

ELIMINATING MALARIA

Case-study 9

Climbing towards elimination
in Bhutan



UCSF GLOBAL HEALTH SCIENCES
THE GLOBAL HEALTH GROUP
From evidence to action



World Health Organization

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Any errors and omissions remain the responsibility of the authors.

ACRONYMS AND ABBREVIATIONS

ABER	annual blood examination rate
ACT	artemisinin-based combination therapy
API	annual parasite index
APMEN	Asia Pacific Malaria Elimination Network
BHU	basic health unit
BBIN	Bangladesh, Bhutan, India and Nepal
BCC	behaviour change communication
CAG	Community Action Group
DDT	dichlorodiphenyltrichloroethane
DOT	directly observed therapy
EQA	external quality assurance
GDP	gross domestic product
GIS	geographic information system
GNH	gross national happiness
G6PD	glucose-6-phosphate dehydrogenase
IEC	information, education, communication
IRS	indoor residual spraying
ITN	insecticide-treated mosquito net
IVM	integrated vector management
KAP	Knowledge, Attitudes and Practices
LLIN	long-lasting insecticidal net
NMCP	National Malaria Control Programme
ORC	outreach clinic
PCD	passive case detection
RCC	Rolling Continuation Channel
RDT	rapid diagnostic test
SAARC	South Asian Association for Regional Cooperation
SEARO	WHO Regional Office for South-East Asia
SPR	slide positivity rate
VDCP	Vector-borne Disease Control Programme
WHO	World Health Organization

GLOSSARY

The terms listed in this glossary are defined according to their use in this publication. They may have different meanings in other contexts.

active case detection

The detection by health workers of malaria infections at community and household level in population groups that are considered to be at high risk. Active case detection can be conducted as fever screening followed by parasitological examination of all febrile patients or as parasitological examination of the target population without prior fever screening.

annual blood examination rate

The number of examinations of blood slides for malaria by microscopy per 100 population per year.

annual parasite index

The number of reported malaria cases per 1 000 population at risk per year.

case definition (control programmes)

confirmed malaria

Suspected malaria case in which malaria parasites have been demonstrated in a patient's blood by microscopy or a rapid diagnostic test.

suspected malaria

Patient illness suspected by a health worker to be due to malaria. Fever—with history of travel to a malaria-endemic area—is usually one of the criteria.

case definition (elimination programmes)

imported

A case whose origin can be traced to a known malarious area outside the country in which it was diagnosed.

indigenous

Any case contracted locally (i.e. within national boundaries), without strong evidence of a direct link to an imported case. Indigenous cases include delayed first attacks of *Plasmodium vivax* malaria due to locally acquired parasites with a long incubation period.

induced

A case whose origin can be traced to a blood transfusion or other form of parenteral inoculation but not to normal transmission by a mosquito.

malaria

Any case in which, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis.

case investigation

Collection of information to allow classification of a malaria case by origin of infection, i.e. imported, introduced, indigenous or induced. Case investigation includes administration of a standardized questionnaire to a person in whom a malaria infection is diagnosed.

case management

Diagnosis, treatment, clinical care and follow-up of malaria cases.

case notification

Compulsory reporting of detected cases of malaria by all medical units and medical practitioners, to either the health department or the malaria elimination service (as laid down by law or regulation).

elimination

Reduction to zero of the incidence of infection by human malaria parasites in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

endemic

Applied to malaria when there is an ongoing, measurable incidence of cases and mosquito-borne transmission in an area over a succession of years.

epidemic

Occurrence of cases in excess of the number expected in a given place and time.

eradication

Permanent reduction to zero of the worldwide incidence of infection caused by human malaria parasites as a result of deliberate efforts. Intervention measures are no longer needed once eradication has been achieved.

evaluation

Attempts to determine as systematically and objectively as possible the relevance, effectiveness and impact of activities in relation to their objectives.

focus

A defined, circumscribed locality situated in a currently or former malarious area containing the continuous or intermittent epidemiological factors necessary for malaria transmission. Foci can be classified as endemic, residual active, residual non-active, cleared up, new potential, new active or pseudo.

gametocyte

The sexual reproductive stage of the malaria parasite present in the host's red blood cells.

hypnozoite

The dormant stage of the malaria parasite present in the host's liver cells (limited to infections with *Plasmodium vivax* and *P. ovale*).

incubation period

The time between infection (by inoculation or otherwise) and the first appearance of clinical signs.

intervention (public health)

Activity undertaken to prevent or reduce the occurrence of a health condition in a population. Examples of interventions for malaria control include the distribution of insecticide-treated mosquito nets, indoor residual spraying with insecticides, and the provision of effective antimalarial therapy for prevention or curative treatment of clinical malaria.

malaria-free

An area in which there is no continuing local mosquito-borne malaria transmission and the risk for acquiring malaria is limited to introduced cases only.

malaria incidence

The number of newly diagnosed malaria cases during a specified time in a specified population.

monitoring (of programmes)

Periodic review of the implementation of an activity, seeking to ensure that inputs, deliveries, work schedules, targeted outputs and other required actions are proceeding according to plan.

passive case detection

Detection of malaria cases among patients who, on their own initiative, go to a health post for treatment, usually for febrile disease.

population at risk

Population living in a geographical area in which locally acquired malaria cases occurred in the current year and/or previous years.

rapid diagnostic test

An antigen-based stick, cassette or card test for malaria in which a coloured line indicates that plasmodial antigens have been detected.

receptivity

Relative abundance of anopheline vectors and existence of other ecological and climatic factors favouring malaria transmission.

re-establishment of transmission

Renewed presence of a constant measurable incidence of cases and mosquito-borne transmission in an area over a succession of years. An indication of the possible re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections in the same geographical focus, for two consecutive years for *Plasmodium falciparum* and for three consecutive years for *P. vivax*.

sensitivity (of a test)

Proportion of people with malaria infection (true positives) who have a positive test result.

slide positivity rate

Proportion of microscopy slides found to be positive among the slides examined.

specificity (of a test)

Proportion of people without malaria infection (true negatives) who have a negative test result.

surveillance (control programmes)

Ongoing, systematic collection, analysis and interpretation of disease-specific data for use in planning, implementing and evaluating public health practice.

surveillance (elimination programmes)

That part of the programme designed for the identification, investigation and elimination of continuing transmission, the prevention and cure of infections, and the final substantiation of claimed elimination.

transmission season

Period of the year during which mosquito-borne transmission of malaria infection usually takes place.

vector control

Measures of any kind against malaria-transmitting mosquitoes intended to limit their ability to transmit the disease.

vigilance

A function of the public health service during a programme for prevention of re-establishment of transmission, consisting of watchfulness for any occurrence of malaria in an area in which it had not existed, or from which it had been eliminated, and application of the necessary measures against it.

vulnerability

Either proximity to a malarious area or the frequency of influx of infected individuals or groups and/or infective anophelines.

SUMMARY

This report describes the policies and practices used to control malaria in Bhutan since the 1960s, with a focus on how local transmission has been brought close to zero since 2006.

History of malaria and malaria control

Bhutan has made major strides in controlling malaria since the launch of its National Malaria Eradication Programme (later renamed National Malaria Control Programme) in 1964. With implementation of active surveillance and indoor residual spraying (IRS) using dichlorodiphenyltrichloroethane (DDT), reported cases had declined to 114 by 1966.

In subsequent years, however, reported cases rose. Surveillance was considered inadequate, leading to delays in identification of cases. Health system decentralization in the late 1970s was another major factor: while it expanded the primary health care system through increases in basic health units, it also created inefficiencies, with dzongkhags (districts) being unable to swiftly implement indoor residual spraying. Insecticide stock-outs, early chloroquine resistance, and population movement and instability in the southern portion of the country exacerbated the problem. By 1994 reported malaria cases had increased to almost 40 000—the highest on record.

In the 1990s Bhutan shifted further responsibility for the implementation and oversight of health services and malaria control to the dzongkhag and gewog (subdistrict) levels. The National Malaria Control Programme was renamed the Vector-borne Disease Control Programme (VDCP) in 2003 and its mandate was extended to include

other vector-borne diseases. Nevertheless, the primary workforce of the malaria programme—malaria technicians (later renamed medical technicians)—posted in hospitals and basic health units, maintained a focus on malaria diagnosis, surveillance, reporting, coordination of vector control and entomological surveillance, and awareness-raising activities. Malaria cases declined from 1996 to 2005.

Over the period 2006–2013, a phased malaria elimination strategy was adopted, aiming to eliminate the disease first in the nine epidemic-prone dzongkhags while continuing enhanced control strategies in the seven endemic dzongkhags in the south of the country. Bhutan received a major Round 4 grant from the Global Fund to Fight AIDS, Tuberculosis and Malaria in 2006 and a Round 7 grant in 2008. These grants supported the scale-up and integration of new malaria interventions, notably the procurement and distribution of long-lasting insecticidal nets (LLINs) and the introduction of artemisinin-based combination therapy (ACT) for treatment of *Plasmodium falciparum* infections. Cases declined during this period until 2009, when an increase resulted from earlier than usual monsoon rains, delays in focal IRS application, fishery project development, and reduced effectiveness of the LLINs that had been distributed in 2006. Remedial action was taken and, by 2013, there were 16 indigenous and 29 imported cases reported in total.

How will Bhutan achieve elimination?

Bhutan's malaria elimination programme concentrates on enhanced surveillance and vector control activities, on increased technical capacity and—in the border areas—on imported malaria. Its aim is to achieve nationwide

elimination of malaria by 2016—and certification of this achievement by 2020—by interrupting transmission in the seasonal transmission areas, maintaining the absence of transmission in malaria-free areas, and intensifying malaria control along the country's southern border with India. To achieve these aims, in 2013 the programme organized training in case classification of infection origin, and prospective and retrospective case mapping using mobile technology and geographic information systems (GIS).

Malaria foci will be identified and classified to allow better targeting of interventions and outbreak response. Surveillance will be strengthened by active case detection, targeting mobile and migrant populations, and by support for health facilities at development project sites. Entomological capacity and surveillance activities will also be enhanced, with monitoring of sentinel sites in all malarious areas. The establishment of rapid response teams at the dzongkhag level will assist in containing outbreaks by more rapidly identifying their location and ensuring the availability of buffer stocks of antimalarials and insecticides.

Bhutan faces some important challenges. The capacity of the VDCP requires strengthening in diagnosis, quality control and entomological surveillance. Although the VDCP has secured funding from the Global Fund for 2013–2015 through the Transitional Funding Mechanism, sustainable funding for elimination and beyond is a priority. Lastly, malaria along the country's southern border with India and the daily migration of workers and visitors into Bhutan may pose obstacles to elimination of malaria; further cross-border collaboration with India is thus part of the elimination plan. Intersectoral collaboration will play an important role, with development project managers, security forces and forest officials working with the VDCP on malaria elimination strategies. Community engagement in the border areas will increase participation of local citizens in malaria elimination activities.

Lessons learned

Bhutan has overcome many obstacles and is now nearing its goal of elimination. The history of malaria control in the country shows that IRS has been effective when well implemented and should be continued in the endemic zone and around index cases. Success in reducing peak transmission and in protecting hard-to-reach populations has been achieved with the distribution of LLINs. At the same time, ACT has been introduced for *P. falciparum* infections and 14-day primaquine treatment has been continued for *P. vivax* infections.

Passive case detection (PCD) has continued to be the mainstay of the malaria control programme and has been boosted by further training of medical technicians in case detection and by case follow-up. Case mapping, classification of origin of infection and active case detection will be important elements of the effort to achieve elimination.

The programme has recently invested in operational and technical capacity. The medical technician cadre is of particular importance as it provides all malaria services. If the responsibilities fulfilled by medical technicians are integrated with other vector-borne diseases, however, progress towards malaria elimination may be slowed. Community engagement, through the creation of Community Action Groups (CAGs), is seen as an important way to maintain support for malaria elimination.

Major socioeconomic progress over the past decade in Bhutan has facilitated progress towards elimination, and funding and technical support from various sources have contributed significantly. However, securing sustainable funding will be a major challenge for the programme, as will the risk of malaria importation through continuing population movement.

INTRODUCTION

The malaria elimination case-study series

The Global Malaria Programme of the World Health Organization (WHO/GMP) and the Global Health Group of the University of California, San Francisco—in close collaboration with national malaria programmes and other partners and stakeholders—are jointly conducting a series of case-studies on elimination of malaria and prevention of re-establishment. Many countries are embarking upon or considering a malaria elimination goal; in order for them to make well-informed decisions on whether or how to pursue malaria elimination, historical and current experience of malaria elimination and prevention of re-establishment in other countries—particularly those in similar eco-epidemiological settings—is critical. The objective of this case-study series is to build an evidence base to support intensification of malaria elimination as an important step in achieving international malaria targets.

Ten case-studies are being prepared that, together, will provide insights into and lessons to be learned from a wide range of elimination approaches and geographical settings.

The UCSF Global Health Group collaborated with the Vector-borne Disease Control Programme (VDCP) of Bhutan and the Asia Pacific Malaria Elimination Network (APMEN) on this case-study. Bhutan has made tremendous progress towards malaria elimination, yet the country's experiences have not been well documented. The main authors of the case-study collaborated in the data collection process, focusing on the progress made since 1995. The methods used for data collection and analysis are summarized in Annex 1.

Malaria in South-East Asia

In 1984, Maldives became the first country in the WHO South-East Asia Region to achieve malaria elimination. In other countries of the Region many challenges remain, although significant progress has been made. From 2002 to 2005, the number of malaria cases in the Region declined sharply, notably in Bhutan, the Democratic People's Republic of Korea, India, Nepal, Sri Lanka and Thailand (1); Sri Lanka has now reached the elimination phase, and Bhutan and the Democratic People's Republic of Korea are in the pre-elimination phase.

Malaria in Bhutan

Bhutan has made great advances in reducing the impact of malaria, although not without considerable difficulty. In the 1960s, when the surveillance system was still in its infancy, the reported malaria burden was low with a reported annual parasite index (API) of 5.5 per 1 000 population. Following introduction of IRS using dichlorodiphenyltrichloroethane (DDT), an API of 1.2 per 1 000 population was reported. During the 1970s and 1980s, however, rising levels of DDT and drug resistance became apparent; cases started to rise, peaking in 1994 with 39 852 confirmed malaria cases and 48 deaths (2–4).

Since the 1990s, Bhutan has made major progress toward malaria elimination and is now considered to be in the pre-elimination phase (1). With new support from the Global Fund, long-lasting insecticidal nets (LLINs) replaced regular ITNs and new drugs were introduced that helped the country scale up interventions and further reduce the malaria burden. The number of cases rose slightly between 2008 and 2009. By 2013, however, only 16 indigenous cases were reported (1). The country

still faces challenges, especially in the border area with malaria-endemic India, where 77% of Bhutan's malaria cases originate (5).

This case-study considers the effective measures of the malaria control programme that have brought Bhutan to the brink of success, focusing particularly on the challenge of malaria importation.

COUNTRY BACKGROUND

Geography, population and economy

Nestled on the southern slopes of the eastern Himalayas, between China to the north and India to the west, south and east, the small country of Bhutan covers a total area of 38 394 km² (6). Although landlocked, Bhutan spans a diverse ecological geography: the mountainous terrain of the north, cut through by deep valleys, gives way to subtropical deciduous forests in the south.

During monsoon season, from early June until late September, heavy rains can be expected, accounting for 60–90% of the rainfall in the western region of Bhutan. The monsoon rains not only contribute to the country's booming hydroelectric industry but also cause frequent landslides and blockages of roads and bridges, often limiting access to health care facilities and clinics (7).

Bhutan has a population of approximately 721 000, of which almost 31% are urban dwellers (8, 9); it is considered to be a lower-middle-income country. Since the 1960s, a series of five-year plans have produced rapid economic and social development, particularly in the past decade: gross domestic product (GDP) rose from US\$ 702.7 million in 2004 to US\$ 1 779.6 million in 2012 (6, 10, 11). The economy is based mainly on agriculture but also depends on forestry, tourism and hydroelectric power. Rice, corn, root crops and citrus fruit are among the main agricultural products; 2.9% of land is considered arable, with the remainder being forest (8).

Bhutan is the only country to measure its gross national happiness (GNH), which is based on the four pillars of: sustainable and equitable economic development; conservation of the natural environment; preservation and promotion of culture and tradition; and good governance. The GNH measure includes nine domains: psychological

well-being, health, time use, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, living standard and education (12). The concept implies that sustainable development should take a holistic approach towards notions of progress and give equal importance to non-economic aspects of well-being.

Health systems and population health profile

With GNH as the country's guiding philosophy, the government has prioritized and addressed a range of health issues, including both access to basic health services and creation of the infrastructure needed to sustain these services. As a result, the health status of the Bhutanese people has improved dramatically over the past decade; however, there are still areas in need of development.

Bhutan provides health care to citizens and residents of the country through a three-tiered integrated health care system in which there are 31 hospitals, 184 basic health units (BHUs), and 654 outreach clinics (ORCs) that reach 90% of the population (13, 14). Within this system, the VDCP addresses vector-borne diseases including malaria, dengue, kala-azar, chikungunya and Japanese encephalitis. The VDCP covers all *dzongkhags* (districts) in Bhutan but focuses its malaria-specific programmes on those where the disease is endemic or seasonally transmitted.

Table 1 highlights indicators of health service provision in Bhutan for 2011 (8). In 2010, the country had only 0.02 physicians per 1 000 population; for other lower-middle-income countries the average figure is 0.8 per 1 000 (15). Bhutan also has fewer nurses and midwives (0.24 per 1 000 population) than other similar countries in the Region (1.4 per 1 000) (15).

Table 1. Health service provision indicators, Bhutan, 2011

Indicator	Number
Hospitals	31
Basic health units	184
Doctors	181
Doctors per 10 000 persons	3.0
Persons per hospital bed	555

Source: reference 8

In 2011, 33.1% of the population were aged 0–14 years, 62.3% were aged 15–64 years, and 4.7% were aged 65 years and over; the annual population growth rate was 1.3% (8). Life expectancy at birth for males and females was 65 and 69 years, respectively (15). The maternal mortality ratio, modelled estimate per 100 000 births, declined from 270 in 2005 to 180 in 2010 (15). Childhood coverage with measles immunization has reached 95%, which is a notable success for Bhutan's universal health care system.

Health expenditure accounts for 5.19% of the country's GDP (15). Bhutan is ranked 141 of 187 in the Human Development Index of the United Nations Development Programme (16). More detailed demographic data and health and health economics indicators can be found in [Annex 2](#).

HISTORY OF MALARIA AND MALARIA CONTROL

Parasites and vectors

Malaria in Bhutan is described through a stratification system based on the nationality and residency of patients. Cases occurring in Bhutanese nationals are designated N1 and those occurring in foreign nationals who stay overnight or longer in Bhutan are designated N2. Both N1 and N2 cases are included in the annual national caseload reporting and are considered to be indigenous, or locally acquired, infections. Cases that occur in foreign nationals who enter Bhutan but do not stay overnight are considered to be imported and are designated N3.

Until 2013 there was no assessment in place to classify cases as either indigenous or imported. N3 cases were assumed to be imported as they consisted of daily visitors—those who did not stay overnight in Bhutan and posed little risk for secondary infection. In 2013 a new case investigation form and system for classifying cases as imported or indigenous was implemented (see [Table 2](#)), and 16 out of a total of 45 (N1+N2) cases that year were considered to be indigenous.

Malaria in Bhutan is caused by *Plasmodium vivax* and *P. falciparum*: of the 45 confirmed malaria cases (N1+N2) in 2013, 26.6% (n = 12) were due to *P. falciparum*. A small number of cases of mixed infection (i.e. malaria cases in which both *P. vivax* and *P. falciparum* parasites are identified) are reported each year ([17](#)).

