ELIMINATING MALARIA

Case-study 1

Achieving elimination in Turkmenistan

UCSF GLOBAL HEALTH SCIENCES
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From evidence to action

World Health Organization

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WHO Library Cataloguing-in-Publication Data

Achieving elimination in Turkmenistan.
(Eliminating malaria case-study, 1)

1.Malaria – prevention and control. 2.Malaria – epidemiology. 3.National health programs. 4.Turkmenistan I.World Health Organization. Global Malaria Programme. II.University of California, San Francisco.

ISBN 978 92 4 150430 0 (NLM classification: WC 765)

Photo credit cover: © Rossitza Kurdova-Mintcheva/WHO

Design by Paprika-annecy/University of California San Francisco Global Health Group

Printed by the WHO Document Production Services, Geneva, Switzerland

Publications of the University of California, San Francisco are available on the UCSF web site (http://globalhealthsciences.ucsf.edu/global-health-group), Global Health Group, the University of California, San Francisco

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ACKNOWLEDGEMENTS

This case-study is part of a series of malaria elimination case-studies conducted by the World Health Organization (WHO) Global Malaria Programme and the University of California, San Francisco (UCSF), Global Health Group.

The two groups wish to acknowledge the financial support of the Bill & Melinda Gates Foundation in developing the elimination case-studies.

The following institutions and people participated in the collection and analysis of information that is included in this report:

Dr Leili Shamuradova, Vice Minister, Ministry of Health and Medical Industry

Dr Maral Aksakova, Ministry of Health and Medical Industry

Dr Sofia Alieava, Ministry of Health and Medical Industry

The manuscript was written by Dr Rossitza Kurdova-Mintcheva, Dr Aafje Rietveld and Dr Richard Cibulskis of the WHO Global Malaria Programme. The map was drawn by Mr Ryan Williams.

During the preparation of the manuscript a valuable support was obtained from Dr Mikhail Ejov, WHO Regional Office for Europe and Dr Bahtygul Karriyeva, Head of the WHO country office in Turkmenistan.

The authors would like to thank the honourable Minister of Health, Dr Gurbanmammet Ylyasov, and his staff, as well as the staff of the WHO country office in Turkmenistan for their support and assistance in the preparation of this case-study.

The authors acknowledge with thanks the contributions of the many people who participated in the collection and analysis of country information, including Professor D. Tesler, Dr Kasim Roziev, Dr Sachli Nuriyeva, and the heads and staff of the Experimental Production Centre in Ashgabat and of the provincial and district sanitary epidemiological services of the Ministry of Health and Medical Industry of Turkmenistan, as well as the WHO external evaluation experts Dr Anatoly Kondrashin and Dr Allan Schapira.

The following experts, recruited by the WHO Regional Office for Europe contributed to Turkmenistan's success in eliminating malaria and to the body of evidence contained in this case-study: Dr Andrei Zvantsov, Professor Vladimir Davidyants, Professor Rossitza Kurdova-Mintcheva, Professor Alla Baranova, and Dr Ara Kysheshan.

Dr Robert Newman and Mrs Cara Smith Gueye reviewed the case-study and provided important assistance and feedback. The authors remain responsible for any errors and omissions.

ACRONYMS AND ABBREVIATIONS

ABER	annual blood examination rate
ACD	active case detection
ACT	artemisinin-based combination therapy
API	annual parasite index
CFR	case–fatality rate
CISID	Centralized Information System for Infectious Diseases
DDT	dichlorodiphenyltrichloroethane
EQA	External Quality Assurance
EPC	Experimental Production Centre
GDP	gross domestic product
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GMEP	Global Malaria Eradication Programme
G6PD	glucose-6-phosphate dehydrogenase
IRS	indoor residual spraying
MDA	mass drug administration
MDG	Millennium Development Goals
MOHMI	Ministry of Health and Medical Industry
NMCP	national malaria control programme
NRL	national reference laboratory
PCD	passive case detection
PPP	purchasing power parity
QA	quality assurance
RDTs	rapid diagnostic tests
SES	Sanitary Epidemiological Service
SOP	standard operating procedure
SPR	slide positivity rate
SSR	Soviet Socialist Republic
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
WHO	World Health Organization

GLOSSARY

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

active case detection

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

annual blood examination rate

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

case-based surveillance

Every case is reported and investigated immediately (and also included in the weekly reporting system).

case definition (elimination programmes)

autochthonous – A case locally acquired by mosquito-borne transmission, i.e. an indigenous or introduced case (also called "locally transmitted").

