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A survey of simian *Plasmodium* infections in humans in West Kalimantan, Indonesia

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The simian parasite *Plasmodium knowlesi* is the predominant species causing human malaria infection, including hospitalisations for severe disease and death, in Malaysian Borneo. By contrast, there have been only a few case reports of knowlesi malaria from Indonesian Borneo. This situation seems paradoxical since both regions share the same natural macaque hosts and *Anopheles* mosquito vectors, and therefore have a similar epidemiologically estimated risk of infection. To determine whether there is a true cross-border disparity in *P. knowlesi* prevalence, we conducted a community-based malaria screening study using PCR in Kapuas Hulu District, West Kalimantan. Blood samples were taken between April and September 2019 from 1000 people aged 6 months to 85 years attending health care facilities at 27 study sites within or close to jungle areas. There were 16 *Plasmodium* positive samples by PCR, five human malarias (two *Plasmodium vivax*, two *Plasmodium ovale* and one *Plasmodium malariae*) and 11 in which no species could be definitively identified. These data suggest that, if present, simian malarias including *P. knowlesi* are rare in the Kapuas Hulu District of West Kalimantan, Indonesian Borneo compared to geographically adjacent areas of Malaysian Borneo. The reason for this discrepancy, if confirmed in other epidemiologically similar regions of Indonesian Borneo, warrants further studies targeting possible cross-border differences in human activities in forested areas, together with more detailed surveys to complement the limited data relating to monkey hosts and *Anopheles* mosquito vectors in Indonesian Borneo.

One of the aims of the Global Technical Strategy for malaria 2016–2030 developed by the World Health Organisation (WHO) was for a reduction in malaria case incidence and mortality rate of at least 40% between 2015 and 2020¹. Malaysia is one of the countries to have achieved this goal, with zero reported indigenous non-zoonotic malaria cases since 2018. However, zoonotic malaria due to *Plasmodium knowlesi* increased from 1600 cases to >4000 between 2016 and 2018 before declining to 3213 and 2609 cases in 2019 and 2020, respectively⁴. Malaysia is the nation with the highest reported incidence of human *P. knowlesi* infections in South-east Asia^{2,3} and, in the Malaysian Borneo states of Sabah and Sarawak, the majority of malaria cases and most malaria-associated hospitalisations are caused by *P. knowlesi*^{4–6}. The presence of this parasite in jungle areas harbouring its natural macaque monkey hosts and *Anopheles* mosquito vectors is a clear impediment to achieving malaria eradication once human malarias have been eliminated^{7,8}.

Indonesia is another South-east Asian country that has come a long way in controlling malaria. In the late 1940s, malaria was identified as a major public health problem with substantial implications for economic activity⁹, and 70 years later there were still large estimated numbers of clinical cases each year (1.3 million *Plasmodium falciparum* and 1.5 million *Plasmodium vivax* in 2010)^{10,11}. However, enhanced control measures had reduced the burden of malaria to an estimated 0.3 million clinical cases of *P. falciparum* and 0.4 million clinical cases of *P. vivax* by 2021.¹² The Indonesian government aims to eliminate malaria in stages by 2030, from the most to the least developed islands¹³. As in the example of Malaysia, transmission of *P. knowlesi* is likely to

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