Towards a malaria-free world

Elimination of malaria in Uzbekistan

World Health Organization

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Abbreviations

CSSES	Centre of State Sanitary and Epidemiological Surveillance (now Sanitary-Epidemiological Welfare and Public Health Committee of the Republic of Uzbekistan)
DDT	dichlorodiphenyltrichloroethane
GDP	gross domestic product
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
SSES	State Sanitary Epidemiological Service
WHO	World Health Organization

Glossary

case, confirmed	Malaria case (or infection) in which the parasite has been detected in a diagnostic test, i.e. microscopy, a rapid diagnostic test or a molecular diagnostic test. Note: on rare occasions, the presence of occult malaria infection in a blood or organ donor is confirmed retrospectively by the demonstration of malaria parasites in the recipient of the blood or organ.
case, imported	Malaria case or infection in which the infection was acquired outside the area in which it is diagnosed.
case, indigenous	A case contracted locally with no evidence of importation and no direct link to transmission from an imported case.
case, introduced	A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first-generation local transmission).
case, locally acquired	A case acquired locally by mosquito-borne transmission. Note: locally acquired cases can be indigenous, introduced, relapsing or recrudescent; the term "autochthonous" is not commonly used.
malaria elimination	Interruption of local transmission (reduction to zero incidence of indigenous cases) of a specified malaria parasite in a defined geographical area as a result of deliberate activities. Continued measures to prevent re-establishment of transmission are required. Note: the certification of malaria elimination in a country will require that local transmission is interrupted for all human malaria parasites.
malaria eradication	Permanent reduction to zero of the worldwide incidence of infection caused by human malaria parasites as a result of deliberate activities. Interventions are no longer required once eradication has been achieved.
malaria reintroduction	Malaria reintroduction is the occurrence of introduced cases (cases of the first-generation local transmission that are epidemiologically linked to a confirmed imported case) in a country or area where the disease had previously been eliminated. Note: malaria reintroduction is different from re-establishment of malaria transmission (see definition).
malaria-free	Describes an area in which there is no continuing local mosquito-borne malaria transmission and the risk for acquiring malaria is limited to infection from introduced cases.

transmission, re-establishment of	Renewed presence of a measurable incidence of locally acquired malaria infection due to repeated cycles of mosquito-borne infections in an area in which transmission had been interrupted. Note: a minimum indication of possible re-establishment of transmission would be the occurrence of three or more indigenous malaria cases of the same species per year in the same focus, for three consecutive years.
transmission, interruption of	Cessation of mosquito-borne transmission of malaria in a geographical area as a result of the application of antimalarial measures.

Executive summary

This publication describes the history of malaria in Uzbekistan. It evaluates the policies and strategies applied after the re-establishment of local transmission to contain malaria outbreaks in the 1990s and early 2000s, and highlights the interventions subsequently used to eliminate malaria in the country. Uzbekistan was officially certified by the World Health Organization (WHO) as a malaria-free country in 2018. Lessons for countries embarking upon elimination are distilled.

Initial malaria control and elimination

Previously, malaria was one of the most widespread diseases on the territory of present-day Uzbekistan. The largest outbreaks of malaria were registered in the former Turkestan in 1892–1893, 1902–1903 and 1921–1923, and many people died from malaria. Three *Plasmodium* species – *P. vivax*, *P. falciparum* and *P. malariae* – were distributed in the country.

From 1922, a network of antimalarial institutions was established and control interventions were started. The use of the antimalarial medicines plasmocid and acrichine played a major role in control of malaria and clearing of many malaria-hyperendemic foci. Vector control activities included reducing mosquito habitats, extensive drainage of swamps, rebuilding irrigation networks, adapting swampy areas for cotton plantations, and larval control in water bodies with *Gambusia affinis* fish.

Uzbekistan achieved considerable success in malaria control. The total number of cases dropped from 717 721 cases (943 cases per 10 000 people) in 1932 to 164 600 in the period 1935–1940. The outbreak of the Second World War, however, significantly changed this. In 1943, the highest number of malaria cases was recorded (total 520 695 cases).

In the post-war years, extensive measures were launched across the country to control malaria, which dramatically reduced the burden. An elimination (eradication) programme was launched in 1946. The number of malaria cases dropped from 19 512 in 1953, to 49 in 1959, and to 11 in 1960. Local *P. vivax* transmission had ceased by 1961. *P. falciparum* was last reported in the 1950s. Uzbekistan was not certified as malaria-free by WHO, however, because at that time it was a part of the former Soviet Union, on which territory some malaria areas still existed.

Malaria control and elimination activities included epidemiological surveillance and vector control. Active case detection and radical treatment with acrichine, plasmocid and bigumal (proguanil) were prioritized. All people with malaria were registered and followed up for 18 months.

The wide use of the powerful insecticides dichlorodiphenyltrichloroethane (DDT) and hexachlorane played a major role in the elimination programme. Mosquito larval control was implemented universally by treating breeding sites with mineral oil and Paris green and introducing *G. affinis* fish. Swamps were drained, and irrigation and drainage networks were cleaned.

Malaria-free period

As local transmission was interrupted, malaria surveillance activities decreased, although the borders with Afghanistan and Tajikistan remained vulnerable. Sporadic *P. vivax* cases and several small-scale outbreaks (three to nine cases) were registered due to delayed detection of cases imported from other countries. All outbreaks were contained promptly by activities of the Sanitary Epidemiological Service (now the State Sanitary Epidemiological Service, SSES) and general health-care facilities, which maintained expertise in malaria diagnosis and case management.

To prevent the re-establishment of local malaria transmission, vector control measures continued, with larval control of mosquito breeding sites, including larviciding, distribution of *G. affinis* fish, and draining and filling of swamps. In higher-risk areas, indoor residual spraying was applied as epidemiologically indicated.

Re-establishment of local transmission, malaria control and elimination

The epidemiological situation in 1980–1989 worsened due to the withdrawal of demobilized troops from Afghanistan. Malaria importation by soldiers increased, and isolated locally acquired *P. vivax* cases and a few outbreaks arose. In 1986–1988, locally acquired *P. vivax* cases were registered in the Papsky district of Namangan province and in Termez province.

The situation changed dramatically in 1994, when a large-scale epidemic in Tajikistan developed. This was followed by a sharp increase in the number of imported cases in Uzbekistan in 1998–2000. Almost all cases were reported from the previously highly endemic province of Surkhandarya in the south of the country.

Intensive migration of the population to and from Tajikistan, and delays in case detection, treatment and response led to re-establishment of local *P. vivax* transmission, especially in areas along the Tajik border. Kashkadarya, Surkhandarya and Tashkent provinces were involved.

Although surveillance activities had been maintained after the first elimination, it is likely that over the years, with only isolated malaria cases and few serious epidemiological consequences, the system weakened and was not able to respond quickly and adequately to the increased risk of importation and receptivity in the country.

Recognizing these challenges, the Ministry of Health promptly mobilized SSES and general health-care facilities and reinforced malaria surveillance and control activities to contain the malaria outbreaks, prevent further spread and interrupt transmission.

Uzbekistan adopted an integrated approach towards malaria control and elimination, including measures to eliminate the source of infection, reduce transmission and protect the healthy population. The Ministry of Health formulated a complex of strategic approaches, with programmes for malaria control and then elimination, with the aims of prompt containment of outbreaks and clearing up foci.

Strategies to intensify malaria activities after resumption of local transmission included:

- vector control, including indoor residual spraying, larviciding of water reservoirs and mosquito breeding sites, environmental management and entomological surveillance;
- scaled-up epidemiological surveillance, including active (household visits) and passive case detection, improvement of laboratory diagnosis, registration and reporting, and prompt response to and epidemiological investigation of cases and foci;

- mass prophylactic treatment of the population in active malaria foci and of demobilized military personnel with primaquine, with follow-up over three years;
- strengthening of human resources and deployment of antimalarial mobile teams in regions bordering Afghanistan and Tajikistan;
- health education of the population and social mobilization.

As a result, the epidemiological situation improved and the malaria burden reduced. Following reinforced control and surveillance operations, Uzbekistan has reported a gradual decrease in numbers of locally acquired and imported cases since 2001. The number of indigenous cases fell from 46 in 2001 to 31 in 2004.

Sound results in malaria control inspired Uzbekistan to move to a programme for malaria elimination in 2006, and a large reduction in malaria incidence was achieved. The last three indigenous *P. vivax* cases were registered in 2010. Since 2011, only isolated imported malaria cases have been reported.

The following key strategies and approaches proved to be effective in malaria elimination:

- Scaled-up case-based surveillance and response enabled evidence-based decisions, planning and timely implementation of actions.
- Proactive case detection was carried out through house-to-house visits and fever screening in all malaria foci. This was combined with screening of the population at higher risk (e.g. foreign students). Mass screening was carried out in 2006–2015 in Surkhandarya province as part of a Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) project. Reactive case detection was performed during epidemiological investigations of cases at places of residence and work by mass blood surveys. At the primary care level, passive case detection was performed by public and private general health-care facilities. Once transmission was reduced, greater attention was paid to imported cases.
- Reliable and timely malaria diagnosis was provided free of charge by a wide network of upgraded diagnostic laboratories. These were covered by the national external quality assurance programme and coordinated by the national malaria reference laboratory.
- All people with malaria were administered radical treatment free of charge in a timely manner and in accordance with the national malaria treatment protocol.
- An efficient information system was operated covering compulsory notification, recording and reporting. An updated malaria database was maintained at the national, provincial and district levels.
- Prompt and comprehensive epidemiological investigation of every case and focus enabled timely evidence-based formulation, planning and conducting of adequate response activities. A malaria focus was regarded as the minimum unit for antimalarial actions. Foci were monitored, their classification was updated annually, and a focus register was maintained. This information was important for the timely initiation of interventions when necessary, and for determining the appropriate nature, scope and period of application of those interventions.
- Assigning temporary mobile teams of epidemiologists, parasitologists, entomologists, clinicians and laboratory technicians to areas affected by malaria led to timely responses and good coverage with urgent control measures.
- Residents of active foci and other people exposed to the risk of malaria (e.g. military personnel, oil workers) were given interseasonal prophylactic treatment with primaquine.

- Evidence-based integrated vector control activities and entomological surveillance included:
  - full indoor residual spraying coverage of all foci to shorten the lifespan of female mosquitoes, and larviciding of mosquito breeding habitats with larvivorous *G. affinis* fish and chemical larvicides to reduce larval density, leading to a decrease in mosquito density and longevity;
  - reducing the number of breeding places through environmental management (mainly infilling of non-productive water bodies and cleaning of open irrigation canals);
  - reducing human–vector contact through housing improvements and use of long-lasting insecticide-treated nets since 2005.
- Entomological surveillance by SSES staff was conducted across the country, with particular attention paid to areas on the border with Tajikistan. Surveillance included identifying, registering and regularly monitoring vector breeding sites and mosquitoes at sentinel points every 10 days during the malaria season; maintaining and annually updating registers of breeding sites at the district level; studying and collecting information on *Anopheles* mosquito species and their density and vector bionomics; and studying meteorological data. Entomological monitoring information was used as the basis for defining the parameters of the potential malaria season, for planning adequate vector control interventions, and for evaluating and stratifying the receptivity of different parts of the country according to the risk of malaria transmission re-establishment.

Protection of the population in malaria foci was supplemented with seasonal chloroquine prophylaxis and intensive health education.

SSES at the national, provincial and district levels played a key role in coordinating and implementing surveillance and control activities. Parasitology departments at SESS centres, with substantial expertise in control and elimination, covered malaria surveillance, vector control, entomological surveillance, and external quality assurance of laboratory diagnosis. Participation of general health-care facilities was essential for timely and adequate disease management.

The expertise of SSES staff and other specialists was maintained through intensive training and retraining in malariology within the continuous professional education system, additional courses and individual training.

Intersectoral collaboration of the Ministry of Health with other ministries yielded positive results in malaria control and elimination.

Scaled-up health education of the population and increased community awareness through building up community-level intervention channels have included the whole population in malaria elimination and prevention.

Cross-border collaboration, especially with Kyrgyzstan and Tajikistan, has been strengthened. A joint statement on cross-border cooperation for malaria elimination among Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan was signed in 2010, and plans for joint measures for the prevention and control of malaria were developed to ensure a timely response and improvement of the epidemiological situation in border territories.

High-level political commitment to malaria control and elimination was key for malaria elimination in Uzbekistan. The Government provided policies, strategic programmes, plans, guidelines and sufficient funding for the interventions. Global Fund support was crucial for reaching the target of elimination.

WHO provided technical assistance for developing strategies, policies, strategic plans and guidelines, and played an essential role in capacity-building.

The Global Fund played a large role. Financial support from the Global Fund within the framework of two grants (covering 2000–2015) contributed towards upgrading health facilities, improving malaria expertise of staff, and providing insecticides, antimalarial medicines and other consumables.

Monitoring and evaluation of the effectiveness of interventions were carried out.

Operational research was carried out on parasites and vectors through molecular genetic studies, and on the epidemiological aspects of *P. vivax* malaria resurgence.

Prevention of malaria re-establishment

Although malaria has been eliminated in Uzbekistan, the risk of malaria remains. The risk depends on the malariogenic potential (based on the receptivity and risk of importation of a territory) and the efficiency of the health-care system.

After the interruption of malaria transmission, a large part of Uzbekistan remained receptive because of the landscape, vector breeding areas (e.g. rice fields, irrigation systems and other water bodies favourable for mosquitoes), climatic conditions, and the presence of malaria vectors registered during entomological surveillance. These areas are in river valleys, mostly in the south-eastern and eastern parts of the country. Several provinces have a higher level of receptivity – Andijan, Fergana, Khorezm, Namangan, Samarkand, Surkhandarya, Syrdarya and Tashkent.

The risk of importation (vulnerability) is likely to be low. In 2006–2022, 70 imported cases were registered across 11 provinces and one city, but most of these (56) were detected during the period of malaria elimination (2006–2010). Since the interruption of local transmission in 2011, only 14 imported cases have been reported, indicating that the risk of importation has decreased.

It should be noted that although previously all areas along the borders with malaria-endemic Afghanistan and Tajikistan, where intensive migration of the population took place, were at higher risk, presently the risk of importation has decreased. In 2023, Tajikistan was certified by WHO as a malaria-free country. Malaria is endemic in Afghanistan, but there is strong border control on the Uzbek side, preventing illegal crossing.

Although it is likely that the vulnerability to malaria of Uzbekistan is low, expanding international relations in economics, trade, tourism and culture should be taken into account, as they may change the situation in the future.

To maintain the country's malaria-free status, prevent resumption of local malaria transmission and establish effective mechanisms for the post-elimination period, the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan (2017–2021) was approved and financially supported by the Government.

The main goal of the National Strategic Programme is to maintain the current epidemiological status by implementing a series of integrated measures towards preventing the re-establishment of local transmission, emergence of introduced cases (secondary cases from imported cases) and indigenous cases by:

- maintaining a well-organized general health-care service and strong surveillance and response services;
- early detection and timely radical treatment of malaria cases;
- early mandatory notification and registration of malaria cases;

- timely epidemiological investigation and classification of cases and foci,[1] implementation of response measures in foci, and monitoring of malaria foci;
- monitoring of the malariogenic potential (risk of importation and receptivity) and conducting risk assessments for the re-establishment of malaria in changing conditions;
- entomological surveillance and appropriate vector control, especially in areas at high or medium risk of re-establishment of malaria;
- prediction and early recognition of the danger of epidemics, and rapid implementation of necessary measures;
- rapid implementation of response measures in the case of re-establishment of indigenous transmission;
- intersectoral, interdepartmental and cross-border cooperation on malaria prevention;
- maintaining malaria expertise by training and retraining malaria specialists within the health system;
- intensification of cooperation and use of effective systems of communication between all stakeholders in the National Strategic Programme;
- maintaining awareness and vigilance of the population regarding malaria.

Based on receptivity indicators, the malaria situation in the recent past, and malaria importation (which is currently low but may change over time), SSES staff stratified the country according to the risk of re-establishment of malaria and applied preventive measures accordingly. According to this stratification, Surkhandarya province has a high level of malariogenic potential, and Bukhara and Samarkand provinces have a medium level of malariogenic potential.

Uzbekistan maintains a strong health system and a malaria surveillance mechanism in which attention is given to imported cases. In 2017, Uzbekistan signed the Ashgabat Statement: Preventing the Re-establishment of Malaria Transmission in the WHO European Region.

Sufficient funds are currently allocated by the Government for the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan.

Outlook for the future

Since malaria elimination in Uzbekistan, malaria importation has declined dramatically and the risk of importation from neighbouring countries has decreased. A large part of the country remains receptive, however. A strong surveillance and response system and a well-organized general health-care system are crucial to prevent reintroduction of malaria. Any weakness in the programme will prevent a timely response to changes in the malariogenic potential (receptivity and risk of importation), which may lead to resumption of local transmission and possible epidemic outbreaks. Efforts should be directed towards timely detection of imported cases, their radical treatment and response measures to prevent local transmission.

Maintaining the status of a malaria-free country is essential for the economic and social development in Uzbekistan.

Lessons learned during the period of malaria control and elimination show that even though Uzbekistan is now malaria-free, malaria expertise and financial allocations should be maintained.

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[1] The category of "potential focus" was used in addition to the "active", "residual non-active" and "cleared" foci categories recommended by WHO in 2017.

Introduction

Malaria was eliminated in Uzbekistan by 1961, although single locally acquired *Plasmodium vivax* cases and several rapidly contained small-scaled outbreaks occurred after the interruption of local transmission. In 1986–1988, in Namangan and Termez provinces, locally acquired *P. vivax* cases were registered related to malaria importation following withdrawal of military troops from Afghanistan *(1–3)*.

In 1999, local *P. vivax* transmission was re-established, mainly along the border with Tajikistan. This was due to intensive migration of the population to and from Tajikistan, where a large-scale malaria epidemic had developed *(1, 3–6)*.

As a result of the successful implementation of the National Malaria Control Programme, supported by grants from the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), the malaria burden declined and the country moved towards malaria elimination. The last three indigenous *P. vivax* cases were detected in 2010 *(7)*. Uzbekistan was officially certified by the World Health Organization (WHO) as a malaria-free country in 2018 *(8)*. Following malaria elimination, the National Malaria Control Programme reoriented towards prevention of re-establishment of malaria.

This publication documents the history of malaria in Uzbekistan and examines the evidence-based strategies and policies used to dramatically reduce the malaria burden and interrupt local transmission. The report highlights the strong political commitment, successful efforts of the well-developed surveillance system and general health facilities, and sustainable funding required to implement the complex approaches needed for malaria control and elimination. Lessons for countries embarking on malaria elimination are distilled.

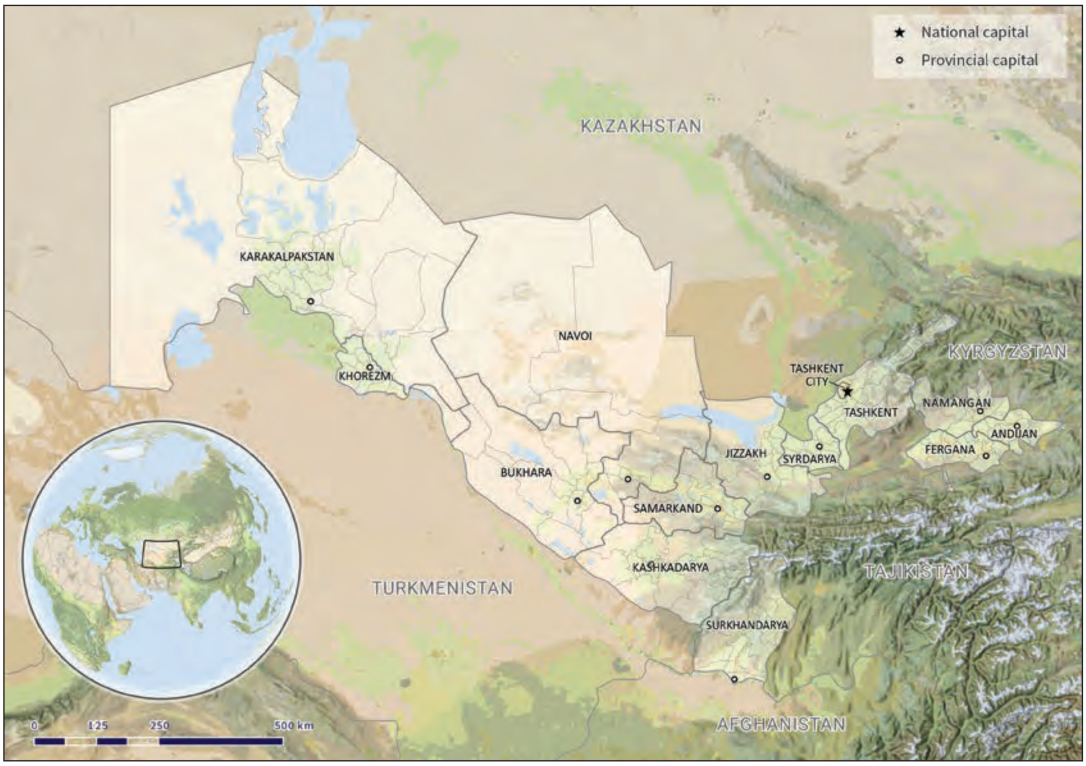
See Annex 1 for details of the data collection and analysis methods used.

Country background information

Geography, climate and vegetation

Uzbekistan is a landlocked country in central Asia between latitude 37–46 °N and longitude 56–74 °E. The area to the north and north-east borders Kazakhstan; to the east and southeast, Kyrgyzstan and Tajikistan; to the west, Turkmenistan; and to the south, Afghanistan (Fig. 1).

Fig. 1. Geographical location of Uzbekistan



Source: WHO GIS Centre for health, DNA/DDI.

Uzbekistan covers an area of 4489 km². The country measures 1425 km from west to east and 930 km from north to south *(9)*.

Most of the country is plains, although mountains and foothills account for about a fifth of the area. The spurs of Pamir and Tian Shan are located in the east and north-east. The large Kashkadarya, Samarkand, Surkhandarya and Zarafshan depressions stretch between mountains. The largest depression is the Fergana Valley. The extensive Amudarya depression is located on the border with Afghanistan. Part of the northern and central areas are occupied by the Kyzylkum Desert (one of the largest in the world), and the west by the Karakum Desert *(3)*.

Uzbekistan is located between the two major central Asian rivers – the Amudarya and the Syrdarya. Tributaries of these are used for irrigation. Lakes are mainly located in valleys. The largest lake is the Aral Sea, which is gradually drying out. Uzbekistan has several artificial water reservoirs *(3)*.

Uzbekistan has an arid continental climate characterized by large variations in temperature within days and between seasons. It has a long dry hot summer, a cool damp autumn, and a mild winter with little snow. The average annual temperature in 1999–2022 was 14.3–14.9 °C *(3, 10)*.

Uzbekistan has low forest cover. Only 7% of the land is forested *(11)*. The flora contains more than 3700 species of plants *(12)*.

The terrain, hydroecology and climatic conditions of some parts of the country are favourable for the habitation and breeding of malaria mosquitoes and for transmission of malaria to humans.

Population and demography

As of 1 January 2022, the resident population of Uzbekistan was 35.271 million people (Table 1), an increase of 712 400 people (2%) compared with the previous year. Of the total resident population, 31.2% are young dependents, 57.6% are people of working age, and 11.2% are older dependents *(13)*.

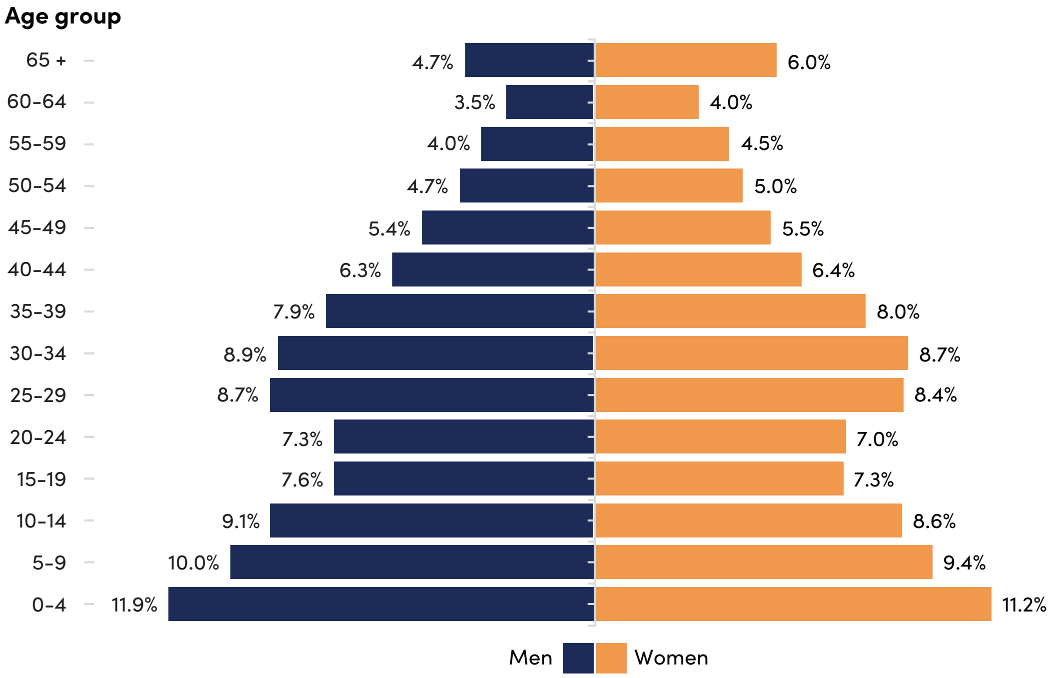
Table 1. Population of Uzbekistan

Province or city	2000	2010	2020	2022
Andijan	2 186 200	2 549 100	3 127 700	3 253 500
Bukhara	1 419 300	1 612 500	1 923 900	1 976 800
Fergana	2 664 400	3 074 600	3 752 000	3 896 400
Jizzakh	974 800	1 116 800	1 382 100	1 443 400
Kashkadarya	2 166 800	2 616 100	3 280 400	3 408 300
Khorezm	1 323 900	1 561 600	1 866 500	1 924 200
Namangan	1 924 300	2 258 500	2 810 800	2 931 100
Navoi	783 300	851 600	997 100	1 033 900
Republic of Karakalpakstan	1 503 000	1 632 000	1 898 300	1 948 500
Samarkand	2 670 300	3 119 000	3 877 400	4 031 300
Surkhandarya	1 736 700	2 075 000	2 629 100	2 743 200
Syrdarya	642 200	714 400	846 300	878 600
Tashkent	2 350 200	2 585 900	2 941 900	2 939 700
Tashkent city	2 142 300	2 234 300	2 571 700	2 862 400
Total	**24 487 700**	**28 001 400**	**33 905 200**	**35 271 300**

Source: Statistics Agency under the President of the Republic of Uzbekistan (https://stat.uz/en/official-statistics/demography).