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

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

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

introduced – A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first generation from an imported case, i.e. the mosquito was infected from a case classified as imported).

locally transmitted – A case locally acquired by mosquito-borne transmission, i.e. an indigenous or introduced case (also called "autochthonous").

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

case investigation

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

case management

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

case notification

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

certification of malaria-free status

Certification granted by WHO after it has been proved beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in an entire country for at least 3 consecutive years.

elimination

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

endemic

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

epidemic

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

eradication

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

evaluation

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

focus

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

gametocyte

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

hypnozoite

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

incubation period

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

intervention (public health)

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

local mosquito-borne malaria transmission

Occurrence of human malaria cases acquired in a given area through the bite of infected *Anopheles* mosquitoes.

malaria-free

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

malaria incidence

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

malaria prevalence

The number of malaria cases at any given time in a specified population, measured as positive laboratory test results.

monitoring (of programmes)

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

national focus register

Centralized database of all malaria foci in a country.

national malaria case register

Centralized database of all malaria cases registered in a country, irrespective of where and how they were diagnosed and treated.

outpatient register

List of patients seen in consultation in a health facility. The register may include the date of consultation, patient's age, place of residence and presenting health complaint, tests performed and diagnosis.

parasite prevalence

Proportion of the population in whom *Plasmodium* infection is detected at a particular time by means of a diagnostic test (usually microscopy or a rapid diagnostic test).

passive case detection

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

population at risk

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

rapid diagnostic test

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

rapid diagnostic test positivity rate

Proportion of positive results among all the rapid diagnostic tests performed.

receptivity

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

re-establishment of transmission

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

relapse (clinical)

Renewed manifestation of an infection after temporary latency, arising from activation of hypnozoites (and therefore limited to infections with *P. vivax* and *P. ovale*).

sensitivity (of a test)

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

slide positivity rate

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

specificity (of a test)

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

surveillance (control programmes)

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

surveillance (elimination programmes)

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

transmission intensity

Rate at which people in a given area are inoculated with malaria parasites by mosquitoes. This is often expressed as the "annual entomological inoculation rate", which is the number of inoculations with malaria parasites received by one person in one year.

transmission season

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

vector control

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

vector efficiency

Ability of a mosquito species, in comparison with another species in a similar climatic environment, to transmit malaria in nature.

vectorial capacity

Number of new infections that the population of a given vector would induce per case per day at a given place and time, assuming conditions of non-immunity. Factors affecting vectorial capacity include: the density of female anophelines relative to humans; their longevity, frequency of feeding and propensity to bite humans; and the length of the extrinsic cycle of the parasite.

vigilance

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

vulnerability

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

SUMMARY

This case-study describes and evaluates the policies and strategies used to contain malaria outbreaks in Turkmenistan in the 1990s and early 2000s and the process subsequently used to eliminate malaria from the country. Lessons for countries that are embarking upon elimination are distilled.

History of malaria and malaria control

Plasmodium vivax transmission was interrupted in Turkmenistan by 1960 during the Global Malaria Eradication Programme. The country subsequently maintained surveillance systems to prevent and detect the reintroduction of malaria. During the period 1960–1980, sporadic imported and introduced malaria cases of *P. vivax* were reported, without further epidemiological consequences. From the 1980s onwards, the receptivity (the likelihood that imported parasites will be locally transmitted) of some areas in the country increased as a consequence of the construction and exploitation of major water resource projects. Vulnerability (parasite importation pressure) also increased with growing population movements from Afghanistan and other neighbouring countries. As a result, more malaria cases were imported in the 1980s and 1990s and were followed by an increase in autochthonous cases. The health system did not respond to the increased vulnerability and receptivity.