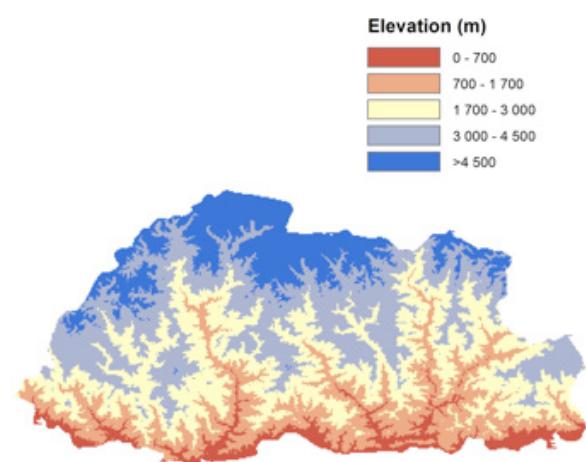
Malaria transmission in Bhutan occurs only at altitudes below 1 700 metres (5 577 feet), i.e. in the southern portion of the country (see [Figure 1](#)) ([18, 19](#)). Thus transmission has historically been concentrated in the seven southern dzongkhags of Chhukha, Dagana, Pemagatshel, Samdrup Jongkhar, Samtse, Sarpang, and Zhemgang ([Figure 2](#)), with a population of 284 512 (42% of the total population). According to national malaria stratification,

these dzongkhags—which border the malaria-endemic Indian states of Assam, Arunachal Pradesh and West Bengal—are considered to be endemic, or “perennial” transmission areas, where transmission occurs throughout the year ([20](#)).

Table 2. Classification and reporting of malaria cases by type in Bhutan

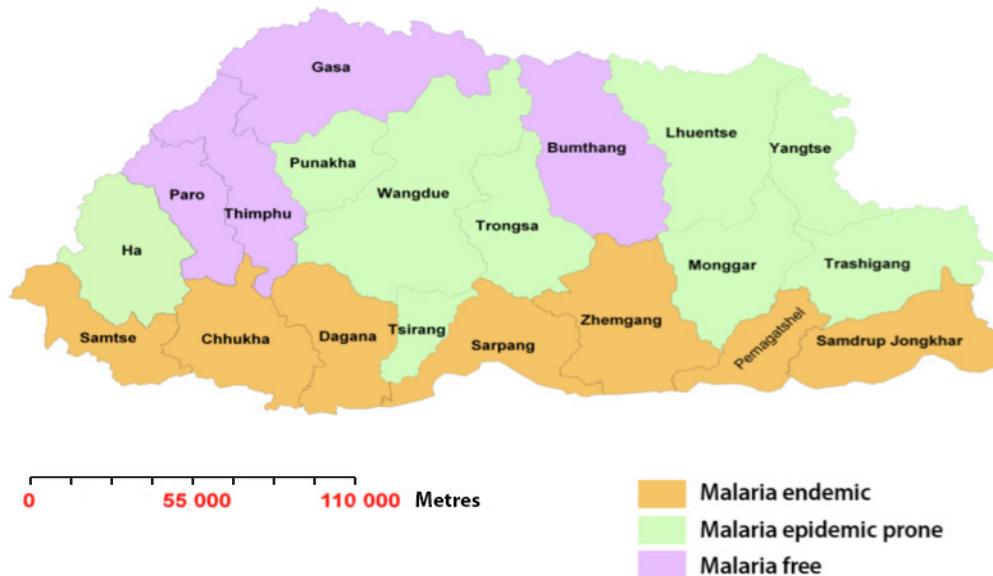
Classification	Description	Reporting
N1	Bhutanese origin	Included in annual caseload
N2	Foreign national with overnight stays in Bhutan	Included in annual caseload
N3	Foreign nationals entering Bhutan (e.g. daily workers) who do not stay overnight; considered to be imported cases	Not included in annual caseload

Figure 1. Map of elevation of Bhutan



Source: references 18, 19

Figure 2. Stratification map of malaria risk in Bhutan, by dzongkhag



Source: reference 3

The nine dzongkhags of Ha, Lhuentse, Monggar, Punakha, Trashigang, Trongsa, Tsirang, Wangdue and Yangtse make up an epidemic-prone, or “seasonal” transmission, area. These dzongkhags, which run roughly in a band from east to west across the centre of the country, have a history of local transmission, although some have had no N1 or N2 cases in the past three years. This zone contains 34% of the population.

The four dzongkhags in the north-east and central part of the country (Paro, Thimphu, Gasa, and Bumthang), home to 24% of the population, are considered to be malaria-free (7). Because of their high elevation and cooler temperatures, these areas are not receptive to malaria transmission; N1 and N2 cases occurring here are considered to be imported cases from other dzongkhags. However, the programme continues to monitor

entomological parameters and parasite presence within these areas, especially in the light of climate change.

Bhutan is most receptive to malaria transmission from April to September, or during the warm monsoon period ([Figures 3, 4](#)) (21). (A north-east monsoon occurs in winter, from November to March, with snowfall at higher elevations.) Malaria in Bhutan is seasonal, following a two-peak pattern: the first peak occurs before the start of the monsoon season and the second at the end. In April, the rivers are shallow and temperatures sufficiently warm for vector breeding. During the monsoon, frequent heavy showers wash away the mosquito larvae but, as the rainy season subsides in August, conditions become once again conducive to vector breeding. The timing of IRS attempts to address the peak in malaria incidence.

Figure 3. Malaria cases (N1+N2) in Bhutan, by month, 2008–2012

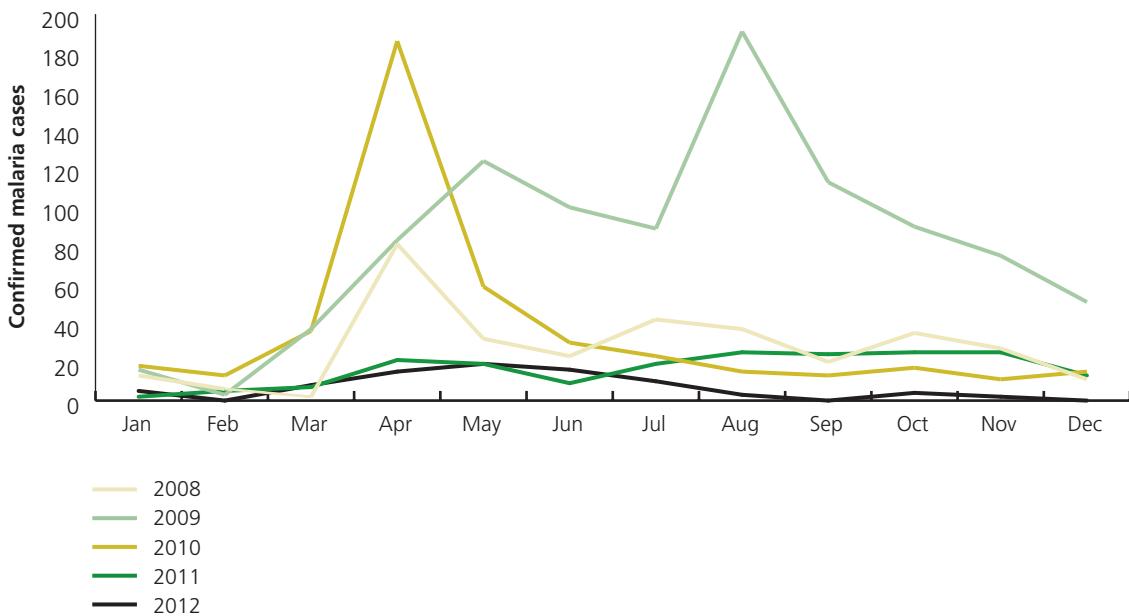
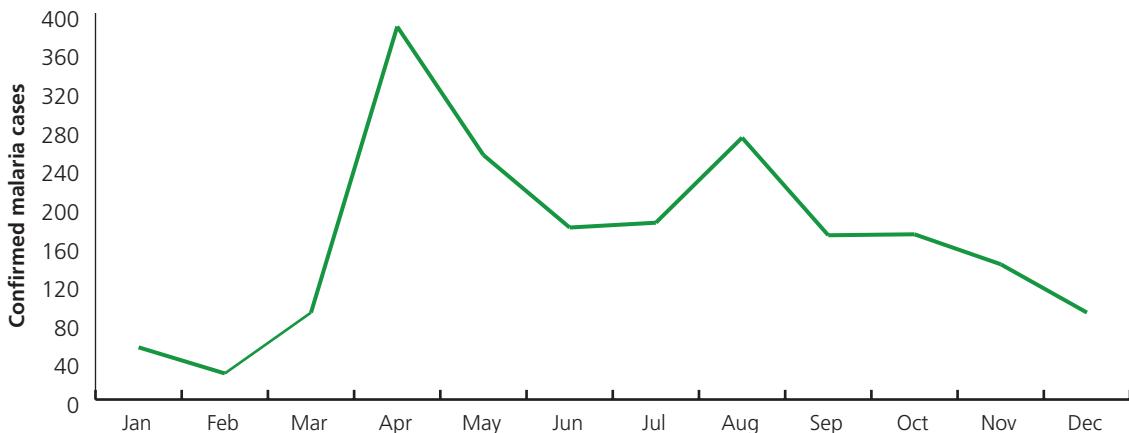


Figure 4. Total malaria cases (N1+N2) in Bhutan, by month, 2008–2012



There are few data on vector bionomics and their role in malaria transmission in Bhutan. However, the primary vectors believed to be responsible for malaria transmission over the past 10 years are *Anopheles pseudowillmori* and *An. culicifacies* (17, 22), and it is suggested that *An. dirus* (23), *An. sinensis*, and *An. aconitus* (24) also may play a role. Secondary vectors in Bhutan include *An. annularis*, *An. barbirostris* and *An. maculatus* (24).

Paddy fields and irrigation channels located in the wetlands of subtropical climate zones are optimal breeding habitats for all vectors (25). *An. pseudowillmori* and *An. culicifacies* exhibit diverse behaviours, characterized as both endo- and exophagic (indoor- and outdoor-feeding), and are largely anthropophilic (exhibiting a preference for biting humans). *An. dirus* favour forested or forest-fringe areas for both breeding and biting (23). These forested regions are associated with an increased malaria risk, especially where there are development projects such as hydropower stations (26). Annex 4 provides more information on vectors in Bhutan.

Pre-control

Malaria has long affected Bhutan, especially residents along the country's southern border with India who have historically been at the highest risk for the disease. Nonetheless, historical records on malaria incidence and corresponding indicators (e.g. slide positivity rate (SPR), API, annual blood examination rate (ABER)) have been kept only since 1965—one year after Bhutan formally established its malaria programme (27). The country's first

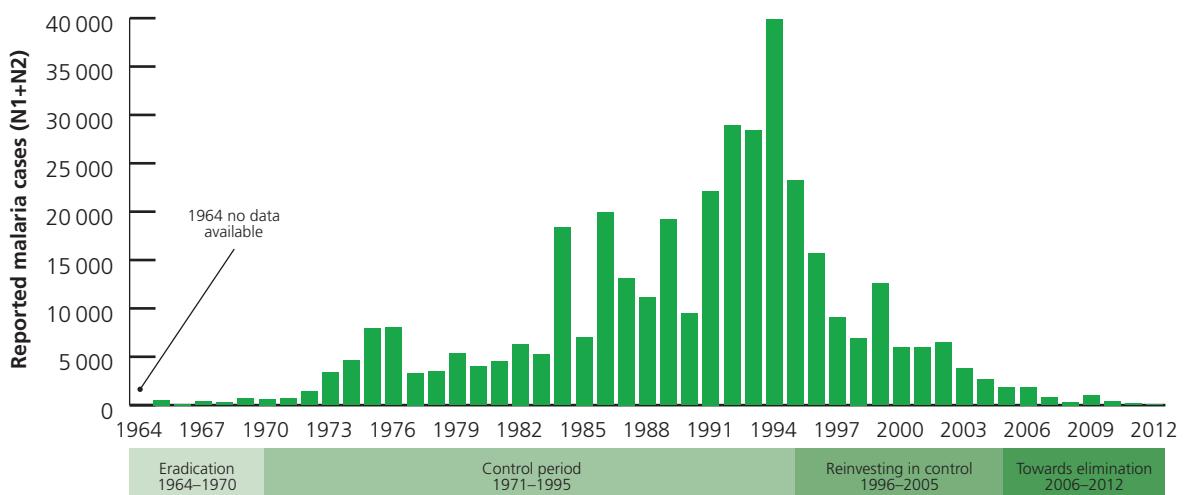
malaria survey was conducted in November 1962, led by India's National Malaria Eradication Programme (27). Results indicated that Bhutan did have local malaria transmission, at varying intensities depending on altitude and climate (28). Parasite rates in children ranged from 10.7% to 55.5% (4), with higher prevalence of parasites in children living in Bhutan's foothill regions (altitude 150–300 metres) (28). The 1962 survey also showed that *P. vivax* accounted for 47% of all malaria infections in Bhutan, whereas *P. falciparum* and *P. malariae* were responsible for 42% and 11% of total cases, respectively (28).

Malaria eradication programme (1964–1970)

In 1964, Bhutan launched its own National Malaria Eradication Programme (later renamed National Malaria Control Programme, NMCP), led by Dr N. Sarkar of the Government of India. A reported 32 surveillance inspectors were in place by 1969, and until 1975 the programme was largely overseen by Indian staff who trained local personnel in malaria control (27). Programme efforts were in line with the Global Malaria Eradication Programme, led by WHO, with the goal of eliminating malaria in Bhutan. The lowest number of recorded cases—114—was reported in 1966 (Figure 5, Table 3) (28). At that time, however, surveillance activities were still in their infancy, with a limited number of centres identifying and reporting cases; in 1961, for example, there were only two hospitals, 11 dispensaries and three doctors in the country (29, 30).

Figure 5. Malaria cases (N1+N2) in Bhutan, 1965–2012, with programme phases

Note: Cases were classified as N1, N2 or N3 beginning in 1994. Cases reported before 1994 were reported as indigenous. Until 2000, not all cases were confirmed.



Source: reference 28

Table 3. Historical malaria cases and trends in Bhutan, 1964–1970

Year	Blood films	Positive cases	ABER	API	SPR	% PF ^a
1964	N/A	N/A	N/A	N/A	N/A	N/A
1965	10 189	518	11	5.5	5.1	20.1
1966	7 148	114	7.1	1.5	2	15.5
1967	15 329	405	7.6	2	2.6	11.2
1968	12 913	247	6.4	1.2	1.9	12.3
1969	25 531	672	12.4	3.1	2.6	28.8
1970	30 886	630	14	2.9	2	24.5

% PF^a = percentage of cases due to *P. falciparum*.

Source: reference 28

Starting in 1969, several centres for active case detection were established in the southernmost dzongkhags, which generally experienced the highest burdens of malaria (14; D.B. Rasaily, personal communication). In these areas, surveillance workers collected samples (information could not be obtained on how often or whether only from persons with fever) from every household and sent slides to the Indian malaria technician in Sarpong Dzongkhag for testing (28). These active surveillance activities continued until 1989. At the same time, the number of health facilities increased dramatically: by 1977 there were 10 hospitals, 31 BHUs and 52 doctors.

Through the 1960s and 1970s, the main vector control intervention was IRS with DDT. Between 1965 and 1974, the Bhutan programme conducted three rounds of IRS in malaria-endemic areas each year (28). An estimated 40% of the population at risk for malaria were reached in 1965, but by 1973 an estimated 89% coverage had been achieved (28). The impact of IRS was rapidly apparent, reducing the API from 5.1 per 1 000 population in 1965 to 2.6 in 1967 (Table 3). In 1974, however, the application of IRS was reduced to twice a year, and the programme struggled for the next five years to provide IRS to more than 50% of the country's at-risk populations. While this

altered spraying schedule was in force, no malaria prevention activities preceded the June to September transmission (28).

From 1971 onwards, malaria cases rose rapidly and the programme transitioned from an eradication programme to that of malaria control.

Malaria control (1971–1995)

The number of reported cases of malaria rose rapidly from 720 in 1971 to 3 402 in 1973 (Table 4) (28, 30). This rise was believed to be related to the increase in surveillance in the southern districts and greater access to passive case detection in the new hospitals and BHUs. Reported malaria cases peaked in 1975 and 1976, with approximately 8 000 cases each year. Over this period, too, the proportion of cases due to *P. falciparum* increased, from 11.2% in 1967 to 56.9% in 1975 (Table 3, Table 4), possibly as a result of the reduction in IRS frequency that began in 1974. In 1979, the programme shifted its objective to focus once again on malaria control and was integrated into the Government's general health services platform.

The Fifth Five Year Plan of Bhutan (1981–1987) laid out goals of higher health standards in the country to be achieved by means that included health education, sanitation, hygiene and better nutrition, and prevention and control of common epidemics and communicable diseases including malaria (31). Basic health facilities for treatment and care were also to be extended (28). The Alma Ata Declaration of 1978 (32), calling for the expansion of the primary health care approach, had been formally adopted by Bhutan in 1979 and the functions to be decentralized to dzongkhag level were set out by the Planning Commission in that year (33). In 1985, four years after integration within the primary health care system and six years after the programme began reorienting towards malaria control (1979), the malaria eradication programme was renamed the National Malaria Control Programme, NMCP (3). Malaria control was integrated within the primary health care system, which at the same time expanded to service 65 additional BHUs by 1987 (28). The central level was still responsible for

administration, training and major referrals, while the dzongkhags managed the delivery of basic services to the population through a network of dzongkhag-based hospitals, BHUs and ORCs.

During the same period, there was an increase in malaria incidence across the country with cases rising from 5 213 in 1983 to 18 368 in 1984 (Table 4). Most infections at this time were due to *P. falciparum*, which accounted for 59% of all infections in 1983 (Table 4). From 1985 to 1993, malaria cases fluctuated, from a low of 7 043 reported cases in 1985 to 28 900 in 1992.

The increase in transmission in 1984 was thought to be the result of several changes to the programme. In 1974, IRS—the primary malaria control intervention—had been reduced from three rounds to two each year (28). Moreover, because of integration, administration of IRS was handed over to dzongkhags. During this transition period, the quality of spraying activities was lower because of lack of supervision and guidance (28). In addition, the programme had introduced voluntary labour for IRS operations, but discontinued this practice around 1987 because it was found that coverage had decreased when volunteers were used (28). In 1984, a stock-out of insecticide also resulted in reduced IRS coverage and contributed to the increase in cases. Reports for 1984–1987 also indicate the presence of resistance to chloroquine for treatment of *P. falciparum* (28).

Vulnerability to malaria transmission at this time was increased by the movement of itinerant labourers, in particular those who moved between the state of Assam in India and Bhutan, coming into Bhutan for work (28). The 1985 outbreak began in Gurung Village in the Samtse District, and all cases occurred in male members of itinerant population groups. Those affected had reportedly travelled to Assam to sell potatoes some two–three weeks before becoming symptomatic (28). Frequent crossing of the porous border between Assam and Bhutan by migrant labourers was documented during this time (28).

In the 1990s Bhutan was also affected by the armed insurgency in Assam, India. Indian separatist groups established illegal camps in Bhutan's southern forests,

Table 4. Historical malaria cases and trends, 1971–1995

Note: Cases during this period were considered indigenous. The N1-N2-N3 classification system was not yet implemented.

Year	Blood films	Positive cases	ABER	API	SPR	% PF ^a
1971	31 369	720	14.2	3.3	2.3	22.3
1972	38 703	1 376	16.2	5.7	3.6	25.3
1973	47 909	3 402	21.5	15.2	7.1	37.3
1974	47 874	4 623	21.3	20.5	9.6	48.4
1975	48 170	7 929	20.7	33	16.5	56.9
1976	47 699	8 035	31.3	50.6	16.9	53
1977	33 619	3 328	29	27.5	9.9	48
1978	39 518	3 483	30.3	28.7	8.8	42
1979	41 079	5 375	43.2	44.3	13.1	59
1980	45 487	3 993	41.5	45.9	8.7	55.7
1981	48 361	4 522	35	32.7	9.4	60.4
1982	51 939	6 328	34.8	42.4	12.2	48.2
1983	42 633	5 213	32.6	39.3	12.2	59
1984	62 667	18 368	48	140	29.3	55.9
1985	31 763	7 043	24.3	53.9	22.2	56.3
1986	82 639	19 916	52.5	126.4	24.1	52
1987	69 029	13 134	53.9	120.7	19	47.3
1988	51 164	11 134	44.6	97.2	21.7	46.8
1989	71 653	19 162	20.4	54.7	27	43.9
1990	33 973	9 497	19	54	28	43.5
1991	67 699	22 126	19	63	33	59.3
1992	73 986	28 900	21	83	39	48.7
1993	80 980	28 392	23	81	35	45.9
1994	97 425	39 852	28	114	41	42.3
1995	83 899	23 195	24	66	28	31.5

a. %PF = percentage of cases due to *P. falciparum*.

from which they were not ousted until 2003. Because of this instability, malaria control and prevention in the southern villages became very difficult, and active surveillance and IRS activities were halted. Early DDT resistance and resistance of *P. falciparum* infections to chloroquine and sulfadoxine-pyrimethamine were also noted during this time (27).

