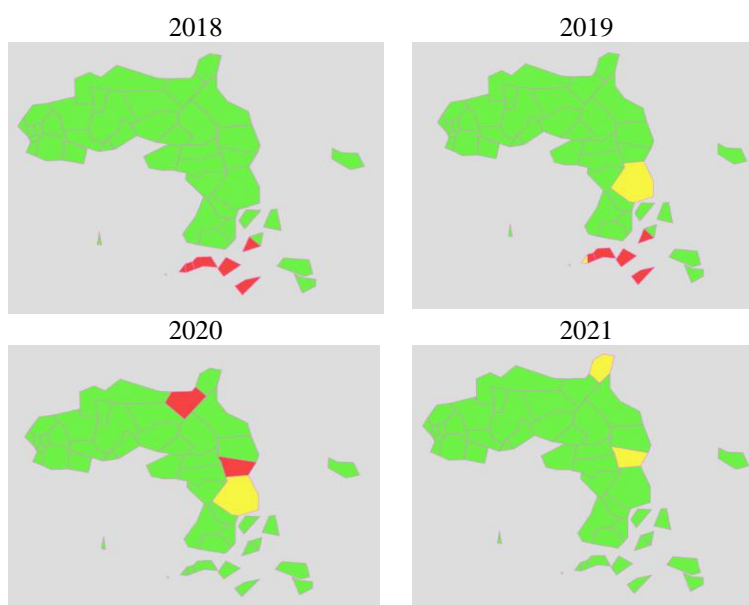


Figure 4. Malaria endemicity based on API in Bintan Regency in 2018-2021

### Characteristics of Malaria Cases

The tendency of malaria cases in Bintan Regency in 2018-2021 was occurred in the age group 15-64 years where this group is the most frequently infected with malaria with the highest incidence recorded in 2020 of 0.6 per 1000 population compared to other age groups. In addition, in the same year, the male sex had the highest positive malaria case percentage of 54% with an incidence of 0.5 per 1000 population.

Table 2. Malaria cases based on age, gender, plasmodium type and type of treatment in Bintan District 2018-2021

Malaria Cases	Year 2018	Year 2019	Year 2020	Year 2021
<b>Age Patients</b>				
0-11 month	2	0	0	0
1-4 year	5	4	3	1
5-9 year	10	5	11	3
10-14 year	15	4	28	3
15-64 year	42	47	102	13
>64 year	0	0	6	0
<b>Sex</b>				
Male	37	39	81	13
Female	37	21	69	7
<b>Type Plasmodium</b>				
Pf	35	45	3	0
Pv	8	5	147	19
Po	0	0	0	0
Pm	0	0	0	0
Pk	0	0	0	0
Mix	31	10	1	1
<b>Type of Treatment</b>				
ACT	74	59	147	20
Non ACT	0	1	3	0

During the period 2018-2021, malaria in the District Bintan mostly affects the age group of 15-64 years (67%). The dominance of the 15-64 year age group occurs almost every year. Positive malaria cases recorded by malaria surveillance at the Puskesmas noted that the highest number of cases occurred in 2020. This occurred in all age groups and sexes (Figures 5 and 6).

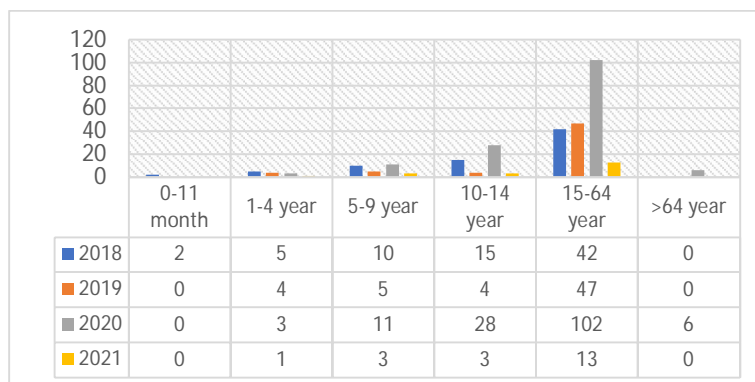


Figure 5. Malaria cases based on age in Bintan Regency in 2018-2021

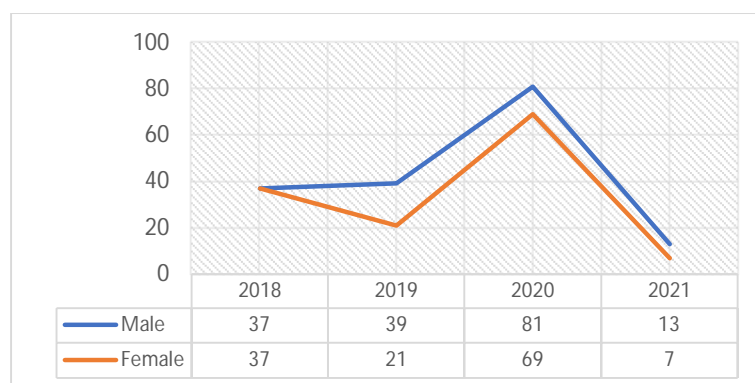


Figure 6. Malaria cases based on gender in Bintan Regency in 2018-2021

The majority of malaria cases in Bintan Regency in 2018-2021 occurred in May and July, then tended to decrease to December (Figure 7)