In 1998–1999 and in 2002–2003, two outbreaks of *P. vivax* malaria occurred in Mary province near Turkmenistan's border with Afghanistan. The outbreaks first affected military staff and oil and gas workers deployed near the border and subsequently the population of nearby settlements. Programmatic factors – delayed diagnosis, treatment and reporting of malaria cases, especially in rural areas – also played a role in the occurrence of the outbreaks. In addition, there was a lack of drugs (chloroquine and primaquine) to treat the first cases in 1998 and an insufficient supply of insecticides for vector control interventions at the beginning of the outbreak. Since the first cases among military personnel and oil and gas workers were not promptly identified and properly treated, and vector density was not rapidly reduced, it may be inferred that local transmission occurred not only in the military camp but also in the local rural population. In addition, soldiers with asymptomatic infections who were demobilized carried malaria into other provinces.

During the 2002–2003 outbreak, a delay in recognizing the index case was reflected in the delayed response. However, by mobilizing specialized and general health services and implementing a massive scale-up of control and surveillance activities in the affected areas, the national malaria programme managed to limit the transmission to Mary province alone. After an improvement of the malaria situation in 2004, and in line with the malaria elimination strategy of the WHO Regional Office for Europe (EURO), the Government of Turkmenistan decided to reorient the malaria programme towards eliminating the last foci and preventing reintroduction. As a result of the elimination efforts, the last autochthonous cases in Turkmenistan were registered in 2004. In 2010, WHO certified the country as free of malaria.

Control of the outbreaks

Interventions for the containment of the outbreaks were coordinated by the Sanitary Epidemiological Service (SES). Mobile teams consisting of epidemiologists,

parasitologists, entomologists, clinicians and laboratory technicians were assigned to the affected areas.
An integrated approach was applied that included:

- eliminating the sources of infection by,
  - timely case detection through active and passive case detection followed by radical treatment,
  - prompt and comprehensive investigation of every case to detect and treat further infections, and define the population at risk of malaria transmission, and
  - interseasonal prophylactic treatment with primaquine for all who had been exposed to the transmission risk;
- conducting integrated vector control guided by investigations of foci, using a combination of indoor residual spraying (IRS), larviciding, environmental management and housing improvements; and
- providing health education and prevention for populations in the foci through seasonal chloroquine prophylaxis.

Elimination of malaria, 2004–2010

A comprehensive approach was adopted in order to eliminate the source of infection, reduce transmission by vectors and provide health education and prevention to the populations affected. A malaria focus was considered the minimum unit for antimalarial action. A focus register was established and regularly updated to reflect the functional status of each focus (e.g. transition from a new active focus to a focus that had been cleared, or vice versa). Various strategies were employed to interrupt transmission:

- Both passive and active case detection were conducted. There was case-based surveillance, which involved the timely recording, reporting and investigation of laboratory-confirmed malaria cases as well as maintaining a database of individual cases at district, provincial and national levels. Prompt treatment of patients was provided free of charge, in accordance with the updated national policies and guidelines. Once transmission was interrupted, greater attention was paid to identifying imported cases – setting up an outpatient consulting room in Ashgabat on tropical diseases for travellers; clinical examination of travellers from Afghanistan with malaria examination of febrile individuals at the border sanitary quarantine points; sustained vigilance in the general health services.
- The national territory and neighbouring areas were stratified by levels of receptivity according to the results of entomological monitoring. Entomological investigations were undertaken and integrated vector control activities were applied in transmission foci. Larval control using fish was widely applied. No IRS has been performed since 2005 but a stock of insecticides is maintained by SES in case of emergency.
- Community awareness was increased through the mass media and other avenues, and the participation of the whole population in malaria elimination and prevention was encouraged.

The malaria control programme benefited from an upgrading of health facilities, including recruitment and training of staff and provision of equipment and transport (microscopes, computers, cars). The national system of external quality assurance (EQA) of malaria was improved and covered all laboratories where malaria was diagnosed. The national reference laboratory, which conducted the national EQA, was included in an international EQA programme and internationally certified.