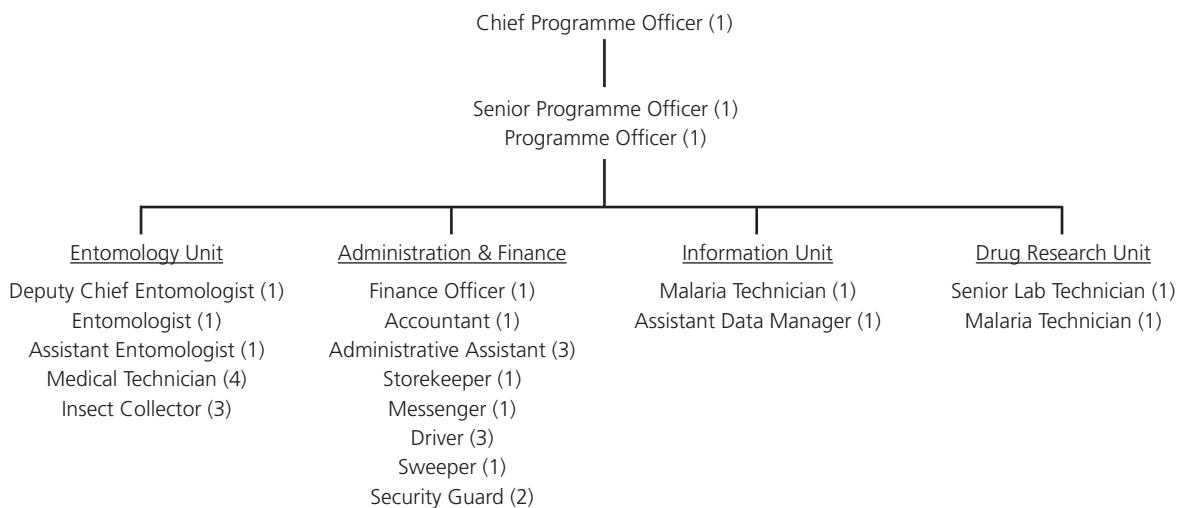
As a consequence, malaria cases rose to the highest ever recorded number—39 852—in 1994, with 62 malaria-related deaths (4); 42.3% of cases that year were due to *P. falciparum* infection and API peaked at 114 per 1 000 population. In 1995, 23 195 cases were recorded (28).

Reinvesting in control (1996–2005)

Over the period 1996–2005, Bhutan’s development goals included the further decentralization of authority to the dzongkhags as capacity continued to increase in the lower administrative units. In addition, delegation of authority and functions from dzongkhag to gewog—or subdistrict—level, which had begun in 1990, was scaled up (33). To facilitate this transfer of authority, Gewog Yargye Tshogchung (Block Development Committees) were established in each of the 196 gewogs (34). With this further decentralization, the Government reinforced the role of community involvement in all aspects of Bhutan’s development. Throughout this transition, it remained the responsibility of line ministries to create the frameworks and standards for the operation of dzongkhag and gewog administrations (33).

In 2003 Bhutan’s NMCP was renamed the Vector-borne Disease Control Programme, extending its programmatic activities to include other diseases (35). The VDCP continued to be responsible for coordinating dzongkhag health teams and ensuring their capacity to carry out prevention of malaria and other vector-borne diseases (dengue, kala-azar, chikungunya, and Japanese encephalitis). The VDCP was—and is—a part of the Communicable Disease Division within the Department of Public Health of the Ministry of Health. It comprises four main units—Administration, Information, Entomology and Drug Research—and employs 31 staff, as shown in [Figure 6](#) (3).

Figure 6. Organizational diagram of Bhutan’s Vector-borne Disease Control Programme



Source: reference 3

The VDCP relies upon the structure of Bhutan's national health system (see Annex 3) to provide malaria surveillance, case management, and prevention through an integrated community health approach (3). The national primary health care system is comprised of national and regional referral hospitals, dzongkhag hospitals, BHUs and ORCs; ORCs undertake antenatal care and immunizations but do not play a major role in malaria control.

The service delivery structure of the VDCP is based on multipurpose malaria health workers, previously termed malaria technicians and now called medical technicians (malaria), deployed to hospitals and BHUs in endemic districts as well as some epidemic-prone districts that have active foci of transmission (7). These medical technicians (malaria), whose salary is paid by the Ministry of Health, work only on malaria and provide a wide range of services, including reading blood slides for malaria diagnosis, issuing treatment, case reporting and case follow-up. They also support IRS and LLIN distribution, entomological surveillance, and information, education and communication (IEC) activities. Medical technicians are supported by health assistants, nurses and doctors who provide malaria treatment and care. Village health

workers help in carrying out IEC activities while spray operators conduct IRS, coordinated by the medical technicians.

The major goals of the VDCP during this period included accessing remote and rural, hard-to-reach populations, combating malaria transmission through cross-border prevention and management, and increasing public awareness of malaria (33).

From 1994 onwards, malaria cases were classified as N1, N2 and N3 as described earlier (see Table 2). Total cases (N1+N2) declined by 55.7% between 1996 (15 696 cases) and 1998 (6 955 cases) (see Table 5) (28, 30). In 1996, a relatively low proportion (38.3%) of recorded malaria cases were caused by *P. falciparum* (36). Between 1996 and 2000, API fell from 45 to 17 per 1 000 population, respectively, but increased again—to 36—in 1999, when there were 12 591 cases and 53 deaths (4, 36); the worst-affected age group in 1998 and 1999 was 15–49 years (36). Between 2001 and 2004, malaria cases declined by nearly half, with only 2 670 confirmed cases in 2004 (37) of which 41.0% were due to *P. falciparum* infection. Reported malaria deaths declined from 39 in 1995 to 11 in 2002 and five in 2005 (1, 35).

Table 5. Historical malaria cases and trends (N1+N2), 1996–2005

Year	Blood films	Positive cases	ABER	API	SPR	% PF ^a
1996	76 019	15 696	22	45	21	38
1997	68 153	9 029	19	26	13	40
1998	58 086	6 955	17	20	12	49
1999	79 859	12 591	23	36	16	51
2000	76 445	5 935	22	17	8	46
2001	65 974	5 982	19	17	9	53
2002	74 696	6 511	20	18	9	54
2003	61 246	3 806	17	9	5	44
2004	54 892	2 670	9	5	5	41
2005	60 152	1 825	14	4	3	52

a. % PF = percentage of cases due to *P. falciparum*.

Source: references 28, 30

Moving towards elimination (2006–2013)

Bhutan established its most recent national malaria elimination agenda in 2010, aiming to achieve a 75% reduction in malaria morbidity and mortality from 2005 levels by 2013, elimination by 2016 and certification by 2020 (17). Although the VDCP operates as a central programme, covering the 20 dzongkhags, its principal focus is on areas where vector-borne diseases are more prevalent, including the seven endemic and nine epidemic-prone dzongkhags ([Figure 2](#)).

The 2008–2013 malaria control strategy focused on: programme planning and management; prevention and control; early diagnosis and prompt treatment; epidemic and outbreak prediction and control; and human resources development (3). This period saw the role of malaria technicians beginning to be integrated with control of other vector-borne diseases; these newly integrated health workers were then renamed “medical technicians (malaria).” It is expected that this integration of the position’s roles may diminish malaria vigilance as other vector-borne diseases become a greater priority. Laboratory workloads in hospitals, especially during the peak malaria season, may result in medical technicians (malaria) having to forgo malaria field activities, such as outreach (38). Furthermore, malaria microscopy training has not consistently been carried out; the last sessions were conducted in 1992, 1997, and 1998 (37). Malaria diagnostic skills are at risk.

In 2006, Bhutan received a Round 4 grant of US\$ 1.34 million (total signed amount) from the Global Fund to Fight AIDS, Tuberculosis and Malaria. This grant supported the scale-up and integration of new malaria interventions, including the introduction of LLINs and the introduction of artemisinin-based combination therapy (ACT)—artemether-lumefantrine (25, 35). A Round 7 grant began in 2008, with a total signed amount of US\$ 2.65 million; Phase 2 of the grant was still ongoing in 2013 (39). The Round 7 grant continued support of LLIN procurement and distribution, capacity building, and community leadership and action through Community Action Groups.

In 2006, Bhutan documented 1 868 malaria cases considered to be indigenous (N1+N2), 408 cases in foreign nationals considered to be imported (N3), and 6 malaria-attributable deaths ([Tables 6, 7](#)) (40), as well as a declining API of four per 1 000 population (17).

Between 2008 and 2009 malaria cases increased almost threefold, from 329 to 972. In 2009 there was an increase in cases in all health centres in Sarpang Dzonkhag, along the southern border, which often receives cases from foreign nationals south of the border (7). Another outbreak was reported in Tsirang Dzonkhag (7). [Table 8](#) lists the malaria outbreaks reported and investigated in 2009 (7). These outbreaks were attributed to a combination of unusually early monsoon rains in 2009, delays in focal IRS application, fishery project development, and reduced insecticide effectiveness of the ageing LLINs distributed in 2006 and used beyond their intended 3-year lifespan (7, 17).

Table 6. Malaria surveillance and confirmed cases in Bhutan (N1+N2), 2006–2012

Year	Blood films	Total positive	Total PF	%PF ^a	ABER	SPR	Death	CFR/100 ^a
2006	66 079	1 868	772	41.3	13.9	2.8	6	0.7
2007	51 446	793	288	36.3	10.7	1.5	2	0.5
2008	47 268	329	136	41.3	9.7	0.7	2	1.1
2009	62 341	972	474	48.8	12.6	1.6	4	0.7
2010	54 709	436	140	32.1	20.9	0.8	2	1.1
2011	44 481	194	87	44.8	6.5	0.4	1	1.0
2012	42 512	82	33	40.2	5.9	0.2	1	2.9

a. %PF = percentage of cases due to *P. falciparum*; CFR = case-fatality rate.

Table 7. Malaria-confirmed cases in non-Bhutanese (N3), considered to be imported, 2006–2012

Year	Blood Films	Total positive	Total PF ^a	% PF ^a	SPR
2006	9 692	408	255	62.5%	4.2
2007	9 020	60	28	46.7%	0.7
2008	4 038	32	18	56.3%	0.8
2009	6 043	126	99	78.6%	2.1
2010	8 529	29	14	48.3%	0.3
2011	10 205	45	35	77.8%	0.4
2012	16 047	24	14	58.3%	0.1

a. % PF = percentage of cases due to *P. falciparum*.

From 2010 to 2012 the number of cases declined, from 436 to 82 (N1+N2); 57.3% of the 82 cases in 2012 were attributed to *P. vivax* infection. There were also 24 cases in foreign nationals (N3) in 2012, of which 58.3% were due to *P. falciparum*. A new Malaria Case Notification Form was introduced in 2013, to identify cases as indigenous or imported (see Annex 5). Using this form, the programme reported 18 N1 cases, of which 16—after analysis of travel history and taking into account an incubation period of 10–14 days—were considered indigenous (Table 9). All indigenous cases of 2013 were traceable by place of infection in Bhutan; the two N1 infections classified as imported were contracted in India. All 25 N2 cases were considered to be imported as they occurred in migrant hydropower project workers in areas

where elimination had already been achieved. Two N3 cases were reported. Thus, there were 16 indigenous cases and 29 imported cases in 2013.

As yet there is no evidence of the reintroduction of parasites due to cases considered to be contracted outside Bhutan. During mass malaria screening of migrant labourers at development project sites, none had patent gametocytes (sexual stage of parasite) and no secondary transmission was identified. These results could be attributable to low numbers, or absence, of vectors as a result of ecological disturbances, cool climate or other factors. In the future it is hoped that the programme can conduct parasite genotyping to identify the exact location of the origin of infection.

Table 8. Outbreaks in 2009

Place of outbreak	No. of cases	Date of outbreak	Time of outbreak investigation	Outbreak investigators	Remarks
Patalay (Tsirang Dzongkhag)	5	18–22 April 2009	24 April 2009	Dzongkhag and VDCP	This outbreak occurred as the focal IRS was delayed in the stratified areas.
Doban (Sarpang Dzongkhag)	6		July 2009	Dzongkhag and VDCP	6 cases had been reported from January to July, so an investigation was done in the non-transmission villages in Sarpang.
ChepChepi (Sarpang Dzongkhag)	9	Second week of May 2009	20 May	Dzongkhag and VDCP	This area had been the source of transmission to Doban in 2009. People of Doban arrive for business and stay overnight before returning home.
Gelephu Fishery Project (Sarpang Dzongkhag)	5	First week of August 2009	7 August 2009	VDCP	Indigenous transmission within the fishery project area.

Source: adapted from reference 7

Table 9. Malaria infections in Bhutan in 2013

	Blood films	Positive cases	Indigenous	PF ^a	Deaths
N1	27 632 (both N1 and N2)	18	16	8	0
N2		25	0	5	0
N3	3 947	2	0	1	0

a. PF = *P. falciparum* infections.

FACTORS CONTRIBUTING TO CHANGE OVER TIME

Receptivity

Bhutan has shown an ongoing receptivity to malaria, having several types of vectors thought to be efficient transmitters of malaria. *Anopheles pseudowillmori* and *An. culicifacies* are suspected to be the main vectors, and both species are relatively abundant during the peak transmission season. In the areas bordering India, houses on both sides of the border are within the flight range of vectors and the environment appears suitable for transmission (38).

The rapid economic development underway in Bhutan may change—or may have already changed—the level of receptivity. Between 2000 and 2011, GDP per capita increased from US\$ 768.8 to US\$ 2 346.3 (current US\$, meaning that dollar figures for GDP are converted from domestic currencies for that particular year—2000 and 2011) (15). The level of poverty in Bhutan (measured against the international poverty line) decreased from 49.5% of the total population in 2003 to 29.8% in 2007 (16). The combination of these two factors, leading to improvements in household structure and an increase in urbanization, may have reduced the country's receptivity to malaria. The road network increased by 43% between 2001 (3 746 km) and 2008 (5 363 km), creating potential for increased access to health services and also urbanization. In addition, almost all houses are now supplied with electricity, and the greater availability of lighting and use of electric fans may be having a deterrent effect on mosquito feeding.

What is not yet known is the possible shift in receptivity in development sites, such as fishery projects and dam construction. These sites may be less conducive to transmission than previously thought; in the case of dams, water level management may be a means of controlling

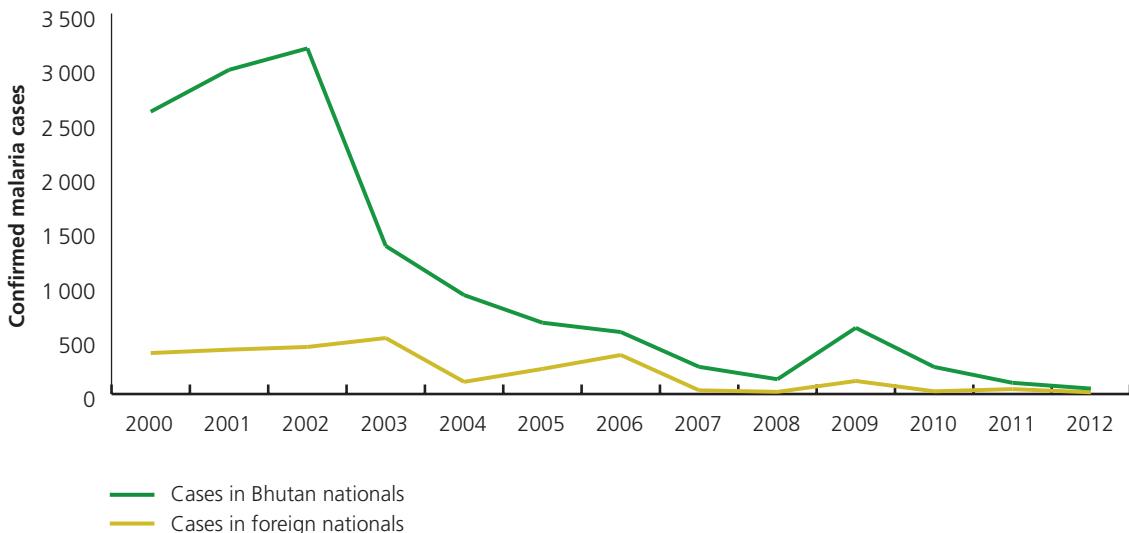
risk (38). However, the temporary housing built for labourers, which is generally located near vector breeding areas, may pose a risk of transmission should parasites be introduced.

Vulnerability

Bhutan is highly vulnerable to the continual introduction of malaria parasites across its southern border. The country is bordered in the east, west and south by the Indian states of Arunachal Pradesh, Sikkim, Assam and West Bengal. Assam—the largest of the border states—is composed principally of forest reserve and is malaria-endemic. Historically, the area is characterized by political instability, transient and semi-permanent settlements, mobile populations and impoverished conditions, all of which hinder malaria prevention and control efforts (20). As a result, members of various Assamese population groups often enter Bhutan to seek health care, in particular at the dzongkhag hospital in Sarpang. Other migrant groups include daily contractual workers and casual labourers. It is estimated that 1 000 people enter Bhutan daily through each regulated checkpoint in 10 border towns. How many migrants pass through unregulated border areas is unknown, so there are no reliable estimates of total cross-border movement.

Malaria cases identified as occurring in foreign nationals accounted for 21.8% of all confirmed cases in 2006 and 29.3% in 2012. From 2000 to 2012, Sarpang Dzongkhag, bordering Assam, consistently recorded most of the cases occurring in foreign nationals; moreover, 61% of cases in Bhutanese nationals in 2012 occurred in Sarpang. Between 2000 and 2010, Sarpang recorded an average of 86.5% of foreign national cases and 48.8% of Bhutanese cases occurring in the whole of Bhutan. In 2009 an outbreak of malaria reported in Assam resulted in a 26.8%

Figure 7. Confirmed malaria cases in Sarpang Dzongkhag, 2000–2012



rise in reported cases (20); this increase was mirrored in Sarpang, where a threefold rise in cases was reported that year (see Figure 7) (41).

Current major development projects may further increase movement across the border into Bhutan. Construction of hydropower dams and other projects have led to large influxes of migrant workers, typically from malaria-endemic areas within India and Bangladesh, thus increasing the risk of both importation and onward transmission of malaria.

Most of the 35 000 documented migrant workers in Bhutan are employed in large-scale development projects in the interior of the country and in southern dzongkhags. In 2011, there was only one *P. vivax* case out of the 1 148 migrant workers screened for malaria in the survey (42). The majority of workers were from the Indian states of West Bengal, Bihar, Jharkhand and Uttar Pradesh (42). In 2012, a cross-sectional prevalence survey conducted at two hydroelectric plant construction sites (Wangdue and Dagana Dzongkhags) indicated that only a small proportion of workers were parasitaemic; there were eight positive cases among the more than 5 000 workers screened by microscopy, and all but one were asymptomatic (42).

Other population movements result from the national resettlement programme, which relocates Bhutanese from areas of low transmission to endemic areas to increase access to arable land. These resettled populations may lack both malaria immunity and knowledge about the disease and its prevention and treatment (43).

How did the programme respond to outbreaks from 1980 to 2005?

Malaria infections rose sharply from 1983 to 1984, when nearly 19 000 cases were reported. There are no records of the cause of the outbreak, although it is suspected that resistance to the first-line malaria treatment, chloroquine, may have been a factor. In addition, a report from 1990 indicates that active surveillance was discontinued during the decentralization process of 1981; the national malaria eradication programme relied entirely on passive surveillance, reinstating active surveillance activities only in the event of an outbreak. The programme's response to this outbreak could not be obtained. Records indicate that IRS was maintained in malarious areas from 1980 to 1986, with coverage ranging from 38.6 to 58.0% of the population (28); however, IRS coverage was reported to be much lower in 1984 because of a stock-out of insecticide.

