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The history and current epidemiology of malaria in Kalimantan, Indonesia

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Abstract

Kalimantan is a part of Indonesia, which occupies the southern three-quarters of the island of Borneo, sharing a border with the Malaysian states of Sabah and Sarawak. Although most areas of Kalimantan have low and stable transmission of *Plasmodium falciparum* and *Plasmodium vivax*, there are relatively high case numbers in the province of East Kalimantan. Two aspects of malaria endemicity in Kalimantan differentiate it from the rest of Indonesia, namely recent deforestation and potential exposure to the zoonotic malaria caused by *Plasmodium knowlesi* that occurs in relatively large numbers in adjacent Malaysian Borneo. In the present review, the history of malaria and its current epidemiology in Kalimantan are examined, including control and eradication efforts over the past two centuries, mosquito vector prevalence, anti-malarial use and parasite resistance, and the available data from case reports of knowlesi malaria and the presence of conditions which would support transmission of this zoonotic infection.

Keywords: Kalimantan, Malaria, History, Epidemiology, *Plasmodium knowlesi*

Background

Indonesia, the fourth most populated country and occupying most of the largest archipelago in the world, had an estimated 800,000 malaria cases in 2021 according to the latest World Health Organization (WHO) report, the second highest number in South-east Asia after India [1]. Although the Indonesian government has targeted malaria elimination by 2030 [2], case numbers have remained relatively stable over the past 5 years [3]. Approximately 130 million Indonesians live in high risk regions [3–5], but the geographical distribution of transmission is highly heterogeneous [4]. Of the 514 districts and municipalities of Indonesia, 351 (68.3%) were certified free of malaria in 2022 [6]. In the remainder, and based on the most complete estimates, the prevalence varies from 0.02 to 12.07% [7]. Even though the majority of provinces have hypoendemic to mesoendemic malaria

[3, 8], there is relatively intense transmission in eastern Indonesia [7, 9] including parts of Indonesian Borneo (Kalimantan) [7, 10].

Kalimantan occupies the southern three-quarters of the island of Borneo (Fig. 1). In the north, it shares a border with the Malaysian Borneo states of Sabah and Sarawak. Most areas of Kalimantan have low and stable transmission of the dominant *Plasmodium* species, *Plasmodium falciparum* and *Plasmodium vivax* [11]. The average Annual Parasite Index (API; number of positive cases per 1000 individuals in a year) is below 0.15 except for relatively high transmission areas in East Kalimantan [2, 11]. There are two aspects of malaria endemicity in Kalimantan that differentiate it from the rest of Indonesia. First, although the island of Borneo has one of the largest remaining forested areas in South-east Asia, about a third of Borneo has been deforested in the last 50 years [12] which, with increasing urbanization and climate change [13], has the potential to impact malaria transmission. Second, the zoonotic malaria caused by *Plasmodium knowlesi* is widespread in South-east Asia [14] and there are relatively large numbers of cases in both Sarawak [15–18] and Sabah [19–21]. Although *P.*

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