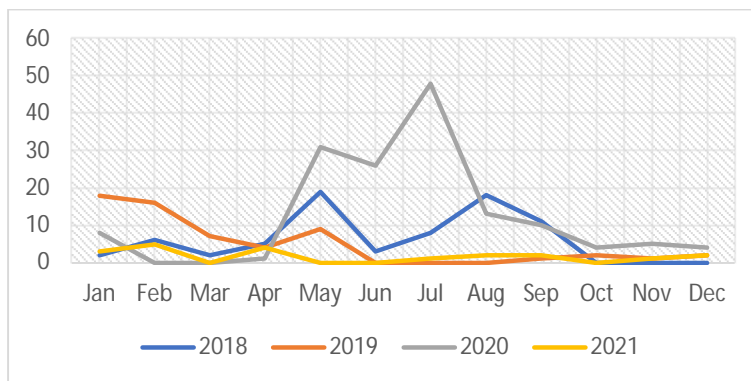


Figure 7. Malaria cases based on time in Bintan District in 2018-2021

In the 2010-2019 period most malaria cases in Bintan District occurred in the working areas of the manggar health center, Kawal health center and Berakit health center. In 2020 the highest cases of malaria occurred at the Kawal Health Center and Berakit Health Center, namely 75 cases each and the least in Teluk Sebong Health Center and Kelong Health Center, namely 1 case (Figure 8).

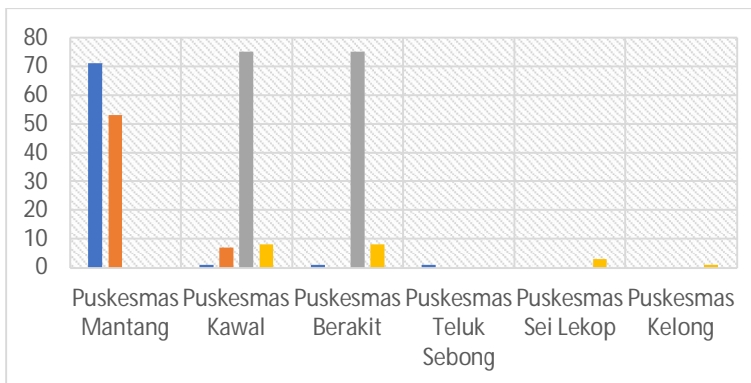


Figure 8. Malaria cases by place in Bintan Regency in 2018-2021

The types of malaria parasites recorded in the monthly report on malaria discovery and treatment are *P.falciparum*, *P.vivax*, *P.malariae*, *P.ovale* and mix. During the last 4 years the distribution of malaria cases in Bintan district based on *Plasmodium* was more in *Plasmodium vivax*, *Plasmodium falciparum* and mix. never found *P.malariae*, *P.ovale* and mix.

*Plasmodium* that infects humans in Bintan District.types *Plasmodium* in blood based on RDT and microscopic laboratory results (Figure 9).

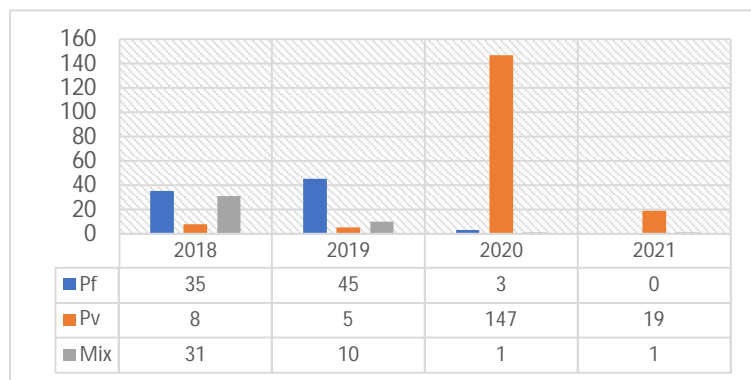


Figure 9. Malaria cases based on *Plasmodium* in Bintan Regency in 2018-2021

Malaria cases in Bintan Regency in 2018-2021 each year come from indigenous cases. The highest number of indigenous cases in Bintan Regency in 2020 was 146 cases (Figure 10).

