

Imported malaria and its implication to achievement of malaria-free Bhutan

Running title: Implication of imported malaria in Bhutan

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39 **Highlight**

40 As Bhutan nears malaria elimination goal, imported malaria through cross-border human mobility has emerged
41 as major source of transmission. This report highlights key epidemiological characteristics of imported
42 infections and the need to strengthen pro-active and targeted surveillance and response interventions by the
43 national elimination program to achieve elimination and sustain it.

44

45 **Keywords:** Bhutan, malaria, imported, surveillance, elimination, epidemiology

46 The WHO's *Global Technical Strategy for Malaria 2016–2030* (GTS) envisages to eliminate malaria in at least
47 25 countries by 2025 known as E-2025, including Bhutan.⁽¹⁾ While the number of recorded malaria cases has
48 declined by over 99% between 2000 (5935 cases) and 2020 (54 cases) and local malaria transmission is
49 successfully contained in most of the districts, imported malaria, particularly along the southern border has
50 emerged as a major threat to elimination efforts.⁽²⁾ We report some of the epidemiological characteristics of
51 imported malaria and its potential implications for a sustainable malaria elimination program in Bhutan.

52 We collated information from malaria surveillance records collected between 2013 and 2021, maintained by the
53 national malaria program of Bhutan. All reported cases were classified as indigenous or imported according to
54 National surveillance guidelines adapted from WHO case classification definitions.⁽³⁾ Imported cases were
55 defined as patients with a positive malaria diagnosis by blood film microscopy or rapid diagnostic tests (RDTs)
56 and a history of travel to a malaria endemic country other than Bhutan within one month prior to the diagnosis.
57 Between 2013 and 2021 a total of 515 malaria cases were recorded and 317 were classified as imported malaria
58 (62%). Besides 2020, the proportion of annual imported cases was consistently higher than that of indigenous
59 cases, ranging from 57% to 76%. Imported malaria cases were detected in 15 of the 20 districts in Bhutan,
60 though 71% (225/317) of cases were reported from the border districts of Sarpang (26%, 83/317) and Chukha
61 (20%, 64/317) and the interior districts of Wangdi Phodrang (14%, 43/317) and Trongsa (11%, 35/317) (**Figure**
62 **1**). Almost all of imported cases originated from India (99%, 314/317), while three infections originated from
63 African countries of Sudan (2) and Liberia (1). Seventy percent (222/317) of imported malaria cases were among
64 Indian nationals, and 55% (122/222) of them were recorded as daily visitors seeking medical treatment in
65 Bhutanese health centers. Among infections that were determined with source in India, 26% (81/314) originated
66 from the Indian states of Assam (54) and West Bengal (27) followed by Uttar Pradesh (7), Bihar (5), Jharkhand
67 (4) and Bihar (3) while in the remaining cases from India did not have specific States specified in the surveillance
68 records.

69 Our analysis revealed increasing trend in imported malaria which will continue to pose a significant challenge
70 to Bhutan's malaria elimination program. Throughout the entire surveillance period between 2013 and 2021
71 annual number of imported cases exceeded local cases with the exception of 2020, when the COVID-19
72 pandemic imposed lockdowns not only halted cross border population movement but also disrupted the national

73 malaria control program resulting in local malaria outbreak in Sarpang district.⁽⁴⁾ Bhutan shares a border with
74 the Indian states of Assam and West Bengal that report some of the highest case numbers in India.⁽⁵⁾ An
75 estimated 1000 daily migrants cross the border from India into Bhutan and this group of visitors is currently not
76 screened for any *Plasmodium* infection, though a recent study reported 0.42% (2/739) of immigrants to be
77 positive for a *Plasmodium* infection by polymerase chain reaction.⁽⁶⁾ These group of daily migrants enter and
78 exit border on the same day for various purposes including for seeking healthcare in Bhutanese health facilities
79 who accounted for 39% of imported cases in this study. These category of migrants pose a significant infectious
80 risk to the local population in the absence of routine screening for the malaria parasite. Hence appropriate
81 surveillance needs to be designed that target this high risk group. The priority should be accorded these group
82 of cross border migrants who live across the international border and come to Bhutan for employment,
83 particularly considering the difference in disease transmission level and malaria control measures on the two
84 side of the borders.⁽⁷⁾

85 Although importation risk are mainly in bordering areas, the interior districts of Wangdi Phodrang and Trongsa
86 accounted for a quarter of imported cases, possibly due to the large number of Indian migrant workers employed
87 at two mega hydropower projects (**Figure 1**). The detection of sporadic imported cases from other malaria free
88 or low risk districts pose a risk of re-introduction and re-establishment of malaria in the country. While short
89 term daily migrants are unlikely to move beyond the border districts, long term migrants will proceed to interior
90 districts and could potentially trigger local outbreaks in districts where the conditions are favourable. However
91 imported cases were reported at low frequencies from almost all districts of the country. Considering the
92 continuous threat of introduction and re-establishment of malaria transmission despite sound control measures
93 within the country, comprehensive screening including the daily migrants originating from adjacent border areas
94 for *Plasmodium spp.* at border crossings and airports and a strengthening of the current 1-3-7 response system⁽³⁾
95 within the country are needed. An integrated malaria screening posts for mobile populations at strategic
96 locations including border crossings and migration port could be established to tackle the risk of imported
97 malaria.⁽⁸⁾ These measures must be complimented by continuous training of health workers to diagnose malaria
98 and maintain a high level of vigilance for any case of malaria, irrespective of origin.⁽⁹⁾

99 Since the majority of imported cases were from India, comprehensive cross-border collaborations around
100 *Plasmodium* surveillance and control strategies must be strengthened between Bhutanese and Indian authorities.
101 In addition, strategies for mandatory testing of daily workers from India and Bhutanese citizens returning from
102 malaria endemic areas must be developed and implemented as priority intervention until regional malaria
103 elimination is achieved as is implemented in Sri Lanka.⁽¹⁰⁾ Ideally these measures should include sensitive
104 diagnostics for the detection of sub-clinical parasitaemia especially among long term migrants and high
105 throughput screening methods at border crossings and airports for all migrants irrespective of nationality.

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107 **Declarations**

108 Authors have nothing to declare.

109 **Data availability**

110 The datasets underlying the results of this study are available from the corresponding authors upon reasonable
111 request.

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114 data and approving to conduct this study.

115 **Contributions**

116 KP and KW conceived, accessed, cleaned, analysed and drafted the original manuscript. All other authors
117 contributed to the contents and critically reviewed and edited the manuscript, read and approved the final
118 manuscript.

119 **Conflict of interest**

120 All authors have nothing to disclose.

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152 **Tables and Figures**

153 **Figure 1: Distribution of imported malaria in Bhutan 2013-2021.** Purple circles and green circles are the

154 locations of two hydro projects in Bhutan. Note: Locations of 22 long term migrants were missing.

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