The age and sex composition of the resident population is presented in Fig. 2. As of 1 July 2023, permanent residents of urban settlements were 50.1% men and 49.9% women; permanent residents of rural areas were 50.6% men and 49.4% women.

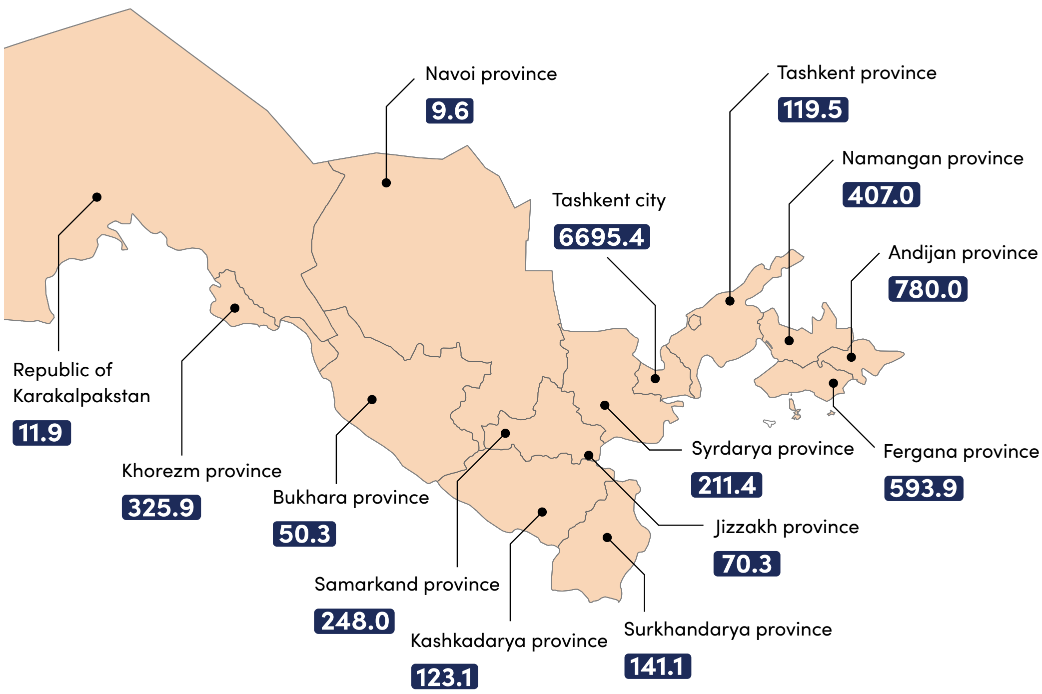
Fig. 2. Age and sex composition of resident population of Uzbekistan, 1 January 2023



Source: Statistical yearbook of the Kyrgyz Republic. Bishkek: National Statistical Committee of the Kyrgyz Republic; 2022 (http://www.stat.kg/kg/publications/statisticheskij-ezhegodnik-kyrgyzskoj-respubliki/).

The average population density is 78.6 people/km², but it is much higher in Andijan, Fergana, Namangan, Tashkent city and some other provinces (Fig. 3) *(13)*.

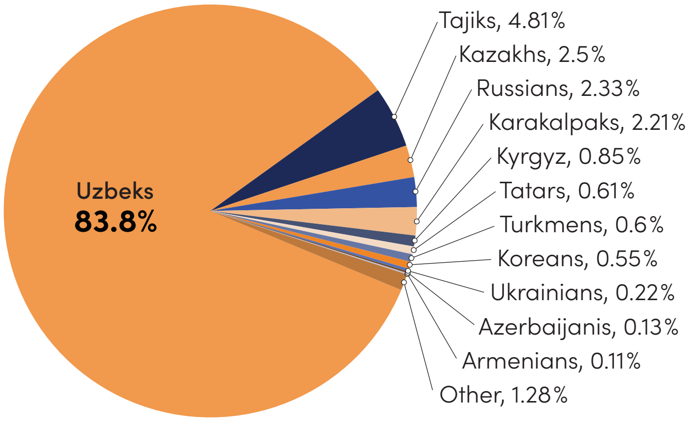
Fig. 3. Population density of Uzbekistan, 1000 people/km², 2022



Source: Statistics Agency Under the President of the Republic of Uzbekistan (https://stat.uz/en/quarterly-reports/39036-2023-eng-2#january-june).

The ethnic structure of the population of Uzbekistan is predominately Uzbek people (83.8%) (Fig. 4).

Fig. 4. Ethnic structure of the population of Uzbekistan, 2017



Source: Demographic situation in the Republic of Uzbekistan *(13)*.

Life expectancy in 2022 was 74.3 years, compared with 73.0 years in 2010 and 73.4 years in 2020. Life expectancy for women in 2022 was 76.6 years (75.1 years in 2010, 75.5 years in 2020), and for men 72.1 years (70.6 years in 2010, 71.2 years in 2020).

The birth rate was 25.9 births per 1000 population in 2021, compared with 22.0 in 2010 and 24.6 in 2020 *(14)*.

Political organization and economy

Uzbekistan is a democratic state. The President is the head of state. The supreme state representative body is the Parliament, which consists of the legislative chamber (lower chamber) and the senate (higher chamber) *(15)*.

The administrative and territorial division of Uzbekistan has several levels: the Republic of Karakalpakstan, 12 provinces, the capital Tashkent, 168 rural and urban districts, 119 cities of national, provincial and district jurisdiction, 1081 urban settlements, 1468 rural communities, 10 998 rural settlements and 8208 *mahalla* communities.

Uzbekistan is classified as a lower-middle-income country *(16)*. There is a rising trend in the gross domestic product (GDP), which was US$ 69.24 billion in 2021, compared with US$ 13.36 billion in 1990. GDP per capita was US$ 1980.20 in 2021 *(17)*. The main economic indicators are presented in Table 2.

Table 2. Main economic indicators for Uzbekistan

	1990	2000	2010	2021
GDP (billion US$)	13.36	13.76	49.77	69.24
GDP growth (annual %)	1.6	3.8	7.6	7.4
Inflation, GDP deflator (annual %)	4.0	47.3	48.6	13.6
Agriculture, forestry and fishing, value-added (% of GDP)	33.0	30.0	27.0	25.0
Industry and construction, value-added (% of GDP)	33.0	20.0	21.0	32.0
Exports of goods and services (% of GDP)		25.0	24.0	24.0
Imports of goods and services (% of GDP)		19.0	25.0	40.0
Gross capital formation (% of GDP)	44.0	20.0	27.0	41.0

Source: Uzbekistan. World Development Indicators database. Washington, DC: World Bank (https://databank.worldbank.org/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=UZB).

Agriculture and industry contribute equally to the economy. Uzbekistan is a large producer of cotton and gold and has substantial deposits of silver, strategic minerals, gas and oil. Tourism is well developed *(3, 18)*.

Health-care system and policies and health profile

The Ministry of Health is the central body for the state management of health care. Its activities cooperate with other bodies of the state administration, bodies of executive power of the autonomous Republic of Karakalpakstan, the provinces and Tashkent, and public and international organizations *(3)*.

In 1998, reform of the health-care system, regulated by a special decree, was launched *(19)*. This is based on the principles of social protection of the population, the gradual transfer of some health institutions to mixed and private sources of financing, and universal access to a guaranteed amount of health services.

Health-care services are provided by a network of facilities at all administrative levels – primary, intermediate (provincial and district), and central. Facilities include hospitals, clinics for groups of diseases, outpatient clinics, centres for maternal and child care, and centres for emergency care.

Primary health care is provided by rural health centres, village family clinics, city clinics, outpatient clinics, central multidiscipline district clinics, and centres for emergency care (Fig. 5).

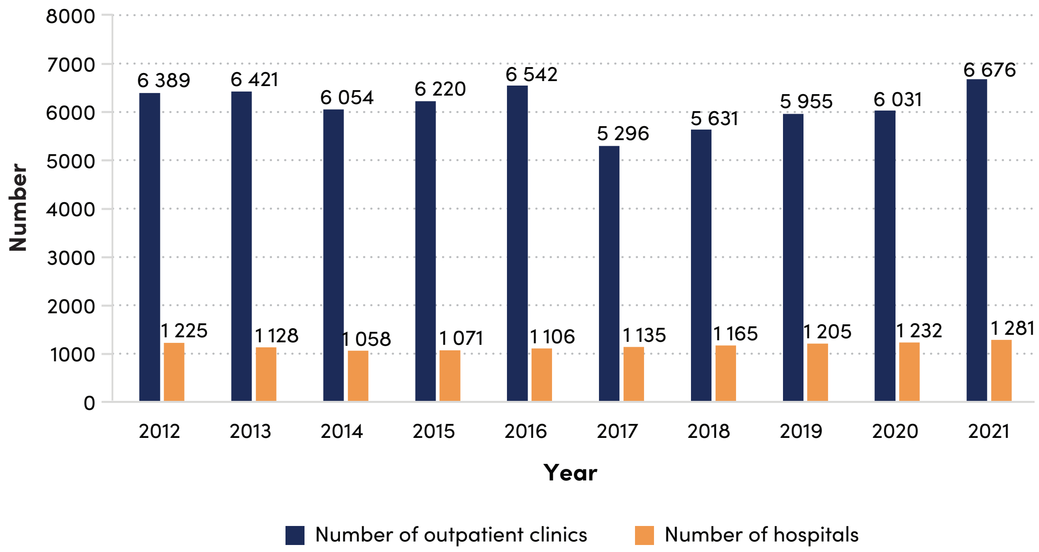
Public health institutions of the Ministry of Health SSES include the following:

- Central level: Republic Centre of State Sanitary Epidemiological Surveillance, renamed in 2023 to the Sanitary-Epidemiological Welfare and Public Health Committee of the Republic of Uzbekistan.
- Intermediate level: provincial Centres for State Sanitary Epidemiological Surveillance (CSSES) (12 centres), CSSES of the Republic of Karakalpakstan and CSSES of Tashkent city, renamed in 2023 to Offices of the Committee for Sanitary and Epidemiological Welfare and Public Health.
- District and city levels: district/city Centres for State Sanitary Epidemiological Surveillance (CSSES) (166 administrative units) and district/city CSSES of the Republic of Karakalpakstan (11 centres), renamed in 2023 to Departments of the Committee for Sanitary and Epidemiological Welfare and Public Health.

Under the Ministry of Health, there are also disinfection stations, centres for prevention and control of AIDS, centres for prevention of quarantined and especially dangerous infections, centres and stations for blood transfusion, and research institutes.

Other sanitary and epidemiological institutions are involved in antimalarial activities, such as the sanitary epidemiological station of the national airline, national railways, national security service stations, the Navoiy mining and smelting plant, and the border service.

Fig. 5. Number of health facilities in Uzbekistan, 2012–2021



Source: Statistics Agency under the President of the Republic of Uzbekistan (https://stat.uz/en/official-statistics/social-protection).

All health facilities are well staffed (Table 3). The development of private medicine has been given greater attention by the Ministry of Health in recent years *(20)*.

Health expenditures on malaria

Allocations of Government funds to health care generally followed an upward trend between 2018 and 2020. Health expenditure was US$ 2672 million in 2018 and US$ 4040 million in 2020. Expenditure on health per capita was US$ 82 in 2018 and US$ 121 in 2020 (Table 4). As a percentage of GDP, the health-care budget was 5% in 2015–2019 and 7% in 2020 *(21)*.

In 2020–2021, within the context of the COVID-19 pandemic, the burden on the health-care system increased. In 2021, 4.3 trillion soms was allocated to combat COVID-19, while the amount of funds allocated for other health spending was over 21 trillion soms (3.1% of GDP) *(22)*.

Table 3. Numbers of health-care staff in Uzbekistan, 2012–2021

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Physicians, total	81 300	81 700	82 000	83 400	84 100	85 400	89 800	91 900	93 300	95 600
Physicians, Sanitary Epidemiological group	4 500	4 400	4 500	4 600	4 600	4 500	4 600	4 800	4 800	4 000
Nurses	324 600	327 400	332 400	336 400	341 300	348 200	356 700	365 700	369 800	372 500
Physicians per 10 000 people	27.1	26.8	26.4	26.4	26.2	26.1	27.2	27.1	27.0	27.1
Number of people per physician	369	373	378	379	382	383	367	369	370	369

Source: Demographic situation in the Republic of Uzbekistan *(13)*.

Table 4. Spending on health care in Uzbekistan

	Current health expenditure (US$ million)	Per capita (US$)	% of GDP
2016	4 061	129	5
2017	2 972	93	5
2018	2 672	82	5
2019	3 251	99	5
2020	4 040	121	7

Source: World Health Organization. Global Health Expenditure Database (https://apps.who.int/nha/database/ViewData/Indicators/en).

General health profile

Over the past 20 years, health indicators in Uzbekistan have gradually improved. The death rate fell from 10.4 per 1000 people in 1973 to 6.0 per 1000 people in 2022. Maternal mortality was 29 deaths per 100 000 live births in 2020, compared with 39 deaths per 100 000 live births in 2003 *(23)*.

The neonatal mortality rate was 7.6 deaths per 1000 live births in 2020, compared with 26.9 deaths per 1000 live births in 2001. The infant (aged under one year) mortality rate was 12.5 deaths per 1000 live births in 2020, compared with 48.4 deaths per 1000 live births in 2001. The child (aged under five years) mortality rate was 13.9 deaths per 1000 live births in 2020, compared with 57.4 deaths per 1000 live births in 2001 *(23)*.

The birth rate has decreased from 20.523 births per 1000 people in 2020, to 19.875 births per 1000 people in 2021, to 19.226 births per 1000 people in 2022 *(24)*.

Uzbekistan has experienced an epidemiological transition from communicable to noncommunicable and chronic diseases over the past 10–20 years. In 2021, 61.7% of deaths were due to diseases of the circulatory system, 7.8% to neoplasms, 6.7% to respiratory diseases, 5.2% to accidents, poisonings and injuries, 4.1% to diseases of the digestive system, 3.1% to infectious and parasitic diseases, and 11.4% to other diseases *(13)*.

The most commonly registered infectious diseases in the past decade were influenza, acute infections of the upper and lower respiratory tract, acute intestinal infections and viral hepatitis *(13)*.

History of malaria and malaria control

Malaria parasites and vectors

In the past, three malaria species – *P. vivax*, *P. falciparum* and *P. malariae* – were registered in Uzbekistan. Since 1961, however, *P. vivax* has been the only malaria parasite known to be transmitted in the country. Indigenous *P. falciparum* was eliminated in the late 1950s. Single imported *P. falciparum* cases have been observed since, but no secondary cases occurred in any of these instances *(1, 25, 26)*.

Seven species of malarial mosquito are found in Uzbekistan *(27–35)*:

- *An. algeriensis* Theobald, 1903
- *An. artemievi* Gordeev et al., 2005
- *An. claviger* Meigen, 1804
- *An. hyrcanus* Pallas, 1771
- *An. martinius* Shingarev, 1926
- *An. pulcherrimus* Theobald, 1902
- *An. superpictus* Grassi, 1889.

An. artemievi and *An. martinius* are twin species that do not differ morphologically. They may be identified only by genetic markers and the structure of polytene chromosomes. Both species belong to the *An. maculipennis* complex, which consists of several more species that are very similar morphologically *(28, 35)*.

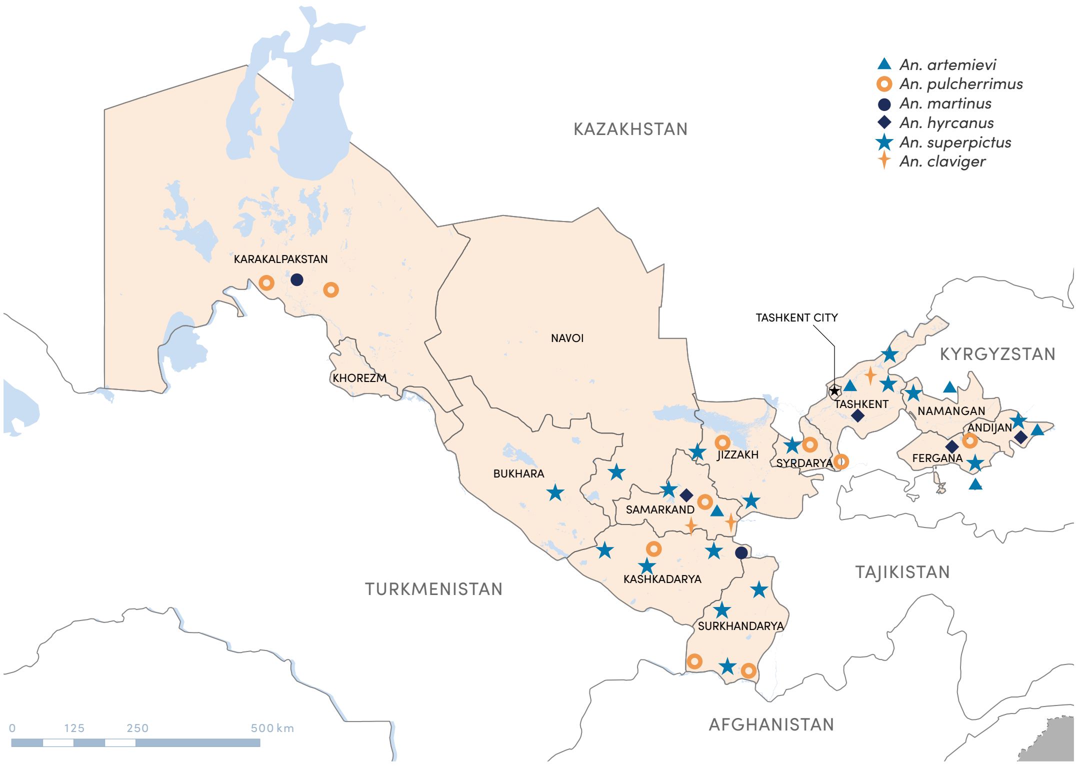
In Uzbekistan, several physiographic regions have been defined on the basis of variations in the climatic and terrain features, and the species composition of vectors (Table 5, Fig. 6).

Table 5. Anopheles species in physiographic regions of Uzbekistan

Physiographic region	*Anopheles* species
Chirchik-Akhangaran	*An. artemievi* *An. claviger* *An. hyrcanus* *An. superpictus*
Fergana	*An. artemievi* *An. claviger* *An. hyrcanus* *An. superpictus*

Physiographic region	*Anopheles* species
Kashkadarya	*An. martinius* (limited distribution) *An. pulcherrimus* (extremely rare) *An. superpictus*
Kyzylkum	Almost no breeding grounds or malaria vectors
Lower Amudarya	*An. martinius* *An. pulcherrimus* (98.3%)
Mirzachul	*An. artemievi* *An. claviger* *An. hyrcanus* *An. pulcherrimus* *An. superpictus*
Surkhandarya	*An. claviger* *An. hyrcanus* *An. pulcherrimus* *An. superpictus*
Ustyurt	Almost no breeding grounds or malaria vectors
Zarafshan	*An. artemievi* *An. hyrcanus* *An. pulcherrimus* *An. superpictus*

Fig. 6. Distribution of *Anopheles* species in Uzbekistan



Source: Adapted from Zhakhongirov SM, Muminov MS, Ponomarev IM, Shokirov MK. Detection of *Anopheles artemievi* (*Diptera, Culicidae*) in Uzbekistan [in Russian]. Med Parasitol Parasit Dis Moscow. 2011;1:31–33.

The main characteristics of *Anopheles* mosquitoes in Uzbekistan are presented in Annex 2.

Malaria in the past

Previously, malaria was one of the most widespread diseases on the territory of present-day Uzbekistan, which had a negative influence on the social and economic development of the country until the middle of the twentieth century. The largest outbreaks of malaria were registered in the former Turkestan in 1892–1893, 1902–1903 and 1921–1923, related to river floods.

In 1892–1905, 39 640 people died of malaria (11% of the entire population of the province) in Tashkent province, 12.3% in Chinaz, 17% in Pskent, and 35.6% in Toi-Tyube.

In 1917, of the prisoners of war in Zolotaya Orda infected with malaria, 68% contracted *P. vivax* malaria, 30% *P. falciparum* and 2% *P. malariae*. There were over 10 000 fatalities. Syrdarya province and the valleys of Surkhandarya and Zarafshan provinces were highly endemic. In the former Turkestan, 218 403 malaria cases were recorded in 1921, 173 738 in 1922, and 99 264 in 1923 *(3)*.

Control of malaria

In the process of controlling malaria as a mass disease in Uzbekistan, three main periods may be distinguished: setting up the antimalarial network, implementing scaled-up malaria control interventions, and an increase in malaria incidence during the Second World War.

Setting up the antimalarial network (1921–1929)

The creation of a network of antimalarial institutions started in the early years of Uzbekistan as a country. The first study on malaria epidemiology was launched in 1922 in Bukhara by a scientific team from the Moscow Tropical Institute and supervised by Dr LM Isaev. The Bukhara Tropical Institute, which was founded in 1923 and then moved to Samarkand in 1931, became a scientific and supervising centre for the control of malaria in Uzbekistan.

A network of antimalarial stations and centres coordinating activities, implementing vector control and providing treatment was founded. Malaria stations were established in 1921 at Golodnaya Step and Tashkent, and in 1922 in Samarkand. By 1924, about 30 antimalarial facilities and 10 temporary field units were operating. In 1927, 31 physicians and 37 nurses worked at antimalarial facilities – by 1952, their numbers had reached 448 and 1592, respectively *(3)*.

Implementing scaled-up malaria control interventions (1930–1940)

The establishment of the antimalarial service led to the improvement of malaria case detection. In 1930–1940, a total of 3 110 944 cases were registered. In 1932 alone, the incidence of malaria in Uzbekistan was 1474 cases per 10 000 people (717 721 cases). The incidence gradually dropped due to the intensive control activities conducted by the expanded specialized antimalarial network.

A major role was played by treating people with plasmocid and acrichine, clearing many malaria-hyperendemic foci, and implementing vector control activities, including reducing mosquito habitats, extensive drainage, rebuilding the irrigation network, adapting swampy areas for cotton plantations, and larval control with *Gambusia affinis* fish in water bodies (the latter introduced by Isaev in 1938).

Antimalarial activities were guided by key government documents. Malaria control was regarded as part of the national economic plan, with implementation mandatory for all ministries and departments.

During this period, Uzbekistan achieved considerable success in malaria control, and the total number of cases between 1935 and 1940 dropped to 164 600 *(3)*.

Increase of malaria incidence during the Second World War

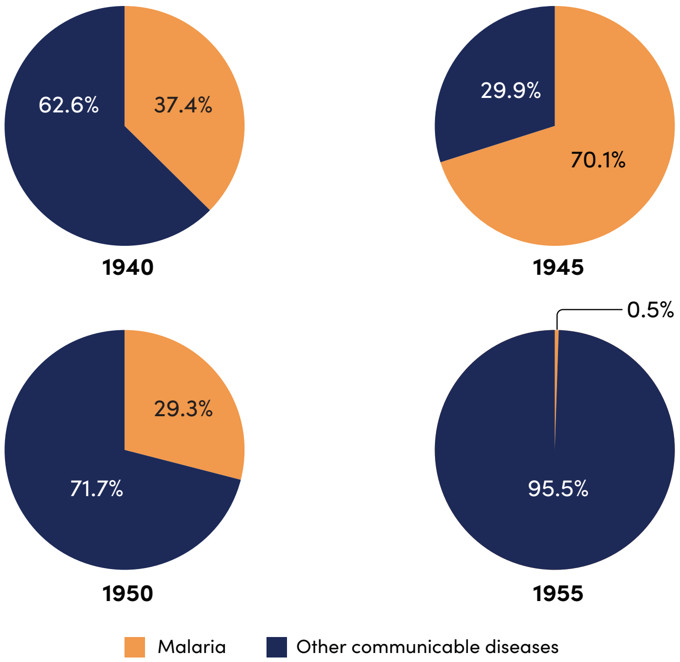
The outbreak during the Second World War significantly influenced the outcome of malaria control during the period 1941–1945 *(3)*. There was a dramatic rise in malaria incidence, with 2 133 405 malaria cases registered during this period. In 1943, the highest level of incidence was recorded – 943 cases per 10 000 people (520 695 cases). Malaria accounted for 37.4% of all cases of infectious diseases in 1940, but by 1945 this had reached 70.1% (Fig. 7).

The second World War saw many challenges, including evacuation of people from other parts of the Soviet Union to Uzbekistan, reduced provision of medicines, and increased areas of *Anopheles* breeding sites due to a decrease in malaria control measures *(1, 3)*.

Wide-scale antimalarial campaign with the goal of malaria eradication (elimination) (1946–1960)

In the post-war years, extensive measures were launched to control and eliminate malaria in Uzbekistan. An elimination (eradication) programme was launched in 1946, and the entire health network was upgraded and sufficiently staffed. In 1950, 149 malaria stations and 412 malaria posts were operating. In this period, a total of 1 372 915 malaria cases were officially registered. Malaria accounted for 29.3% of all cases of communicable diseases in 1950, but this had dropped to 0.5% in 1955 (Fig. 7) *(3)*.

Fig. 7. Proportion of malaria cases among all cases of communicable diseases, Uzbekistan, 1940–1955



Source: National report on malaria elimination in the Republic of Uzbekistan *(3)*.

The implementation of all antimalaria activities in Uzbekistan was guided by the principles of global malaria eradication adopted by the Eighth World Health Assembly in 1955 and by the WHO Expert Committee on Malaria Recommendations in 1956.

Complex malaria control activities were directed towards the source of infection (infected people), to the vectors, and to the protection of the population. Active case detection and radical treatment of people with *P. vivax* malaria with acrichine, plasmocid and bigumal were prioritized.

An important step was the designation of community health workers (a total of 1735 were employed in 1952) in collective farms, who were responsible for the distribution of acrichine tablets. All people with malaria were registered and followed up for 18 months after treatment.