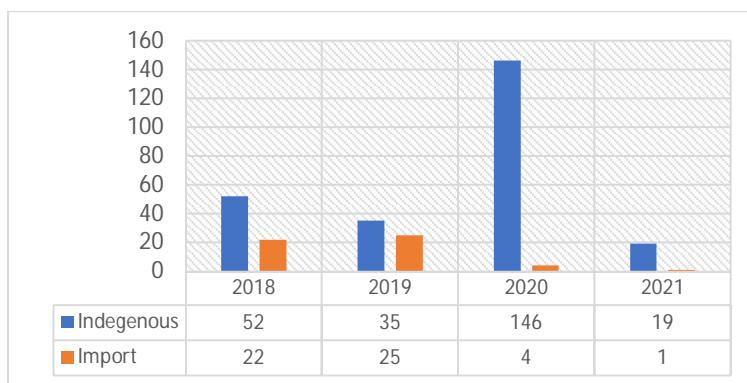


Figure 10. Malaria cases by type of case in Bintan District in 2018-2021

The majority of malaria sufferers in Bintan District participated in the ACT treatment program (Figure 11).

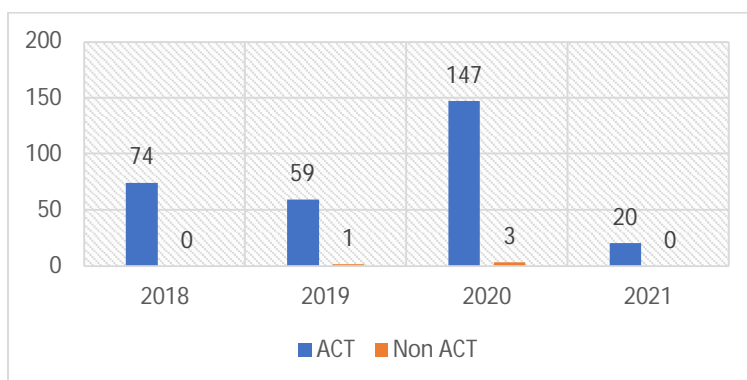


Figure 11. Malaria cases by type of treatment in Bintan Regency in 2018-2021

## DISCUSSION

### Malaria Endemic Level

Determination of endemicity stratification is determined based on the API value. Low endemic area if API <1, medium endemic if API is 1-5, and high endemic if API >5. Malaria morbidity can be determined by assessing the *Annual Parasite Incidence* (API) indicator per 1,000 population. This indicator is obtained by calculating the proportion of malaria positive patients to at-risk populations in certain areas<sup>(3)</sup>. Based on the API indicator, during 2018-2021 Bintan Regency was categorized as an area with low endemic. Meanwhile, the tendency for the highest malaria cases in Bintan Regency to increase occurred in 2020 as many as 150 cases with an *incidence rate* (IR) of 0.93 per 1,000 population and experienced a decrease in cases the following year. This increase in cases was influenced by an abnormal situation, where people did not go to health care facilities for malaria treatment due to the COVID-19 pandemic which resulted in people not being thorough in taking medicine<sup>(13)</sup>.

### Malaria Cases by Person

Based on the results of the study, it was also known that the most malaria sufferers in 2018-2021 in Bintan Regency were patients in the age group 15-64 years with a total of 204 cases (67%) and male sex (56%) had a higher prevalence than female (44%). This is related to the high mobility of these sufferers who are of productive age and have more activities outside the home, so they are very at risk of suffering from malaria. The individual's activity of leaving the house at night is a behavior that increases the risk of contact with *Anopheles sp.* mosquitoes that bite at night, from 18.00-04.00 WIB<sup>(14)</sup>. Another study stated that men are 1.10 times more likely to get malaria than women<sup>(15)</sup>. According to Mantra, the potential age group for circular mobility generally comes from the age group between 20-40 years and is male. This is because men with the potential age are considered responsible for the family, so to provide for the family's economy they have to work. This provides a great opportunity for men of productive age to carry out circular mobility<sup>(16)</sup>.