Strong political commitment to malaria elimination and broad governmental support played an important role in malaria elimination in Turkmenistan. The Government and WHO EURO provided the funding for the interventions, which were regulated in the National Strategy and Plan of Action for Malaria Elimination. Assistance from WHO in developing strategies, policies, strategic plans and guidelines ensured that the complex of measures was based on up-to-date WHO recommendations and was properly conducted with adequate coverage. WHO also played an essential

role in strategic guidance and technical assistance on capacity building, disease management, vector control, malaria surveillance, operational research, community involvement and intersectoral collaboration. The Turkmen SES, with its comprehensive network of field presence in every district, coordinated the malaria programme activities. Its expertise in malaria control and elimination was highly instrumental in the achievement of the goals.

Outlook for the future

A plan of action for prevention of malaria reintroduction in the country has been developed and introduced, aiming at prompt and timely response to changes in the receptivity and vulnerability of the territory of the country, maintaining a high vigilance, timely detection of any malaria case and preparedness for undertaking response actions when required.

The lessons learned during the malaria outbreaks and subsequent elimination efforts highlight the importance of maintaining epidemiological surveillance at a level that will ensure prompt detection and treatment of cases, as well as timely response to any emergency. Financial allocations to fund malaria activities should continue: Turkmenistan has an ongoing duty – not only to its own people but also to its neighbours – to sustain this dedication to remaining free of malaria.

ДОСТИЖЕНИЕ ЭЛИМИНАЦИИ МАЛЯРИИ В ТУРКМЕНИСТАНЕ
ТЕМАТИЧЕСКОЕ ИССЛЕДОВАНИЕ

Резюме

В данном тематическом исследовании дается описание и оценка мер политики и стратегий, применявшихся в Туркменистане для подавления вспышек малярии в 1990-х и в начале 2000 х годов, а также процесса, применяемого в дальнейшем для элиминации малярии в этой стране. Особо выделены уроки, полезные для стран, которые также приступили к элиминации данного заболевания.

ИСТОРИЯ МАЛЯРИИ И БОРЬБЫ С НЕЙ

Передача возбудителя малярии *Plasmodium vivax* была прервана в Туркменистане к 1960 году в ходе реализации Глобальной программы по ликвидации малярии. В дальнейшем в стране поддерживалась система эпидемиологического надзора с целью профилактики завоза и восстановления передачи малярии. В период, охватывающий 1960–1980-е годы, отмечались спорадические случаи завозной и вторичной от завозной вследствие местной передачи малярии, вызванной *P. vivax*, не имевшие, однако, эпидемиологических последствий. Начиная с 1980-х годов восприимчивость (способность местных переносчиков поддерживать передачу малярии от завезенных паразитов) некоторых регионов страны выросла в результате строительства и эксплуатации крупных водохозяйственных объектов. Уязвимость территории (мера вероятности завоза инфекции) также увеличилась в связи с ростом перемещения населения из Афганистана и других пограничных стран. В результате в 1980-х и 1990-х годах увеличилось число случаев завозной малярии, а вслед за этим и число автохтонных случаев вследствие местной передачи. Система здравоохранения не отреагировала на повышение уровней уязвимости и восприимчивости.

В 1998–1999 и 2002–2003 годах в Марыйском районе вблизи границы Туркменистана с Афганистаном произошли две вспышки малярии, вызванной *P. vivax*. Вспышки вначале затронули военнослужащих и рабочих-нефтяников, дислоцированных вблизи границы, а затем – жителей соседних населенных пунктов. Поздний диагноз и задержки с лечением и сообщением о выявленных случаях, особенно в сельской местности, также явились факторами, которые сыграли важную роль в возникновении вспышек. Кроме того, для лечения первых случаев в 1998 году отсутствовали необходимые лекарства (хлорохин и примахин) и не хватало инсектицидов для борьбы с переносчиками малярии в начале вспышки. Поскольку первые случаи заболевания среди военнослужащих и рабочих-нефтяников не были своевременно выявлены и больные не получили надлежащего лечения, а передача малярии не была быстро снижена, можно предположить, что местная передача происходила не только в пределах военного городка, но и среди местного сельского населения. В дополнение

к этому демобилизованные военнослужащие с бессимптомной инфекцией занесли малярию в другие области республики.