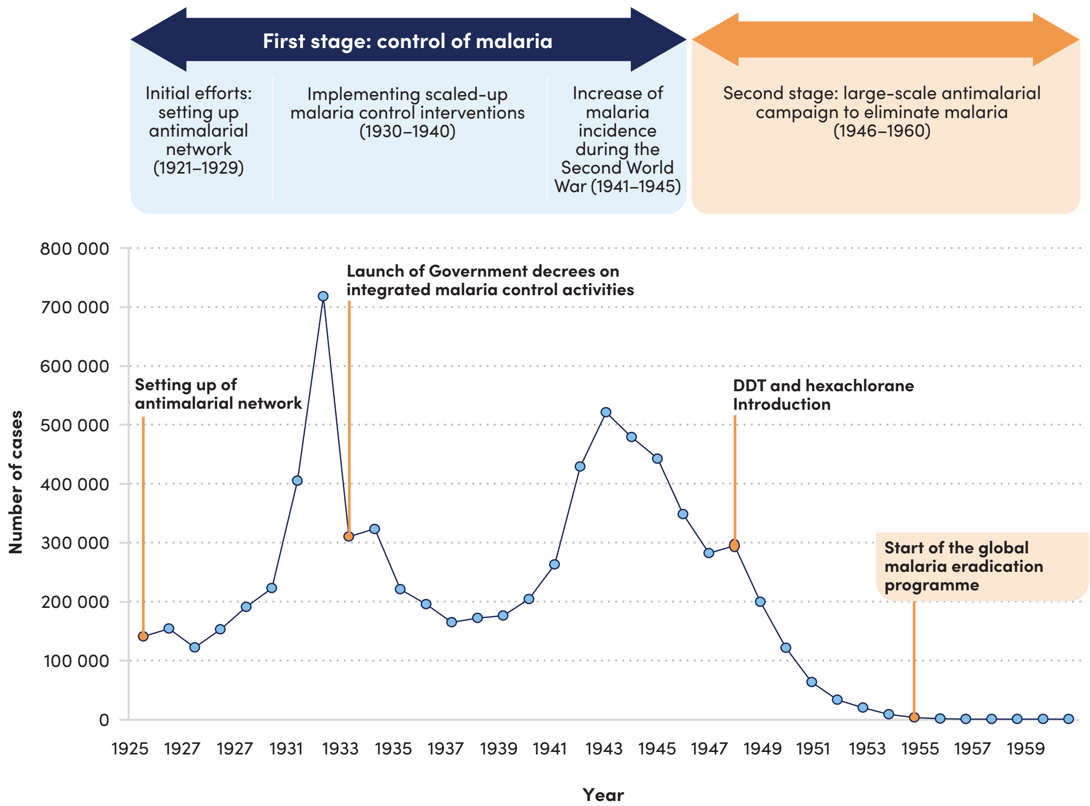
A major intervention in the elimination programme was the wide use of the powerful insecticides dichlorodiphenyltrichloroethane (DDT) and hexachlorane. The extent of indoor residual spraying, launched in 1947, increased every year, and by 1954 a total of 538 million m^2 had been sprayed. In 1955, 114 million m^2 of indoor space were sprayed *(3)*.

Mosquito larval control was implemented universally. In 1946–1954, a total of 148 000 hectares were sprayed from the ground and over 980 000 hectares from the air. A total of 14 391 hectares of breeding sites were treated with mineral oil and 136 841 hectares with Paris green. *G. affinis* fish were introduced into 118 000 hectares of water reservoirs.

Environmental management was conducted by the Ministry of Agriculture and the Ministry of Water Resources Management and other departments. In 1946–1950, 17 000 hectares of swamps were drained, and over 3400 km of the drainage network was cleaned *(3)*.

As a result of the complex measures applied, and of combining interventions against the source of infection with interventions for vector control, malaria in Uzbekistan was eliminated (Fig. 8). In 1953, 19 512 malaria cases were detected in 2802 (27.9% of all) settlements; in 1959, there were 49 malaria cases in 30 (0.3%) settlements; and in 1960, only 11 malaria cases were registered. In 1961, no indigenous malaria cases were detected in the country. The local transmission of malaria was interrupted *(3)*.

Fig. 8. Stages of malaria control and elimination in Uzbekistan, 1921–1960



Malaria-free period (1961–1979)

As local transmission was interrupted, malaria surveillance activities decreased, but the areas bordering Afghanistan and Tajikistan remained highly vulnerable. Due to malaria importation from abroad and delayed detection of sporadic locally acquired *P. vivax* cases, several small-scale (three to nine cases) outbreaks were registered. In 1962, in the Boysun district of Surkhandarya province, three *P. vivax* cases were detected. Local outbreaks of *P. vivax* malaria arose in 1966–1967 in the same district, and in the Termez district of Surkhandarya province bordering Afghanistan. All outbreaks were promptly contained *(1, 2, 25, 26)*. During this period, a total of 245 cases, mainly imported, were registered.

To prevent the re-establishment of local malaria transmission, vector control measures continued. *G. affinis* fish were introduced to an area of 2400 hectares in 1971–1975, swamp land was drained and filled, and indoor residual spraying was applied, on epidemiological indications, in higher-risk areas *(36)*. In parallel, expertise in malaria diagnosis and case management was maintained.

Re-establishment of local malaria transmission and malaria control (1980–2005)

The epidemiological situation worsened in connection with military operations in Afghanistan in 1980–1989 and the subsequent withdrawal of troops from Afghanistan, when malaria importation by soldiers increased. In 1986–1988, isolated introduced and indigenous *P. vivax* cases were detected along with some small-scale outbreaks in the Papsky district of Namangan province and in Termez province (Figs 9 and 10).

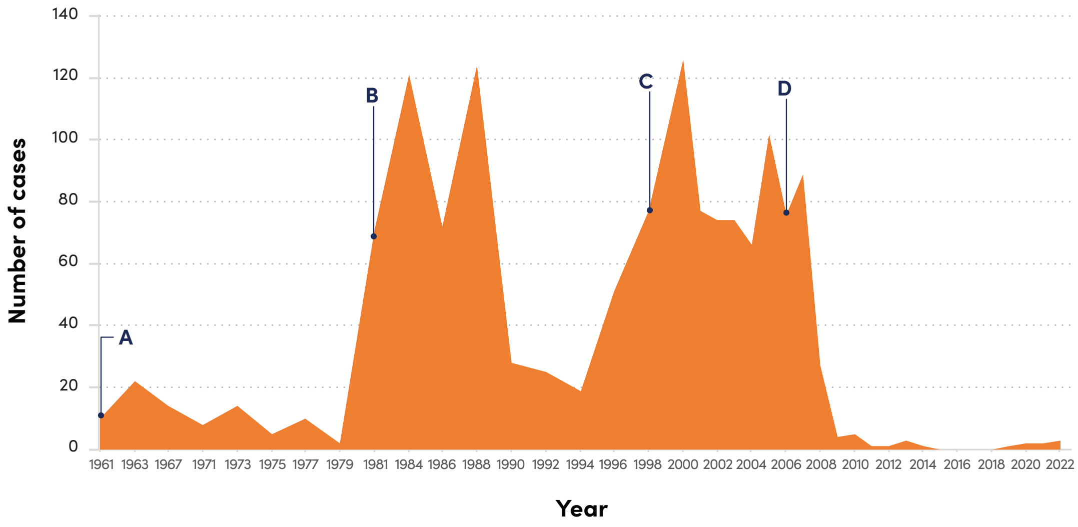
The situation changed dramatically in 1994, when a large-scale epidemic in Tajikistan developed. Numbers of imported cases in Uzbekistan increased sharply in 1998–2000, with almost all cases reported from the province of Surkhandarya in the south, resulting in registration of locally acquired *P. vivax* cases (Figs 9 and 10), *(1, 5, 37, 38)*.

All regions along the border with Tajikistan were affected, where there was intensive migration of the population. In 1999, 85 *P. vivax* cases were detected (Figs 9 and 10), seven of them introduced *(37)*. In 2000, the number of cases increased to 126; of these, 46 were locally acquired, of which all were registered in the border areas of Surkhandarya province *(1)*. During this period, locally acquired *P. vivax* cases were registered in the southern provinces of the country bordering Afghanistan and Tajikistan: in the Fergana Valley, in Kashkadarya and Surkhandarya provinces, and in Tashkent province.

In the post-elimination period after 1961, *P. vivax* was the cause of all cases of local transmission. All registered *P. falciparum* cases were imported, and there were isolated fatalities.

The Ministry of Health responded by strengthening the surveillance system and undertaking intensified malaria control interventions, backed up by regulations including decrees and a national programme of malaria surveillance in 2000. The reinforced control and surveillance operations brought about a gradual decrease in the total number of malaria cases *(1, 5, 6)*.

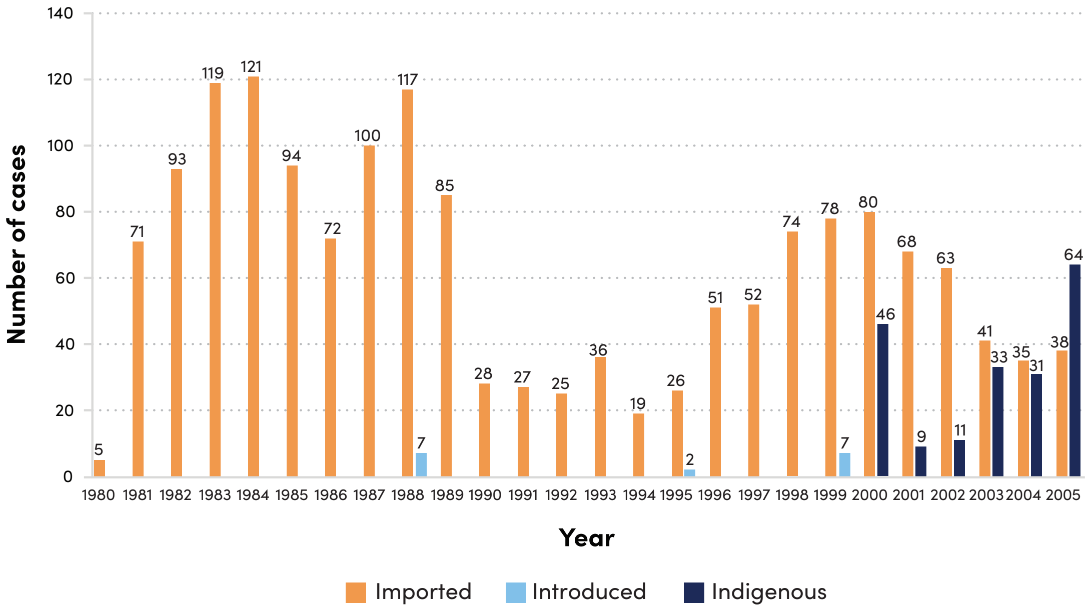
Fig. 9. Malaria cases in Uzbekistan, 1961–2022



A – first malaria elimination; B – massive malaria importation from Afghanistan; C – massive malaria importation from Tajikistan, and scaling-up of the malaria control programme activities; D – start of National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan.

Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Fig. 10. Malaria cases in Uzbekistan, 1980–2005



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Malaria elimination (2006–2010)

The results of malaria control inspired Uzbekistan to move towards malaria elimination. In 2005, Uzbekistan signed the Tashkent Declaration: the Move from Malaria Control to Elimination in the WHO European Region *(39)*. In accordance with the WHO recommendations and the Regional Strategy: From Malaria Control to Elimination in the WHO European Region, 2006–2015 *(40)*, the National Malaria Control Programme was reoriented towards elimination.

As a result of successful elimination interventions, a large reduction in malaria incidence was achieved *(25, 26, 38)* (Fig. 9). Decreases in the number of imported cases and in the consequences of importation were registered. The number of indigenous malaria cases dropped from 60 in 2006, to 16 in 2008, to three in 2010. The last indigenous *P. vivax* cases were registered in 2010 (see Annex 3). Since 2011, only isolated imported cases have been registered. Active malaria foci in Surkhandarya province were cleared, and the number of foci dropped from 42 in 2005 to two in 2010 *(3, 25, 26)*.

Prevention of malaria re-establishment and certification of malaria elimination (2011 onwards)

The National Malaria Control Programme conducted activities directed at preventing a resurgence of malaria in areas that were already malaria-free while Uzbekistan was still eliminating malaria. After the interruption of malaria transmission all over the country, the Government transitioned to preventing malaria re-establishment countrywide, guided by the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan (2017–2021) *(41)*. The National Strategic Programme is supported and financed by the Government and carried out under the supervision of the Ministry of Health, with the participation of other ministries, departments and organizations.

In 2017, Uzbekistan signed the Ashgabat Statement: Preventing the Re-establishment of Malaria Transmission in the WHO European Region with nine other countries in the region that had experienced a malaria resurgence followed by malaria elimination *(42)*.

Uzbekistan targeted official validation and recognition of the interruption of local malaria transmission and applied for WHO certification. In 2018, Uzbekistan was certified by WHO as malaria-free *(8)*. It is continuing to implement the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan.

In 2007–2009, no malaria importation was reported. In 2010–2022, single imported *P. vivax* and *P. falciparum* cases were detected without any epidemiological consequences. Other malaria species were not found.

Factors contributing to malaria re-establishment

Many factors influenced receptivity and risk of importation (vulnerability), contributing to the deterioration of the malaria situation and resurgence of local malaria transmission in Uzbekistan.

Receptivity

After the first malaria elimination, in several parts of Uzbekistan the climate and terrain remained favourable for malaria vectors. Malaria vectors were still present, and former malaria areas of the country remained receptive to a resumption of transmission. There was an increase in areas of *Anopheles* breeding sites in connection with economic activities, such as the creation of rice fields and fish farming *(1)*.

Risk of importation (vulnerability)

Malaria importation increased in the 1980s with the return of demobilized troops from Afghanistan, followed by the breakup of the former Soviet Union. Locally acquired *P. vivax* cases appeared and active foci of local transmission arose as a result, but the reinforced antimalarial interventions managed to clear them.

From 1996, another wave of increased malaria importation to Uzbekistan was registered due to the epidemic in the neighbouring Tajikistan (which started in the 1990s) and intensive migration from the neighbouring country (see the section "Re-establishment of Local Malaria Transmission and Malaria Control (1980–2005)"). As a result, local transmission of *P. vivax* malaria was re-established in the regions along the Tajikistan border. For Uzbekistan, malaria became a real health problem again in the 1990s.

Data suggest that infected mosquitoes can fly across river barriers. Entomological studies show that in the Termez district of Surkhandarya province, *An. pulcherrimus* and *An. hyrcanus* could easily fly from the Afghan bank to the Uzbek bank of the 750 m-wide Amudarya River *(43–45)*. People living or working in Uzbekistan close to the border might have been exposed to infected mosquitoes originating from the neighbouring Afghanistan, where malaria was endemic.

Programmatic factors

After the first malaria elimination in 1961, for many years there were only isolated malaria cases and no serious epidemiological consequences. It is likely that the malaria surveillance system weakened and was not able to respond quickly to the increased risk of importation and receptivity in Uzbekistan. Delayed diagnosis and treatment, especially in rural areas, and late reporting contributed to the re-establishment of local transmission.

Another important factor was the insufficient supply of antimalarial medicines to treat the first cases, and of insecticides for vector control interventions at the beginning of the resurgence.

The primary response did not happen quickly enough, the imported and first introduced cases were not identified and treated properly, and vector density was not rapidly reduced – and so local transmission expanded.

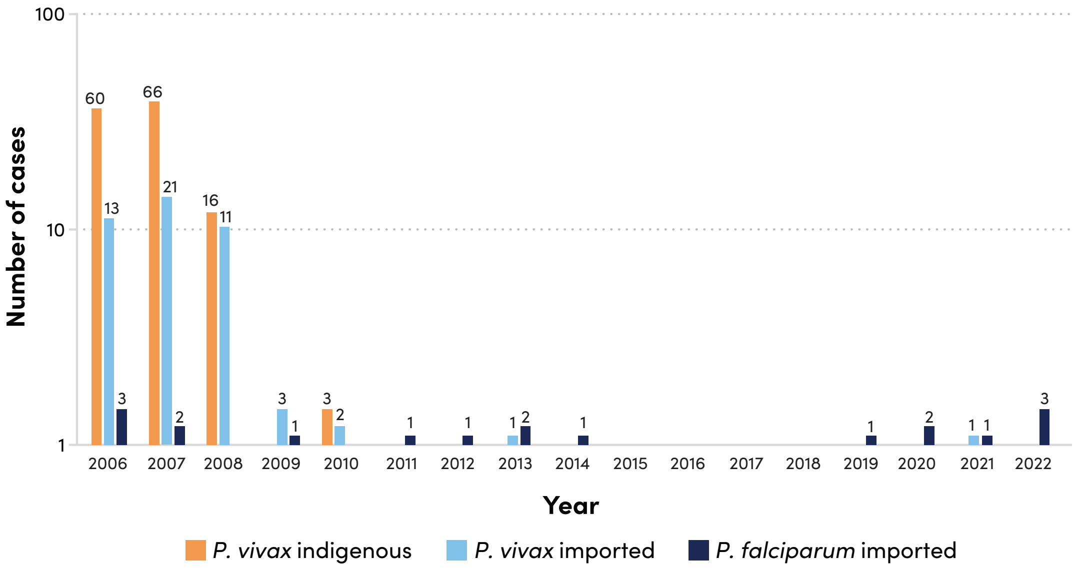
Epidemiological features of malaria during malaria elimination and prevention of re-establishment

Malaria cases

Since the launch of malaria elimination, a total of 215 malaria cases have been officially registered (145 indigenous, 70 imported) in 2006–2022 (Fig. 11). All locally acquired cases were caused by *P. vivax*. Of the 70 imported cases, 74.29% were caused by *P. vivax* and 25.71% by *P. falciparum*. Other imported *Plasmodium* species were not detected. *P. vivax* is more adaptive to local vectors, which creates a major risk for local transmission as a consequence of importation.

In 2006–2010, the total number of cases was 201. Of these, 145 (72.13%) were locally acquired *P. vivax* cases and 56 (27.87%) were imported cases (50 *P. vivax*, six *P. falciparum*) (Fig. 11). Since 2008, the number of indigenous and imported cases has dropped dramatically. Since 2011, no locally acquired (indigenous or introduced) cases and only 14 imported cases (two *P. vivax*, 12 *P. falciparum*) have been detected.

Fig. 11. Indigenous and imported malaria cases in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Distribution of malaria

During malaria elimination in 2006–2010, indigenous cases were detected in only three provinces. A total of 133 cases (91.7%) were found in Surkhandarya province, 11 cases in Kashkadarya province, and one case in Tashkent province (Fig. 12).

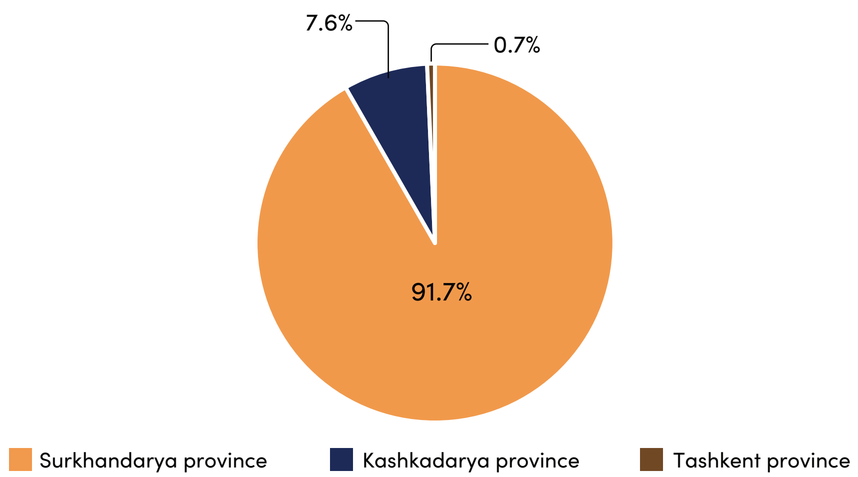
In 2006–2022, cases were imported to Surkhandarya province (35 cases, 50%), Tashkent city (13 cases, 18.57%), Fergana province (four cases, 5.7%), Kashkadarya province (three cases, 4.8%), Syrdarya province (three cases, 4.8%) and Tashkent province (four cases, 5.71%). There were also one or two cases in some other provinces (Fig. 13).

There was a correlation between the intensity of importation and the number of indigenous cases reported during the period of malaria elimination. Surkhandarya province was the most affected in the country by both importation and local transmission in 2006–2010, but in 2019–2022 only one imported case was registered in this province.

Two of the last three people with locally acquired malaria in 2010, who were residents of Syrdarya province, contracted the infection in Kashkadarya province. There were no epidemiological consequences following the detection of imported malaria cases in Tashkent city or Abdijan, Fergana, Jizak, Namangan, Navoy or Syrdarya provinces.

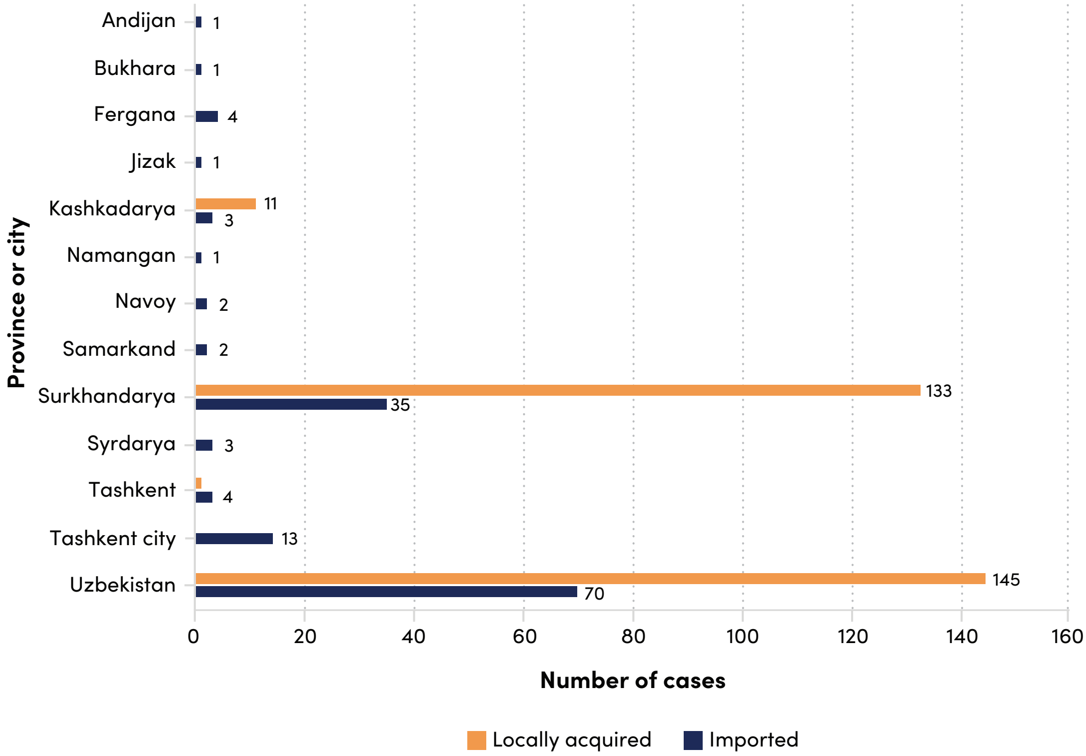
The malaria foci were simple (formed only by *P. vivax*) and functionally independent (they could exist through self-reproduction of cases).

Fig. 12. Distribution of indigenous malaria cases in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

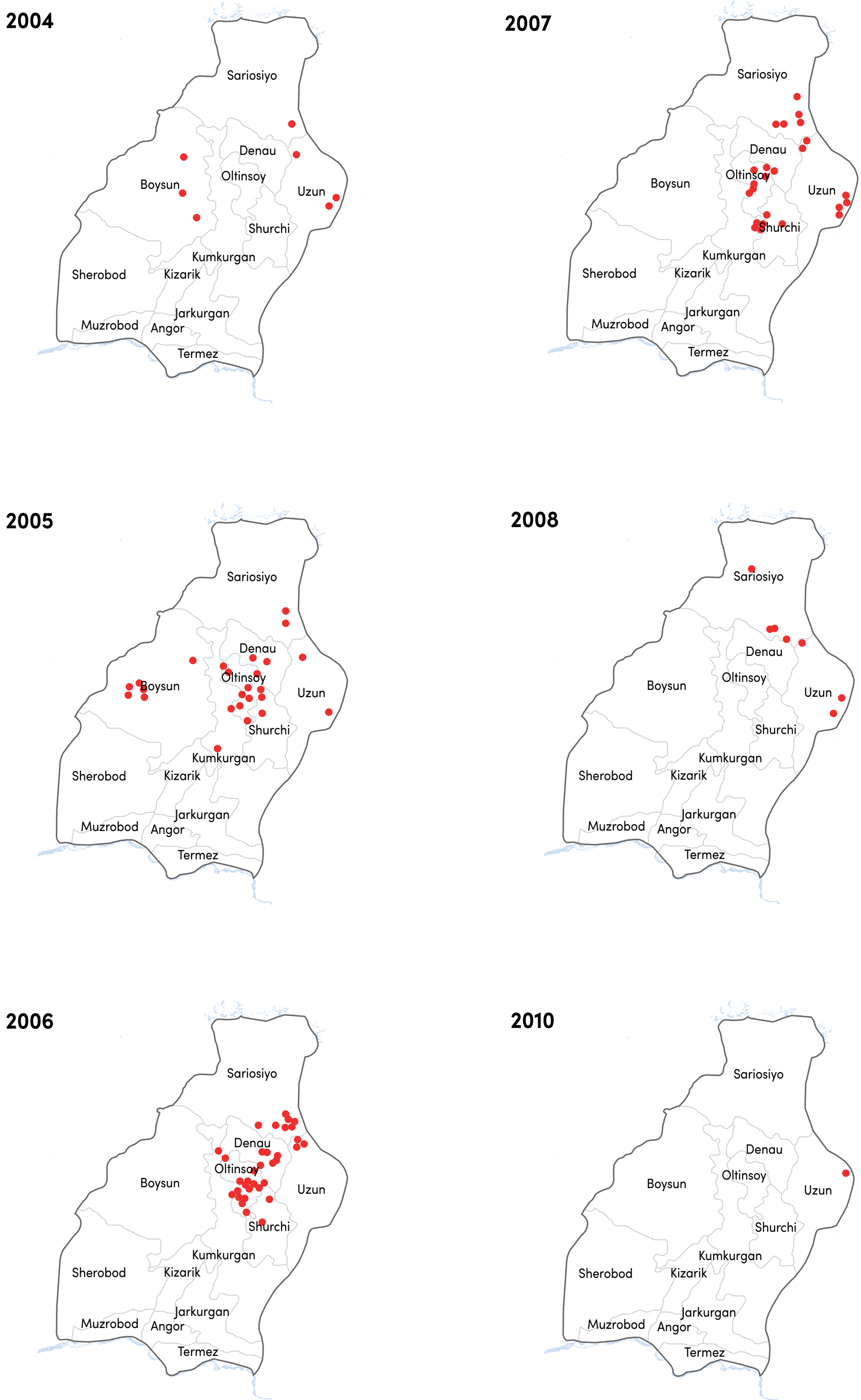
Fig. 13. Distribution of imported and locally acquired malaria cases in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

During the period of malaria elimination, and also historically, Surkhandarya was the most affected province. Surkhandarya benefited from the efforts of the malaria network through enhanced malaria surveillance and vector control interventions, which resulted in a gradual decrease in the malaria burden and the number of active foci (Fig. 14). This is an example of a successful malaria elimination programme.