The major outbreak of malaria in 1994, resulting in nearly 40 000 cases, was thought to be caused by growing insecticide and treatment resistance, disruption of IRS in the southern region because of security problems, and increased vulnerability (as described above). In 1995, the Bhutan NMCP stopped using DDT and introduced deltamethrin, a pyrethroid that was considered to be safer, more effective and more acceptable (14, 27).

A “two-pronged attack” on malaria was launched in 1997 when the NMCP implemented bioenvironmental control measures and started distributing ITNs (44). Under this new strategy, IRS was largely halted by 1998, and ITNs became the primary vector control measure (25, 27, 36). The ITN distribution programme was launched in the context of the Roll Back Malaria initiative, aiming to rely on personal protection sustained by community involvement and participation (36); in some areas, however, IRS activities continued alongside ITN distribution (25). In addition, to improve the NMCP’s capacity for rapid detection of and response to malaria outbreaks, a “rapid response team” was launched in 1998 (27).

The number of cases almost doubled in 1999 compared with the previous year, rising from 6 955 in 1998 to 12 591; the proportion of infections due to *P. falciparum* rose from 40% to 51%. In 2000, the NMCP began supplying all health centres with rapid diagnostic test (RDT) kits in an effort to improve response to emergency situations (36). Nevertheless, the cornerstone of the programme throughout this period remained microscopy, and all health centres in malaria-endemic areas had at least one functioning microscope (36).

The programme underwent a comprehensive review in April 2001 (36). Afterwards, the NMCP renewed its malaria control strategies, emphasizing the continued scale-up of vector control interventions and treatment availability. Bhutan’s *Annual Health Bulletin of 2001* notes the cross-border malaria challenges in the country, particularly malaria transmission along the border with the Indian states of Assam and West Bengal (36). Records indicate a lack both of coordination of malaria control activities along the border and of standardization in vector control and treatment strategies. Foreign nationals

(N3) sought treatment in Bhutan on a daily basis, underlining the possibility of cross-border malaria transmission (36). However the low SPR in the N3 group may translate to a lower risk than previously thought (36).

The programme’s objectives for 2001 included ensuring microscopy and treatment facilities and diagnostic and treatment skills in all health centres and endemic areas (27). In addition, IEC advocacy activities were to be intensified, with the goal of increasing awareness of malaria and basic knowledge of its prevention and control. Distribution of ITNs was to coincide with the initiation of collaborative control activities in the southern dzongkhags and strengthening of dzongkhag-level capacity to manage malaria control activities.

In 2004, the VDCP reinstated IRS on a focal basis to supplement the use of ITNs, which were found to be less effective than IRS for vector control (35): two rounds were conducted immediately before the two transmission peaks but only in targeted areas that had met the following criteria for the past three years:

- API exceeding 5 per 1 000 population;
- SPR above 3%;
- *P. falciparum* rate over 50%; or
- at least one malaria-attributable death within the designated area or village (14).

Use of ITNs continued, but the malaria programme and local community health workers struggled to successfully retreat all ITNs every six months, further reducing the effectiveness of the intervention.

How did Bhutan progress to pre-elimination status between 2006 and 2013?

Between 2006 and 2012 there was a 95.6% decline in malaria cases found in Bhutan (N1+N2), from 1 868 to 82, although small outbreaks were reported in 2009, mainly in the southern endemic dzongkhags and one in the seasonal malaria transmission zone in the middle of the country (7). On the basis of this success, and of the strengths of the national health system and the VDCP, Bhutan is embarking on malaria elimination

and is currently considered to be in the pre-elimination phase (1). In 2013, only 16 cases were considered to be indigenous.

ORGANIZATION AND PROGRAMME MANAGEMENT

Decentralization of malaria control prevention (through IRS), diagnosis and treatment to the dzongkhag level is thought to have contributed significantly to the decline in malaria cases in Bhutan (3). The process has increased access to diagnosis and treatment for communities through the expansion of facilities and deployment of malaria workers in all health centres of endemic dzongkhags (3). Diagnosis and treatment of malaria are free of charge for both Bhutanese and foreign nationals.

Malaria control activities have been continued by maintaining a cadre of medical technicians (malaria). These medical technicians are the backbone of malaria diagnosis, treatment and control, providing microscopy, RDTs, recording and reporting, IEC materials, case follow-up, support for the delivery of both IRS and LLINs, and entomological surveillance and larval source control. The role of these dedicated malaria staff will soon change, however, as they are integrated into other vector-borne disease priorities. This integration puts the current progress towards elimination at risk. There is also a need for these technicians to be deployed to the epidemic districts in addition to the endemic districts in order to maintain elimination activities.

Beyond the medical technicians, there have historically been shortages of highly trained workers in Bhutan: there is no medical college in the country and physicians and most technical professionals were trained abroad (14, 45). Between 2000 and 2012, however, the number of physicians in Bhutan rose from 109 to 181 (8). Since 2009, there has also been an increase in the number of technical staff; entomological capacity has been strengthened and more malaria vector surveys have therefore been carried out on a regular basis.

With the establishment of the University of Medical Sciences of Bhutan—an autonomous body—in Thimphu in June 2012 and of the National Centre for Tropical and

Zoonotic Diseases under the Ministry of Health, the country is now developing the local institutions necessary to support the malaria workers and research needs of the country. Further progress has been achieved with the institution of a two-year in-service Bachelor of Public Health programme and an increase in the recruitment of nurse-assistants, pay rises and more expatriate recruitment are also planned (39).

Access to hard-to-reach populations—a key group, given the difficult terrain in parts of the country—has increased over the past five years, particularly because of additional support from the Global Fund. These groups have been targeted with LLINs, and expansion of BHUs has brought advancements in providing diagnosis and treatment services to remote areas.

POLICY AND LEGISLATION

Bhutan is developing its next five-year malaria strategic plan for which an external review was conducted in August 2013. The tenth five-year plan (2008–2013) included goals to reduce malaria morbidity and mortality (from 2005 baseline) by 75% by 2013 and contribute to Millennium Development Goal 6 and Target 8 “to have halted by 2015 and begun to reverse the incidence of malaria and other major diseases” (46). Its main objectives were to strengthen human resource development, improve community participation, scale up malaria prevention through integrated vector management (use of LLINs, focal IRS and bioenvironmental management), strengthen early detection and prompt treatment with a focus on hard-to-reach areas, revamp surveillance and strengthen monitoring and evaluation (46). Dzongkhag-level plans of action were developed, based on the national strategic plan.

Medical screening is required for all foreign national labourers working in the interior of the country. Migrant workers for the major hydropower projects are screened for tuberculosis, sexually transmitted diseases and malaria in two hospitals, Gelephu and Phuntsholing. However, because of the number of workers it has been reported that not all labourers are screened as intended. Even without screening all labourers, the screening procedures may have helped reduce the number of malaria infections

existing in the country, as evidenced by the low numbers of positive infections found in the survey of labourers.

Malaria elimination goals are also supported by local legislation. In one community, for example, a small fine is levied on anyone who fails to contribute labour to the Community Action Group during campaigns to rid the area of mosquito breeding sites. Fines gathered are used for community health activities.

ENABLING CONTEXTUAL FACTORS

Bhutan's progress in reducing malaria incidence has been facilitated by the general socioeconomic and developmental improvements. As described earlier, the country has made major advances in economic development in the past decade, with substantial growth in GDP in recent years (45). There are now 9 492 km of roads—up by more than 150% from 2001 (3 746 km). Revenue from tourism increased more than fivefold between 2001 and 2012 (from US\$ 9.2 million to US\$ 47.7 million) (8). In addition, Bhutan has a strengthened health system and, as part of its constitution, provides free essential health care to all its people. In 1998, WHO gave its 50th anniversary award for primary health care to Bhutan, referring to the country's system as “one of the best in South-East Asia” (47).

The malaria elimination agenda benefits from a stronger health system than exists in most lower-middle-income countries. Bhutan has a relatively high annual per capita expenditure on health, spending up to US\$ 75 per capita (45).

The malaria programme also benefits from a strong national supply and logistics system. For example, there have been no reported antimalarial drug stock-outs in recent years (7); dzongkhag and sub-dzongkhag health facilities coordinate movement of supplies to avoid these problems. Bhutan's health services are almost all provided by the public sector. There are no private medical facilities and only a handful of retail pharmacy shops, which are not allowed to sell antimalarial treatment (7, 43). The Government thus has a high level of control of case management and malaria control measures.

EPIDEMIOLOGICAL SURVEILLANCE

The strength of Bhutan's primary health care system, which provides ever-greater access to health care—including malaria diagnosis and treatment—at the dzongkhag and sub-dzongkhag levels, means that passive case detection (PCD) is the main method of parasitological surveillance. Despite the challenges posed by the rugged terrain of much of the country, health facilities with microscopy testing are available at national, regional and dzongkhag levels. At the community level, BHUs also use microscopy to provide the bulk of malaria diagnosis (21); RDTs were introduced in 2006 with support from the Global Fund and are used in the rare instances where microscopy is not available (48). Back-up blood smears taken from all RDT-confirmed patients are sent to the VDCP to be tested (25). While the policy in Bhutan is to give treatment according to blood smear results (or RDT results where applicable), only the results of microscopy confirmation are reported, not the number of treatments provided.

Dzongkhags are stratified according to the type of transmission—malaria-endemic, epidemic-prone or malaria-free (Figure 2). Some VDCP activities, such as vector control, vary according to the zone while others are similar everywhere (Table 10).

Until 2012 malaria cases were stratified according to patient origins as N1 (Bhutanese), N2 (foreign nationals staying overnight or longer in the country) or N3 (foreign nationals not staying overnight) (see Table 2, Table 11). The diagnostic and treatment services provided and subsequent reporting varied with the classification of cases. National caseload estimates included N1 and N2 cases because they are assumed to be of indigenous origin; N3 cases, because they return across the border and do not stay overnight in Bhutan, are considered to be imported. However, this classification is not comprehensive in that it does not classify cases according to origin of infection—imported or indigenous. A comprehensive assessment began in 2013 to determine the origin of each case through the use of a new Malaria Case Notification Form (Annex 5). This form, to be used during case investigation, ensures collection and recording of data on residence, travel history and occupation among other details;

this has allowed the VDCP to classify cases as indigenous or imported across the N1, N2 and N3 groupings.

Case mapping also began in 2013 for all cases, with retrospective case mapping for the years 2011 and 2012. Maps are created for each case nationwide, geo-located to the place of infection (not diagnosis), most typically the household of the case. The maps generated will show distribution of malaria cases, malaria species and nationality of malaria cases. After reviewing entomological data, the VDCP will analyse the maps and classify all foci throughout the country, using the maps as a baseline for monitoring, for evaluation and to guide interventions in targeted villages.

The foci classification system adopted in 2012 can be found in [Annex 5](#).

In 2006, ABER was 13.9%, declining to 5.9% in 2012 in parallel with the fall in the number of malaria cases. The number of blood films collected from foreign nationals has varied over the past 10 years; in 2012, 16 047 blood films were collected from foreign nationals (N2+N3), of which 24 were positive. The rise in the number of films collected from foreign nationals between 2008 and 2012 may be attributable to the increase in imported labour for hydropower and other development project areas.

Proactive case detection, or household malaria screening by surveillance workers of those with fever was conducted in Bhutan from the 1960s until 1989. Since 2011, proactive case detection, or focal screening and treatment by mobile clinics, with the aim of eliminating parasite reservoirs, has been used again, on an ad hoc basis, with a focus on development project areas. The clinics are operated by the local BHUs and staffed by village health workers or volunteers, as they are located in the risk areas. There is no malaria screening at antenatal clinics.

External support and collaboration vary across the stratified areas, with Global Fund support concentrated in the epidemic and endemic dzongkhags. The Government of India, WHO, and APMEN provide support to the country as a whole.

CASE MANAGEMENT AND REPORTING

Evidence-based case management policies, including use of ACT for *P. falciparum* cases, may have contributed to the declining malaria transmission in Bhutan (25). Any deaths attributed to malaria are evaluated at review meetings, which started in 2009; therapeutic efficacy monitoring also began at about this time.

Until 2005, chloroquine alone was used to treat *P. vivax* infections among adults. The treatment policy then changed, adding primaquine (0.25 mg/kg) for 14 days in addition to chloroquine (25 mg/kg, divided doses) over three days. The VDCP considers this primaquine dose to be effective, although WHO guidelines suggest that higher doses are required in South-East Asia to eliminate hypnozoites (49). Bhutan has no point-of-care testing for glucose-6-phosphate dehydrogenase (G6PD) deficiency before treatment; radical cure of *P. vivax* with primaquine may cause haemolysis in some G6PD-deficient patients (50). Patients taking primaquine at home, without observation, are therefore asked to report any signs indicating haemolysis. To date, however, no such adverse effects of primaquine treatment have been reported to the Drug Regulatory Authority.

From 2000 onwards, treatment for uncomplicated *P. falciparum* infections in adults consisted of artesunate (3 days) with doxycycline (7 days); ACT (artemether-lumefantrine) was introduced in 2006. From July 2011, revised guidelines include administration of a single dose of primaquine (0.75 mg/kg) as an antigameteocyte for *P. falciparum* infection. Adult patients with mixed parasite infections receive artemether-lumefantrine (full 3-day treatment course) with primaquine (15 mg daily) for 14 days for radical cure of *P. vivax*.

Patients with severe and complicated *P. falciparum* infections receive intramuscular artemether (3.7 mg/kg) on admission, then daily injections of 1.6 mg/kg (number of days is dependent upon the patient's condition), followed by a full course of artemether-lumefantrine once they are able to tolerate oral medicines. For patients in whom artemether is contraindicated, quinine is given intravenously followed by oral doses.

Table 10. Malaria control activities by dzongkhag stratification, 2012

Control activity	Malaria-free dzongkhags	Epidemic-prone dzongkhags	Malaria-endemic dzongkhags
Surveillance	Passive case detection	Passive case detection; Active case detection (focal screening and treatment) focused in development project areas	Passive case detection; Active case detection (focal screening and treatment) focused in development project areas
Case management and reporting	<i>P. vivax</i> : chloroquine and primaquine (non-directly observed therapy [DOT]) <i>P. falciparum</i> : ACT (arthemether-lumefantrine) and single dose primaquine; admitted for 3 days	<i>P. vivax</i> : chloroquine and primaquine (non-DOT) <i>P. falciparum</i> : ACT (arthemether-lumefantrine) and single-dose primaquine; admitted for 3 days	<i>P. vivax</i> : chloroquine and primaquine (non-DOT) <i>P. falciparum</i> : ACT (arthemether-lumefantrine) and single dose primaquine; admitted for 3 days Sentinel sites established for drug efficacy monitoring
Laboratory support, external quality assurance/control	Blood film cross-checking conducted every 3 months	Blood film cross-checking conducted every 3 months	Blood film cross-checking conducted every month
Entomological surveillance	Carried out in collaboration with the Environmental Health Programme in one sentinel site (Gasa Dzongkhag)	Carried out in collaboration with the Environmental Health Programme in two sentinel sites (Punakha, Wangue Dzongkhags)	Vector density studies, bioassay tests and susceptibility tests conducted on a monthly basis; one dzongkhag (Sarpang) has insecticide resistance monitoring; carried out in collaboration with the Environmental Health Programme in one sentinel site (Dagana Dzongkhag)
Vector control	None	Small-scale distribution of LLINs in hard-to-reach areas only	LLIN distribution; Focal IRS carried out two rounds per year
Health education, IEC	None	None	Community Action Groups formed
External support and collaboration	Government of India, WHO, APMEN	Global Fund Round 7, Government of India, WHO, APMEN	Global Fund Rounds 4 and 7, Government of India, WHO, APMEN

Table 11. Stratification of cases, services received and reporting in Bhutan, 2012

	Description	Services received	Reporting
N1	Bhutanese origin	Treatment and follow-up	Included in annual caseload
N2	Foreign national, with overnight stays in Bhutan	Same treatment and follow-up services as Bhutanese (admitted for three days for <i>P. falciparum</i> infection)	Included in annual caseload
N3	Foreign nationals entering Bhutan (e.g. daily workers) but not staying overnight	Diagnosis and treatment services if presenting at Bhutanese health facility (admitted for three days for <i>P. falciparum</i> infection); case follow-up challenging because patients return across the border	Not included in annual caseload, assumed to be imported infections

All patients with *P. falciparum* infections, whether imported or indigenous, are routinely admitted to the hospital where they receive directly observed therapy. Daily blood slides are regularly taken during the hospital stay—on discharge, patients are advised to return for a repeat blood slide examination after three more days. Those who fail to return are traced by medical technicians with the aim of preparing at least one blood slide. This follow-up is rarely achieved in the case of N3 patients because they have usually left the area. Post-treatment follow-up of *P. falciparum* cases started with Global Fund Round 4 support, but was already in practice in health centres in some endemic dzongkhags; it is now mandatory and includes case investigation with monitoring of vector breeding sites by BHU staff. The report form used for this investigation captures information on patients' travel history, reported adherence to treatment, household residents, LLIN condition, and IRS coverage and potential breeding sites in the area of residence (see Annex 5). Twenty-eight-day follow-up of *P. vivax* infections to measure treatment adherence and efficacy is planned but has not yet been introduced.

Since 1984, drug efficacy monitoring has focused on treatment of *P. falciparum* (Table 12) (35). Five sentinel sites were established in endemic dzongkhags in 2006 to monitor drug resistance to ACT, and the efforts were boosted by Global Fund support (Round 7). Artemether-lumefantrine has been shown to be 100% efficacious for the treatment of *P. falciparum*, according to VDCP data. The strategic plan for malaria elimination calls for therapeutic efficacy studies of *P. vivax* treatment (Table 13) (35).

Malaria is a notifiable disease in Bhutan. All cases, regardless of nationality and of classification (N1, N2 or N3) are reported; however, in calculations of incidence in Bhutan, or for national or subnational statistics, only N1 and N2 cases are recorded. Until 2013 there was no classification of N1, N2 or N3 cases as indigenous or imported,

although it was assumed that N3 cases were imported. The new classification system, using the Malaria Case Notification Form, allows for the identification of cases as imported or indigenous. After diagnosis and treatment, N1 and N2 cases are followed up; follow-up of N3 cases is attempted but is not usually successful because patients usually return across the border.

Health workers are required to report malaria cases to the notifiable disease centre at the Public Health Laboratory—the central agency for all notifiable diseases. Reports for the VDCP are submitted weekly. As private-sector health practice in Bhutan is minimal, underreporting of malaria by this sector is considered to be negligible (48). Reports flow from health facilities to the dzongkhag level, then to the VDCP (7), and are finally submitted to the health information system of the Ministry of Health every quarter. The data for reports are subject to on-site verification during monitoring and supervision visits to the health centres. In addition, the VDCP checks with individual centres by telephone if there are missing or incomplete reports.

The VDCP analyses the reports and, if an increase in cases is reported, the health centre concerned is alerted; vector and case surveillance and IEC activities are carried out to locate the source of transmission and implement containment strategies, including IRS if the area has not had two spraying rounds that year (25). Mass screening of fever cases is also conducted within the affected locality (no fixed radius). A team from VDCP, accompanied by the medical technician from the relevant health centre, conducts the investigation outlined above.

As ranked by WHO, data completeness is 97% for reported cases, admissions and deaths, and 79% for confirmed laboratory cases (1).

Table 12. Therapeutic efficacy study on artemether-lumefantrine treatment for uncomplicated *P. falciparum* malaria, 2006–2012

Drug study result	2006		2007		2008		2009		2010		2011		2012	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total cases enrolled	20		67		16		49		11		6		11	
Early treatment failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Late treatment failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Withdrawn/lost/dropped out	0	0	3	4	0	0	1	2	0	0	0	0	0	0
Adequate clinical parasitological response	20	100	64	95	16	100	48	98	11	100	6	100	11	100

Source: reference 35

Table 13. Therapeutic efficacy study on chloroquine for uncomplicated *P. vivax* malaria, 2006–2012

Drug study result	2006		2007		2008		2009		2010		2011		2012	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total cases enrolled	17		70		4		14		11		2		8	
Early treatment failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Late treatment failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Withdrawn/lost/dropped out	0	0	3	4	0	0	0	0	0	0	0	0	0	0
Adequate clinical parasitological response	17	100	67	96	4	100	14	100	11	100	2	100	8	100

Source: reference 35

LABORATORY SUPPORT, EXTERNAL QUALITY ASSURANCE/QUALITY CONTROL

In malaria-endemic areas, compulsory cross-checking of microscopic blood films is conducted monthly by the VDCP. In at-risk seasonal transmission and malaria-free areas, slides are sent to the VDCP for cross-checking every three months; 10% of negative and 50% of all positive slides are cross-checked for accuracy and quality. Malaria microscopy training is ordered if false-positive or false-negative rates exceed an acceptable limit—which is likely to be one false-positive or false-negative. A single false-positive in 2013 led to the VDCP intensifying vigilance by increasing supervisory visits to areas of foci. Refresher training will now be conducted every year. The programme has conducted external quality assurance (EQA) since 2010 in some selected health centres in endemic areas, with the intention of expanding. Unfortunately, sending slides by post results in some arriving broken and unreadable, which is a significant challenge for the EQA scheme. Results for EQA for malaria slides are shown in [Table 14](#) (35).