В ходе вспышки 2002–2003 годов позднее выявление первичного случая привело к запоздалому реагированию. Однако благодаря мобилизации специализированных и общих служб здравоохранения и принятию в массовом масштабе экстренных мер по борьбе с вспышечной заболеваемостью и усилению эпидемиологического надзора на пораженных территориях в рамках государственной программы по борьбе с малярией удалось ограничить перенос только Марыйской областью. После улучшения ситуации по малярии в 2004 году и в соответствии со стратегией элиминации малярии Европейского регионального бюро ВОЗ (EURO) правительство Туркменистана приняло решение о переориентации программы по борьбе с малярией на элиминацию последних очагов и профилактику завоза и повторного восстановления передачи малярии. В результате элиминационных мер последние автохтонные случаи в Туркменистане были зарегистрированы в 2004 году. В 2010 году ВОЗ сертифицировала территорию этой страны как свободную от малярии.

БОРЬБА С ВСПЫШКАМИ МАЛЯРИИ

Меры по сдерживанию распространения вспышек заболевания координировались санитарно-эпидемиологической службой (СЭС). Для работы на пораженных территориях были сформированы выездные бригады в составе эпидемиологов, паразитологов, энтомологов, врачей-клиницистов и лаборантов. Применялся комплексный подход, предусматривавший:

- Элиминацию источников инфекции путем
  - своевременного выявления случаев заболевания посредством применения активных и пассивных методов выявления больных с последующим радикальным лечением,
  - своевременного и всестороннего эпидемиологического расследования каждого случая малярии в целях выявления других случаев и их лечения, а также определения групп населения, подверженных риску заражения малярией,
  - межсезонной химиопрофилактики примахином всех, кто подвергался риску заражения болезнью;
- Применение комплексных мер борьбы с переносчиками инфекции, где основное место отводилось обработке помещений инсектицидами остаточного действия (ОПИОД). Наряду с ОПИОД также применялись ларвициды и меры по оздоровлению экологической обстановки и улучшению жилищных условий;
- Обеспечение санитарного просвещения и предупреждения заболеваемости населения в очагах малярии за счет сезонной химиопрофилактики хлорохином.

ЭЛИМИНАЦИЯ МАЛЯРИИ, 2004–2010 ГОДЫ

Для борьбы с малярией был принят комплексный подход, предусматривавший элиминацию источников заражения, снижение уровня передачи инфекции и улучшение санитарного просвещения и профилактики среди населения. За минимальную единицу, требующую применения противомалярийных мер, был принят малярийный очаг. Был создан и регулярно обновлялся регистр очагов, отражающий функциональный статус каждого очага (т. е. переход от статуса “новый активный очаг” к статусу “оздоровленный” или наоборот). Для прерывания передачи

использовались различные стратегии, в том числе:

- Проводилось как пассивное, так и активное выявление случаев заболевания. Осуществлялся эпиднадзор на основе случаев заболеваний, включавший своевременную регистрацию, извещение и исследование лабораторно подтвержденных случаев заболевания малярией, а также ведение базы данных по отдельным случаям на уровне районов, областей и страны в целом. Пациентам бесплатно предоставлялось ранее лечение в соответствии с новыми общенациональными правилами и руководствами. После того как было осуществлено прерывание передачи, внимание переносилось на выявление случаев завоза малярии: так, в Ашхабаде был открыт консультативный кабинет по тропическим заболеваниям для лиц, выезжающих и прибывающих из-за рубежа; проводился медицинский осмотр лиц, прибывающих из Афганистана, и проверка на малярию лиц с симптомами лихорадки в пограничных санитарных пунктах; поддерживалась постоянная бдительность всех служб здравоохранения.
- Территория страны и соседние области были зонированы по уровням восприимчивости в соответствии с результатами энтомологического мониторинга. Были проведены энтомологические исследования и введены комплексные методы борьбы с переносчиками малярии в очагах передачи. Широко применялись мероприятия, направленные на борьбу с личинками переносчиков с использованием рыб-ларвифагов. ОПИОД не проводились с 2005 года, однако на случай чрезвычайных ситуаций СЭС держит запас инсектицидов.
- Через СМИ и другие каналы повышался уровень информированности населения, поощрялось участие всего населения в мерах по элиминации и профилактике малярии.