Fig. 14. Active malaria foci in Surkhandarya province, Uzbekistan, 2004–2010



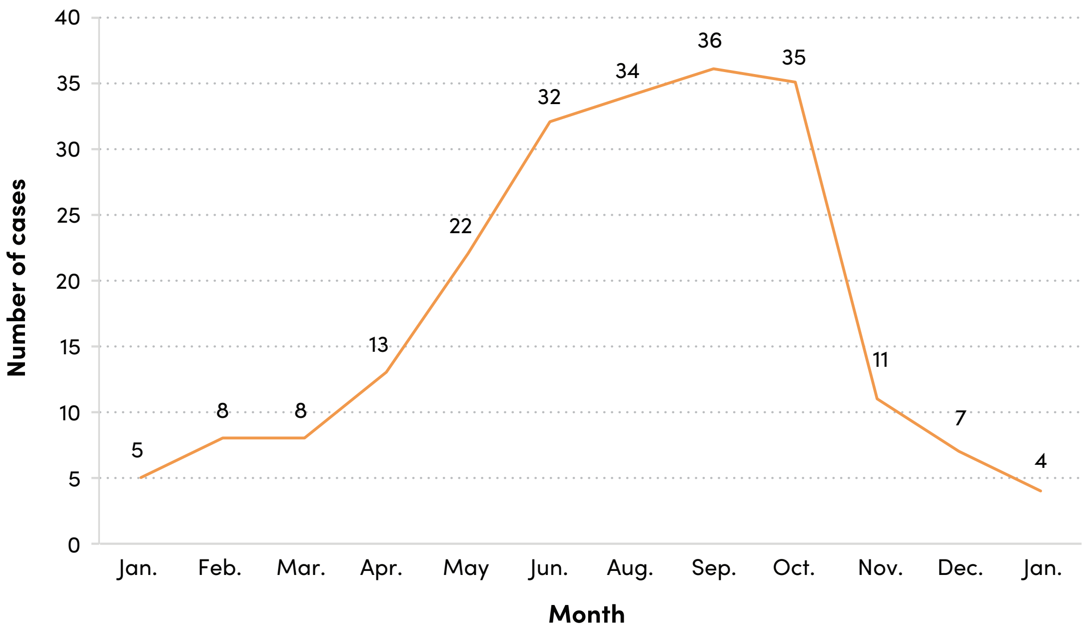
● = malaria focus.

Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Seasonality of malaria

Most malaria cases in 2006–2022 occurred during the malaria transmission season, from May to September, when 76.44% (159 cases) of all cases were registered (Fig. 15). Malaria importation during the malaria season creates a certain risk for the appearance and distribution of local malaria transmission if interventions are not adequate.

Fig. 15. Distribution of malaria cases in Uzbekistan, 2006–2022

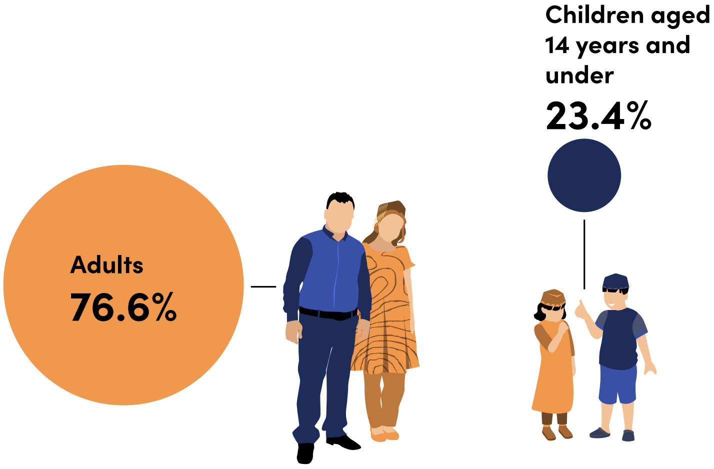


Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Populations most affected by malaria

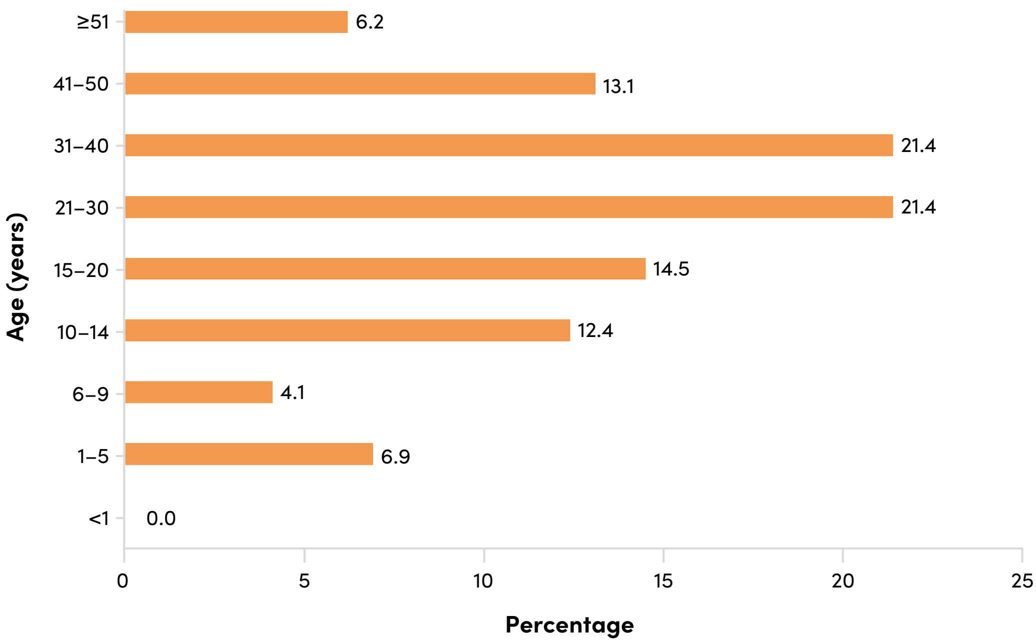
During malaria elimination, the majority of people with local malaria were adults (76.6%). Children aged 14 years and under accounted for the remaining cases (Fig. 16). The most affected age group was people aged 15–40 years (57.3%) (Fig. 17). This may be explained by the engagement of people from this age group in seasonal agricultural work. It is likely, however, that there was also a high rate of malaria transmission in households, as almost a quarter of infected people were children.

Fig. 16. Locally acquired malaria cases in adults and children in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Fig. 17. Age distribution of indigenous malaria cases in Uzbekistan, 2006–2010

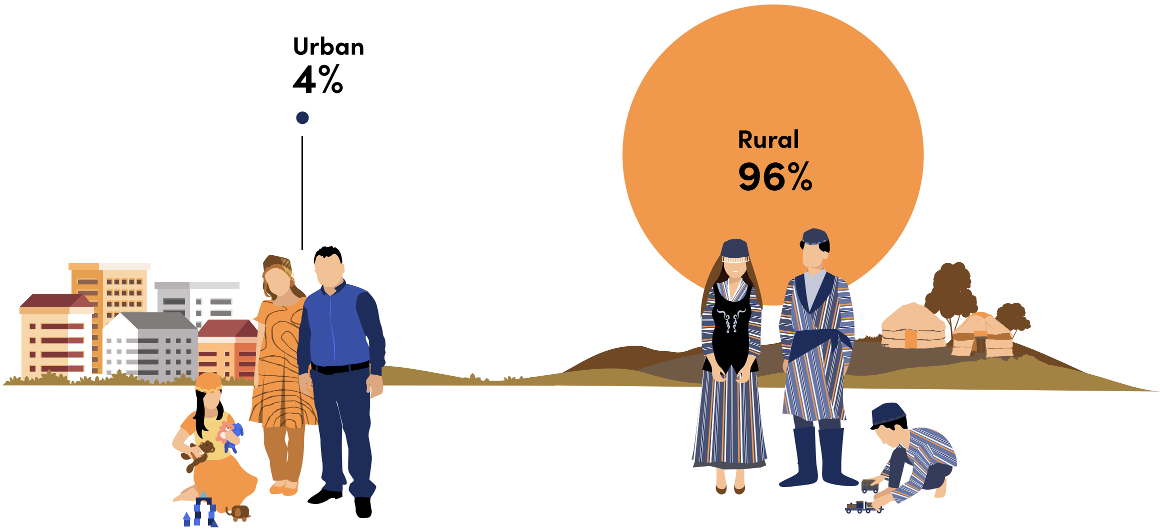


Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

In 2006–2010, the rural population was predominantly affected by local malaria (96%) (Fig. 18). Almost a third of all people with local malaria were engaged in seasonal agricultural work (27%), and another third were registered as officially unemployed or self-employed (28.3%; this category includes people occupied in trades and seasonal jobs, but often working in parallel in their own fields). Workers and employees accounted for 18%, schoolchildren and university students for 17%, and children not attending daycare institutions 9.7% (Fig. 19).

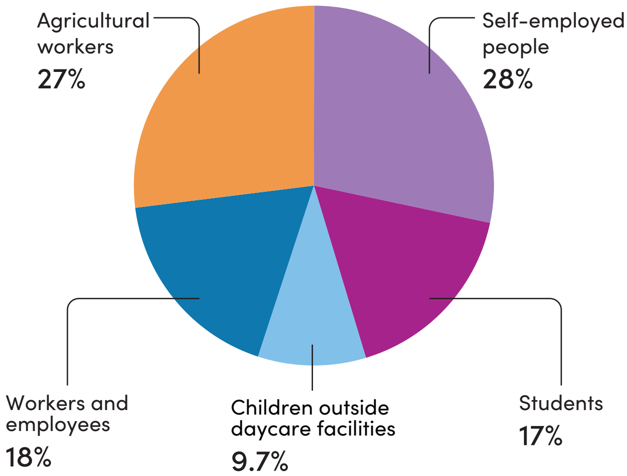
A large proportion of people with indigenous malaria were males (61%). It is likely that many men were more active in agriculture and farming, worked long hours outdoors, and were more vulnerable to contracting malaria.

Fig. 18. Distribution of locally acquired malaria cases among urban and rural populations in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

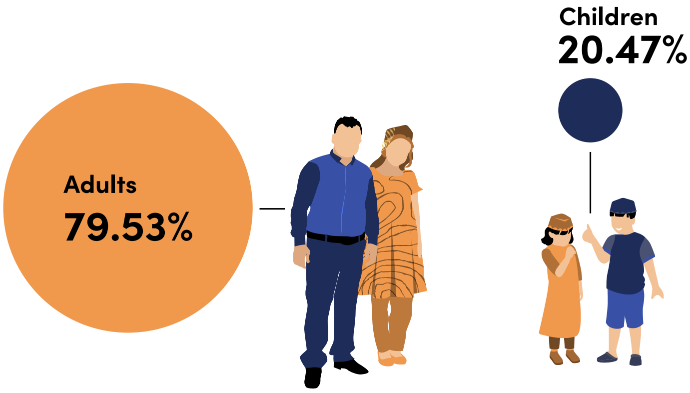
Fig. 19. Socioprofessional composition of people with indigenous malaria in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

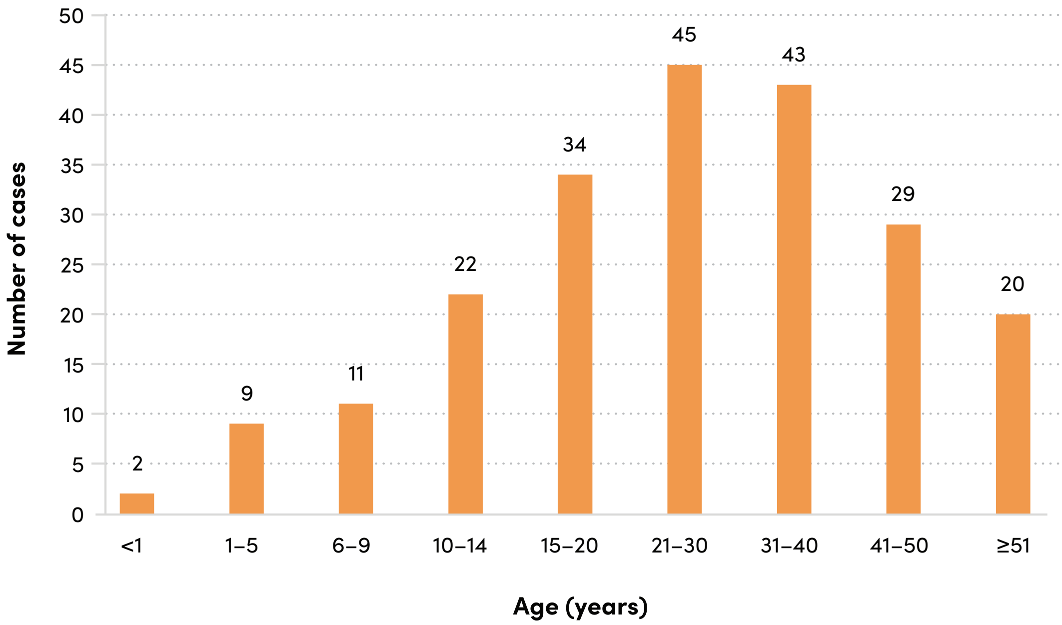
Analysis of data regarding imported malaria in 2006–2022 showed that most people were adults (79.53%). The most affected age group was people aged 15–50 years (70.23%) (Figs 20 and 21).

Fig. 20. Imported malaria cases in adults and children in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

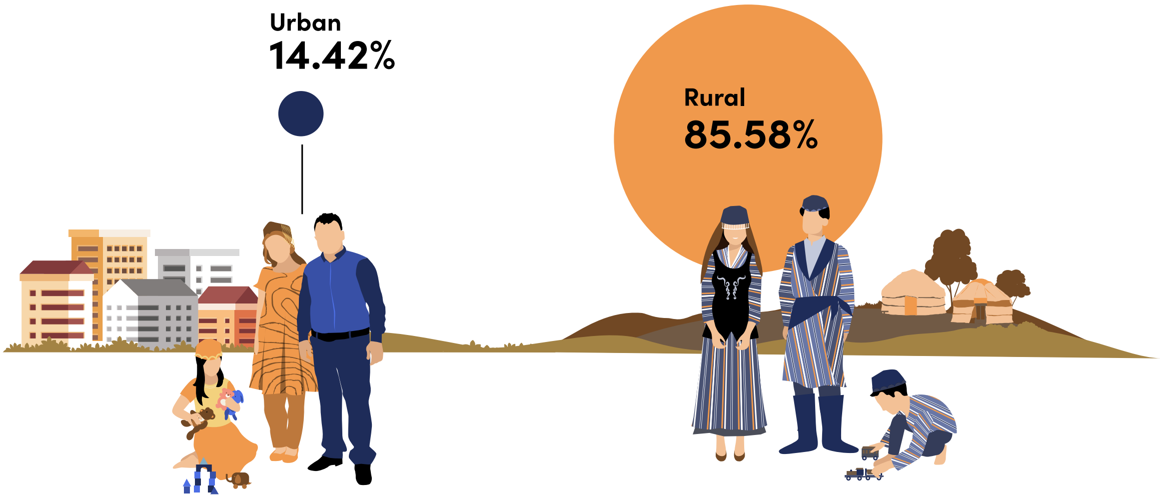
Fig. 21. Age distribution of imported malaria cases in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

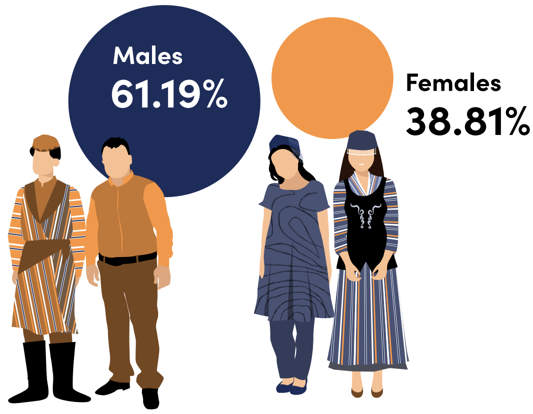
More rural residents (85.58%) than urban residents, and more males (61.19%) than females, were affected with imported malaria (Figs 22 and 23).

Fig. 22. Distribution of imported malaria cases among urban and rural populations in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Fig. 23. Distribution of imported malaria cases by gender in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

In 2006–2022, there was a large variety of socioprofessional groups importing malaria to Uzbekistan. Rural and seasonal workers accounted for the largest proportion of imported malaria cases (29.3%), followed by housewives (18.6%) and students (18.1%).

The majority of people with imported malaria were citizens of Uzbekistan (90.3%). Of these, 43% had visited relatives in Tajikistan and 57% had travelled to malaria-endemic countries for business or as hired seasonal labourers. Epidemiological investigation of malaria cases revealed gaps in prevention measures taken by these people, such as individual chemoprophylaxis and protection from mosquito bites *(3)*.

How was malaria controlled and eliminated again?

Malaria network

The malaria control and elimination programme was coordinated and conducted by the Ministry of Health SSES, headed by the Deputy Minister of Health (see the section "Health-care system and policies and health profile" and Annex 4). The national coordinator was the Republic Centre of State Sanitary Epidemiological Surveillance. Its branches – the Centres of State Sanitary Epidemiological Surveillance – were responsible for malaria control and surveillance at provincial, district and city levels. The key actors were staff members of the Departments of Parasitology, with a national reference laboratory at the Republic CSSES and 208 provincial and district-level CSSES laboratories. These departments were responsible for surveillance and control of all parasitic diseases, including malaria.

Mobile teams composed of epidemiologists, parasitologists, laboratory specialists, clinicians and entomologists were assigned to affected areas to facilitate antimalarial activities.

The responsibilities of the general health facilities that played an important role in malaria control and elimination are described in the following sections.

Private health-care facilities carried out passive case detection, laboratory diagnosis, registration and notification.

Staff training

Recognizing the key role of staff expertise in malaria, the National Malaria Control Programme strengthened staff capacity in laboratory diagnosis, disease management, surveillance, control and prevention.

Staff training was integrated into the national system for continuous professional education at the Tashkent Institute of Advanced Medical Education. Additional training was carried out at CSSES.

The Global Fund contributed to capacity-building of malaria network staff in 2005–2015. A training centre was created in Termez in Surkhandarya province, hosted by the city CSSES, which was a branch of the LM Isaev Research Institute of Medical Parasitology (Fig. 24) *(3)*.

Fig. 24. Malaria training for National Malaria Control Programme staff at LM Isaev Research Institute of Medical Parasitology, Samarkand, 2008

Source: photo courtesy of R. Kurdova-Mintcheva.

Key strategies and approaches

Malaria control and elimination activities were guided by contemporary policies and strategies legislated by a number of decrees, orders, regulations and guidelines of the Ministry of Health *(46–51)*.

In 2000–2004, the following main objectives of the National Malaria Control Programme in accordance with the malaria situation in different areas of the country were formulated *(47, 48)*:

- prevention of re-establishment of local transmission from imported cases (including internal importation) in the north-west of the country, where only isolated imported cases were recorded and in areas without importation and local transmission;
- prompt interruption of re-established local transmission in areas bordering Tajikistan, such as Kashkadarya province (except Surkhandarya, as such a target was not realistic at the time);
- limiting the transmission of malaria in Surkhandarya province, where many *P. vivax* malaria foci had been established, followed by its interruption.

Strategies for intensifying antimalarial activities after resumption of local transmission are summarized in Box 1.

Box 1. Strategies to intensify antimalarial activities after resumption of local transmission

- Vector control and entomological surveillance – including indoor residual spraying, larviciding, and environmental management.
- Scaled-up epidemiological surveillance and response – active (household visits) and passive case detection, improvement of laboratory diagnosis, radical treatment and follow-up of patients, registration and reporting, prompt response and epidemiological investigation of cases and foci.
- Mass prophylactic treatment with primaquine of the population in active malaria foci and of demobilized military personnel, and follow-up of demobilized military personnel over three years.
- Strengthening human resources and deployment of antimalarial mobile teams in regions bordering Afghanistan and Tajikistan.
- Health education of the population and social mobilization.

After stabilization of the epidemiological situation in the areas bordering Afghanistan and Tajikistan, and restriction of the wider distribution of malaria to the rest of the country, Uzbekistan moved towards malaria elimination. The main goals of the National Strategy and Action Plan on Malaria Elimination were (*51*):

- interruption of local transmission of *P. vivax* malaria in the country by 2015;
- prevention of re-establishment of malaria transmission in malaria-free areas.

The integrated approach of antimalarial activities was directed towards eliminating sources of infection, reducing and interrupting transmission, and protecting the healthy population.

Scaled-up epidemiological surveillance and response

The malaria surveillance and response system functioned throughout the whole country, regardless of the malariogenic potential or epidemiological situation. The aim was early case detection and treatment, notification and registration, and timely implementation of epidemiological investigation for each case and focus, with an appropriate response.

Case detection

Passive and active case detection were given special attention, depending on the epidemiological situation and the level of receptivity and vulnerability of the area.

Passive case detection was carried out by physicians and other health staff at all health-care facilities, including hospitals, polyclinics, and children's and youth health clinics. Peripheral general health services were central to the case detection effort. Vigilance was reinforced throughout the country so that all people who sought treatment and presented with suspected malaria symptoms were examined for malaria as soon as they contacted the health services.

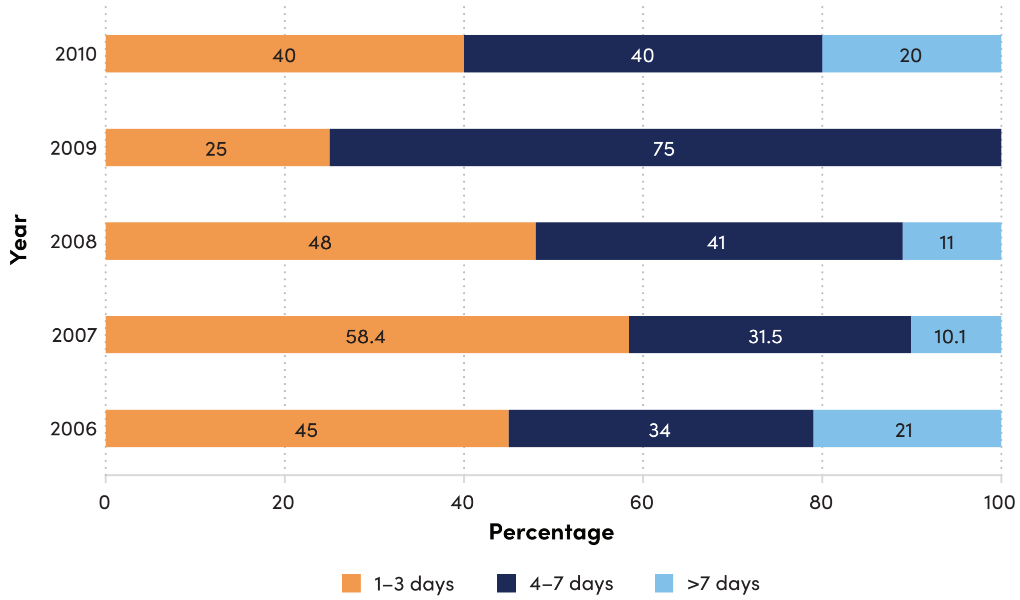
Indications for malaria testing included:

- periodic rises in temperature and chills;
- fever for four days or more despite treatment being carried out for the established diagnosis;
- fever for four days or more with an unestablished diagnosis or a diagnosis of fever of unclear aetiology;

- hepatosplenomegaly, jaundice or anaemia of unclear aetiology;
- history of travel to a malaria-endemic country or area;
- in blood donors, before giving blood;
- on registration or during follow-up of citizens arriving from malaria-endemic countries with clinical and epidemiological indications;
- during follow-up of people after treatment for malaria in any case of fever;
- laboratory examination of foreign citizens with clinical and epidemiological indications.

Between 2006 and 2010, although efforts were made to increase awareness of malaria among the general population, some people underestimated the importance of the disease or had insufficient information and delayed seeking treatment. In the first three days following the day of the onset of illness, 25–58.4% of people sought medical assistance; on the fourth to seventh days, 31.5–75%; and later, 10.1–21% (Fig. 25). In 2007, a person with imported *P. falciparum* malaria in Andijan died because he sought treatment too late.

Fig. 25. Timeframe from day of onset of malaria symptoms to seeking medical assistance in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Active case detection was carried out by primary health-care staff, mainly in rural medical centres and polyclinics, and by mobile teams.

Proactive case detection was based on active case detection of people with fever. At regular intervals (at least once every 14 days), home visits were conducted to collect blood samples (thin and thick blood films) from all people with current or recent fever in malaria-affected areas. Screening of the population at higher risk, such as foreign students, was also performed.

Mass screening was carried out in 2006–2015 in Surkhandarya province by mobile groups, as part of the Global Fund project (Table 6). In active malaria foci and border areas, 12 221 samples from residents were tested in laboratories. Two *P. vivax* cases were detected – one in the Uzun district (2006) and one in the Sariasi district (2007).

Reactive case detection was performed as a response to the epidemiological investigations of cases at places of residence and work. All contacts of a confirmed case were tested.

Between 700 000 and 800 000 blood samples were tested annually in Uzbekistan, including over 50% of cases with fever.

Table 6. Mass malaria screening by microscopy of the population of Surkhandarya province, Uzbekistan, 2006–2015

District	Number of people examined/number of detected *P vivax* malaria cases										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Altinsai	–	–	–	750	–	–	–	–	–	–	750
Baisun	–	–	–	–	303	–	–	–	–	–	303
Denauz	–	–	940	–	–	–	–	–	1009	49	1998
Sariasi	105	900/1	–	–	1031	–	335	573	–	20	2964/1
Shurchi	–	–	–	–	–	–	–	–	846	39	885
Uzun	110/1	1100	1012	1056	1219	–	239	164	404	17	5321/1
Total	215/1	2000/1	1952	1806	2553	–	574	737	2259	125	12 221

Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Laboratory support and external quality assurance

As of 1 January 2017, there were 2852 laboratories in Uzbekistan conducting microscopic diagnosis of malaria (208 at CSSES, 2644 at hospitals and health centres). The current numbers of laboratories and laboratory practices and procedures are similar to those in 2017.