Table 14. External quality assurance results for malaria microscopy, 2010–2012

Note: Identification error refers to error in identifying *Plasmodium* species.

Year	Total blood slides received	Total error	False-positive	False-negative	Identification error
2010	3 518	41	22	7	12
2011	2 560	33	21	7	5
2012	3 152	8	7	0	1

Source: reference 35

ENTOMOLOGICAL SURVEILLANCE

Entomological surveillance, including vector population monitoring, is implemented in the endemic southern dzongkhags. Vector density studies, bioassay tests on LLINs and susceptibility tests are carried out monthly. Insecticide resistance monitoring is conducted at three sentinel sites in Sarpang Dzongkhag, which has the highest number of cases. In 2010, vector susceptibility to insecticides for LLIN and test kits was reported as almost 100% (7). The malaria elimination programme calls for

the insecticide resistance studies to be extended to areas in the interior of the country at risk for seasonal transmission. Starting in 2012, the VDCP—in collaboration with the environmental health programme—expanded vector surveillance to sentinel sites in malaria-free and epidemic areas as well as to additional endemic districts.

VECTOR CONTROL

As described above, IRS was reintroduced in 2004 on a focal basis, implemented alongside the distribution of ITNs. From 2011 onwards, as a consequence of major reductions in caseload, stratification thresholds for deployment of IRS became more stringent, defined as SPR above 2% and API above four per 1 000 population. Vector prevalence, behaviour and proximity to populations along and across the border (villages sharing border with India having Indian residents within one–two km of India) were introduced as additional stratification criteria for of the combined IRS/LLIN strategy. Two rounds of IRS per year are conducted for households within 1 km of an indigenous case (pre-2013, all N1 and N2 cases); spraying

is carried out in both endemic (perennial) and epidemic (seasonal) transmission areas, based on case reporting. A Malaria Indicator Survey, containing a Knowledge, Attitudes and Practices (KAP) component, was conducted in 2009 and found that 57% of respondents felt that “IRS did help in controlling the number of mosquitoes” but that many believed that “IRS effects were short-lived” (51). Use of bed nets was preferred to IRS by 87% of households.

A WHO programme review reported IRS coverage as over 90% in 2010 (7). The programme extended IRS beyond the targeted population in 2012, covering 103.5% —i.e. more than the population targeted. However, calculating population coverage from the number of persons covered by IRS out of the estimated population at risk nationwide indicates a lower level of coverage. Coverage peaked at 28.9% in 2009 and was estimated to be 13.6% in 2012. In 2010, cyfluthrin replaced deltamethrin as the insecticide for IRS in order to prevent resistance and also because of complaints from the public about skin irritations resulting from the spraying.

When LLIN distribution began in 2006, most nets were sent to the endemic southern dzongkhags; more than 20 000 were sent to areas throughout the country considered “hard-to-reach” or more than three hours’ walking distance from the nearest health centre or BHU. A survey conducted in 2009 found that 82.5% of targeted households had at least one LLIN (51). A second mass distribution was conducted in April and May of 2010 in the malaria-endemic dzongkhags. The VDCP asked dzongkhags to distribute the LLINs immediately after arrival because those distributed in 2006 now had

significantly reduced efficacy. The programme believed that this timely distribution helped in avoiding the usual August peak in transmission in 2010 (Figure 8) and 2011 when rainfall was similar to that in previous years. A total of 250 393 LLINs were distributed between 2006 and 2012 (Figure 9).

In 2012, LLIN coverage of the total national population was an estimated 44.7%; this estimate assumed that nets were appropriately used, provided protection for two people, and were effective for at least three years. In both 2009 and 2013 KAP surveys, ITN and LLIN utilization rates were estimated to be 90% (51, 52). From 2009, malaria cases increased—a trend that continued until April of 2010 but reversed after the mass LLIN distribution in April and May of 2010.

Larviciding, using Abate®, has been carried out in Bhutan since 1990; however, it was reported that larviciding was largely phased out in 2010 and used only in the case of outbreaks or emergencies (38). The Programme plans to review the process and evaluate its benefit against cost in terms of effort, resources and use of chemicals (3).

Figure 8. Malaria cases 2009–2010, by month, with LLIN distribution of 2010

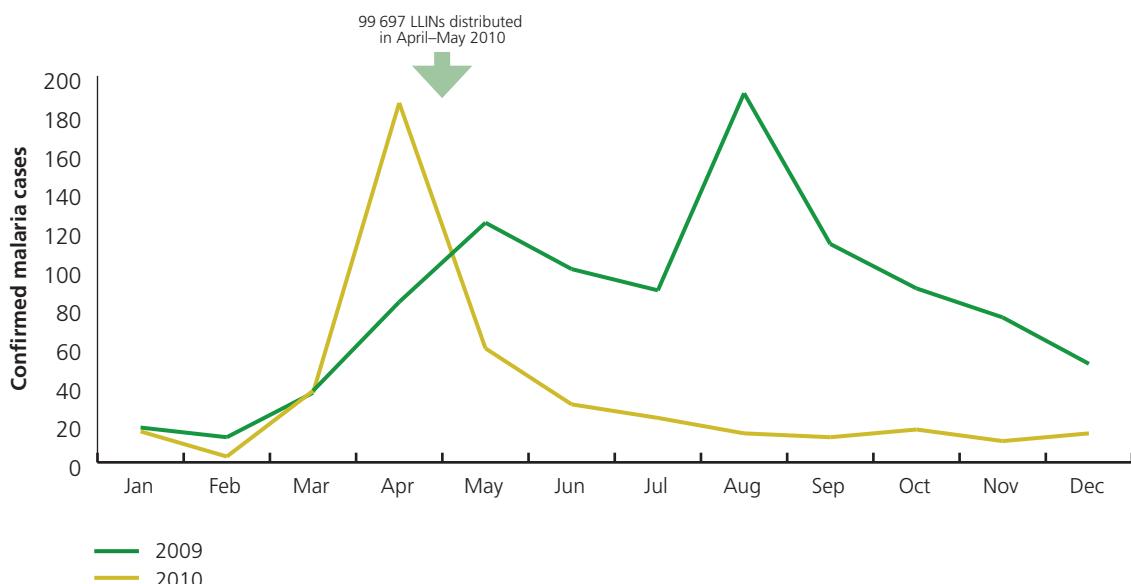
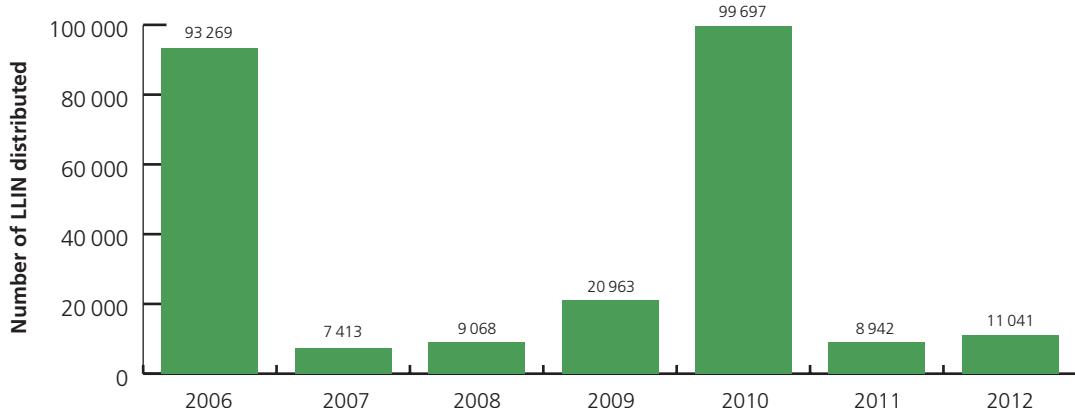


Figure 9. Annual LLIN distribution, 2006–2012



OUTBREAK MONITORING AND RESPONSE

The weekly fever and malaria reporting system is used for epidemic detection, and the programme intends to develop a surveillance system for malaria, taking into account meteorological data, morbidity and mortality, and entomological and socioeconomic variables (7). Response measures will include containment of transmission and prevention of further spread of disease (7). The programme recognizes the importance of dzongkhag and BHU staff being able to perform data analysis in order to fully investigate outbreaks and plans to strengthen this capacity (3). The response to outbreaks includes focal IRS (53).

HEALTH EDUCATION, IEC

Bhutan has 1 200 village health workers, trained to conduct IEC and behaviour change communication (BCC) activities on malaria in addition to meeting other public health needs. There are plans to train these health workers in malaria screening and referral.

Despite continued efforts by these health workers to educate the population about malaria, misconceptions persist that impede early diagnosis, prompt treatment, and prevention and control (43). Some portions of the population believe that malaria is caused by working

under the sun, by drinking cold water in hot weather or by evil spirits, and that malaria symptoms could be aggravated by eating sour fruits. Further, it is common for people to visit local healers or religious leaders in the first instance, consulting health workers only when encouraged to do so by these individuals.

The national five-year plan for 2008–2013 outlines the need for further community education on malaria and to equip communities with IEC tools for behavioural change. One of the strategies adopted by the programme is that of community engagement and empowerment through the formation of Community Action Groups at the lowest administrative level (chiwog). The Global Fund grant has supported the formation of CAGs—groups of people at the chiwog level who are nominated by their village members to work on health priorities in their communities.

Training for CAG members is provided by local health workers and monitored by local leaders; costs of training and tools are met by VDCP. Although CAGs focus mainly on malaria, they could also address other health issues in the communities, such as sanitation and antenatal care. Funded initially by the Global Fund, CAGs were piloted in 2009 in Chhukha Dzongkhag and then expanded into all chiwogs in five dzongkhags (38); more than 500 people were trained in more than 30 communities (Figure 10).

Principal activities for CAGs, often working with other sectors, include assisting in education on malaria prevention and control and on safe drinking-water, and regular community cleaning campaigns to eliminate breeding sites and promote community cleanliness. The CAG brief also covers integrated vector management (IVM), and volunteers are trained in identification of mosquito breeding sites, environmental management and IRS. In Sarpang, volunteers conduct bimonthly mass environmental cleaning campaigns (38). Studies conducted in Sarpang, showed that CAGs help to create sustainable systems for malaria elimination (53); in communities with CAGs, malaria incidence declined and LLIN usage increased (54). A schematic diagram of the educational intervention by CAGs can be found in Annex 6.

EXTERNAL SUPPORT AND COLLABORATION

The Government of India has provided financial and technical support to Bhutan in its malaria prevention and control activities since the inception of the programme. Since the start of the five-year plans, when Bhutan began taking control of its malaria activities, India has provided 40 million ngultrum (US\$ 742 354 (in 2013 US\$)) every five years to procure chemicals for IRS (55).

WHO has also been an important partner, providing technical support in all areas of malaria prevention and control when requested by the Programme and the Ministry of Health, including the development of funding proposals and human capacity strengthening.

Bhutan has received two grants from the Global Fund—in Round 4, between 2005 and 2010 (a total signed amount of US\$ 1 343 198), and in Round 7, between 2008 and 2013 (total signed amount of US\$ 2 646 162, with Phase 2 still ongoing) (39). The Round 4 and 7 grants allowed for the scale-up of prevention and control strategies and the introduction and dissemination of new tools, in particular a new ACT (artemether-lumefantrine) for treatment of *P. falciparum* malaria and LLINs. In 2012, Bhutan received an “A” rating (approved without any recommendations) for its proposal to the Global Fund Transitional Funding Mechanism for a total amount of US\$ 820 766, covering July 2013 to June 2015, to sustain API at or below one per 1 000 population and to achieve zero malaria-related deaths. The objectives of the grant, which will be used for LLINs and malaria treatment, are to: sustain malaria control and prevention in malaria-endemic areas; sustain early diagnosis and prompt treatment; and sustain an essential health workforce in malaria control and prevention.

Figure 10. Community Action Groups, in training and in practice



The 2013 funding will build upon past successes. The Round 4 grant provided funding for improved access to early detection and prompt treatment of malaria through community participation, plus dissemination of IEC materials. It also supported the strengthening of microscopy capacity in the public sector, procurement of RDTs for epidemics, survey investigation, etc. Further, there was support for: enhanced quality assurance of diagnostics through extension of cross-checking activities; procurement of ACTs to treat *P. falciparum* malaria; training on referral and also procurement of pre-referral drugs; and training of trainers for diagnosis and patient management, of health care providers on malaria prevention and control, and of laboratory technicians and other health staff on microscopy.

The Round 7 grant focused on the endemic and epidemic-prone dzongkhags (15), the main activity being the distribution of LLINs to hard-to-reach population groups, the issue of LLIN replacement, and provision of IRS as an epidemic control tool. Training, improved laboratory services and use of RDTs were implemented in order to scale up early diagnosis and prompt treatment for malaria, particularly among remote communities. There was support for the detection of fever and referral of patients to health facilities by village health workers in hard-to-reach areas, and BCC activities were scaled up through village health workers, medical technicians, community leaders and mass media outlets. In addition, the VDCP and hospital systems were strengthened through equipment and staff training. There was also staff recruitment and training in the areas of management, entomology and vector control, clinical case management and service delivery. Community leadership was enhanced in support of the formation of CAGs, as described above. Surveillance activities were enhanced through support for reporting, database use and mapping. WHO's Regional Office for South-East Asia (SEARO) provided support for case mapping implementation.

Bhutan is one of the founding countries of the Asia Pacific Malaria Elimination Network (APMEN) and has participated actively in the network activities. In recent years, the country has collaborated on research projects with APMEN (see "Research" section on page 33).

CROSS-BORDER COLLABORATION

Border malaria is seen as a major challenge for the success of control in Bhutan (46) and strategic control plans have consistently stressed the need for collaboration with neighbouring states in this regard (3). This collaboration for prevention and control was to be led by the dzongkhag level in Bhutan, working with local governments across the border and focusing on information-sharing, case notification and synchronized vector control in border areas (3).

These efforts have been continuing since 1995, and there have been several initiatives to improve malaria control, surveillance, research and information-sharing across the Bhutan-India border. Between 1995 and 1997, the Indo-Bhutan collaboration received WHO assistance and resources for meetings between the malaria programmes, dzongkhag malaria officers, and administrative officers from the national or dzongkhag level. It was the aim of this collaboration to share information about programme activities, conduct study tours, provide joint training, begin case and epidemic reporting across the border, conduct joint operational research and strengthen entomological surveillance.

In 2000, a regional initiative between Bangladesh, Bhutan, India and Nepal (BBIN) was developed to implement cross-border activities for control of malaria, leishmaniasis and Japanese encephalitis. Funding was received from the USAID (United States Agency for International Development) Bureau for Asia and the Near East and USAID/Nepal. The goal was to support the development of new interventions and expansion of proven interventions, and to improve surveillance programmes. At the first meeting in 2000, SEARO and the South Asian Association for Regional Cooperation (SAARC) agreed to coordinate activities.

Several of the planned activities could not be implemented because of a lack of resources, follow-up and coordination support. However, reports on the status of drug and insecticide resistance were produced for BBIN countries (2, 56). A study was also conducted on cross-border population movement (2003) across Nepal and

India, capturing target population demographics, health care access and care-seeking behaviour. Many respondents reported crossing the border to seek treatment at a nearby facility or to find free treatment.

The BBIN network was eventually disbanded due to lack of funding. Nevertheless, a number of recommendations emerged from the collaboration, including the need to seek external funding and to establish focal points in the health ministries of each country for all cross-border strategies and activities. It was considered that SEARO and SAARC were best suited for the higher-level dialogue and institutionalization of agreements and programme guidelines.

RESEARCH

Past research has included studying asymptomatic *P. falciparum* carriers in the community through cross-sectional surveys, investigations of drug compliance and ethnomedical practices in the community, and studies on malaria treatment-seeking behaviour.

The Ministry of Health has proposed upgrading the current VDCP and renaming it the Centre for Tropical and Zoonotic Diseases, strengthening research and development in order to achieve and sustain malaria elimination. Planned research projects in Bhutan include a Malaria Indicator Survey and exploratory studies on parasite strains. VDCP also plans research on transmission related to vector biology, the role of insect growth regulators and larvivorous fish, and studies on the use of mosquito repellents by farmers for prevention. Studies will also be conducted on the prevalence of haemoglobinopathies and their role in clinical manifestation of malaria.

In collaboration with APMEN, Bhutan is participating in a clinical trial on parasitic clearance and recurrence rates among *P. vivax* patients treated with chloroquine and primaquine. Further studies are being conducted on strengthening malaria surveillance using mobile technology, such as use of cell phones for reporting, for malaria elimination.

Which populations are most affected by malaria?

In general, malaria risk areas are mainly forest and forest-fringe human settlements, in particular those with irrigation or development projects, such as hydropower project sites (17).

Males, particularly farmers and students aged 15–49 years, are the population groups at highest risk for malaria (25). Although there is no comprehensive assessment of risk factors, an increased risk is most likely to be the result of various occupational factors, such as forest work, firewood collection, guarding fields at night from animals, or travel to India for business (7, 14). For example, students living in dormitories often stay outdoors late into the night, increase their chance of being bitten by infected mosquitoes (38). Likewise, late-night television watching or resting on the veranda during the night are other behaviours that may increase risk (38).

What is the cost of malaria elimination?

Domestic resources, both tax and non-tax revenues, cover two-thirds of total health-related expenditure in Bhutan, and external financing provides approximately one-third (21). The Royal Government of Bhutan has provided an increasing amount of support to the VDCP over the past five years, contributing 21.5% of the programme's total budget of US\$ 445 950 (for both malaria and other vector-borne diseases) over the period 2009–2010. In 2011, Government support for the VDCP was US\$ 222 222, the highest amount to date (1). These figures do not include contribution to the districts, which is integrated within the primary health care system.

The Government of India, a long-time partner of the Royal Government of Bhutan, has contributed funding for the procurement of insecticides for IRS. This collaboration has continued since the 1960s. Between 2009 and 2011, an estimated US\$ 384 735 was provided by other bilateral donors (1). Grants from the Global Fund have also provided significant input to the programme, as already

noted, and technical assistance and some financial support (an estimated US\$ 63 414 from 2009 to 2011) have come from WHO (1).

HOW IS THE PROGRAMME CHANGING TO ACHIEVE ELIMINATION?

The elimination goal and strategies

Bhutan generally sees an increase in malaria cases when incidence rises across the border in India. Because of this—and taking into account general trends in transmission, the recent reduction in confirmed cases, and deficiencies in infrastructure for proper surveillance and response measures—Bhutan has set a national elimination goal of 2020. To achieve this goal, the country aims to interrupt transmission in the seasonal areas, maintain malaria-free zones, and intensify malaria control activities in the southern border dzongkhags to reduce the potential for importation of parasites from Assam and, to a lesser extent, West Bengal. Box 1 describes the objectives of the VDCP for 2011–2016 (53).

The nine dzongkhags considered to be epidemic-prone (i.e. areas of seasonal transmission) are targeted first for malaria elimination and the seven endemic dzongkhags for intensified malaria control. The transmission-specific strategies are described in the sections that follow.

EPIDEMIOLOGICAL SURVEILLANCE

In all areas of the country, the programme plans to continue strengthening the surveillance system and introduce use of GIS and mobile technology for data input and collection. Mobile technology is currently being piloted in a few health centres of Sarpang Dzongkhag; if it proves successful—and if resources are available—its use will be expanded. The case-mapping that began in 2013 will be continued: the identification and classification of foci will assist the VDCP in outbreak forecasting and response. A further objective of the strategic plan is the development and maintenance of case registers at the central level.