### Malaria Cases by Time

Based on the time variable, the highest incidence of malaria in Bintan Regency in 2018-2021 occurred in 2020 in May with 59 cases and July 57 cases which was the rainy season with an average wind speed of 3.00 m/s. During the rainy season in Bintan Regency itself causes uncontrolled environmental changes so that new naturally

formed breeding places appear as places for mosquito breeding. Several studies state that there is a relationship between rainfall and the incidence of malaria<sup>(17)(18)(19)</sup>. The existence of abandoned ponds, ponds and puddles with lots of water, and swamps are breeding grounds for mosquitoes. Rain interspersed with hot weather will increase the breeding of the *Anopheles sp*<sup>(20)</sup>. Excessive rainfall does not always trigger a malaria epidemic because it is also influenced by the situation and geographical conditions of an area<sup>(21)</sup>. The incidence of malaria according to rainfall shows a negative trend, i.e. when rainfall tends to increase, the incidence of malaria decreases conversely when the incidence of malaria tends to increase with low rainfall<sup>(22)</sup>.

### Malaria Cases by Location

By location, the majority of malaria cases in Bintan District occurred in the working areas of the manggar health center, Kawal health center and Berakit health center. This area is a coastal area where most of the physical environment of the people's houses is with semi-permanent house walls, in contrast to urban communities with permanent walls. Physical environmental factors statistically affect the incidence of malaria. The physical condition of the house with holes in the wall category will make access for *Anopheles sp*. so that the transmission of malaria will be even greater<sup>(23)</sup>. House construction in the form of house walls with a composition of house walls made of wood and bamboo has a higher risk of contracting malaria than house construction with house walls made of bricks. Houses with open walls, for example the walls of houses that use wood, bamboo or stone house walls have gaps for mosquitoes to enter and leave which increases the risk of homeowners contracting malaria<sup>(24)</sup>.

### Malaria Cases by Type of Plasmodium

The type of *Plasmodium* that most infects in Bintan Regency in 2018-2021 is *Plasmodium vivax*. *Plasmodium vivax* can cause malaria which is also known as benign tertian malaria. The special feature of *Plasmodium vivax* is fever that occurs every 48 hours or every third day, especially in the afternoon and evening. Swelling of the spleen also occurs in patients affected by *Plasmodium*. The incubation period for *Plasmodium* is between 12-17 days<sup>(25)</sup>. Apart from *Plasmodium vivax*, were also found in Bintan Regency *Plasmodium falciparum* and mix (combined) whose numbers are quite high. The clinical manifestations of malaria vary depending on the specific properties of the parasite. The characteristics of *Plasmodium falciparum* are the shortest incubation period, the shortest infection period, symptoms of fever occur intermittently and can be continuous. This type of malaria most often becomes severe malaria that causes death. *Plasmodium vivax* generally presents with symptoms of recurrent fever with a fever-free interval of 2 days, resulting in low parasitemia, and a longer incubation period<sup>(26)</sup>.

### Malaria Cases by Case Type

The type of malaria in Bintan Regency that infects a lot in 2018-2021 is *indigenous*. malaria *indigenous* dominates the Bintan Regency every year during this period. Topographically, Bintan Regency consists of islands, generally low hills surrounded by swamps. This area is endemic for malaria because there are many swamps in the area and in summer it is a potential breeding ground for *Anopheles sp*<sup>(4)</sup>. Then information from the Health Office of Bintan Regency stated that the cause of several areas in Bintan Regency which are still endemic for malaria is the behavior of the community and the environment. Where there are still parasites as a source and *Anopheles sp*. as an intermediary for the transmission of malaria and as a breeding ground for malaria mosquitoes, there are still many that have not been handled optimally due to uncontrolled environmental changes.

### Malaria Cases by Type of Treatment

The majority of malaria treatment providers in Bintan Regency have used *Artemisinin-Based Combination Therapy* (ACT) drugs, namely artemisin plus amodiaquine and primaquine, which are WHO recommendations in the treatment of malaria. Artesunate has the ability to eliminate parasitemia more quickly than standard antimalarials such as chloroquine and quinine<sup>(27)</sup>. Inadequate treatment can lead to resistance. Resistance to malaria treatment makes it difficult to treat malaria because of the potential for severe malaria and an increase in malaria cases.

## CONCLUSION

Malaria endemicity in Bintan Regency from 2018-2021 is getting better, which in 2021 there are no areas with high levels of endemicity like in previous years. The majority of malaria cases for the 2018-2021 period were 15-64 years old and male. Based on the time when the highest malaria cases were in May and July 2020 with the distribution sites being in the working areas of the manggar health center, Kawal health center and Berakit health center. The type of parasite found was *Plasmodium falciparum* in 2018-2019, while in 2020-2021 most sufferers were infected with *Plasmodium vivax*. During this period most of the malaria cases came from *indigenous*. In the treatment of malaria, the majority have used the drug *Artemisinin-Based Combination Therapy* (ACT), namely, artemisin + amodiaquine and primaquine, which is a WHO recommendation. Efforts to prevent and control malaria in Bintan Regency are carried out continuously, with various types of control program efforts.

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