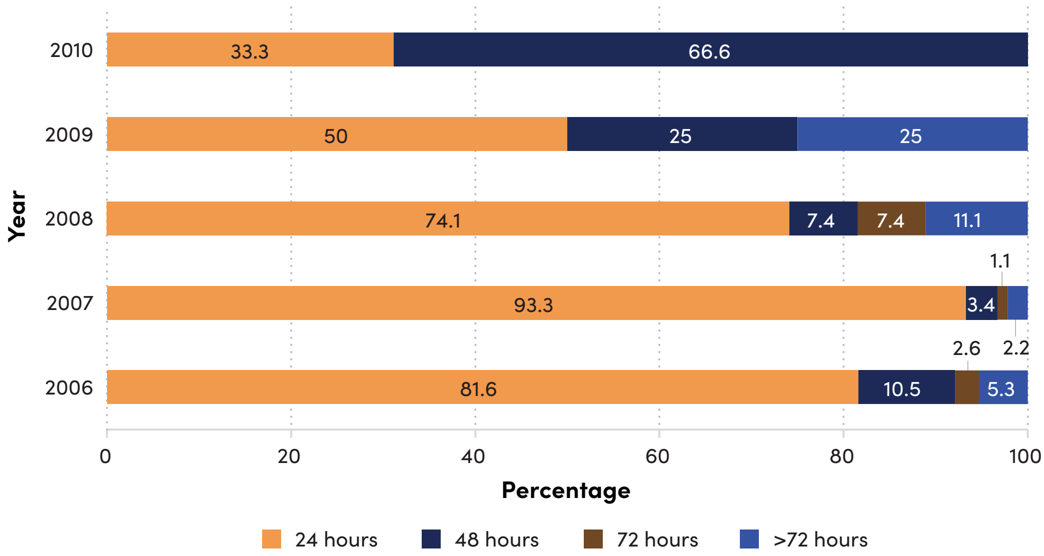
Laboratories are well staffed and equipped. Through the Global Fund grants in 2005–2015, 192 laboratories were upgraded and equipped with contemporary microscopes *(3)*.

All laboratories are guided in their work by a number of regulations *(52–55)*.

The primary laboratory diagnosis of malaria is carried out by clinical laboratories at health-care facilities. Malaria diagnosis is based on microscopic examination of Romanowsky Giemsa-stained blood slides (thin and thick blood films) according to standard operating procedures approved by the Republic Centre of State Sanitary Epidemiological Surveillance. Rapid diagnostic tests and polymerase chain reaction have not been used. All cases are laboratory-confirmed. When the examination takes place at a clinical laboratory, the diagnosis of malaria is confirmed by a CSSES laboratory before treatment is started. Malaria diagnosis and treatment are free of charge in Uzbekistan.

Analysis of laboratory data for 2006–2010 (during elimination) shows that in most cases, the diagnosis was made within 24–48 hours after seeking medical assistance (Fig. 26). There were some single cases of late diagnosis in 2006–2009. It is concerning that two of the last three cases detected in the country in 2010 were diagnosed after a long delay. The discrepancy between confirmed malaria diagnosis during cross-checking and the diagnosis of the primary laboratories in 2006–2010 was 22% of cases, which indicated the usefulness of diagnosis confirmation and showed the need to maintain expertise at primary-level laboratories.

Fig. 26. Timeframe from seeking medical assistance to laboratory diagnosis of malaria in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

A system of quality control of laboratory diagnosis has existed in Uzbekistan since the first elimination campaign, and it is periodically updated and improved. The national external quality assurance and control programme includes a system of cross-checking of slides and supervision of controlled laboratories at various levels. It covers malaria diagnostic laboratories (including the health-care facilities of the national railway) and is coordinated by the national reference laboratory at the Republic CSSES.

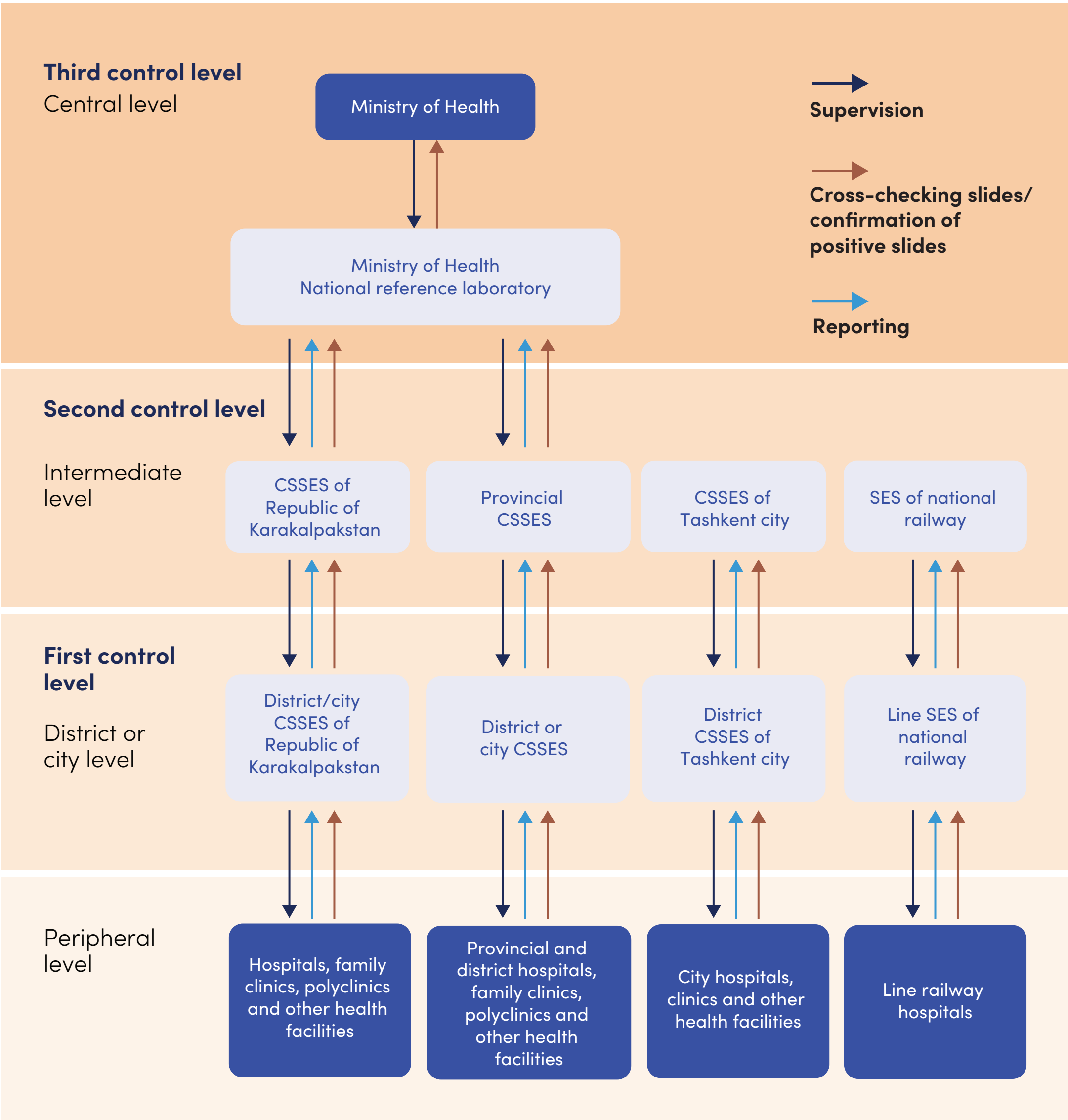
Confirmation of all positive slides and monthly cross-checking of at least 10% of all negative slides is conducted at three levels according to the approved standard operating procedures (Fig. 27): at district or city CSSES parasitology laboratories; at provincial, Tashkent city or Republic of Karakalpakstan parasitology laboratories; and at the national reference laboratory.

All malaria cases are confirmed by CSSES parasitology laboratories at all levels and reconfirmed by the national reference laboratory. The controlling laboratories send regular feedback on the cycles conducted to controlled laboratories. The national reference laboratory provides an annually summary on the quality control programme activities to all participating laboratories and to the Ministry of Health.

On the basis of the results analysed, the national reference laboratory and CSSES laboratories plan and hold training sessions for laboratory staff across the country.

The national reference laboratory is part of the international exercise for the external quality control of laboratory diagnosis of malaria. It was certified by the Parasitological Laboratory of the National Centre of Infectious and Parasitic Diseases in Sofia, Bulgaria.

Fig. 27. Structure and functions of the national external quality assurance programme for malaria laboratories in Uzbekistan, 2022



Case management

Treatment of malaria is well regulated, organized and conducted. All categories of the population have access to health-care services. Malaria treatment is free and is carried out in a timely manner in state provincial, city and district hospitals in infectious diseases clinics and wards; at Scientific Research Institute for Epidemiology, Microbiology and Infectious Diseases hospitals; and at LM Isaev Research Institute of Medical Parasitology hospitals.

According to the malaria treatment protocol, and in line with WHO recommendations, the radical treatment of *P. vivax* malaria consists of chloroquine phosphate 25 mg (base)/kg for three days and primaquine phosphate 0.25 mg (base)/kg for 14 days.

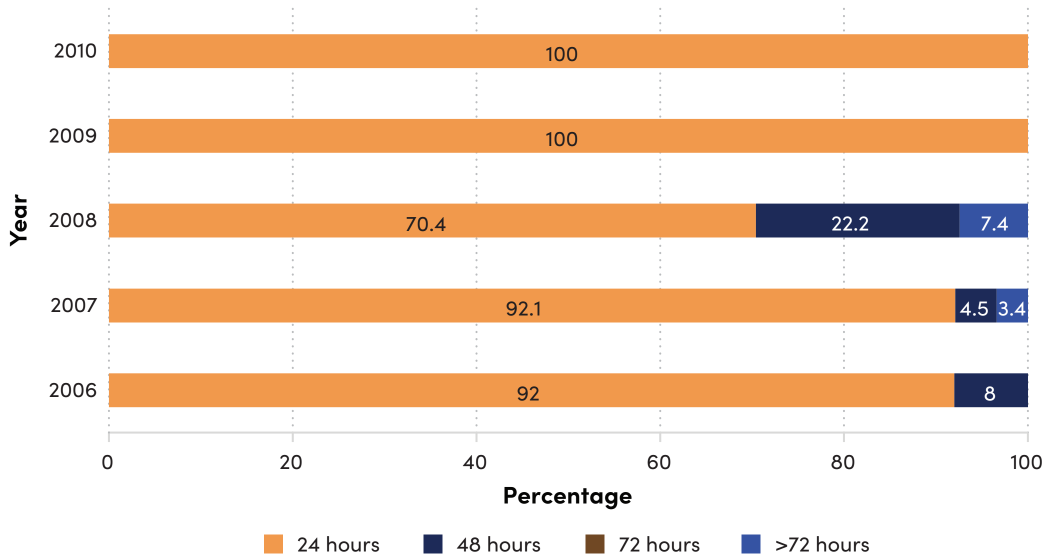
For imported *P. falciparum* malaria, combinations of antimalarial medicines are recommended – artemether-lumefantrine; artesunate plus amodiaquine; artesunate plus mefloquine; artesunate plus sulfadoxine-pyrimethamine; artesunate plus tetracycline or doxycycline or clindamycin and quinine plus tetracycline or doxycycline or clindamycin – depending on availability.

All people with falciparum malaria (except pregnant women and children aged under one year) are administered one dose (0.25 mg of active substance/kg) of primaquine on the first day of the treatment with artesunate combination therapy. Treatment is monitored and patients are followed up.

Medicines are procured centrally by the Ministry of Health. A supply of antimalarial medicines is stored at the Republic Centre of State Sanitary Epidemiological Surveillance. Medicines can be sent to the required destination in the country within hours.

In 2006–2010, most people with malaria (92–100%) received treatment within the first 24 hours of diagnosis (Fig. 28). In 2006–2008, a few people were treated within 48 hours (8–22.2%) or after more than 72 hours (3.4–7.4%).

Fig. 28. Timeframe from malaria diagnosis to starting treatment in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Epidemiological investigation of malaria cases and foci

Confirmed malaria cases and foci were subject to epidemiological investigation and classification by district or city CSSES staff. This approach has been applied since the first elimination efforts in the 1960s. Immediately after receiving a case notification, a team of a parasitologist and an entomologist, and sometimes extra specialists, conducted epidemiological investigation of the case and the focus, including entomological investigation.

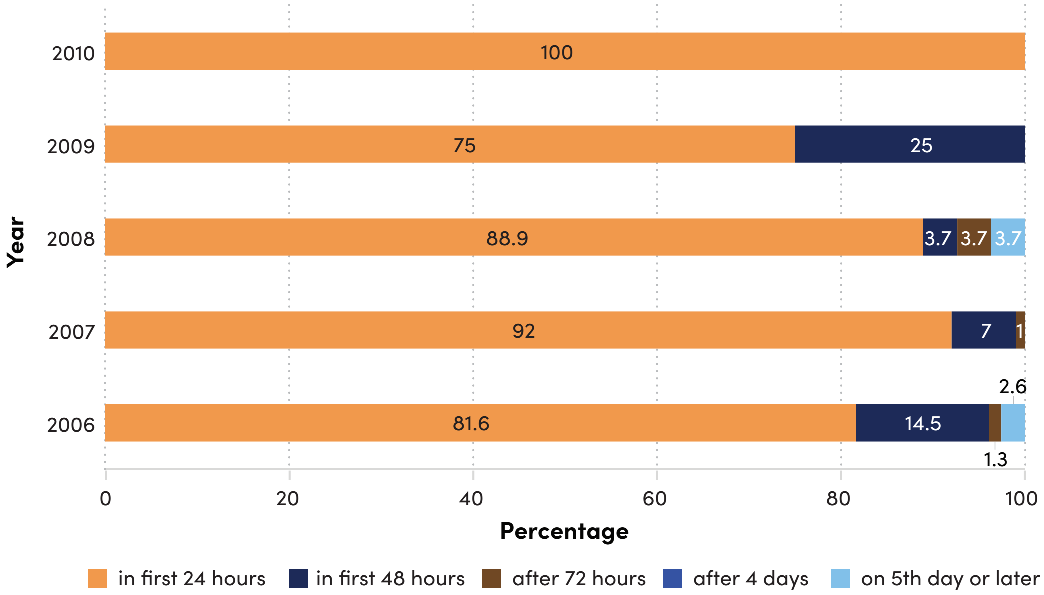
Conclusions were made regarding the place of contracting malaria, the source of infection, conditions that may have led to the emergence of local transmission and the spread of malaria, the presence of malaria vectors and breeding sites, the borders of the focus, and "contacts" of the case.

A case definition (indigenous, introduced, imported, induced, relapsing) and focus categorization (potential, pseudo, new active, residual active, residual non-active, cleared up) were used during malaria elimination according to WHO definitions *(56–58)*. A unified recording form was filled. All forms were kept at the district or city CSSES, and copies were sent to higher levels. The information on the focus was entered into a focus recording form, with mapping of every focus in accordance with the Ministry of Health guidelines, which were updated and maintained by CSSES *(49, 51, 52)*.

Following the investigation, response activities were planned and conducted.

The programme benefited much from the well-established practice of timely and comprehensive epidemiological investigations in Uzbekistan, with adequate and prompt responses targeting prevention of local transmission and further distribution of malaria. As a general rule, investigations were carried out within the first 24 hours of receiving a case notification, with a delay for only a few cases (Fig. 29).

Fig. 29. Timeframe of carrying out epidemiological investigation of a malaria case and focus in Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Monitoring of malaria foci

A local parasitologist and an entomologist periodically visited and inspected foci during malaria season. Household visits and follow-up of people treated for malaria (three years for *P. vivax*, one year for *P. falciparum*), entomological surveillance and health education of the population were carried out.

The information in the focus registering form was regularly updated and the focus classification was reviewed annually. In 2006–2010, there were 26 new active foci and 24 residual non-active foci. These were all cleared by 2013.

Information systems

Malaria is on the Ministry of Health list of diseases that require mandatory notification and registration *(59, 60)*.

Health workers who detect or suspect malaria cases are mandated to report them to the district or city CSSES within 24 hours of registration of a case. Information is sent to the provincial and Republic CSSES. All confirmed cases are registered in the register of infectious diseases at health facilities and in CSSES structures at all levels. A national register of malaria cases is maintained at the Republic Centre of State Sanitary Epidemiological Surveillance.

Lower CSSES levels send progressive and annual reports on the malaria situation and activities conducted to upper CSSES levels.

In 2011, an electronic information system for epidemiological monitoring of communicable diseases was introduced that brought about improvement and effective functioning of malaria surveillance at all levels.

Vector control and entomological surveillance

The malaria programme in Uzbekistan has a well-organized network of entomological specialists at all administrative levels of CSSES (see Annex 5). Staff are responsible for malaria vector control and entomological surveillance *(3)*. All interventions are well regulated, planned, and performed accurately and in a timely manner.

Indoor residual spraying was the primary vector control intervention during malaria control. Treatment of indoor spaces (residential and non-residential buildings and livestock barns) with insecticides was well legislated and carried out according to WHO recommendations *(61–63)* and national guidelines *(64)*. Indoor residual spraying was conducted by district SESS staff.

The list of disinfection, insecticidal and rat extermination chemicals registered and permitted in Uzbekistan is updated annually by the State Department for Sanitary and Epidemiological Surveillance. Synthetic pyrethroids (alpha-cypermethrin, alpha-cypermethrin + tetramethrin, beta-cyfluthrin, bifenthrin, deltamethrin, lambda-cyhalothrin) were predominantly used, along with organophosphate insecticides, carbamates and neonicotinoids.

The indoor residual spraying activities used in 2006–2010 are summarized in Table 7. In 2008, the total treated area was 13 437 643 m^2, 67 188 households were treated, and 403 129 people were protected.

Table 7. Indoor residual spraying in Uzbekistan, 2006–2010

Year	Total treated area (m^2)	Number of households treated	Number of people protected
2006	12 210 595	61 053	366 318
2007	13 019 194	65 096	390 576
2008	13 437 643	67 188	403 129
2009	10 988 080	54 940	329 642
2010	8 160 708	40 804	244 821

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Indoor residual spraying has been supplemented by the implementation of long-lasting insecticide-treated nets since 2005. These nets aim to protect people in malaria-affected areas from mosquito bites, preventing malaria infection and local transmission. They were provided and distributed free of charge by the Global Fund.

In Andijan, Fergana, Kashkadarya and Surkhandarya provinces, 99 600 long-lasting insecticide-treated nets were distributed between 2005 and 2013. The highly vulnerable population of Surkhandarya province was prioritized and received 90 600 nets. Nets were also provided for national railway workers building a railroad in Afghanistan *(3)*.

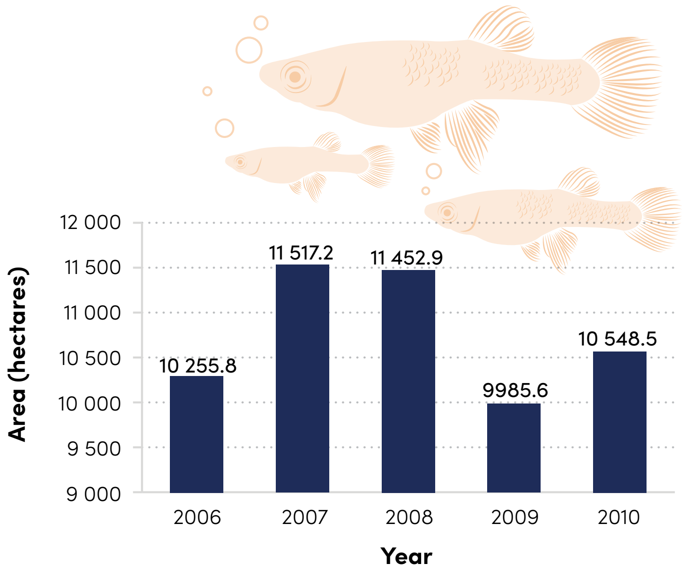
Larval control aims to reduce the larval source in water bodies during the malaria transmission season. Measures include treatment of water bodies with insecticides (pyrethroids, organophosphates, combined pyrethroids and organophosphates), diesel oil, bacterial products *(Bacillus thuringiensis)*, and distribution of *G. affinis* fish. Methods used in Uzbekistan were in line with WHO recommendations and local guidelines *(62, 64–67)*.

According to national reporting, areas of mosquito breeding sites of 11 517.2 hectares in 2007 and 11 452.9 hectares in 2008 were covered with larval control (Fig. 30) *(3)*.

Larval control was carried out all over the country, but special attention was paid to areas with higher malariogenic risk, such as Fergana and Surkhandarya provinces and Tashkent city *(3)*.

Larval control of water bodies continues as part of sandfly control, with the aim of reducing the mosquito population density in areas that have maintained high receptivity and risk of malaria importation.

Fig. 30. Total area of water bodies treated with larval control or with *G. affinis* fish introduced in Uzbekistan, 2006–2010



Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Environmental management is an important intervention directed towards receptivity by reducing areas of mosquito breeding sites by drainage and infilling of unneeded water bodies, repairing and cleaning collection and drainage networks, and improving and purifying reservoirs and irrigation networks. These interventions were guided by a number of documents *(62, 64, 68)*. A total of 44 630 030.1 m^2 were managed in 2006–2016 *(3)*.

Entomological surveillance

Entomological surveillance was applied all over the country, especially in the higher-risk areas on the border with Tajikistan. Surveillance included identification, registration and regular monitoring of vector breeding sites and mosquitoes at sentinel points during the malaria season by district entomologists; maintaining and annually updating registers of breeding sites at the district level; studying and collecting information on *Anopheles* mosquito species and their density, vector bionomics; and analysing meteorological data (Figs 31–35).

The information acquired formed the basis for defining the potential malaria season, planning adequate vector control interventions, and evaluating and stratifying the receptivity of areas in the country based on the risk of malaria transmission re-establishment. This approach is still being used.

Fig. 31. Stagnant-water breeding place of *An. pulcherrimus* and *An. hyrcanus* in Termez, Uzbekistan, 2016

Source: photo courtesy of A. Zvantsov.

Fig. 32. Breeding site of *An. superpictus* in Uzun district, Surchandarya province, Uzbekistan, 2016

Source: photo courtesy of A. Zvantsov.

Fig. 33. District entomologist monitoring a mosquito breeding site in Uzun district, Surchandarya province, Uzbekistan, 2016

Source: photo courtesy of A. Zvantsov.

Fig. 34. District entomologist inspecting mosquitoes inside a building in Uzun district, Surchandarya province, Uzbekistan, 2016

Source: photo courtesy of A. Zvantsov.

Fig. 35. Entomological surveillance documentation control in CSSES in Termiz, Surchandarya province, Uzbekistan, 2016

Source: photo courtesy of A. Zvantsov.

Resistance monitoring

Studies on insecticide resistance of malaria vectors were carried out by the LM Isaev Research Institute of Medical Parasitology in Samarkand. Widescale resistance studies were conducted in 2011–2013 in Tashkent province, and in 2012 and 2014 in Samarkand province. As a result of these investigations, it was determined that the primary malaria vectors in Uzbekistan – *An. superpictus*, *An. pulcherrimus* and *An. artemievi* – were sensitive to synthetic pyrethroids, which were the main insecticides used for indoor residual spraying *(3)*.

Raising awareness and vigilance of the population

The participation of the entire population was important to control and eliminate malaria in the country. To raise people's awareness about malaria prevention, Uzbekistan used a number of channels to disseminate information.

A health education programme for the population was developed. CSSES at all levels organized seminars on prevention of malaria for sanitary workers, advisors of *mahalla* committees and primary school teachers. Special attention was given to the malaria-endemic provinces of Kashkadarya and Surkhandarya.

Extensive work was carried out to raise awareness about malaria, including television and radio broadcasts, publications in national and local newspapers and magazines, question-and-answer sessions, roundtables, seminars, talks and lectures. A total of 179 959 leaflets, posters and documentary films on malaria prevention were developed and distributed (Fig. 36) *(3)*.

Fig. 36. Health education materials on malaria for the general population in Uzbekistan

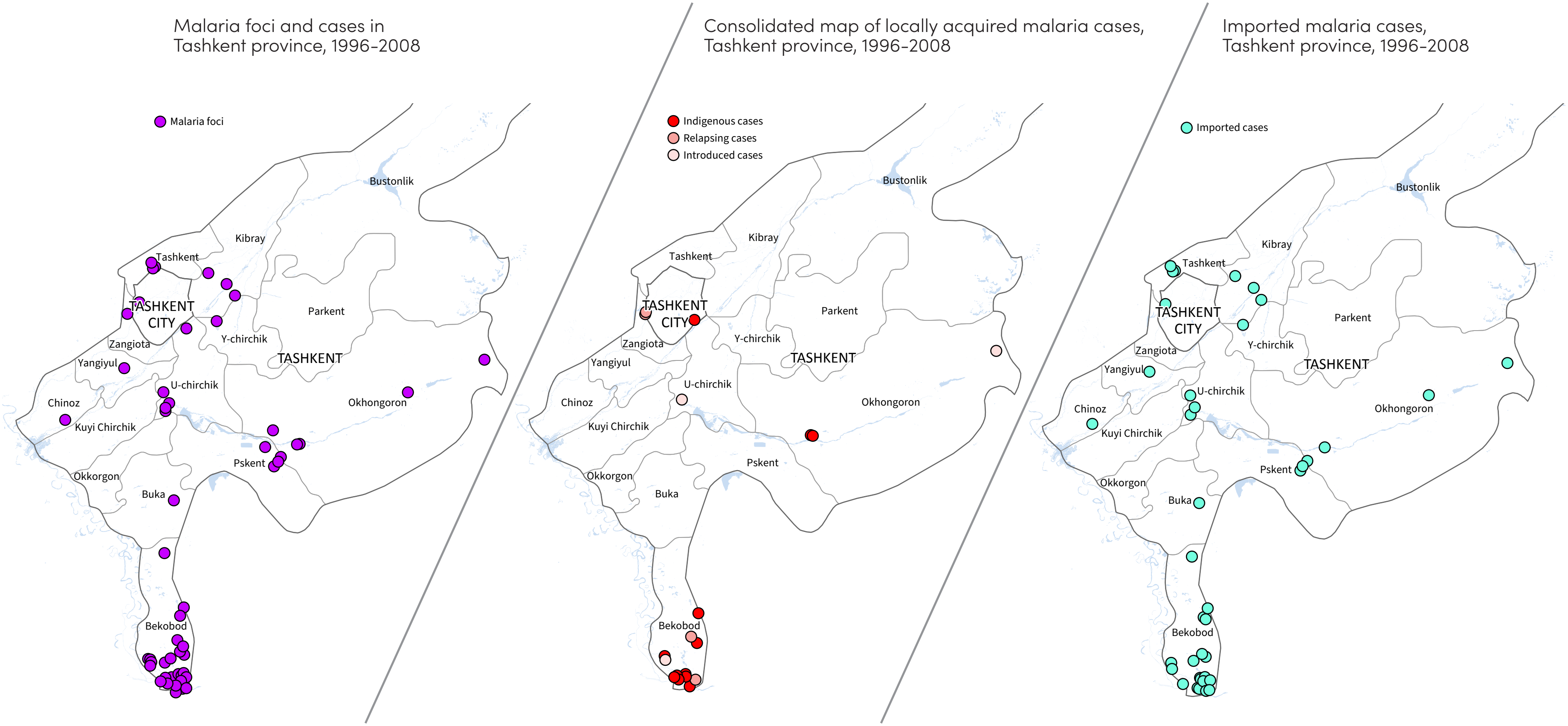
Applied research

Applied studies were carried out on topics relevant to Uzbekistan in the field of malaria surveillance, control and prevention, including the clinical course and epidemiology of malaria; resistance of malaria vectors to insecticides; spread, bionomics and genetic structure of malaria mosquitoes; and stratification of the territory and monitoring of malaria foci (Box 2). The programme benefited from the financial support of the Global Fund and the Ministry of Health *(3)*.