Box 1. Malaria control and elimination objectives, as stated in the National Strategic Plan (Draft) 2011–2016

Objectives of the National Strategic Plan (Draft), 2011–2016

- To eliminate both *P. falciparum* and *P. vivax* malaria by 2016 in nine districts with seasonal transmission
- To intensify malaria control activities in seven districts with perennial transmission to reduce the API by 50% of that reported in 2009 in these districts by 2016
- To strengthen surveillance activities in both districts with both seasonal and perennial transmission with special emphasis on migrant workers
- To strengthen programme management and capacity building to maintain zero transmission and strengthen malaria control activities
- To implement awareness raising and advocacy-related activities

There will be active case detection, through screening of internal mobile and migrant populations, in epidemic-prone areas, in order to identify and contain imported malaria. RDTs will be used in these campaigns and their use will be expanded at the community level. Passive case detection will remain the main surveillance tool.

PREVENTION AND MANAGEMENT OF IMPORTED MALARIA AND ITS CONSEQUENCES

Bhutan has added to its strategic plan the management of imported malaria, specifically the identification, treatment and prevention of malaria in migrant workers. A first step towards this goal was the implementation of a system of classifying imported and indigenous cases. Use of the new Malaria Case Investigation Form in 2013 identified a total of 29 imported and 16 indigenous cases. While these numbers are relatively low, and imported malaria has not yet been shown conclusively to result in onward transmission in Bhutan, importation is still a major issue, particularly considering the estimated 1 000 daily migrants crossing the border into Bhutan and the estimated 35 000 longer-term workers who arrive to work in Bhutan for three months or more. While malaria screening is currently a prerequisite for permits to hire migrant labour, it is reportedly not always completed because of overcrowding at clinics. Border screening centres were considered but were not feasible because of the number of people to be screened. Instead, health check-up facilities are being established at the major development project sites, with delivery of LLINs to all site workers; some health facilities have already been established at project sites in remote areas by project authorities. Additional physicians, nurses and technicians have been deployed at some of the existing health facilities close to project sites, and a number of BHUs are being upgraded to hospitals. Project authorities have helped to meet these additional costs, contributing a reported 60% of hospital and BHU costs (38). Health centres at the project sites have been supplied with RDTs, and the VDCP provides technical support for IRS, mass screening and vector surveillance. Targeting migrant workers with IEC will be discussed with project authorities.

Active case detection has been conducted to assess the level of parasitaemia in migrant workers at project sites. Over the period 2011–2012, screening of both symptomatic and asymptomatic individuals showed a positivity rate of less than 0.01%, with a total of eight *P. vivax* and three *P. falciparum* infections (38).

MANAGEMENT OF DISEASE

The programme will continue to increase access to early, reliable detection (with microscopy), prompt and radical treatment and passive case detection in the endemic and epidemic-prone areas, particularly for migrant workers. Radical treatment for all parasite carriers, in all areas of the country, is the goal. This will be accomplished through treatment with ACTs, plus primaquine as an antigameteocyte, for *P. falciparum* malaria; patients with *P. vivax* will continue to receive the current 14-day treatment regimen of primaquine. This treatment is not directly observed, and it is recommended that village health workers be used to implement DOT for full compliance (38). A continuous supply of medicines must be ensured to make these activities possible.

Follow-up of all cases, whether *P. vivax* or *P. falciparum*, will be conducted throughout the country. Currently, there is follow-up only of *P. falciparum* cases, for a 4-week period. Drug efficacy monitoring through five sentinel sites will continue in the endemic areas and will be introduced in the epidemic-prone areas. A quality assurance system for antimalaria drugs will be established, and a quality control/quality assurance system for diagnosis will be implemented.

FIELD INVESTIGATIONS AND REPORTING

Planned field activities include surveillance along both sides of the border, seeking to identify infections in both symptomatic and asymptomatic individuals and to understand the extent of transmission; this will result in radical treatment for those with asymptomatic infection. A WHO consultant's assignment report recommended an increase in passive and active case detection for the Indian states along the border, which could be accomplished with help from nongovernmental organizations and communities (20). A malaria epidemic prediction and response unit will be established, with response units available in each dzongkhag. There will be countrywide notification of all positive cases by place of transmission and case-based investigation of all positive cases in the nine epidemic-prone dzongkhags; at present, however, some of the epidemic-prone dzongkhags lack the medical technicians (malaria) to carry out these investigations.

(38). Positive indigenous cases are to be reported to the VDCP within 24 hours for case and foci investigation (38). The programme is piloting the use of GIS dynamic malaria surveillance systems and foci identification using mobile technology, which would be important tools for further surveillance systems in Bhutan.

ENTOMOLOGICAL SURVEILLANCE

The programme aims to strengthen entomological surveillance and monitoring at sentinel sites throughout the malarious dzongkhags. This will require increased human resource capacity, capital equipment and supplies, and further skill development in the entomological workforce. Insecticide resistance monitoring will be enhanced.

VECTOR CONTROL ACTIVITIES

Focal IRS will continue to be used to guard against outbreaks and the combined IRS/LLIN strategy will be maintained. Distribution of LLINs in endemic dzongkhags will continue, and LLINs will be introduced for use by migrant workers on development projects, including those in epidemic-prone areas. These activities will be complemented by the introduction of bioenvironmental methods. IVM should be expanded to cover all of the malaria-endemic areas of the country (38).

IMPLEMENTATION OF AN EPIDEMIC PREPAREDNESS AND RAPID RESPONSE STRATEGY

The programme aims to improve epidemic forecasting and preparedness capacity through the establishment of dzongkhag-level rapid response teams to contain outbreaks, use of GIS for malaria case surveillance, and ensuring availability of buffer stocks of antimalarials, including ACTs, and insecticides for IRS.

LABORATORY SUPPORT FOR SURVEILLANCE, EXTERNAL QUALITY ASSURANCE/CONTROL

Diagnostic capacity, in particular in the epidemic-prone areas, is to be enhanced through training of health workers on microscopy and improvements in microscopy facilities. It is reported that quality control and quality assurance of microscopy and RDTs are not yet adequate because of the lack of capacity at national level (38).

SUPPORTIVE PLANNING, LEGISLATION AND REGULATION

Dzongkhags are expected to create plans of action based on the national strategic plan.

PROGRAMME MANAGEMENT

Plans for elimination include ensuring that health institutions, systems and logistic needs for malaria control and elimination, including adequate stores of medicines, are available in all areas of the country.

A reorientation of the health sector and other sectors towards the new goal of malaria elimination is planned, to be accomplished partly through advocacy for political commitment and development of partnerships to enhance community participation. Programme management strengthening, human resource development and capacity building are also needed, particularly in the field of research and development (38).

PROGRAMME FUNDING

Bhutan's VDCP secured a Rolling Continuation Channel (RCC) grant from the Global Fund in 2013, allowing for continued support after the Round 7 grant ended in 2013. This funding will assist the programme in continuing to distribute LLINs to populations at risk. The VDCP expects that the WHO technical inputs and the supply of IRS insecticides by the Government of India will continue.

CROSS-BORDER COLLABORATION

The VDCP plans cross-border collaborative meetings between district and provincial representatives from Bhutan and India, to harmonize and synchronize activities along the border between the two countries, including prevention (IRS; ITN/LLIN distribution) and treatment. A system will also be established for exchanging information on cases, treatment protocols and guidelines among border districts, and a hotline has been suggested for sharing information on outbreaks. Communication between border districts could facilitate the harmonization of drug and insecticide policies, joint malaria control teams, and information-sharing on operational or service delivery.

The programme aims to build public-private partnerships to increase screening and treatment facilities along the border with the goal of reducing the influx of asymptomatic and symptomatic migrant workers—this activity may be included in a future application to the Global Fund for grant funding. The VDCP envisages greater inputs from nongovernmental organizations, community social groups and private organizations in the future, both for malaria and for other diseases.

Despite the challenges, cross-border cooperation has been strengthened, particularly at the local level, through friendship societies, local government meetings and research collaborations.

Challenges for the elimination goal

Malaria in border areas poses a major challenge both for elimination and for the maintenance of elimination once it is achieved. Movement of migrant workers from India and other endemic countries and of Bhutanese from low to higher transmission areas, poses risks both to the individuals concerned and to the areas through which they move (46). For Bhutanese populations, reduced transmission in areas where transmission was once high may have already led to a loss of immunity, increasing the risk of complicated malaria and death (46).

Bhutan is economically dependent on India for the provision of labour. Most migrant labourers are from the Indian states of West Bengal, Bihar, Jharkhand, Orissa and Uttar Pradesh (42). In addition, the many major market centres along the porous border mean that migrants enter and leave the country daily for business or leisure. Bhutan's immigration regulations require all foreign nationals working in Bhutan who are not long-term workers to return at night to their own country. As a result, temporary shelters have sprung up in border towns that do not have ready access to health facilities (20). In the late 1990s, it was estimated that 25–30% of positive cases in Bhutan's southern border cities resulted from the migration of labourers; there are no current estimates, however. This region was, and is still considered to be, highly receptive to malaria transmission. Thus increases in transmission across the southern border in

Assam or West Bengal may directly impact transmission in southern Bhutan (25).

Since 2010 the Global Fund has supported malaria prevention efforts in Assam and Arunachal Pradesh, and the World Bank provides support to West Bengal. These inputs have reportedly helped to bring malaria under control in these regions (38).

Case follow-up of migrant workers and mobile populations is a particular challenge for the programme, requiring resources to find and treat these additional cases. The programme currently follows up all cases, both N1 and N2, in Bhutanese nationals and migrant workers who stay overnight in Bhutan. For the N2 "overnight" visitors, it is important to collect details of travel history, working site, duration of stay, number of fever cases, history of malaria, and treatment received (7). Non-Bhutanese daily workers or other visitors, such as people in the border zone who come into Bhutan seeking hospital services, i.e. the N3 cases, are not followed up because of the difficulty in tracing them once they return across the border; they probably do not pose a risk for secondary transmission, but they must be recorded and reported.

The programme seeks to boost the level of intersectoral collaboration for malaria control. The involvement of other sectors is considered critical because of the major development activities taking place in the country. Development activities increase the socioeconomic status of people in certain areas, which may reduce transmission, but can also increase transmission potential in malaria-receptive areas, thereby putting people at risk. Community participation in malaria is also considered to be inadequate, and the CAGs are one means of boosting the involvement of communities, particularly in the realms of disease and vector surveillance (46).

The shortage of adequate and skilled human resources in many areas of the programme continues to be a challenge. Technical expertise is lacking, notably in entomology. Further studies on understanding mosquito vectors and their bionomics are warranted in order to formulate more specific intervention strategies (17). Training in sibling-species composition, host-blood meal analysis

and techniques for sporozoite infectivity are needed to inform vector control interventions (7). The medical technicians deployed by the VDCP are a pillar of the programme, and a focus on malaria surveillance and response must be maintained in order to ensure vigilance and timely response. The integration of other diseases into the medical technicians' duties may weaken the response to malaria outbreaks.

Bhutan also lacks laboratories and training institutes to conduct research and provide highly specialized laboratory services, such as studies of very-low-density infections, where molecular diagnostics may be useful. The current methods of microscopy and RDT may not be sufficient to detect these infections during the elimination phase.

Financial and technical support for the malaria programme may be at risk, as other vector-borne diseases, such as dengue, kala-azar or Japanese encephalitis, take a greater portion of the integrated VDCP budget. Moreover, it is not known whether the Global Fund, beyond the RCC grant for Bhutan, will sustain the level of funding for malaria control that it has in the past. If Bhutan no longer has access to grants of the size and type it has received so far, the programme could face major

challenges. In the current economic climate, loss of such grants may make the supply of no-cost LLINs impossible and reduce coverage for rural people, which would put elimination goals at risk. As cases decline, malaria may no longer be seen as an important disease by either politicians or communities and it will become more difficult to secure social, political and financial support for elimination.

The programme must ensure that epidemic forecasting and preparedness are adequate to the challenge, and so has established dzongkhag-level rapid response teams to quickly contain outbreaks. Case mapping was begun in 2013 for all cases and retrospective case mapping was conducted for cases in 2011 and 2012. Each case is mapped at the likely place of infection occurrence. Maps will show the distribution of malaria cases, malaria species and nationality of malaria cases. After review of entomological data, the VDCP will analyse the maps and classify all foci throughout the country; the maps will provide the baseline for monitoring, evaluating and guiding interventions in targeted villages. In order to respond to epidemics the programme will ensure the availability of buffer stocks of antimalarials, including ACTs, and insecticides for IRS.

LESSONS LEARNED

Bhutan has overcome many obstacles in its efforts to control malaria and is now nearing elimination of the disease: WHO considers it as a country in the pre-elimination stage. It has a comprehensive plan for achieving and maintaining malaria elimination, with the main objectives of strengthening surveillance, programme management and capacity building, and implementation of selected control activities including awareness building and advocacy.

History has shown that IRS must be continued in endemic areas. Use of ITNs alone for vector control—with the challenges of retreating the nets and of achieving the coverage needed—has led to problems, such as the resurgence in transmission during the period 1998–2002. Two rounds of IRS annually in villages along the border area are essential, with focal IRS within 1 kilometre of index cases. Distribution of LLINs assists the programme with control in hard-to-reach areas and is easier than continual IRS; it will continue to focus on the endemic southern dzongkhags, with small-scale distribution in the epidemic-prone regions.

Continuing vector control has avoided outbreaks and led to the current successes in malaria control. Surveys such as Knowledge, Attitudes and Practices and the Malaria Indicator Survey have helped to clarify the level of coverage—and acceptability to the population—of vector control measures. The programme has also adopted the most recent recommendations on treatment, introducing ACT for *P. falciparum* infections in 2006 and single-dose primaquine in 2011, and continuing the 14-day primaquine treatment for *P. vivax* infections.

Passive case detection is—and will continue to be—the mainstay of the malaria control programme. The capacity of medical technicians (malaria) must increase

to include high-quality case detection, recording a “line listing” with details on each case, continuation of individual case investigation using the new comprehensive investigation form, and comprehensive response measures. If high-quality information is collected and analysed and response is efficient and comprehensive, the country will achieve zero indigenous cases and maintain elimination.

The programme’s investment in operational and technical capacity building has focused on boosting skills and experience in entomology, and on maintaining the strength of the medical technician cadre, which provides all of the malaria-related services—surveillance, diagnosis and treatment, case follow-up, and coordination of vector control measures. Despite the decline in the number of cases, medical technicians have been retained in each dzongkhag, strengthening malaria control across the country. Training of these technicians has also continued; however, the sustainability of these positions in the medium term is not known.

At the same time, the programme has worked to increase community commitment to, and multi-sectoral involvement in, malaria control and elimination; strategies have included the formation of Community Action Groups and efforts to boost activities related to integrated vector management.

Socioeconomic developments, together with the boost in funding from external donors such as the Global Fund and WHO, have been important in reducing malaria cases in Bhutan. However, these enabling factors are offset by the increase in the number of development projects, which in turn have led to greater population movement, particularly of migrant labourers from endemic countries and endemic zones within Bhutan. In some areas, the resulting risks are partially outweighed by the

socioeconomic improvement, including extended road networks and improved access to health care, and easier access to remote populations for medical technicians and other health workers.

The programme is keenly aware of the potential for malaria importation by migrant workers and in the border zone and is developing sustainable strategies to meet this challenge. In this regard, cross-border meetings are held in the affected dzongkhags, but the action areas are limited. Further activities—such as active case detection in these risk areas, and provision of vector control for migrant populations—are considered important. The

programme has made efforts to work with contractors involved in development projects, to ensure that malaria prevention activities are implemented.

The programme has continually sought to ensure adequate funding from various partners, including the Global Fund. The possibility that the funds available from these partners for malaria control will be reduced by the need for resources to control other vector-borne diseases, such as dengue and Japanese encephalitis, means that greater efficiencies and political and community commitment will be critical if malaria elimination is to be achieved.

CONCLUSION

From 1994 to 2012, malaria cases in Bhutanese declined by 99.8% from 39 852 to 82 cases (N1+N2). The number of cases occurring in foreign nationals varied over the years, reaching a low of 24 in 2012. In 2013 there were 16 indigenous and 29 imported cases.

The strategies implemented by Bhutan's malaria programme have been at the heart of the massive decline in cases. Access for at-risk populations to prompt malaria diagnosis and appropriate treatment was expanded throughout the country alongside new, evidence-based case management, including the introduction of ACTs for *P. falciparum* infection and a 14-day primaquine treatment regimen for *P. vivax*. The programme also maintained vector control, increasing coverage of high-risk areas with IRS, ITNs and—after their introduction in 2006—LLINs. Implementation of these measures coincided with other major enabling factors, such as strong economic growth and improving access to health services. Such initiatives must be continued and strengthened: if malaria elimination is to be achieved and sustained in Bhutan, additional resources and continuing commitment from all sectors will be necessary.

The significant progress made by Bhutan in controlling malaria has allowed the country to adopt the goal of national elimination. A challenge in the future will

be prevention and management of malaria infections imported from neighbouring Indian states, although the small number of infections found in labourer groups thus far suggests that the risk may be relatively low. However, a clear understanding of the origin and movements of migrant populations arriving in Bhutan would facilitate both understanding of the level of risk these groups pose for re-establishment of malaria and onward transmission, and the development of effective strategies for managing imported malaria. The VDCP has begun to implement strategies such as active case detection among these populations; it is likely that this work will need to continue in order to achieve elimination and prevent the re-establishment of malaria.

For Bhutan, a country with a small population and strong socioeconomic and political stability, the critical issue in malaria control is not so much whether the goal of elimination will be attained but rather how it will be reached and sustained. Other countries in the Region, and beyond, will watch Bhutan's progress towards elimination with interest; important questions will be raised, especially regarding the sustainability of elimination, that are of particular significance for other landlocked countries with population movement from endemic neighbours.

REFERENCES

1. WHO *World malaria report*, 2012. Geneva: World Health Organization; 2012.
2. Wijeyaratne PM, Valecha N, Joshi AB, Singh D, Pandey S. Activity Report 130. *An inventory on malaria drug resistance in Bangladesh, Bhutan, India and Nepal*. Washington, DC: Environmental Health Project; 2004:1–43.
3. *Bhutan national malaria control strategy, 2008–2013*. Thimphu: Royal Government of Bhutan, Ministry of Health, Vector-borne Disease Control Programme; 2008.
4. *Annual malaria report 2007* (draft). Thimphu: Royal Government of Bhutan, Ministry of Health, Vector-borne Disease Control Programme; 2007.
5. Feachem RGA, Phillips AA, Targett GA, editors. *Shrinking the malaria map: a prospectus on malaria elimination*. San Francisco: University of California, San Francisco, Global Health Sciences,,Global Health Group; 2009.
6. *World factbook: Bhutan*. Washington, DC: Central Intelligence Agency; 2011.
7. *Bhutan malaria control programme review: a report*. New Delhi: World Health Organization Regional Office for South-East Asia; 2010.
8. *Bhutan at a glance, 2012*. Thimphu: Royal Government of Bhutan, National Statistics Bureau; 2012.
9. *Results of population and housing census of Bhutan 2005*. Thimphu: Royal Government of Bhutan, Office of Census Commissioner; 2006.
10. National Statistics Bureau. Thimphu: Royal Government of Bhutan (<http://www.nsb.gov.bt/main/main.php#&slider1=1>, accessed 10 June 2012).
11. World databank. Health, nutrition and population statistics. Washington, DC: World Bank; 2011 (<http://databank.worldbank.org/ddp/home.do?Step=3&id=4>, accessed 25 February 2011).
12. Ura K, Alkire S, Zangmo T, Wangdi K. *A short guide to gross national happiness index*. Thimphu: Centre for Bhutan Studies; 2012:1–96.
13. *Tenth five year plan 2008–2013*. Vol. 2: Programme profile. Thimphu: Royal Government of Bhutan, Gross National Happiness Commission; 2008.
14. Tobgay T, Torres CE, Na-Bangchang K. Malaria prevention and control in Bhutan: successes and challenges. *Acta Tropica*. 2011;117(3):225–8.
15. World databank. Health, nutrition and population statistics. Washington, DC: World Bank; 2012 (<http://data.worldbank.org>, accessed 15 January 2013).
16. World development indicators. Washington, DC: World Bank; 2012 (<http://data.worldbank.org/news/world-development-indicators-2012-now-available>, accessed 6 February 2013).
17. Yangzom T, Smith Gueye C, Namgay R, Galappaththy GNL, Thimasarn K, Gosling R et al. Malaria control in Bhutan: case-study of a country embarking on elimination. *Malar Journal* 2012;11(9):1–11.
18. Infectious diseases related to travel. In: *The yellow book: CDC health information for international travel*, 2012. Atlanta, GA: Centers for Disease Control and Prevention; 2013 (<http://wwwnc.cdc.gov/travel/yellowbook/2012/chapter-3-infectious-diseases-related-to-travel/yellow-fever-and-malaria-information-by-country/bhutan.htm#5441>, accessed 3 May 2013).