Box 2. Applied research studies in the field of malaria surveillance

- Studies were conducted on the biology, ecology, phenology, dynamics, bionomics and spread of species of malaria mosquitoes in Uzbekistan.
- The geographical distribution of the complex of *An. maculipennis*: *An. artemievi* and *An. martinius* was specified.
- The genetic structure of populations of malaria mosquitoes was investigated.
- Characteristics of mosquito habitats were described and mapped.
- The biology and characteristics of *G. affinis* fish (age composition, feeding, fertility, hibernation) in local conditions were specified.
- The effectiveness of ecologically safe methods for control of malaria vectors was studied.
- Entomologists from the Institute for the Biology and Ecology of Malaria Vectors carried out extensive studies and developed methods for the control of mosquitoes at all stages of development.
- Studies on resistance of malaria vectors to insecticides were conducted.
- Stratification of areas according to their malariogenic potential was developed, with recommendations developed for use. Malaria stratification of Tashkent province was carried out in 2006–2007 (Fig. 37).
- Epidemiological features, including malaria incidence, affected population and socioeconomic parameters, were established.
- The therapeutic effectiveness of antimalarial medicines was tested.
- A system of antimalarial interventions with an impact on all links of the epidemiological chain was developed and implemented in health-care services across the country.
- The malariological situation and prognosis in Kashkadarya province was evaluated, and measures for improvement of elimination and prevention activities were developed (2006–2007).
- The malariological situation and malaria prognosis in the Fergana Valley and Surkhandarya provinces was evaluated, and sets of antimalarial interventions for different landscapes and malariogenic zones were developed (2007–2008).
- Computer technologies were introduced into the process of monitoring malaria foci in Tashkent city and Tashkent province. This involved development of a computerized version of the register of malaria foci registered in 1996–2010 with GIS applications for Tashkent city and Tashkent province, using the ArcGIS programme (2011–2012).
- New methods of monitoring and assessing the absence and interruption of local malaria transmission elaborated showed the interruption of indigenous malaria transmission in Surkhandarya province foci (2015–2017).

Fig. 37. Malaria cases, foci and vectors in Tashkent city and Tashkent province, Uzbekistan, 1996–2008



A: malaria foci, 1996–2008. B: malaria cases, 1996–2008. C: active foci, 1996–2008. D: indigenous cases, 1996–2008. E: mosquito species, 1996–2008. F: imported cases, 1996–2008.

Source: Republic Centre of State Sanitary Epidemiological Surveillance, Uzbekistan.

Collaboration

Collaboration with other sectors

Collaboration of the Ministry of Health was in place with the ministries of agriculture and water resources, national education, higher and secondary education, defence, and internal affairs; the National Security Service; the Agency for External Labour Migration under the Ministry of Employment and Labour Relations of the Republic of Uzbekistan; the State Committee of the Republic of Uzbekistan for Tourism Development; the Tashkent Institute for Post-Graduate Medical Education; municipalities; local citizens' self-administration bodies (*mahalla* councils); and the national railways and airlines. Collaboration with other sectors and coordination were facilitated by the Interdepartmental Expert Council under the chair of the Deputy Prime Minister *(3)*.

Collaboration over the years at all levels has yielded positive results. It has included annual national coordination meetings; roundtables; joint actions with the Ministry of Agriculture and Water Resources aimed at reducing mosquito breeding sites; joint actions with the Ministry of Internal Affairs, the Agency for External Labour Migration and the State Committee of the Republic of Uzbekistan for Tourism Development aimed at reducing malaria importation and its consequences; joint field monitoring visits; seminars and training sessions; information exchanges; and development of health education materials.

Cross-border collaboration

Due to the importance of cross-border cooperation in eliminating malaria, Uzbekistan took part in the WHO Regional Office for Europe initiatives on cross-border collaboration. A meeting on cross-border cooperation between Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan was held in Bishkek, Kyrgyzstan on 1–2 November 2010. A joint statement on cross-border cooperation for malaria elimination in Kyrgyzstan, Tajikistan and Uzbekistan and prevention of re-establishment of malaria transmission in Kazakhstan was signed by the health ministers of the respective countries, supported by the WHO country offices of these countries *(69)*. Plans for joint measures in border areas for the prevention and control of malaria were developed, including a Joint Plan of Malaria Control Measures in the Border Settlements of Kyrgyzstan and Uzbekistan aiming to prevent malaria in Batken province in Kyrgyzstan and Fergana province in Uzbekistan.

International cooperation

The national malaria programme in Uzbekistan has operated in close cooperation with WHO for many years. The WHO Regional Office for Europe has provided assistance to Uzbekistan for developing strategies, programmes and plans of action, and training health staff. Many experts and consultants from the Regional Office provided technical assistance and worked with local specialists for many years after the re-establishment of malaria.

The WHO Inception Meeting on the Malaria Elimination Initiative in the WHO European Region was held in Tashkent on 18–20 October 2005 *(5)*. Participants welcomed the regional initiative, and the Tashkent Declaration was approved *(39)*.

Uzbekistan joined the Ashgabat Declaration in 2017 to prevent the re-establishment of malaria transmission in the WHO European Region *(42)*.

In 2000, WHO provided sprayers and antimalarial medicines (primaquine, mefloquine, quinine). WHO manuals on malaria diagnosis and vector control were supplied, along with two vehicles for the Scientific Research Institute for Medical Parasitology and the Surkhandarya province CSSES to facilitate antimalarial interventions.

The Global Fund has provided major financial support to Uzbekistan and played a key role in helping the national malaria programme achieve its goals. Global Fund grant projects Scaling Up the Response to Malaria in Uzbekistan: A Focus on Vulnerable Populations, 2005–2009" (no. UZB-405-G02-M, fourth round) and Strengthening of the Achieved Results and Supporting Measures on Malaria Elimination in Uzbekistan 2010–2015 (no. UZB-809-G04-M, eighth round) were implemented in Uzbekistan.

During the grant periods, CSSES parasitology departments and several health facilities were upgraded and the staff trained or retrained. The Global Fund provided medicines to treat people with malaria and chemoprophylaxis for the population, microscopes, reagents and chemicals, laboratory consumables, vehicles, entomological equipment, computers and mosquito nets. A total of 160 training sessions on malaria were carried out, involving 5967 specialists. Applied research projects on validation of the interruption of malaria transmission in six provinces were conducted. Leaflets, manuals and guidelines were developed and distributed *(3)*.

In 2005, the Aid Agency for Technical Cooperation and Development provided Uzbekistan with 6000 mosquito nets for the residents of the border provinces of Andijan and Fergana and with the insecticide alphacypermethrin 10% to treat the nets.

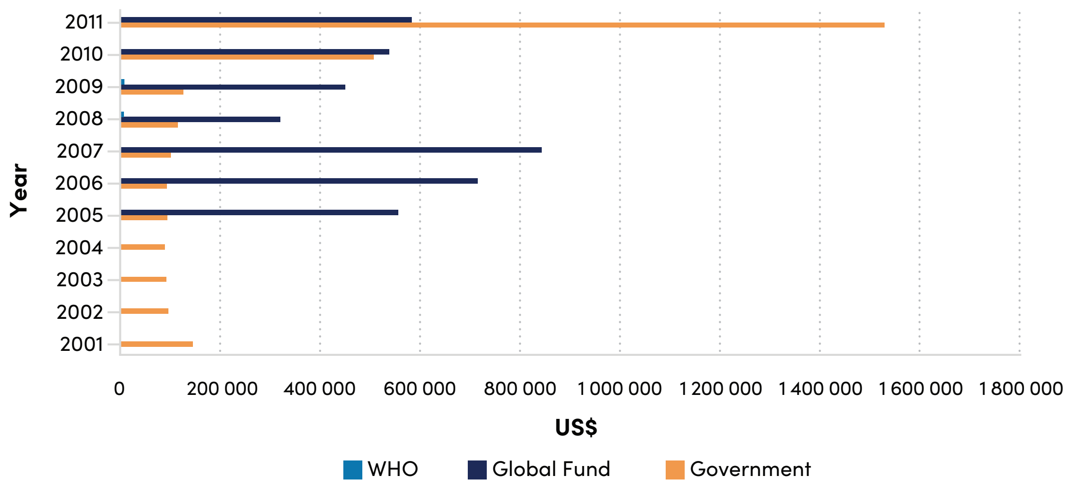
In 2006, the Government of India provided alphacypermethrin 10% for indoor residual spraying.

Cooperation was developed with the United Nations Development Programme. To strengthen the potential of national institutions working together in the field of public health, training sessions and meetings on intersectoral collaboration and coordination were held *(3)*.

Programme funding

To deal with malaria re-establishment, the Government has provided sustainable funding over the years, ranging from US$ 88 404 in 2001, to US$ 507 457 in 2010, to US$ 1 529 810 in 2011. WHO contributed US$ 7175 in 2008 and US$ 7892 in 2009 (Fig. 38). After malaria elimination, funding of the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan was assured.

Fig. 38. Malaria programme funding in Uzbekistan, 2001–2011



Source: World malaria report 2012. Geneva: World Health Organization; 2012 (https://apps.who.int/iris/handle/10665/78945).

The Global Fund grants for 2005–2015 made a major contribution to the malaria programme budget: US$ 2 302 758.49 in 2005–2009 and US$ 2 306 262 in 2010–2015.

Programme transition to prevention of malaria re-establishment

After elimination, the risk of malaria remains, depending on ecological, climatic, entomological, epidemiological and sociodemographic factors. Considering the risk and following the WHO recommendations *(57, 70, 71)* Uzbekistan transitioned to a programme for prevention of malaria re-establishment.

Risk of re-establishment of malaria

Receptivity

During malaria resurgence, the main endemic area of Uzbekistan was Surkhandarya province. Some malaria foci were also registered in Kashkadarya and Tashkent provinces. Areas with the highest malariogenic potential were in the river valleys, mostly in the south-east and east of the country.

After malaria elimination, a large part of Uzbekistan remained receptive to malaria due to the landscape, climatic conditions and presence of malaria vectors registered during entomological surveillance (see Table 5 and Annex 3). Several provinces have a higher level of receptivity – Andijan, Fergana, Khorezm, Namangan, Surkhandarya, Syrdarya and Tashkent *(3)* – because there are numerous mosquito breeding habitats (water bodies, rice fields, irrigation systems), and the temperature conditions are favourable for mosquitoes. In Tashkent city, Bukhara and Navoiy (Kyzylkum Desert) provinces, and the Republic of Karakalpakstan, receptivity is low due to a shortage of vectors, dry climate or high altitude.

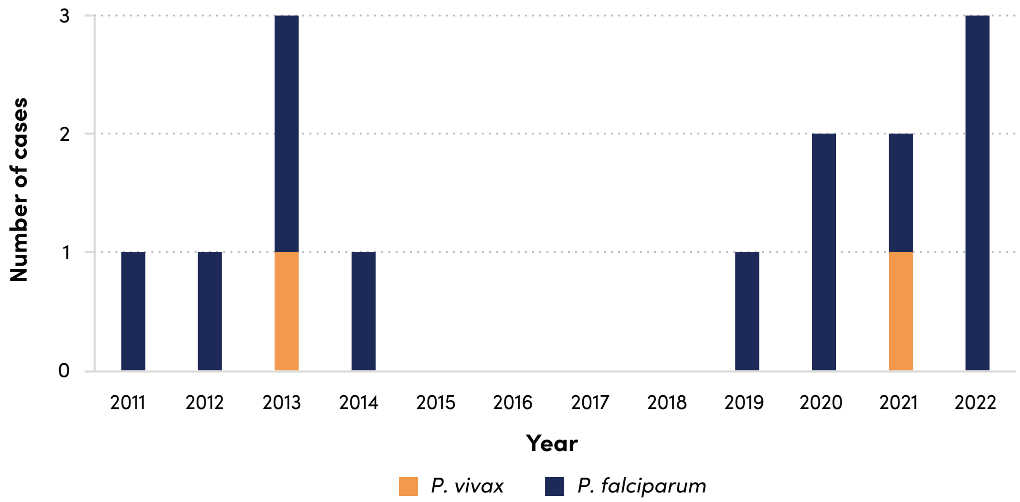
Risk of importation (vulnerability)

In 2006–2022, 70 imported malaria cases were registered (52 *P. vivax*, 18 *P. falciparum*) (see Fig. 11). The main importation was registered during the period of malaria elimination in 2006–2010 (56 of 70 cases), although the decrease in the number of imported cases started in 2009. Since 2011, after the interruption of local transmission, only 14 imported cases have been reported, which is an indicator that the risk of importation (vulnerability) has decreased. In 2015–2018, there was zero importation.

The structure of species importation in the two periods differs. In 2016–2010, *P. vivax* was the predominant species (50 cases, 89.29%). In 2011–2022, *P. falciparum* was the predominant species (12 of 14 cases, 85.71%) (Fig. 39). It is likely that the risk of *P. vivax* reintroduction has decreased.

According to some malariologists, imported *P. vivax* is more adaptive to local vectors than *P. falciparum*. The Afrotropic variety of *P. falciparum* has a number of specific features – in particular, it is not able to infect mosquitoes from the Palearctic region *(56)*. It is likely that in general in central Asia, the resurgence of indigenous *P. vivax* transmission as a consequence of importation is more probable.

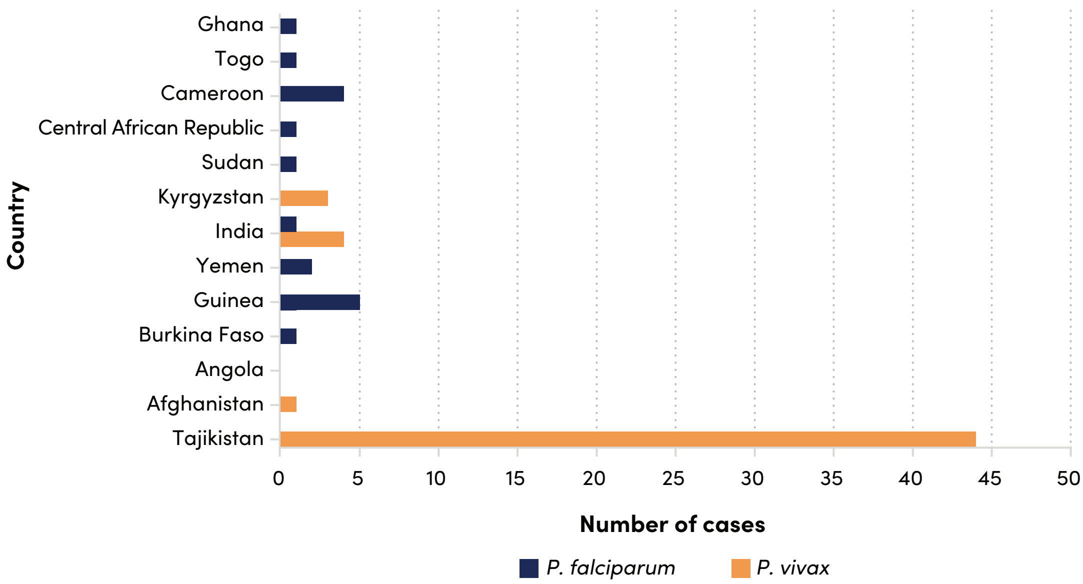
Fig. 39. Imported malaria cases in Uzbekistan, 2011–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance.

In 2006–2022, the main importation of *P. vivax* malaria was registered from the neighbouring countries of Tajikistan (44 cases, 85.62%), Kyrgyzstan (three cases, 5.78%) and Afghanistan (one case, 1.92%), and India (three cases, 5.78%). Imported *P. falciparum* cases were mainly contracted (14 of 18 cases, 77.78%) in Africa (Angola, Burkina Faso, Cameroon, Central African Republic, Ghana, Guinea, Sudan, Togo) (Fig. 40). Importation from Tajikistan was registered during the first years of this period (by 2015 malaria had been eliminated from Tajikistan). Similarly, no local cases have been reported in Kyrgyzstan since 2011.

Fig. 40. Countries from where malaria was imported into Uzbekistan, 2006–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance.

During elimination and prevention of re-establishment of malaria transmission, malaria was imported across 11 provinces and one city (see Fig. 13). The largest number of imported malaria cases were detected in the former endemic and highly receptive Surkhandarya province (35 cases, 50.0%) and in the capital city Tashkent (14 cases, 20.0%), where receptivity is low. Isolated imported cases were detected almost throughout the country. After the first elimination, malaria was re-established in three provinces due to importation – Kashkadarya, Surkhandarya and Tashkent. In the other provinces where malaria was imported, there were no epidemiological consequences. Although the majority of these other provinces (Andijan, Fergana, Namangan, Samarkand, Syrdarya) are characterized with high receptivity, no local transmission was registered, which is an indicator of the good performance of malaria surveillance and control activities.

In 1980–2010, the risk of importation in Uzbekistan was much higher. All areas along the borders with malaria-endemic Tajikistan (where intensive migration of the population took place) and with Afghanistan were at higher risk. The malaria situation in neighbouring countries has since improved, and the risk has decreased. The last officially reported locally acquired cases in Tajikistan were in 2015 *(72)*, and it was certified by WHO as malaria-free in 2023 *(73).*

In Surkhandarya province in 2006–2010, the majority of imported *P. vivax* cases were from Tajikistan. Since 2010, this province has not registered any imported cases, which correlates with the improvement in the malaria situation in Tajikistan.

It is likely that the current vulnerability of Uzbekistan is low. Expanding international relations in the fields of economics, trade, tourism and culture should be taken into account, however, as they could change the situation in the future.

Stratification

The National Malaria Control Programme conducted an evaluation of the degree of the risk of resurgence of local malaria transmission in different parts of the country. This was based on analysis of the malariogenic potential (receptivity and risk of importation indicators) from 2006 until the present and took into account previous malaria endemicity (Table 8).

This allowed stratification of the territory based on the level of risk. In most provinces, the degree of risk is now low, but it may rise if risk of importation and receptivity increase.

In Khorezm province and the Republic of Karakalpakstan, there is no risk, as there has not been any importation for 17 years. The risk in Surkhandarya province is high, based on the potential for importation from neighbouring Afghanistan; the fact that people from Uzbekistan have been employed in building a railroad in Afghanistan was also considered. Bukhara and Samarkand are classified as medium-risk provinces, taking into account the great interest of foreign visitors to these historical places.

Although the situation is currently characterized by a single importation of malaria from abroad, the receptivity of a large part of Uzbekistan shows the potential danger of the re-establishment of transmission of infection from imported cases if malaria surveillance is not performing well.

Decreased interest in malaria prevention and a drop in vigilance since elimination, and the continuing importation of malaria, may lead to the emergence of local malaria cases.

Table 8. Risk assessment of the re-establishment of malaria in Uzbekistan

		Receptivity				Vulnerability		
Province	**Species composition of mosquitoes**	Altitude above sea level (m)	Average number of days with average daily temperature ≥16 °C	Potential transmission season (months)	Degree of receptivity	Importation in 2006–2022 (number of cases)	Degree of risk of importation	**Level of risk**
Tashkent city	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	424–480	195	May–September	Low – breeding sites located on periphery of city	2006: 4 2007: 2 2010: 1 2013: 2 2014: 1 2019: 1 2020: 1 2021: 1 *Total: 13*	Medium	Low, but may rise if risk of importation and receptivity increase
Andijan	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. hyrcanus* *A. claviger*	200–500	191	Late April–October	High – rich in fauna of vectors; many breeding sites, such as rice fields	2007: 1 *Total: 1*	Low	Low, but may rise if risk of importation increases
Bukhara	*A. pulcherrimus* *A. hyrcanus*	229–922	184	May–October	Low – dry climate; few breeding sites; poor fauna of vectors	2021: 1 *Total: 1*	Medium (Many tourists visit Bukhara)	Medium, but may rise if risk of importation and receptivity increase
Fergana	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	300–3000	191	Late April–October	High – rich fauna of vectors; many breeding sites, such as rice fields	2006: 1 2007: 1 2011: 1 2013: 1 *Total: 4*	Low Last imported case in 2013 (*P. falciparum*)	Low, but may rise if risk of importation increases

		Receptivity				Vulnerability		
Province	**Species composition of mosquitoes**	Altitude above sea level (m)	Average number of days with average daily temperature ≥16 °C	Potential transmission season (months)	Degree of receptivity	Importation in 2006–2022 (number of cases)	Degree of risk of importation	**Level of risk**
Jizak	*A. superpictus* *A. pulcherrimus* *A. artemievi* *A. claviger*	382–4000	179	May–October	Medium – many dry areas; high altitudes	2006: 1 *Total 1*	Low	Low, but may rise if risk of importation and receptivity increase
Kashkadarya	*A. superpictus* *A. claviger*	150–4000	183	May–October	Medium – many dry areas; high altitudes; poor fauna of vectors	2008: 1 2009: 1 2010: 1 *Total: 3*	Low	Low, but may rise if risk of importation and receptivity increase
Khorezm	*A. pulcherrimus* *A. martinius* *A. hyrcanus*	98–100	171	May–October	High – extensive rice plantation areas	0	No importation	No risk, but risk may arise if risk of importation increases
Namangan	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	400–1925	197	Late April–October	High – rich fauna of vectors; many breeding sites, such as rice fields	2006: 1 *Total: 1*	Low	Low, but may rise if risk of importation increases
Navoiy	*A. hyrcanus* *A. pulcherrimus*	126–424	200	May–October	Low – most of the province is occupied by the Kyzylkum Desert; vectors are absent on most of the province territory	2012: 1 2020: 1 *Total: 2*	Low	Low

		Receptivity				Vulnerability		
Province	**Species composition of mosquitoes**	Altitude above sea level (m)	Average number of days with average daily temperature ≥16 °C	Potential transmission season (months)	Degree of receptivity	Importation in 2006–2022 (number of cases)	Degree of risk of importation	**Level of risk**
Samarkand	*A. artemievi* *A. martinius* *A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	350–2204	190	May–October	High – rich fauna of vectors; many breeding sites, such as rice fields	2009: 1 2022: 1 *Total: 2*	Medium (Many tourists visit the town)	Medium, but may rise if risk of importation increases
Surkhandarya	*A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	310–3800	210	April–October	High – rich fauna of vectors; many breeding sites, such as rice fields; longest transmission season	2006: 6 2007: 18 2008: 8 2009: 2 2022: 1 *Total: 35*	High	High
Syrdarya	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. hyrcanus*	230–650	188	May–October	High – rich fauna of vectors; many breeding sites, such as rice fields	2006: 1 2007: 1 2008: 1 *Total: 3*	Low	Low, but may rise if risk of importation increases
Tashkent province	*A. artemievi* *A. superpictus* *A. pulcherrimus* *A. claviger* *A. hyrcanus*	305–4301	184	May–September	High: rich fauna of vectors; abundance of breeding sites	2006: 2 2008: 1 2022: 1 *Total: 4*	Low	Low, but may rise if risk of importation increases
Republic of Karakalpakstan	*A. pulcherrimus* *A. martinius* *A. hyrcanus*	−12.8–100	164	May–October	Low: majority of the area is occupied by the Ustyurt plateau and the almost dry depression of the Aral Sea	0	No importation	No risk, but risk may arise if risk of importation increases

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

National Strategic Programme for the Prevention of the Re-establishment of Malaria Transmission

Measures directed towards the prevention of malaria re-establishment in areas where infection was already eliminated were carried out before complete elimination in the country. After reaching the target of complete interruption of malaria transmission, Uzbekistan needed a new programme to ensure the services responsible for prevention of malaria re-establishment remained operational.

The comprehensive National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan (2017–2021) was developed and backed by sustainable political and financial support, endorsed by the Government and implemented *(41)*. The National Strategic Programme was based on the stratification of subnational units in accordance with the risk of malaria re-establishment, and on the experience gained during the period of malaria elimination. It was in line with the latest WHO recommendations *(57, 70, 71)*.

The complex of technical strategies and targeted approaches included in the programme are realistic. In non-receptive areas with no risk of malaria transmission, the key objectives are to prevent serious clinical complications of imported malaria infection (including fatal *P. falciparum* cases) through early detection and radical treatment of infected people.

In receptive areas with a risk of re-establishment of transmission, activities are directed to prevent clinical and epidemiological (resumption of transmission) complications. Key interventions include high-quality passive case detection, good case management, and cases and foci investigations with adequate response. Imported cases are given special attention. The emphasis shifted to prevention of malaria in travellers and the consequences of malaria importation.

The programme is coordinated and implemented by national-level staff at the Republic Centre of State Sanitary Epidemiological Surveillance (reorganized in 2023 as the Central Office of the Committee for Sanitary and Epidemiological Welfare and Public Health) and intermediate-level staff at provincial and district CSSES offices and departments, with the participation of all health facilities and organizations (see Annex 4).

Operational provincial and district plans have been developed on the basis of the National Strategic Programme.

Goals and objectives

The goal of the National Strategic Programme is to maintain the current epidemiological situation of malaria in Uzbekistan by implementing a series of integrated measures directed at preventing the re-establishment of local transmission of malaria, emergence of introduced cases (secondary cases from imported cases), and indigenous cases by:

- maintaining a well-organized general health service and a strong surveillance and response service;
- early detection and timely radical treatment of all malaria cases;
- early mandatory notification of all cases, and their registration;
- timely epidemiological investigation and classification of cases and foci,[2] implementation of response measures in foci, and monitoring of malaria foci;
- monitoring of the malariogenic potential (risk of importation and receptivity) and conducting risk assessments for the re-establishment of malaria in changing conditions;

[2] The category of "potential focus" was used in addition to the "active", "residual non-active" and "cleared" foci categories recommended by WHO in 2017.

- continuation of entomological surveillance and appropriate vector control, especially in areas with high and medium risk of re-establishment of malaria;
- epidemic preparedness, with prediction and early recognition of the danger of epidemics and rapid implementation of necessary measures;
- rapid implementation of response measures in the case of re-establishment of indigenous transmission;
- intersectoral, interdepartmental and cross-border cooperation on malaria prevention;
- maintaining malaria expertise by training and retraining of malaria specialists within the health system;
- intensification of cooperation and use of effective systems of communication between all stakeholders;
- maintaining awareness and vigilance of the population regarding malaria.

Strategic approaches

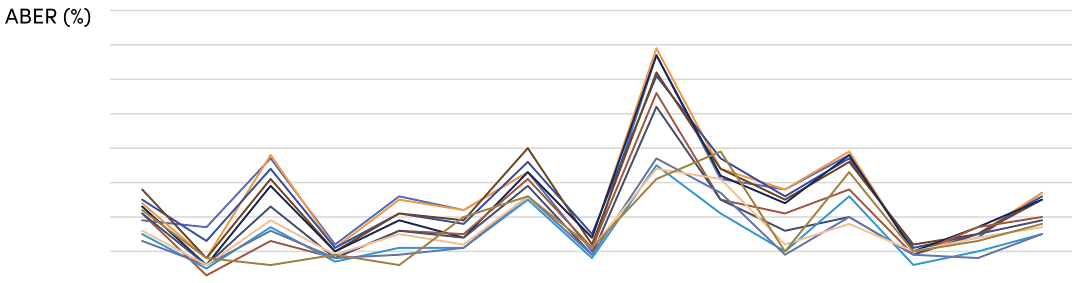
To maintain vigilance and malaria preventive interventions in a manner consistent with the National Strategic Programme, various strategic lines of action are applied.

High-quality detection of malaria cases and case management

Detection of malaria cases is carried out among the population throughout the country by health-care staff at all health facilities. Detection involves passive and/or active case detection, depending on the epidemiological situation and the level of the malariogenic potential (receptivity and risk of importation).

The annual blood examination rate in the post-elimination years varies from 1.5% (2019, 2020) to 2.7% (2012) (Fig. 41). Although the national annual blood examination rate has not been very high in recent years, it remains much higher in high-risk provinces and previously endemic provinces. In Surkhandarya province, the rate was higher than in other provinces (6.7% in 2012, 3.1% in 2022).

Fig. 41. Annual blood examination rate in Uzbekistan, by province or city, 2012–2022



	Tashkent city	Andijan	Bukhara	Jizak	Kashkadarya	Navoy	Namangan	Samarkand	Surxondaryo	Syrdarya	Tashkent	Fergana	Khorezm	Republic of Karakalpakstan	Uzbekistan
2012	1.9	1.7	3.7	1.2	2.6	2.2	3.3	1	6.7	3.1	2.8	3.8	1	1.4	2.7
2013	2.4	0.8	3.8	1.1	2.5	2.2	3.3	1.4	6.9	3.4	2.8	3.9	1	1.5	2.7
2014	2.5	1.3	3.4	1.1	2.1	1.8	3.6	1.5	6.1	3.7	2.6	3.7	1.1	1.5	2.6
2015	2.8	0.8	3.1	1	2.1	1.9	4	1.2	6.2	3.4	2.5	3.6	1.2	1.5	2.5
2016	2.3	0.6	2.9	1	1.9	1.4	3.3	1.4	6.7	3.2	2.4	3.8	1	1.7	2.5
2017	2.1	0.3	1.3	0.8	1.6	1.5	3.1	1.1	5.6	2.5	2.1	2.8	0.9	1.7	2
2018	2.1	0.6	2.3	0.8	1.6	1.4	2.9	0.9	5.2	2.5	1.6	2	0.9	1.5	1.9
2019	1.5	0.5	1.7	0.7	1.1	1.1	2.5	0.8	3.5	2.1	1	2.6	0.6	1	1.5
2020	1.3	0.6	1.6	0.8	0.9	1.1	2.6	0.9	3.7	2.7	0.9	2	0.9	0.8	1.5
2021	1.6	0.6	1.9	0.9	1.5	1.2	2.6	1.1	3.4	3.1	1.2	1.8	1	1.4	1.7
2022	2.2	0.8	0.6	0.9	0.6	2	2.6	1.1	3.1	3.9	1	3.3	1	1.3	1.8

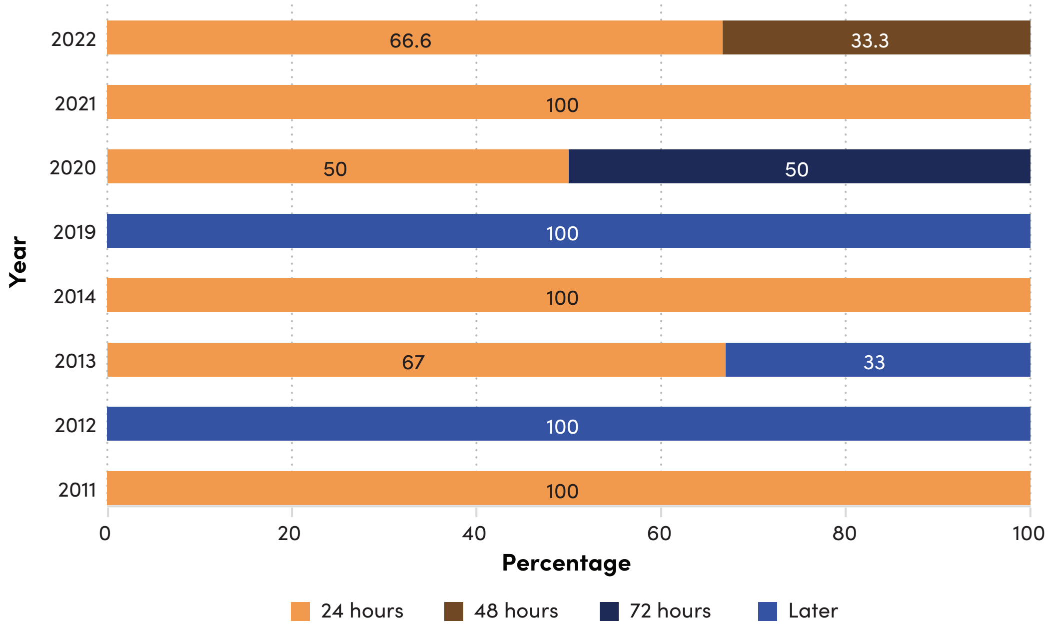
Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Health-care activities are directed towards timely diagnosis in laboratories controlled by the National Programme of External Quality Assurance/Control (see Fig. 27), followed by prompt radical treatment. The whole population has good access to health-care services. Diagnosis and treatment of malaria are free of charge.

Laboratory diagnosis is carried out according to the standard operating procedures. The main method of diagnosis is microscopic examination of blood samples stained by the Romanowsky Giemsa method. All cases are confirmed at CSSES parasitology laboratories at all levels and at the national reference laboratory.

Analysis of the timeframes of laboratory diagnosis of imported cases showed that most diagnoses were made within 24 hours, with a few exceptions. In 2020, one case was diagnosed within 72 h; in each of 2012 and 2019, it took more than 72 hours to make the diagnosis of the only one registered imported case (Fig. 42).

Fig. 42. Timeframe from seeking medical assistance to laboratory diagnosis of malaria in Uzbekistan, 2011–2022[a]



[a] In 2015–2018, there were no imported cases.

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Treatment of malaria is conducted in compliance with the national treatment protocol at state-run infectious diseases hospitals; the Scientific Research Institute for Epidemiology, Microbiology and Infectious Diseases hospital; and the LM Isaev Scientific Research Institute of Medical Parasitology hospital.

In 2011–2022, the treatment of all detected malaria imported cases started within 24 hours of diagnosis.

The national policy and recommendations on treatment and chemoprophylaxis of malaria are updated every two years, taking into account data on resistance of malarial parasites, and in accordance with the latest WHO recommendations *(74)*.

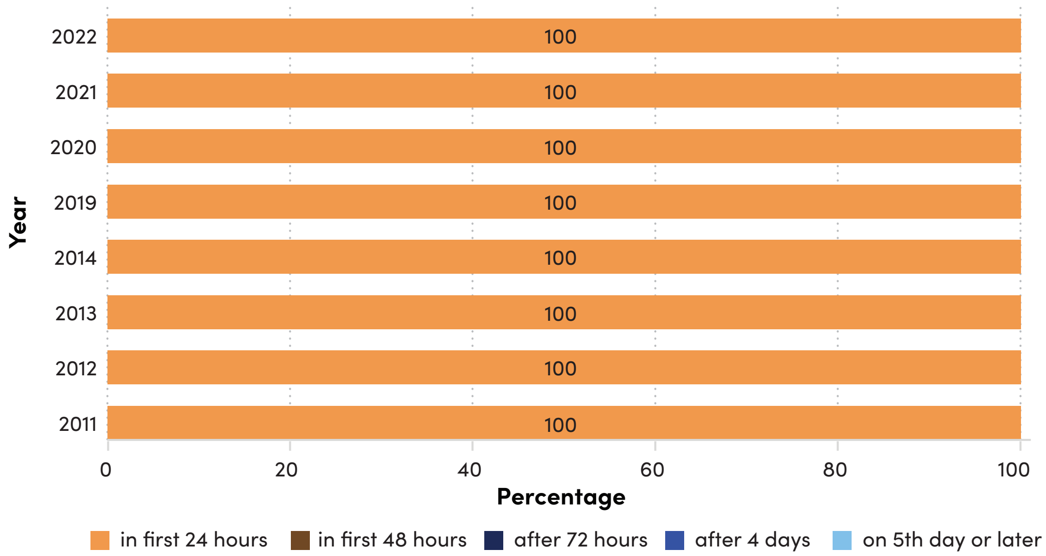
Epidemiological investigation of malaria cases and foci

Immediately after receiving an emergency notification on a malaria case, the parasitologist and entomologist of the district or city CSSES carry out epidemiological investigation of the case and focus in the same way as during the elimination period.

All information on the case and focus and the measures carried out are uploaded to the database, which is reflected in the national register of malaria cases, the national register of foci and the laboratory register.

In 2011–2022, all epidemiological investigations of malaria cases and foci were conducted within 24 hours of notification (Fig. 43).

Fig. 43. Timeframe for carrying out epidemiological investigation of a malaria case and focus in Uzbekistan, 2011–2022[a]



[a] In 2015–2018, there were no imported cases.

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Management of imported malaria and its consequences

Higher-risk people have been identified. These include people travelling to or arriving from malaria-endemic areas, such as tourists, businesspeople, employees in malaria-endemic countries, international cargo drivers, pilots, migrants, students, soldiers, railway construction workers in Afghanistan, and guards on the border with Afghanistan.

To prevent travellers from contracting malaria, awareness must be raised among people visiting malaria-endemic countries. Medical consultations at CSSES parasitology departments before and after travel are provided. Health education leaflets on malaria prevention are disseminated among the population.

The Republic Centre of State Sanitary Epidemiological Surveillance annually updates malaria information following WHO recommendations *(74)*, disseminates this information to CSSES structures and other organizations, and publishes it on its website.

SSES structures carry out joint work with travel agencies and student clinics for the prevention of malaria and supervise the quality of the work.

Before travelling to malaria-endemic countries, people are advised on:

- geographical distribution of malaria caused by different *Plasmodium* species in the country and areas to be visited according to the latest information from WHO *(74)*;
- current data on resistance of malaria parasites;
- medicines recommended by WHO for chemoprophylaxis and standby treatment;
- methods of protection against mosquito bites.

Citizens of Uzbekistan returning from malaria-endemic countries are followed up for three years and must be examined for malaria in case of clinical indications (fever, chills, anaemia, hepatosplenomegaly).

Foreign citizens can undergo laboratory tests according to clinical epidemiological indications in health facilities according to their employer's agreement (for workers), at student clinics or at public health facilities by place of residence. International students from malaria-endemic countries are initially examined for malaria and followed up at the central student clinic in Tashkent city.

Entomological surveillance and vector control

Entomological surveillance is continued in a way applied during malaria elimination, with priority paid to areas of higher malariogenic potential (receptive areas with a risk of importation) (Fig. 44). Meteorological data are collected, and the start and end of the potential effective mosquito infection period and malaria transmission season are calculated.

Registration of rice fields and records of the presence of *G. affinis* fish in water bodies are conducted. Major changes in environmental characteristics and planning of irrigation and drainage projects are monitored. The collected information is used to plan appropriate measures.

Resistance to insecticides is monitored.

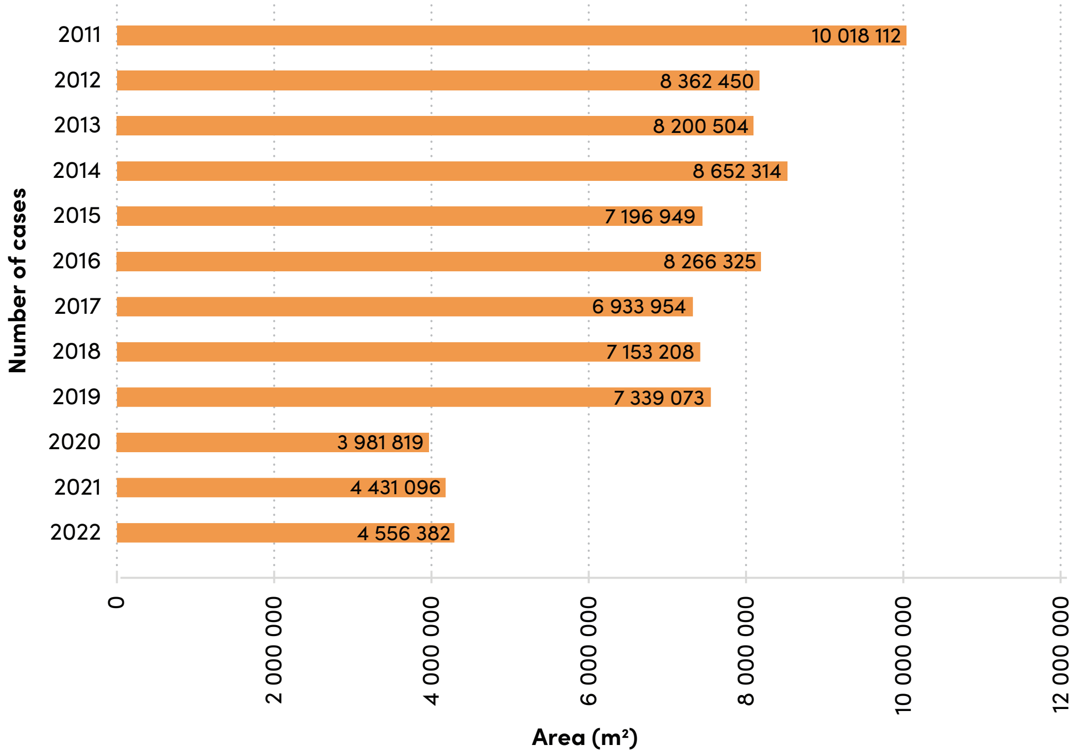
Fig. 44. District entomologist inspecting mosquitoes inside a building in Samarkand province, Uzbekistan, 2021

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Vector control continues in accordance with the entomological indications and approved plans. Indoor residual spraying has gradually decreased, from 10 018 112 m^2 in 2011 to 4 556 382 m^2 in 2022 (Fig. 45), and is now conducted only in residual foci (if any) and in relation with new detected cases or mass migration of refugees or agricultural workers. If the presence of vectors is confirmed, focal spraying of the confirmed case's household and adjoining buildings is carried out (Fig. 46) *(3)*.

Indoor residual spraying is carried out from March to April and from October to November as part of the control of midges.

Fig. 45. Total treated house area with indoor residual spraying in Uzbekistan, 2011–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance.

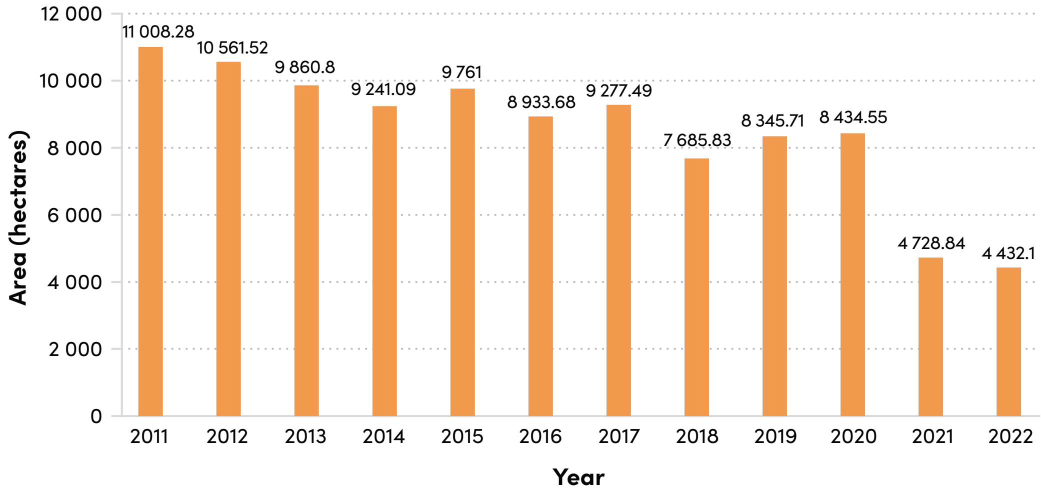
Fig. 46. Indoor residual spraying in Samarkand province, Uzbekistan, 2021

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Larval control of water bodies continues as part of sandfly control, and with the aim of reducing the mosquito population density in areas with maintained high receptivity and risk of malaria importation. The total area of water treated and with distribution of *G. affinis* decreased from 11 008 hectares in 2011 to 4432 hectares in 2022 (Fig. 47).

Environmental management is used widely, guided by national regulations and WHO recommendations *(64, 68)*.

Fig. 47. Total area of water bodies treated and with distribution of *G. affinis* fish in Uzbekistan, 2011–2022



Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Malaria vectors *An. pulcherrimus* and *An. hyrcanus* can fly from the Afghan bank to the Uzbek bank of the Amudarya River, creating a risk of malaria re-introduction *(43–45)*. The programme includes special interventions at the border, including scaled-up entomological surveillance and environmental management along the border, measures to protect the population from mosquito bites, and strengthened vigilance. Efforts to establish a good collaboration with similar services in Afghanistan are made.

Entomological surveillance and treatment of vehicles with insecticides are carried out at airports and at rail and road entry places into Uzbekistan. These activities are coordinated with other services at the state border, such as sanitary and quarantine points, border services and customs services.

Box 3 summarizes the strategic directions of malaria surveillance and vector control in preventing re-establishment of malaria.

Box 3. Strategic directions of the National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan

Health measures	Entomological surveillance and vector control
Territories with high risk of malaria re-establishment	
Passive case detection Active case detection throughout the period of effective mosquito infection of malaria season – household visits at least once every 14 days, depending on the situation (e.g. re-establishment of local transmission caused by imported cases; mass malaria importation through groups of people) Maintaining high level of external quality assurance of laboratory diagnosis of malaria Registration and timely mandatory notification Inpatient treatment of people with malaria Free-of-charge diagnosis, followed by treatment free of charge of all confirmed cases: • blood schizonticidal medicine • anti-relapsing treatment of *P. vivax* malaria cases, administered together with blood schizonticidal medicine • anti-gametocyte treatment of imported *P. falciparum* malaria cases during malaria season Epidemiological investigation and classification of all malaria cases and foci, management of foci, and maintenance of foci database Ensuring appropriate supplies and stocks of antimalarial medicines, equipment, laboratory reagents and other reserves Maintaining malaria expertise	Entomological surveillance of malaria vectors and monitoring of mosquito breeding sites Monitoring of insecticide resistance Meteorological monitoring and determination of potential malaria season Monitoring of major changes in environmental characteristics Monitoring of rational planning of irrigation and drainage projects Distribution of *G. affinis* fish in water bodies where *Anopheles* breeding takes place Other antilarval measures applied only in water bodies with reduced effectiveness of *G. affinis* fish Environmental management Indoor residual spraying carried out in accordance with entomological indications and approved plans as part of control of midges and in exceptional cases (e.g. malaria cases detected during malarial season; mass migration of refugees or agricultural workers; possible inflight of infected mosquitoes through border territories) Ensuring appropriate supplies and stocks of insecticides Maintaining malaria expertise
Territories with low risk of malaria reestablishment	
Passive case detection Maintaining high level of external quality assurance of laboratory diagnosis of malaria Registration and timely mandatory notification Inpatient treatment of malaria Diagnosis followed by treatment free of charge of all confirmed cases according to national protocol Epidemiological investigation and classification of all malaria cases and foci, management of foci, and maintenance of foci database Ensuring appropriate supplies and stocks of antimalarial medicines, equipment, laboratory reagents and other reserves Maintaining malaria expertise	Entomological surveillance of malaria vectors and monitoring of mosquito breeding sites Monitoring of insecticide resistance Meteorological monitoring and determination of potential malarial season Monitoring of major changes in environmental characteristics Environmental management Monitoring of rational planning of irrigation and drainage projects Vector control activities carried out as part of sandfly control and on epidemiological indications Ensuring appropriate supplies and stocks of insecticides Maintaining malaria expertise

Outbreak preparedness and response

Malaria outbreak preparedness and response is included in the country's outbreak response system regulated by the Government *(50, 75)*. An alert system is in place if local transmission is suspected or if there is an influx of a large number of people with malaria. Stocks of diagnostic consumables, antimalarial medicines and insecticides are maintained, and there is a contingency plan for their rapid deployment in case of outbreaks.

Intersectoral cooperation

Maintaining the country's malaria-free status requires multisectoral cooperation, coordinated by the Ministry of Health between a wide range of stakeholders, including the ministries of finance, agricultural and water resources, internal affairs, defence, national education, and emergency situations; the State Committee for the Protection of the State Border of Uzbekistan; and other departments and organizations.

Capacity-building

Maintaining malaria expertise of health-care staff is considered important. Professional training in malaria is integrated into the undergraduate training system and continues in postgraduate specialist education. Training and retraining are provided for parasitologists, entomologists, epidemiologists, clinicians and laboratory specialists. Special attention is given to improving the knowledge and skills of general health-care staff on diagnosis, treatment and prevention of malaria, malaria surveillance, and working with the population.

In 2019, WHO training on the diagnosis of parasitic diseases with special emphasis on malaria was conducted in Tashkent for CSSES staff (Fig. 48). National training was also conducted periodically (Fig. 49).

Fig. 48. WHO training on diagnosis of parasitic diseases with special emphasis on malaria for CSSES staff in Tashkent, Uzbekistan, 2019

Source: Photo courtesy of R. Kurdova-Mintcheva.

Fig. 49. Training on malaria laboratory diagnosis, vector control and entomological surveillance in Tashkent, Uzbekistan, 2021

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

Health education

In the post-elimination period, health education helps to keep the local population vigilant for malaria. Citizens of Uzbekistan visiting malaria-endemic countries are encouraged to prevent malaria infection and seek timely medical assistance in case of fever after they return to Uzbekistan, contributing to early case detection. People are encouraged to eliminate swamps and clean canals and creeks of vegetation. Teachers and pupils are better informed about malaria prevention, and they can disseminate this information among other people. Provincial health centres conduct activities with students, older schoolchildren and employees of public organizations and develop information and educational materials for residents of areas with a high malariogenic potential.

International collaboration

Close cooperation is required with the countries bordering Uzbekistan, particularly Afghanistan, which is malaria-endemic. Efforts are made to coordinate actions aiming at mitigating the risk of the re-establishment of local transmission of malaria. Activities include information exchange between specialized services of these countries if the epidemiological situation changes. Where necessary, adequate joint activities will be coordinated and carried out.

Role of WHO and other international organizations

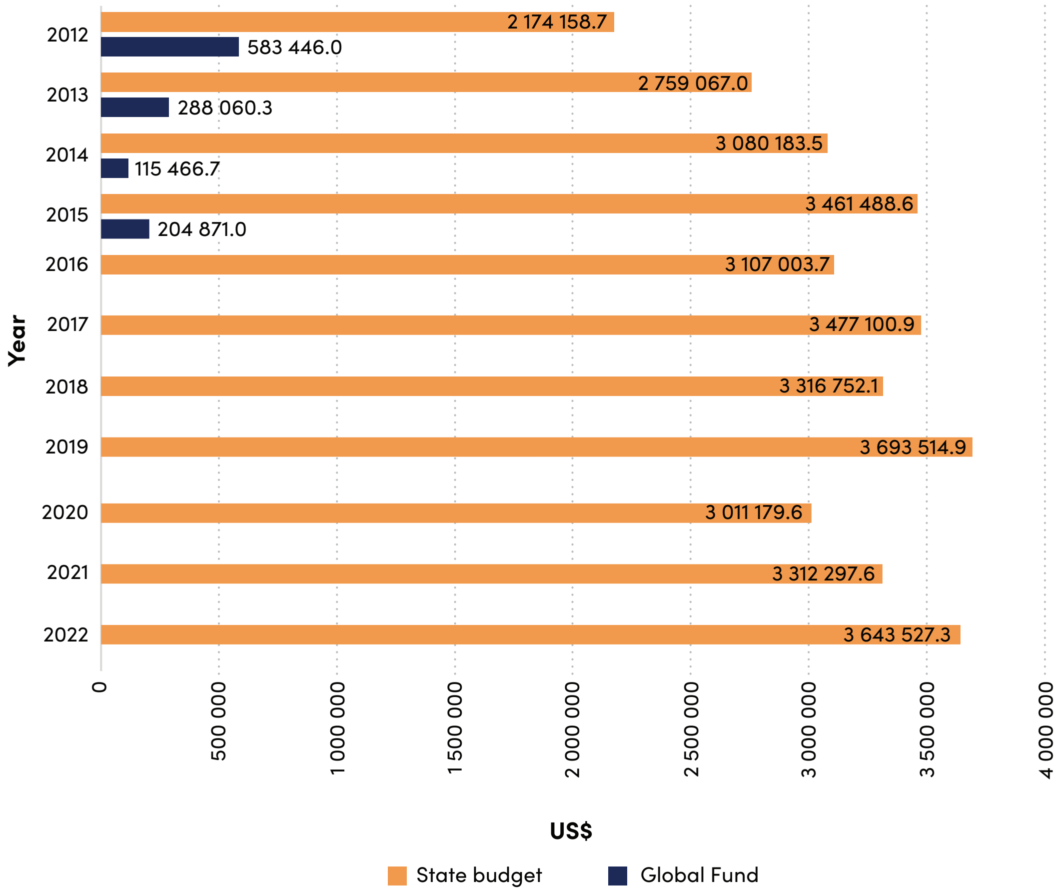
WHO has a special role in the implementation of the programme, providing technical advice and assistance towards preventing the re-establishment of malaria. Uzbekistan continues to submit annual malaria reports to WHO, and emergency reports in the case of local transmission and outbreaks.