19. *Elevation data of Bhutan*. Washington, DC: CGIAR Consortium for Spatial Information (<http://srtm.csi.cgiar.org>, accessed 1 May 2013).
20. Dev V. *Strengthening the capacity of Bhutan malaria control programme in response to epidemics with particular emphasis on vector surveillance and cross-border activities*. Geneva: World Health Organization; 2010 (Assignment Report TRL53651).
21. Wangdi K, Singhasivanon P, Silawan T, Lawpoolsri S, White NJ, Kaewkungwal J. Development of temporal modelling for forecasting and prediction of malaria infections using time-series and ARI-MAX analyses: a case-study in endemic districts of Bhutan. *Malar Journal* 2010;9(1):251.
22. WHO *World malaria report, 2011*. Geneva: World Health Organization; 2011.
23. *Malaria situation in SEAR countries—Bhutan*. New Delhi: WHO Regional Office for South-East Asia, 2011 (http://209.61.208.233/en/Section10/Section21/Section340_4017.htm, accessed 8 February 2012).
24. Sinka ME, Bangs MJ, Manguin S, Chareonviriyaphap T, Patil AP, Temperley WH et al. The dominant *Anopheles* vectors of human malaria in the Asia-Pacific region: occurrence data, distribution maps and bionomic precis. *Parasit Vectors*. 2011;4:89.
25. Wangdi K, Kaewkungwal J, Singhasivanon P, Silawan T, Lawpoolsri S, White NJ. Spatio-temporal patterns of malaria infection in Bhutan: a country embarking on malaria elimination. *Malar Journal*. 2011;10:89.
26. *Annual report. Strengthening malaria prevention and control in Bhutan, Global Fund to Fight HIV, Tuberculosis, and Malaria*. Thimphu: Royal Government of Bhutan, Gross National Happiness Commission; 2008:1–18.
27. National Malaria Control Programme (NMCP). *In: Annual Health Bulletin, 2000*. Thimphu: Royal Government of Bhutan, Ministry of Health and Education, Department of Health Services; 2000 (<http://www.health.gov.bt/statistics/bulletins/Bulletin2000.pdf>, accessed 26 November 2012).
28. Kondrashin AV, Rashid KM, editors. *Epidemiological considerations for planning malaria control in the WHO South-East Asia Region*. New Delhi: WHO Regional Office for South-East Asia; 1987.
29. Tobgay T, Dorji T, Pelzom D, Gibbons RV. Progress and delivery of health care in Bhutan: the Land of the Thunder Dragon and Gross National Happiness. *Tropical Medicine and International Health*; 011;16(6): 731–6.
30. Tshering D, Sithey G. *Climate change and health in Bhutan*. London: International Institute for Environment and Development; 2008 (CLACC Working Paper 4).
31. *Fifth five year plan 1981–1986*. Thimphu: Royal Government of Bhutan; 1981 (<http://www.gnhc.gov.bt/wp-content/uploads/2011/04/05fyp.pdf>, accessed 15 February 2013).
32. *The Declaration of Alma-Ata*. Copenhagen, WHO Regional Office for Europe; 1978 (http://www.euro.who.int/__data/assets/pdf_file/0009/113877/E93944.pdf, accessed 11 June 2014).
33. *Ninth five year plan 2002–2007*. Thimphu: Royal Government of Bhutan; 2002.
34. *Eighth five year plan 1997–2002*. Thimphu: Royal Government of Bhutan; 1997.
35. *Vector-borne Disease Control Programme*. Gelephu: Royal Government of Bhutan, Ministry of Health.
36. National Malaria Control Programme (NMCP). *In: Annual Health Bulletin, 2001*. Thimphu: Royal Government of Bhutan, Ministry of Health and Education, Department of Health Services; 2001.
37. National Malaria Control Programme (NMCP). *In: Annual Health Bulletin, 2004*. Thimphu: Royal Government of Bhutan, Ministry of Health and Education, Department of Health Services; 2004.
38. *Mid-term review of the malaria programme in Bhutan, 19–29 September 2013 (draft report)*. New Delhi: WHO Regional Office for South-East Asia; 2013.

39. *Proposal Form—Round 7*. Geneva: Global Fund to Fight AIDS, Tuberculosis and Malaria; 2007 (http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.theglobalfund.org%2FgrantDocuments%2FBTN-R07-ML_Proposal_0_en%2F&ei=1M2gU6aQIZTioATK1YDABg&usg=AFQjCNEq0cKvFY-PUP6XnzZBXqlv_-lZBQ&sig2=U1gOAKhhtDK0BCFiTQ9blQ&bvm=bv.69137298,d.cGU, accessed 17 June 2014).
40. *WHO World malaria report, 2008*. Geneva: World Health Organization; 2008.
41. *Bhur meteorological data, 2008 to 2010*. Thimphu: Royal Government of Bhutan, Ministry of Economic Affairs, Meteorology Unit (data received in 2011).
42. Dev V. *Assessment of receptivity and vulnerability of development project sites to malaria in Bhutan*. Geneva: World Health Organization; 2010 (Assignment Report TRL53651).
43. Tobgay T, Lhazeen K. Malaria perceptions and practices in Bhutan. *Southeast Asian Journal of Tropical Medicine and Public Health*. 2010;41(2):274–9.
44. National Malaria Control Programme (NMCP). *In: Annual Health Bulletin, 1997*. Thimphu: Royal Government of Bhutan, Ministry of Health and Education, Department of Health Services; 1997.
45. *Annual health bulletin, 2010*. Thimphu: Royal Government of Bhutan, Ministry of Health; 2010:1–114.
46. *Vector-borne Disease Control Programme: Programme profile*. Thimphu: Royal Government of Bhutan, Ministry of Health, Department of Public Health; 2008 (<http://www.health.gov.bt/doph/cdd/vbdcp.pdf>, accessed 15 February 2013).
47. Crossette B. *Bhutan: When environment drives public health policies*. Washington, DC: Disease Control Priorities Project [website]; 2007 (<http://www.dcp2.org/features/45>, accessed 28 May 2014).
48. *WHO World malaria report, 2010*. Geneva: World Health Organization; 2010.
49. *Guidelines for the treatment of malaria, second edition*. Geneva: World Health Organization; 2010.
50. Ramos WM, Sardinha JFJ, Cost MRF, Santana MS, Alecrim MGC, Lacerda MV. Clinical aspects of hemolysis in patients with *P. vivax* malaria treated with primaquine, in the Brazilian Amazon. *Brazilian Journal of Infectious Diseases*. 2010;14:410–2.
51. *Malaria indicator and bed net KAP study, Bhutan*. Thimphu: Centre for Research Initiatives; 2009:1–80.
52. *Malaria indicator and KAP survey report*. Thimphu: Kyingkhor Consultancy Services; 2013 (submitted to Ministry of Health).
53. *Strategic plan for phased elimination of malaria, 2011–2016 (draft)*. Gelephu: Vector-borne Disease Control Programme; 2011.
54. Nidup Y, Phuntsho T. Community engagement for malaria elimination. Presentation: APMEN Community Engagement Workshop, 22–24 November 2011, Chiang Mai, Thailand.
55. XE Currency Converter <http://www.xe.com/currencyconverter/convert/?Amount=40000000&From=BTN&To=USD>, accessed 3 May 2013).
56. Mittal PK, Wijeyratne P, Pandey S. *Activity Report 129. Status of insecticide resistance of malaria, kala-azar and Japanese encephalitis vectors in Bangladesh, Bhutan, India and Nepal (BBIN)*. Washington, DC: Environmental Health Project; 2004:1–98.

ANNEX 1: DATA SOURCES AND METHODS

A literature review was conducted using PubMed, Google Scholar, Google, SpringerLink (<http://www.springerlink.com>), WHO South-East Asia Region Institutional Repository (<http://repository.searo.who.int>) and the WHO Library database (WHOSIS; <http://www.who.int/whosis/en>) and through requests to the WHO Archives at WHO headquarters in Geneva, Switzerland. Search terms were “Bhutan” AND “malaria” OR “prevention” OR “refugee” OR “Nepal” OR “India” OR “supply, supply system” OR “health system” OR “health supply.”

Routine national health facility surveillance data were collected and reviewed from the Vector-borne Disease

Control Programme headquarters in Gelephu. Other data collected were estimates of population at risk and distribution and coverage of long-lasting insecticidal nets, insecticide-treated mosquito nets, and indoor residual spraying. When discrepancies between data sources were found, follow-up information was sought from dzongkhag offices by the VDCP manager.

Data were plotted using Microsoft Excel and trends were observed. Trends were corroborated through the literature review, combined with information provided by the VDCP headquarters and dzongkhag officers.

ANNEX 2: DEVELOPMENT AND HEALTH PROFILE

Table A2.1. Demographic data, 2011 (1)

Variable	Value
Population (thousands)	738 300
Population sex ratio (males per female)	1.13
Population aged 0–14 years (%)	28.84
Population aged 15–64 years (%)	66.33
Population aged 65 years and above (%)	4.83
Population growth rate (annual, %)	1.68
Crude birth rate (live births per 1 000 population)	20.06
Crude death rate (deaths per 1 000 population)	6.862
Infant mortality rate (infant deaths per 1 000 live births)	42
Life expectancy (years) at birth, males/females	65.39/ 69.27

Table A2.2. Main indicators on health economics, 2010 (1, 2)

Indicator	Value
External resources for health as percentage of total expenditure on health	10.951
General government expenditure on health as percentage of total expenditure on health	86.827
General government expenditure on health as percentage of total government expenditure	10.461
Total expenditure on health as percentage of GDP	5.195
Out-of-pocket expenditure as percentage of private expenditure on health	90.777
Per capita government expenditure on health at average exchange rate (US\$)	94
Per capita total expenditure on health at average exchange rate (current US\$)	108.489
Private expenditure on health as percentage of total expenditure on health	13.2
Social security expenditure on health as percentage of general government expenditure on health	0

Table A2.3. Health indicators according to WHO data (2)

Indicator	Sex	Year	Value
Life expectancy at birth	Male	2011	65
	Female	2011	69
	Both sexes	2011	67
Adult mortality rate (per 1 000 adults 15–60 years)	Both sexes	2009	228
Under-5 mortality rate (per 1 000 live births)	Both sexes	2011	54
Maternal mortality ratio (per 100 000 live births)	Females	2010	180

Table A2.4. Distribution of years of life lost by cause, 2008 (2)

Note: Percentage reflects proportion of total years of life lost.

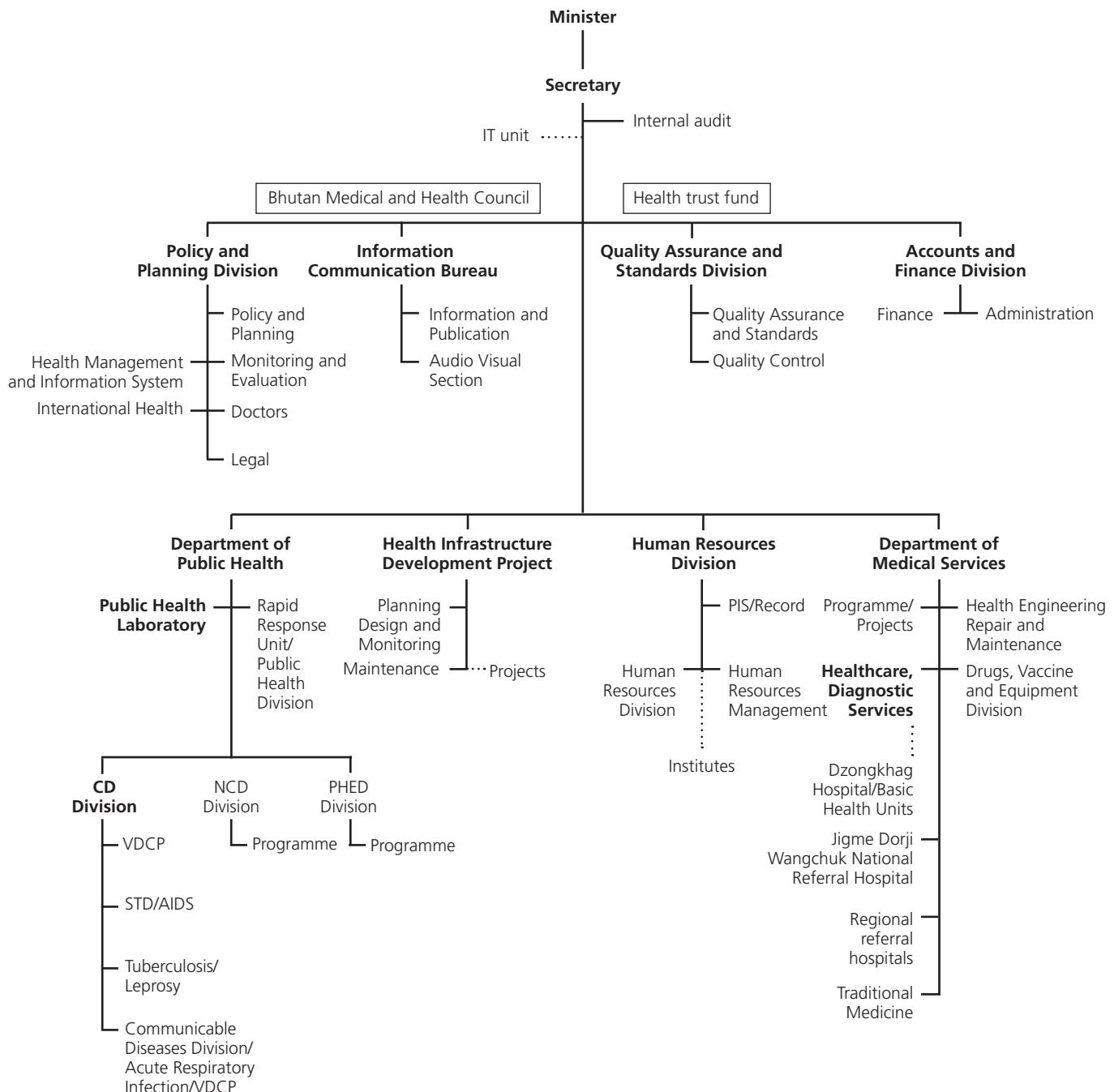
Indicator	Bhutan	Region
Communicable disease	53%	49%
Noncommunicable disease	33%	15%
Injuries	14%	36%

References

1. World databank. Health, nutrition and population statistics. Washington, DC: World Bank; 2012 (<http://data.worldbank.org>, accessed 15 January 2013).
2. Global Health Observatory Data Repository. Geneva: World Health Organization; 2012.

ANNEX 3: STRUCTURE OF THE VECTOR-BORNE DISEASE CONTROL PROGRAMME

A3.1. Structure of the Ministry of Health, Bhutan



CD Div: Communicable Diseases Division

NCD Div: Noncommunicable Diseases Division

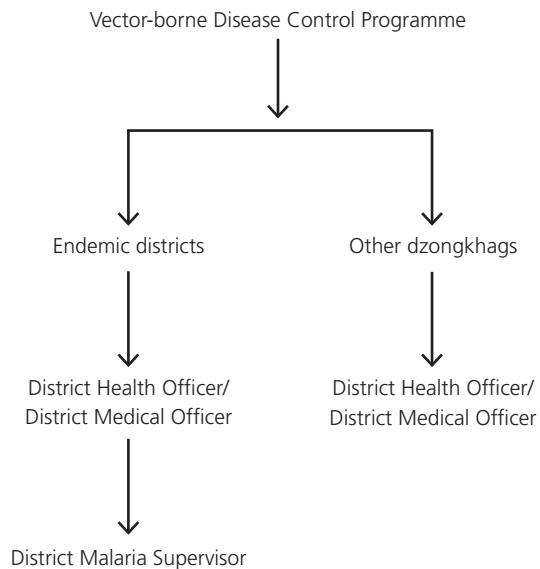
PHED Div: Public Health Engineering Division

VDCP: Vector-borne Disease Control Programme

Source: reference 1

The Vector-borne Disease Control Programme of Bhutan coordinates the dzongkhag health teams and ensures their capacity to carry out prevention of malaria and other vector-borne diseases, namely dengue, kala-azar and Japanese encephalitis. The VDCP relies upon the structure of the national health system of Bhutan to provide the integral components of malaria surveillance, case management and prevention through an integrated community health approach. The national primary health care system is comprised of national and regional referral hospitals, dzongkhag hospitals, basic health units and outreach clinics. Outreach clinics conduct antenatal check-ups and immunizations, but do not play a major role in malaria control.

Figure A3.2 Decentralized vector control activities in Bhutan



Source: reference 1

The service delivery structure of the VDCP is based on multipurpose malaria health workers, termed medical technicians (malaria), who are deployed by the VDCP to hospitals and, in the endemic southern dzongkhags, basic health units as well. These health workers, whose salary is paid by the Ministry of Health, work only on malaria and provide a wide range of services including reading blood slides for malaria diagnosis, issuing treatment, case reporting and case follow-up. They also support IRS and LLIN distribution, entomological surveillance, and IEC activities. Health assistants, nurses and doctors provide the malaria treatment. Village health workers help in carrying out IEC activities. Spray operators conduct the IRS, coordinated by the medical technicians.

The role of medical technicians (malaria) is being extended to and integrated with other vector-borne diseases. These changes in the role and main activities of medical technicians (malaria) may pose the risk of diminishing malaria vigilance as other diseases assume a greater priority. As yet, only a portion of these workers have received the integration training.

Reference

1. *Bhutan National Malaria Control Strategy, 2008–2013.* Thimphu: Royal Government of Bhutan, Ministry of Health, Vector-borne Disease Control Programme; 2008.

ANNEX 4: DETAILED INFORMATION ON VECTORS

Anopheles minimus has been identified as transmitting malaria in Bhutan and it was presumed that *An. fluviatilis* and *An. dirus* were also important vectors. In the past 10 years, however, these species have not been recorded, according to the Bhutan VDCP. *An. pseudowillmori* and *An. culicifacies* are now suspected to be the vectors because of their behaviour (both endo- and exophagic and anthropophilic) and their relative abundance during the peak transmission season.

The Bhutan VDCP has records of 25 *Anopheles* species, of which *An. pseudowillmori*, *An. vagus*, *An. subpictus*, *An. culicifacies*, *An. jamesii*, *An. pseudojamesii*, *An. annularis*, *An. philippinensis*, *An. kochi*, *An. peditaeniatus*, *An. acinitus*, *An. barbirustris*, *An. barbumbrosus* and *An. umbrosus* are more common in the plains. The mountain species encountered are *An. maculatus*, *An. willmori*, *An. lindesayi*, *An. baileyi*, *An. aitkenii* and *An. bengalensis*. The recorded species that have not been encountered during the past few years are *An. minimus*, *An. fluviatilis*, *An. dirus*, *An. tessellatus* and *An. jeyporiensis*.

Reference

1. Bhutan Vector-borne Disease Control Program

ANNEX 5: STANDARD FORMS

1. Malaria Case Investigation Form
2. Malaria Notification Form
3. Malaria Contact Screening Reporting Form
4. Malaria Case Follow-up Form
5. Monthly Malaria Positive Case Reporting Form
6. Malaria Foci Classification Form and Register
7. Malaria Test Laboratory Register
8. Monthly Village-Wise Blood Slide Examined Reporting Form

Reference

1. Bhutan Vector-borne Disease Control Program

MALARIA CASE INVESTIGATION FORM
MINISTRY OF HEALTH
NATIONAL MALARIA PROGRAMME

DISTRICT..... Geog.....
 Name of facility Facility No.....
 Case No...../...../.....
 District No Geog No Case No

Date of investigation _D_D/_M_M/_Y_Y_Y_.....
 GPS of facility Lat ____/____/____ Long ____/____/____

First name of patient
 Age Date of birth D D/_M_M/_Y_Y_Y_.....
 Physical Residential Address
 City/Town/Village
 Head of Household name
 Telephone number home
 Mobile number
 GPS coordinates at home Lat ____/____/____ Long ____/____/____

Type of case detection (i.e. how case was first identified):

Passive Active Other

Specify:

Diagnosis and treatment

Name of laboratory where slide was tested..... Slide result.....
 Name of health facility where RDT was performed..... RDT result.....
 Name of health facility where G6PD test was performed G6PD results.....