Uzbekistan took part in the WHO meeting on cross-border collaboration on malaria between countries of the WHO Eastern Mediterranean and European regions in Dushanbe, Tajikistan in 2019 *(76)*.

Financing and resource mobilization

Sustainable funding for the programme is provided by the Government. Government allocations increased from US$ 2 174 158.70 in 2012 to US$ 3 693 514.90 in 2019. The Government allocated US$ 3 643 527.30 in 2022. In 2012–2015, additional funding was provided by the Global Fund (Fig. 50). Funding of the National Malaria Control Programme was assured after malaria elimination for the programme phase of prevention of re-establishment of malaria.

Fig. 50. Expenditure on antimalarial measures in Uzbekistan, 2012–2022



Source: data from World malaria reports 2012, 2013 and 2014 *(77–79)* and Republic Centre of State Sanitary Epidemiological Surveillance.

Lessons learned

A number of lessons can be learned from the experiences of Uzbekistan in containing malaria epidemics, interrupting the resurgence in transmission, and then maintaining its sustainable malaria-free status for 12 years.

The interruption of local transmission in 1961 and remaining free from malaria for decades indicate that malaria elimination is technically feasible in Uzbekistan. Although malaria surveillance activities were maintained, however, it is likely that over a period with only a few malaria cases without serious epidemiological consequences, the system weakened and was not able to respond quickly and adequately to the increased risk of importation and receptivity in the country.

The programme did not sufficiently address the expansion of mosquito breeding sites due to economic activities (e.g. creation of rice fields, fish farming). Another key challenge was the large increase in imported malaria cases, first in the 1980s and then in the 1990s, related to the return of demobilized military troops from Afghanistan and intensive migration of the population to and from Tajikistan.

Delays in detection and treatment of malaria led to the re-establishment of local malaria transmission, especially in areas along the Tajik border, including the previously highly endemic Surkhandarya province.

Recognizing these challenges, the Ministry of Health mobilized SSES and general health facilities and reinforced malaria surveillance and control activities to contain malaria outbreaks, prevent further spread across the country, and interrupt malaria transmission. This is an example of the importance of keeping a high level of malaria vigilance, and maintaining expertise and a good system of epidemic preparedness after elimination.

Strategies and approaches

The massive scale-up of control and surveillance activities after the resurgence of malaria was important for the efficient control and interruption of the transmission of malaria in Uzbekistan by 2010.

The country adopted a complex integrated approach to malaria control and elimination, including measures directed at sources of infection, vectors and protection of the healthy population. These approaches were formulated in the national programmes of malaria control, and later in malaria elimination, by the Ministry of Health, with the aim of prompt containment of outbreaks and clearing up of foci.

The following key strategies and approaches proved to be effective in the control of malaria transmission re-establishment and elimination:

- Scaled-up case-based surveillance and response enabled evidence-based decisions, planning and timely implementation of actions.
- Timely case detection was enabled through passive and active case detection, followed by radical treatment, notification and reporting. Active case detection was carried out through house-to-house visits and fever screening in malaria foci. This was combined with mass blood surveys among residents of the home villages of people identified with malaria and their professional contacts. This approach was applied by countries of the WHO European Region during the global malaria

eradication campaign and after malaria resurgence in the 1990s. At the primary care level, passive case detection was performed by public and private general health-care facilities. Once transmission was reduced, greater attention was paid to imported cases.

- The programme benefited from a wide net of upgraded diagnostic laboratories covered by the national external quality assurance programme and supervised by the national malaria reference laboratory. This system provided reliable and timely diagnosis and confirmation of every malaria case. Laboratory diagnosis was free of charge.
- All people with malaria were given prompt radical treatment free of charge, in accordance with the updated national malaria treatment protocol, and followed up.
- A prompt information system was administered, including compulsory notification, recording and reporting of malaria cases, and an updated database of national, provincial and district registers of cases and foci. Data collection and analysis brought about adequate planning and timely responses.
- Scaled-up prompt and comprehensive investigation of every case and focus during elimination contributed to correct case definition and focus classification, enabling evidence-based formulation, planning and conducting of response activities in a timely manner. A malaria focus was regarded as the minimum unit for antimalarial action. Foci were monitored and their classification updated annually. A focus register was maintained. This information is critical for the timely initiation of interventions when necessary, and for determining the appropriate nature, scope and period of application of those interventions.
- A fast response, good coverage and good performance were supported by assigning temporary mobile teams of epidemiologists, parasitologists, entomologists, clinicians and laboratory technicians to affected areas to conduct urgent response measures, especially following detection of outbreaks.
- Interseasonal prophylactic treatment with primaquine for all residents of active foci and other people exposed to the risk of malaria (e.g. military personnel, oil workers) helped to reduce the sources of infection in malaria control.
- Evidence-based (guided by foci investigations) integrated vector control activities and entomological surveillance included the following:
  - Full indoor residual spraying coverage of all foci directed at shortening the lifespan of female mosquitoes and larviciding to reduce larval density (using larvivorous *G. affinis* fish and chemical larvicides) led to a decrease in mosquito imago and larvae density and longevity.
  - Reducing the number of breeding places through environmental management (e.g. filling nonproductive water bodies, cleaning open irrigation canals) reduced the vector capacity.
  - Entomological surveillance was carried out, with special attention paid to higher-risk areas, especially at the border with Tajikistan, by identifying, registering and monitoring vector breeding sites and monitoring mosquitoes at sentinel points during the malaria season. Updated registers of breeding sites were maintained at the district level. Entomological monitoring data were the basis for defining the parameters of the potential malaria season, and for the receptivity evaluation and stratification of the country according to the risk of malaria transmission re-establishment.
- Human–vector contact was reduced through housing improvements and health education.
- Protection of the population in malaria foci was addressed by conducting seasonal chloroquine prophylaxis during malaria control and by intensive health education.

Experienced malaria network

The existing SSES network at the national, provincial and district levels, upgraded and expanded over the years, played a key role in coordinating and implementing control and elimination activities. CSSES parasitology departments, with substantial expertise in control and elimination, played a critical role in achieving the goals. They coordinated malaria activities at the national and subnational levels, including malaria surveillance, vector control, entomological surveillance, and external quality assurance of laboratory diagnosis.

Participation of general health-care services was crucial for timely and adequate disease management.

Maintaining a good malaria expertise was specially addressed by the Ministry of Health and SSES. Intensive training and retraining in the field of malariology was carried out within the frame of the national system for continuous professional education, and through additional courses and individual training for SSES staff and other specialists.

Collaboration and community mobilization

Good results were obtained by strengthening intersectoral and international – especially cross-border – collaboration in the field of malaria. Increased community awareness through building up community-level intervention channels strengthened the participation of the whole population in malaria elimination and prevention.

Strong political commitment

High-level political commitment to malaria control and elimination and broad Government support played an important role in malaria elimination in Uzbekistan. The Government provided policies and strategic programmes, plans and guidelines endorsed by the Ministry of Health, along with sufficient funding for interventions. Sufficient funds are currently allocated by the Government to prevent the re-establishment of malaria.

Collaboration with WHO and other international organizations

WHO assistance in developing strategies, policies, strategic plans and guidelines ensured the complex of measures was based on contemporary WHO recommendations and conducted with adequate coverage. WHO also played an essential role in capacity-building.

The Global Fund played a key role between 2000 and 2015 in achieving the goals of the malaria programme. Its financial support contributed towards upgrading health facilities, improving staff expertise in malaria, and providing the country with insecticides, antimalarial medicines and other related consumables.

Prevention of re-establishment of malaria transmission

The National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan established effective mechanisms for the post-elimination period and is preventing the resumption of local malaria transmission.

The following strategies have been important:

- maintaining a strong general health-care system and malaria surveillance and response systems:

- early detection, timely radical treatment, and mandatory notification and registration of imported malaria cases;
- timely epidemiological investigation and classification of cases and response;
- monitoring of malariogenic potential of territories;
- conducting risk assessment of re-establishment of malaria in changing conditions;

- continuation of entomological surveillance and appropriate vector control, especially in areas with high and medium malariogenic potential;
- epidemic preparedness:
  - prediction and early recognition of the danger of epidemics;
  - rapid implementation of response measures and in case of re-establishment of indigenous transmission;
- maintaining malaria expertise;
- good cooperation and use of effective systems of communication between all stakeholders of the National Strategic Programme;
- maintaining awareness and vigilance of the population regarding malaria.

Uzbekistan intends to continue these activities in the future to prevent the re-establishment of local transmission of malaria and the emergence of introduced and indigenous cases.

Outlook for the future

Since elimination of malaria in Uzbekistan, malaria importation has dramatically declined and the situation in neighbouring countries has greatly improved. The receptivity of Uzbekistan remains, however. A strong surveillance and response system and a well-organized general health system, with activities maintained at a satisfactory level, are crucial to prevent reintroduction of malaria. Any weakness may lead to delayed response to changes in receptivity and risk of importation, which may lead to resumption of local transmission and possible epidemic outbreaks.

Maintaining the status of a malaria-free country is essential for the development of economic and social programmes in the country. Re-establishment of malaria would create a threat to planning and implementation of major international integration projects. Development of the tourist industry depends on a favourable infectious and parasitic diseases situation.

Lessons learned during the period of malaria control and elimination show that now, while Uzbekistan is a malaria-free country, maintaining expertise regarding malaria and financial allocations to malaria should not be terminated, and the activities in the National Strategic Programme should be continued.

Conclusions

The story of malaria in Uzbekistan shows that as malaria has not been globally eradicated, the re-establishment of local malaria transmission in receptive areas is possible when the malariogenic potential increases and the activities of the surveillance and response system and general health system are weakened.

The story also shows that renewed local transmission can be interrupted and malaria elimination achieved again, provided there is strong political commitment and adequate funding, ensuring the implementation of adequate policies and strategies by an experienced health network.

Applying a complex of evidence-based traditional and contemporary surveillance and vector control approaches and a rapid response are crucial for reaching the goal of malaria elimination. The control and elimination programmes in Uzbekistan benefited from the strengthened fully functional countrywide SSES, diagnostic and therapeutic capacity, and capacity for entomological surveillance and vector control.

Sustainability of Government financial resources, backed up by the Global Fund, was critical. WHO played an important role in formulating strategies and capacity-building.

Reaching the target of elimination after malaria resurgence has required the united efforts of the whole health system, other sectors and the whole population, as well as essential long-term financial allocations. Continued antimalarial activities are essential after malaria elimination to prevent future unfavourable epidemiological situations.

After malaria elimination, a well-organized surveillance and response system and activities were maintained at a satisfactory level. The National Strategic Programme for the Prevention of the Re-establishment of Malaria in Uzbekistan aims at a prompt and timely response to changes in receptivity and risk of importation, maintaining a high level of vigilance, and timely detection of malaria cases with necessary response actions.

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Annex 1. Data sources and analysis

Data were collected and analysed from the following sources.

- Country data:
  - country publications and manuals;
  - Ministry of Health data – reports, laws, regulations, orders and guidelines;
  - National Malaria Control Programme documentation – reports, registers of cases and foci, maps and guidelines;
  - State Sanitary Epidemiological Service (SSES) reports and registers;
  - National Report on Malaria Elimination in the Republic of Uzbekistan, 2018 *(1)*.
- World Health Organization (WHO) data:
  - review of malaria-related materials in the WHO Registry and Archives collection of reports of technical missions, records, reports of WHO Regional Office for Europe meetings, Centralized Information System for Infectious Diseases, and other information on Uzbekistan up to 2023;
  - literature review of WHO publications;
  - review of country data reported to WHO headquarters and to the WHO Regional Office for Europe as part of the annual reporting cycle, including information submitted for the annual World Malaria Report.
- Scientific publications on malaria in Uzbekistan were identified using PubMed and Google and by screening scientific journals and other sources.
- Authors' materials and data were collected during the study, and from various WHO Regional Office for Europe technical support missions in the country.

All data collected were analysed from an epidemiological perspective, with the aim of characterizing the malaria situation during different periods and the effect of interventions. The analysis used the main epidemiological parameters and indicators, such as the annual number of cases (locally acquired and imported); malaria incidence and mortality; distribution of cases by age, sex and other parameters; geographical distribution of malaria; number, category and transition of malaria foci; and parasites and vectors.

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Annex 2. Main characteristics of *Anopheles* mosquitoes in Uzbekistan

Two species of the subgenus *Cellia* are important vectors. They are mainly found in subtropical regions and in the hottest areas of the moderate climate belt *(1–8)*.

Anopheles superpictus is distributed in Central Asia, Transcaucasia and South Europe. Larvae are encountered abundantly in shallow pebble pools rich in calcium salts, with vegetation consisting mainly of filamentous algae. The typical landscape is gorges and places where mountain rivers come out into the plain. The optimum conditions for breeding are created in late summer, when riverbeds dry out and small ponds remain, including under stones. Years with abundant precipitation and excessively dry years are unfavourable for the species. Adult mosquitoes are thermophilic and resistant to drought. It is a pronounced endophile and endophage. This species is highly susceptible to malarial parasites, including *Plasmodium falciparum*.

An. pulcherrimus is distributed in the plains of the south of Central Asia. Larvae develop in stagnant pools with dense vegetation, such as rice plots. They may develop in salty water. Adult mosquitoes are adapted to the conditions in the hottest desert regions. They are semi-exophilic, and the daytime resting shelters are cattle sheds, open barns, wattle and daub fences, bushes, grass, dried canals and pits. Females are capable of distant migrations in search of prey. The population peaks in June and July. The larvae are resistant to water pollution by nitrogenous matter. The species hibernates in the larval stage. In Uzbekistan, this species is the main malaria vector in plains.

The next five species are classified in the nominative subgenus *Anopheles* and have extremely different significance in malaria transmission.

An. martinius is distributed in the Aral region (western Uzbekistan), northern Turkmenistan and western Kazakhstan. Separate populations are also noted in south Uzbekistan. Larvae develop in well-warmed water bodies at a temperature of 38–40 °C, such as ponds, canals, swamps and rice plots. It can endure high salinity. Adult mosquitoes attack people indoors and outdoors. In villages, they are mainly concentrated in cattle barns and non-residential utility buildings. They hibernate in cold indoor areas. They usually do not feed on blood in winter. In Uzbekistan, the species is a secondary malaria vector because of the decrease in population during the hottest time of year and primary feeding on cattle.

An. artemievi was described in 2005 from the Kyrgyz Fergana area (Batken province) *(8)*. Subsequently, the presence of this species was proved by molecular-genetic methods in the Jalalabad and Osh provinces of Kyrgyzstan, in inner Tian-Shan (Naryn province of Kyrgyzstan), in the south of Kazakhstan (South Kazakhstan region) and in Uzbekistan (Fergana Valley, Jizak, Samarkand, Syrdarya and Tashkent provinces) *(3, 4, 8)*. The role in malaria transmission has not been fully established, but it may be significant, given that the species is numerous and – according to preliminary data – is endophilic and attacks humans much more readily than the previously described species.

An. hyrcanus is found in southern Europe, the Republic of Moldova, the south of Ukraine and the Russian Federation, Transcaucasia, and central Asia. Larvae develop at an optimum temperature of 25–30 °C in the north of the areal in water bodies warmed by the sun, and in the south in shadowed pools. Females attack people outdoors and indoors. They are exophilic. Daytime shelter areas are grass, bushes, banks of irrigation canals, and wattle and daub fences. They hibernate in natural shelters such as cracks in the ground overgrown with weeds and bushes. In Uzbekistan, they are considered a secondary vector owing to their preference for wild animals as prey, and because they are exophilic and less susceptible to infection by malaria agents.

An. claviger larvae develop in cold spring water bodies supplied by ground waters. The optimum water temperature is 14–16 °C. The larva population is often significant, especially in mountainous areas, but drops drastically during the hot time of year. Adult mosquitoes are hydrophilous and exophilic. Daytime resting areas are mainly in damp cool areas in vegetation. They mainly attack in the open air. They seek prey near breeding areas. Despite the large areal (Europe, northern Africa, western and central Asia, Transcaucasia), they rarely play an important role in malaria transmission because adult mosquitoes do not fly far from breeding areas, and their population drops drastically in the hot season, which is the most favourable for malaria transmission. If favourable breeding areas are located near residential buildings, however, mosquitoes of this species are capable of providing intensive transmission. In Uzbekistan, the species is considered to be an episodic malaria vector.

An. algeriensis is a rare species with practically no contact with human beings. It is not a malaria vector.

Uzbekistan has an extensive irrigation network and large areas of agricultural crops (cotton, rice) with a high irrigation module. This leads to the existence of a huge amount of water bodies suitable for the development of larvae of malarial mosquitoes.

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Annex 3. Last malaria cases and foci of local transmission

The last indigenous malaria cases in Uzbekistan were registered in 2010 in Surkhandarya (one case, one focus) and Syrdarya provinces (two cases – infection was contracted in Dekhkanabad district of the Kashkadarya province, one focus).

Case 1

The focus was Toltugai kishlak, Babatag shirkat farm, Uzun district, Surkhandarya province, located in the foothill territory along the plain of the Kofirnigan river 0.5 km from Esanbai kishlak in Tajikistan. It is 100 km from the district centre by mountain road. In the focus, 1892 people reside in 336 households. The population is engaged in livestock breeding and agriculture. Health-care services are provided by the Toltugai rural health centre. The focus has been active since 1998, when the first indigenous *Plasmodium vivax* case was registered.

MA, aged 30 years old, was a seasonal worker resident of the village of Toltugai. He became ill with fever on 20 August 2010. He did not seek medical assistance and administered self-treatment. On 24 August he was actively detected by health workers during household visits, laboratory diagnosed (*P. vivax)* and admitted to the Babatag rural district hospital. Aetiological radical treatment (chloroquine and primaquine full course according to schedule) was started, and an emergency notification was submitted to the district CSSES on the same day.

Epidemiological investigation by specialists of the Uzun district CSSES carried out on 26 August revealed he had not left his place of residence in recent years and he had not previously had malaria. Seventeen "contacts" were immediately laboratory-tested, but their results were negative. Medical observation was started for the population of the focus, with thermometry, covering 1828 people. Two were found to have fever, but when examined they were negative for malaria. Mass screening for malaria of 156 people in the focus provided negative results.

Based on the results of the epidemiological investigation, the case was classified as indigenous and the focus as residual-active. In 2008, malaria cases were not registered in the focus. In 2009, there was one imported case from Tajikistan. Monitoring of the focus was in place.

Entomological investigation detected imago and larvae of *An. superpictus* with an imago density of 8–10 specimens per non-residential space, and 12–13 specimens per 1 hectare of water surface in the flood plain of the Kafirnigan River and the irrigation network.

Vector control interventions included distribution of 196 mosquito nets among the population, indoor residual spraying (28 500 m^2 of space with pyrethroid insecticide), and larviciding of 1.0 hectare of water bodies. Health education on malaria prevention was carried out among the population. In 2011, additional 857 mosquito nets were distributed, and 15 390 m^2 of indoor areas and 1 hectare of water bodies were treated with pyrethroid insecticide. In 2012, 15 390 m^2 of indoor areas and 1.8 hectares of water bodies were treated with pyrethroid insecticide. In 2013, 5400 m^2 of indoor areas and 0.018 hectares of water bodies were treated with pyrethroid insecticide.

A total of 340 leaflets on prevention of malaria were distributed among the population.

As in 2011–2013, malaria cases were not registered in this focus, and it was classified as cleared.

Cases 2 and 3

GSS, aged 47 years, and ARR, aged 32 years, were residents of the Saikhun kishlak of the Saikhunabad district of the Syrdarya province. They were both housewives and they were related to each other. They became ill on 18 August 2010 and administered self-treatment.

On 20 August, GSS went to the central polyclinic of the Saikhunabad district. On 23 August she was admitted to the central district hospital with a diagnosis of bronchopneumonia and anaemia. A blood test for malaria on 25 August was negative. On 6 September, she was discharged with an improved condition. On 21 September, she went to the provincial CSSES for malaria examination, where *P. vivax* malaria was detected. On the same day, she was admitted to the provincial hospital for infectious diseases, and aetiological treatment was started (chloroquine and primaquine full course according to schedule).

ARR received treatment at the central district hospital for bronchopneumonia from 25 August. On 6 September, she was transferred to the provincial hospital with the diagnosis of acute pharyngotracheitis with hyperthermic syndrome. A blood test for malaria on 25 August was negative. On 22 September, she went to the regional CSSES and *P. vivax* was detected microscopically in a thick blood smear. She was admitted to the provincial hospital for infectious diseases, and aetiological treatment was started (chloroquine and primaquine full course according to schedule).

Epidemiological investigation of cases and foci of malaria was carried out on 22 September. It was revealed that neither patient had previously had malaria. On 3–4 August, they had attended a wedding in Boikuran kishlak in the Dekhkanabad district of the Kashkadarya province, in the neighbouring house of the house of patient DY, who had imported malaria.

The response included household visits carried out by 15 health workers of 144–260 households daily. A total of 245 people were examined for malaria, one of them with fever. The results were negative.

An entomological team carried out entomological examinations of households and water bodies of the village. In Obiravon, indoor residual spraying was conducted in 242 households, including 1029 residential and 994 non-residential indoor spaces. The area of treatment was 63 370 m^2, protecting 1492 people. *Gambusia affinis* fish were introduced to 9.12 hectares of water reservoirs. Minor environmental management activities to drain areas of stagnant water were carried out by the population. Indoor residual spraying and larviciding continued in 2010–2013.

A seminar on malaria was held for health workers of the district and provincial hospitals and polyclinic. All health workers were given health education leaflets.

Among the population, active health education work was carried out. A meeting was organized by specialists of the mobile group and the district CSSES with the population. Four lectures and 232 discussions were held on preventing malaria, 150 leaflets entitled "Five signs of malaria" were handed out, and the population was tested for their knowledge of malaria.

According to the results of the epidemiological investigation, the two cases were classified as introduced (secondary from imported) malaria. Infection was contracted in the Dekhkanabad district of the Kashkadarya region. Focus by the place of residence of the people with malaria was classified as potential, by place of infection (Boikurgan kishlak, Dekhkanabad district, Kashkadarya province) the focus status changed from potential to active.

Analysis of the data of the epidemiological investigation of the cases showed insufficient knowledge in malaria diagnosis of the staff at the provincial and district hospitals causing a delay of malaria diagnosis; therefore, the CSSES response included seminars on malaria for health workers.

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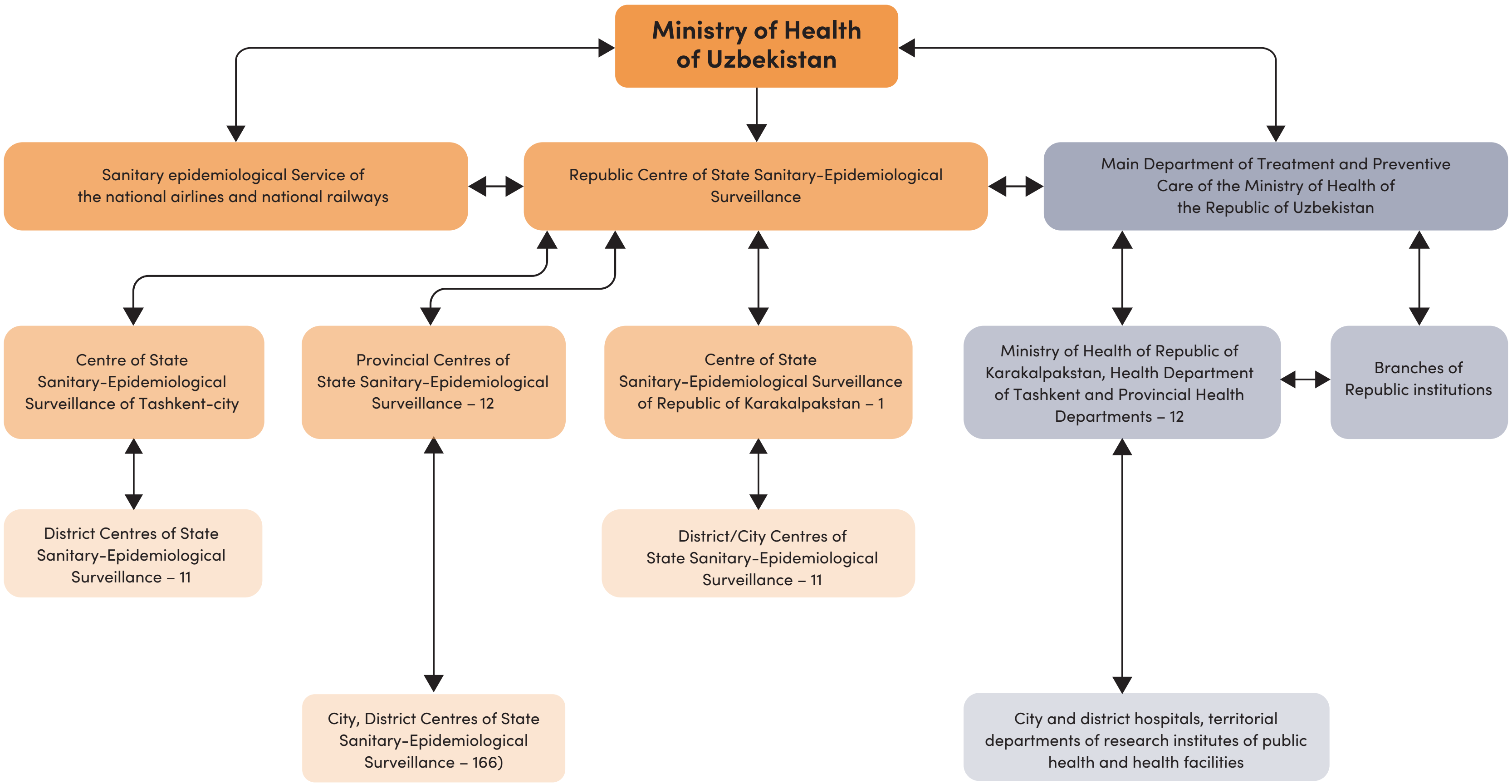
Annex 4. Organization structure of the Ministry of Health of Uzbekistan, 2022



Annex 5. Staff of the National Malaria Control Programme

Table A5.1. Numbers of staff participating in malaria prevention and control in Uzbekistan, 1 January 2017

	Numbers of staff			
Specialists	**National**	**Provincial**	**District**	**Total**
Parasitologists (physicians)	3	21	185	209
Laboratory physicians	1	13	99	113
Entomologists	1	14	141	156
Parasitologists' assistants	1	15	225	241
Entomologists' assistants	0	12	176	188
Laboratory technicians	2	23	248	273
Hydraulic engineers	0	4	21	25
Disinfectors	0	0	210	210
Disinfectors' assistants	0	0	1488	1415

Source: Republic Centre of State Sanitary Epidemiological Surveillance.

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