Treatment given:	AL (Coartem)	Yes	Dosage _____
	Quinine	Yes	Dosage _____
	Primaquine	Yes	Dosage _____

Other (specify).....

History of Malaria Control Measures at Case Home

Date of last indoor residual spraying D_D/_M_M/_Y_Y_Y_.....
 Number of LLINs found hanging in the household..... Number of non-LLINs* found hanging in the household.....
 *ITNs or untreated nets

Complete this section if the number of introduced cases exceeds two:

Geographical reconnaissance information

Total number of houses in foci Total number of inhabitants in foci Radius of foci.....
 Check if m or km

Entomological investigation

Date of investigation ____/____/____

Anopheles species detected at breeding sites? Yes No

Type and location of breeding sites where anopholes were detected.....

GPS Coordinates for Breeding Sites ____/____/____

Type and location of potential breeding sites for anopholes.....

Other entomological monitoring activities undertaken? Yes No

Summarise activity and results:

.....

Recommendation (IRS/LLINs/Larviciding).....

Vector control interventions applied

Long lasting insecticide treated nets (LLINs)

Number of LLINs distributed..... Number of households receiving LLINs..... Date distributed ____/____/____

Indoor residual spraying

Number of households sprayed..... Insecticide used..... Date sprayed ____/____/____

Other intervention applied (explain)

Completed by

Designation

Date ____/____/____

Signature

Date sent from facility to DHMT ____/____/____

Date sent from DHMT to NMP ____/____/____

MALARIA NOTIFICATION FORM		MINISTRY OF HEALTH NATIONAL MALARIA PROGRAMME	
DISTRICT Name of Facility..... GPS coordinates of facility		Date _D _D /M /M /Y /Y /Y .. Case No..... Lat _/ _/ Long _/ _/ District No. Facility No. Case No	
Please indicate if: Is the patient going to be referred? Yes <input type="checkbox"/> No <input type="checkbox"/> If yes, name of facility patient referred to PATIENT INFORMATION		In patient <input type="checkbox"/> or Out patient <input type="checkbox"/> First Name..... Surname..... Gender Male <input type="checkbox"/> Female <input type="checkbox"/> Age Date of birth D.D./M.M./Y.Y.Y Pregnant? Yes <input type="checkbox"/> No <input type="checkbox"/> Nationality Mobile phone number National ID (Oorang)/Passport/Birth Certificate No. Physical Residential Address Telephone number home Current Physical Address (if different than above). City/Town/Village Telephone number home Current occupation Work Address History of Blood transfusion..... Yes/No If working away from village of residence, how Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Annually <input type="checkbox"/> other <input type="checkbox"/> often does the patient return/home?	
		HISTORY Date of onset of illness D.D./M.M./Y.Y.Y.Y Where did the patient sleep during the period before the illness (tick where appropriate)? Address, if different from above: 0-7 Days Home <input type="checkbox"/> Work <input type="checkbox"/> Cattle post <input type="checkbox"/> Masimo <input type="checkbox"/> Other <input type="checkbox"/> 8-14 Days Home <input type="checkbox"/> Work <input type="checkbox"/> Cattle post <input type="checkbox"/> Masimo <input type="checkbox"/> Other <input type="checkbox"/> 18-21 Days Home <input type="checkbox"/> Work <input type="checkbox"/> Cattle post <input type="checkbox"/> Masimo <input type="checkbox"/> Other <input type="checkbox"/> 21-42 days Home <input type="checkbox"/> Work <input type="checkbox"/> Cattle post <input type="checkbox"/> Masimo <input type="checkbox"/> Other <input type="checkbox"/> 42 days -1) Home <input type="checkbox"/> Work <input type="checkbox"/> Cattle post <input type="checkbox"/> Masimo <input type="checkbox"/> Other <input type="checkbox"/>	
		Has the patient travelled to a malaria endemic district/area within in the last 14 days If yes, where did the patient travel? Date(s) of travel From _D.D./M.M./Y.Y._ To D.D./M.M./Y.Y._ Has the patient traveled to any country outside in the last 14 days? If yes, where (State name or country) Date(s) of travel From _D.D./M.M./Y.Y._ To D.D./M.M./Y.Y._ Type of preventative measures taken before and during travel (i.e. prophylaxis, LUNs, mosquito repellants, etc) ... Is the patient going to travel to another area within the next 42 days? If yes, provide exact places to be visited	
DIAGNOSIS AND TREATMENT		Method of diagnosis RDT Date performed D.D./M.M./Y.Y.Y.Y Name of officer contacting RDT Positive <input type="checkbox"/> Negative <input type="checkbox"/> RDT result given Date performed D.D./M.M./Y.Y.Y.Y Date smear examined D.D./M.M./Y.Y.Y.Y Blood slide BS result: Positive <input type="checkbox"/> Negative <input type="checkbox"/> Gamete/oocysts present in smear? Yes <input type="checkbox"/> No <input type="checkbox"/> Name of examining facility PCR (for malaria-free areas) Specimen collected? Yes <input type="checkbox"/> No <input type="checkbox"/> Date collected D.D./M.M./Y.Y.Y.Y DS Card #: Date DBS sample sent to NHL D.D./M.M./Y.Y.Y.Y .. G6PD test Test performed? Yes <input type="checkbox"/> No <input type="checkbox"/> Date performed D.D./M.M./Y.Y.Y.Y .. Type of infection P. Falciparum <input type="checkbox"/> Other specify Drug administered A-L <input type="checkbox"/> Quinine <input type="checkbox"/> primaquine <input type="checkbox"/> Other specify Designation Case No. District No. Facility No. Case No	
ACTION TAKEN (i.e. case investigation, contact screening, etc) Completed by Date D.D./M.M./Y.Y.Y.Y Date sent from DHMT to NMP D.D./M.M./Y.Y.Y.Y .. FOR OFFICIAL USE BY MALARIA PROGRAMME ONLY		Signature Date sent from DHMT to NMP D.D./M.M./Y.Y.Y.Y .. Data report received by National Malaria Programme _____/_____ Geographical location of infection PCR result Positive <input type="checkbox"/> Negative <input type="checkbox"/> Name of examining facility Name of examining officer G6PD result Positive <input type="checkbox"/> Negative <input type="checkbox"/> Name of examining facility Name of examining officer Case classification code number <input type="checkbox"/> Key for classification	
		1 Imported case - contracted outside Botswana 2 Introduced case - contracted within Botswana but in another locality 3 Secondary case - contracted from an imported case (outside Botswana) 4 Introduced case - secondary case, contracted from an imported case (local endemic areas) 5 Indigenous case - local cases, contracted from an introduced or induced case 6 Induced case - contracted locally (blood transfusion) 7 Relapsing case - local (indigenous) case from within the last 16 months	
		Link to another case? Yes <input type="checkbox"/> No <input type="checkbox"/>	

MALARIA CONTACT SCREENING REPORTING FORM
MINISTRY OF HEALTH
NATIONAL MALARIA PROGRAMME

******If positive, complete case notification form

MALARIA CASE FOLLOW-UP FORM
MINISTRY OF HEALTH
NATIONAL MALARIA PROGRAMME

DISTRICT.....Geog..... Chiwog.....
Facility..... Date/...../.....
GPS coordinates of facility Lat/..... Long/..... Case ID...../.....
Date of diagnosis of case/...../..... (9 digit code) District No Geog no. Chiwog no Case no
Method of diagnosis RDT Slide
First name of patient Surname of patient.....
Age Date of birth/...../..... Gender Male Female
Physical Residential Address Pregnant? Yes No
Town/Village
Head of Household name GPS coordinates at home Lat/..... Long/.....
Telephone number home Mobile cell Number

Clinical status

Day 1 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous Yes No Temperature (axillary).....degrees Celcius

Day 2 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Day 3 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Comments if visit is not on day 3, 14, and 28.....

Blood tests for malaria parasites

Day 1 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.
Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No
If yes, which species? P vivax P ovale P malariae

Day 2 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No
If yes, which species? P vivax P ovale P malariae

Day 3 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No
If yes, which species? P vivax P ovale P malariae

Clinical status

Day 7 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous Yes No Temperature (axillary).....degrees Celcius

Day 14 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Day 21 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Comments if visit is not on day 3, 14, and 28.....

Day 28 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Comments if visit is not on day 3, 14, and 28.....

Clinical status

Day 7 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous Yes No Temperature (axillary).....degrees Celcius

Day 14 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Day 21 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Comments if visit is not on day 3, 14, and 28.....

Day 28 (following diagnosis)

Presence of danger signs or signs of severe or complicate Yes No Date/...../.....
History of fever within the previous 24hrs? Yes No Temperature (axillary).....degrees Celcius

Comments if visit is not on day 3, 14, and 28.....

Blood tests for malaria parasites

Day 7 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.....

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No

If yes, which species? P vivax P ovale P malariae

Day 14 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.....

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No

If yes, which species? P vivax P ovale P malariae

Day 21 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.....

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No

If yes, which species? P vivax P ovale P malariae

Day 28 (following diagnosis)

Slide take Yes No Laboratory where slide was sent.....

Slide results

Average number of asexual P falciparum parasites (/µl).....

Presence of P falciparum gametoc Yes No Were species other than P Falciparum ? Yes No

If yes, which species? P vivax P ovale P malariae

MALARIA FOCI INVESTIGATION FORM AND REGISTER
MINISTRY OF HEALTH
NATIONAL MALARIA PROGRAMME

Dzongkhag.....	Geog.....	Name of Chiwog
Reporting month		
Date of Classification _D_D_/_M_M_/_Y_Y_Y_Y_		Catchment population.....
Mosquito Breeding sites present Yes/No		GPS point of Foci ____/____/____
Date of last assessment D_D_/_M_M_/_Y_Y_Y_Y		GPS points of Breeding areas (1) ____/____/____ (2) ____/____/____ (3) ____/____/____

1. Description of Locality:

. Type of environment in relation to receptivity (Urban/Rural , atitude, main geographical features) and vulnerability (eg close to endemic areas across international borders)

.....
.....
.....

2. Types of population in relation to vulnerability (eg migration patterns, presence of large number of temporary workers, typical travel histories)

.....
.....
.....

3. Mapping

To include location of:

- a. Focus and its geographical limits
- b. Households with malaria cases in the past three years (*to attach list of household GPS points*)
- c. Access routes
- d. Other important features

Status of focus

- ⟨ **Endemic** (transmission is occurring and not effectively controlled by malaria interventions)
- ⟨ **Residual active** (transmission is occurring in the area within past two years and effectively controlled with major reduction in malariological indicators after interventions)
- ⟨ **Residual non-active** (there is no local transmission within past two years. Relapses or delayed primary infections with *P. vivax* or recrudesces of an infection acquired before transmission ceased may occur)
- ⟨ **New active** (transmission is occurring in an area that has had transmission for less than two years or has never had local transmission)
- ⟨ **New potential** (isolated imported, induced or relapsing cases are occurring during the transmission season in a receptive area that had no transmission in the past two years or more)
- ⟨ **Cleared-up** (no local transmission has been recorded in the area with the history of malaria and conditions that are suitable for malaria transmission).

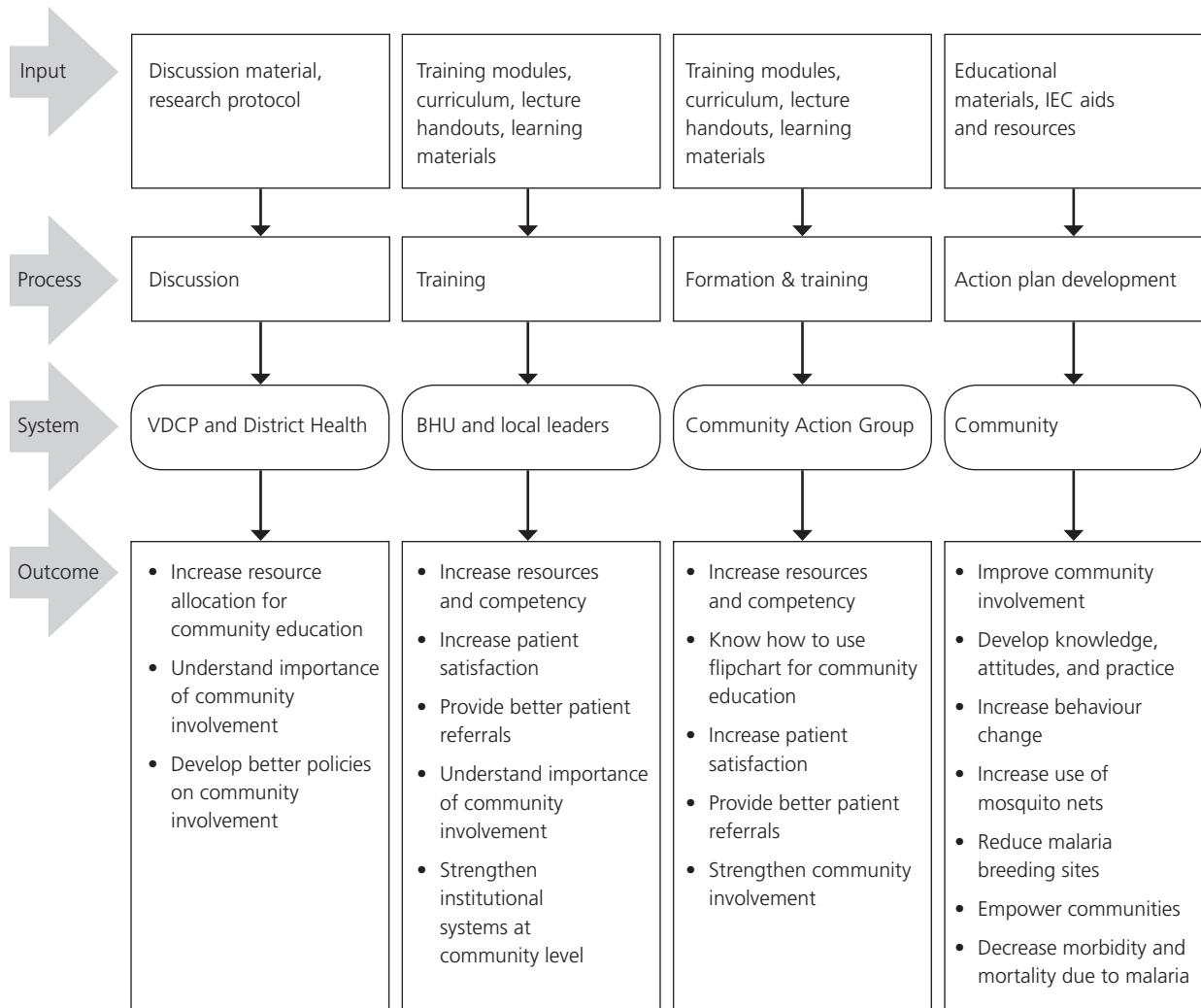
Malaria Test Laboratory Register

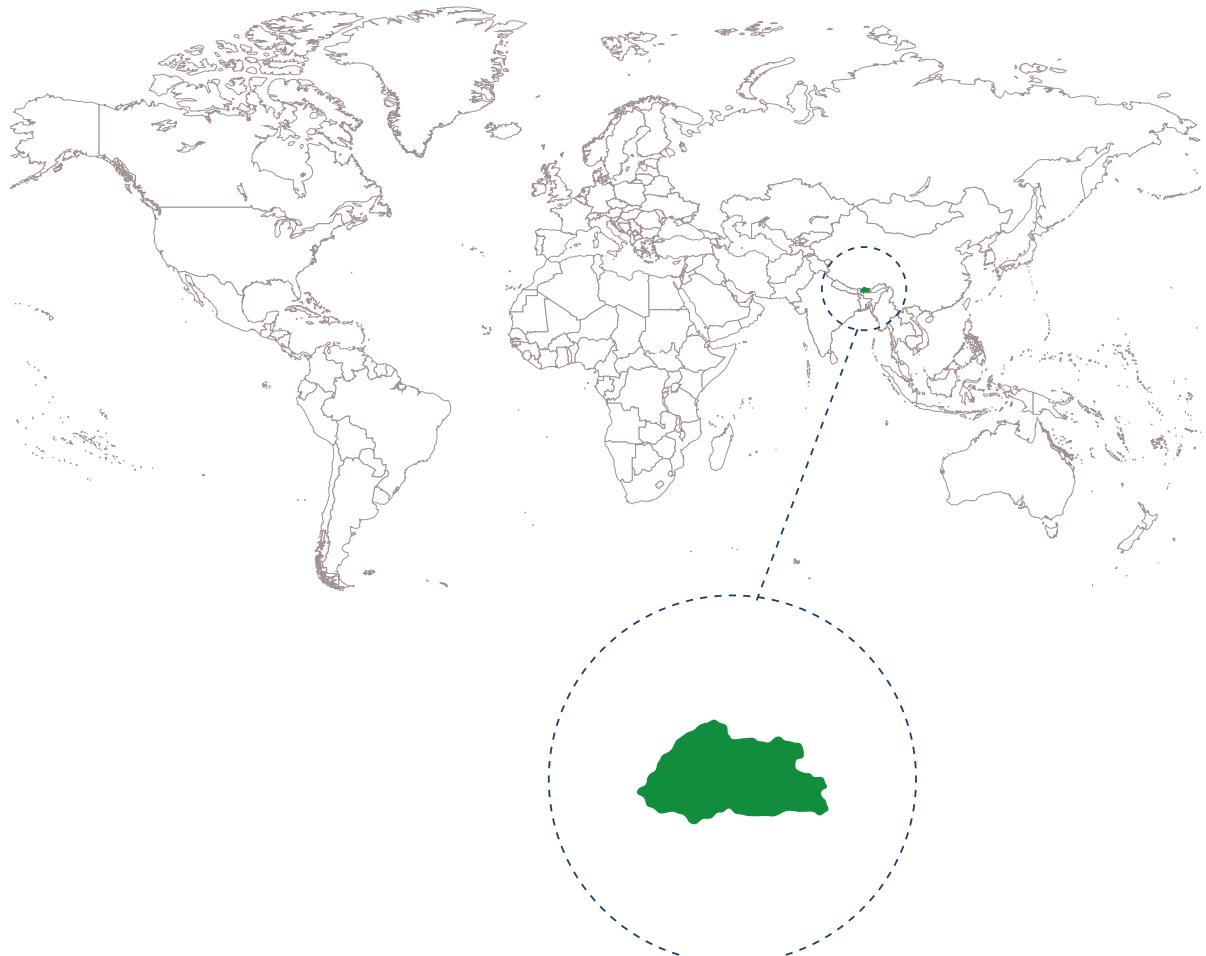
Sl No	Name of patient	Age/sex	House No.	Village	Chitwog	Geewog	Nationally	Occupation	Blood Slide No.	Microscopy test	If female, pregnant? (Y/N)	Severe Malaria	Malaria death	Duration of fever in hours/days	Case investigation done Y/N	Indigenous malaria case Yes/No	Mobile No.
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MOSKOVSKY OF HOEPLI

MONTHLY VILLAGE-WISE BLOOD SLIDE EXAMINED REPORTING FORM
VECTOR-BORNE DISEASE CONTROL PROGRAM (GEI EPHI)

ANNEX 6: SCHEMATIC FLOW DIAGRAM OF THE COMMUNITY-DIRECTED EDUCATIONAL INTERVENTION BY COMMUNITY ACTION GROUPS





This case-study is part of a series of malaria elimination case-studies conducted by the World Health Organization (WHO) Global Malaria Programme and the University of California, San Francisco (UCSF), Global Health Group. The case-studies series documents the experience gained in eliminating malaria in a range of geographical and transmission settings with the aim of drawing lessons for countries that are embarking upon elimination.

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