Реализации программы по борьбе с малярией способствовала модернизация учреждений здравоохранения, предусматривавшая обучение персонала, а также обеспечение таких учреждений необходимым оборудованием и транспортом (микроскопами, компьютерами, автомобилями). Национальная система внешнего контроля качества (ВКК) лабораторных исследований малярии была усовершенствована и распространена на все лаборатории, где проводилась диагностика малярии. Национальная референтная лаборатория, осуществляющая общенациональный ВКК, была включена в международную программу ВКК и получила международную сертификацию.

Важную роль в элиминации малярии в Туркменистане сыграли твердая политическая приверженность решению этой задачи и широкая государственная поддержка. Правительство страны и Европейское бюро ВОЗ предоставили финансовые средства для проведения мер по борьбе с малярией, осуществление которых регулировалось Национальной стратегией и планом действий по элиминации малярии. Благодаря помощи ВОЗ в разработке стратегии, политики, стратегических планов и руководящих принципов в основу комплекса принимаемых мер были положены последние рекомендации ВОЗ, и соответствующие мероприятия проводились надлежащим образом, обеспечивая достаточный охват населения. ВОЗ также сыграла важную роль в обеспечении стратегического руководства и технической помощи в

таких областях, как укрепление кадрового потенциала, улучшение диагностики и лечения, борьба с переносчиками инфекции, эпидемиологический надзор за малярией, проведение оперативных исследований, вовлечение местных сообществ в межотраслевое сотрудничество. Координацию мероприятий в рамках программы по борьбе с малярией осуществляла СЭС Туркменистана, располагающая широкой сетью отделений на местах в каждом районе. Знания и опыт сотрудников СЭС в области борьбы с малярией и ее элиминации в значительной степени способствовали достижению поставленных целей.

ПЕРСПЕКТИВЫ НА БУДУЩЕЕ

Для предотвращения повторного восстановления передачи малярии в Туркменистане был разработан и принят план действий, направленный на незамедлительное и своевременное реагирование на изменения в уровне восприимчивости и уязвимости территории страны к малярии, сохранение повышенной бдительности, своевременное выявление случаев малярии и обеспечение готовности по принятию чрезвычайных мер при необходимости.

Опыт, полученный в ходе борьбы со вспышками малярии и в процессе элиминации малярии, указывает на важность поддержания эпидемиологического надзора на уровне, который обеспечивает незамедлительное выявление случаев инфекции и лечение больных, а также своевременное реагирование на любые чрезвычайные ситуации. Необходимо продолжить выделение средств на противомалярийные мероприятия: долг Туркменистана – не только перед своим населением, но и перед соседними странами – состоит в продолжении этих усилий, позволяющих ему оставаться свободным от малярии.

INTRODUCTION

The malaria elimination case-study series

If countries are to make well-informed decisions on whether or how to pursue malaria elimination, an understanding of historical and current experiences of malaria elimination and prevention of reintroduction in other countries – particularly those in similar eco-epidemiological settings – is critical. The Global Malaria Programme of the World Health Organization (WHO/GMP) and the Global Health Group of the University of California, San Francisco – in collaboration with national malaria programmes and other partners and stakeholders – are jointly conducting a series of case-studies on elimination of malaria and prevention of reintroduction. The objective of this work is to build an evidence base to support intensification of malaria elimination as an important step in achieving international malaria targets.

Ten case-studies are being prepared that, together, will provide insights into and lessons to be learnt from a wide range of elimination approaches, geographical settings and progress towards the goal of zero local transmission.

Turkmenistan was selected for a malaria elimination case-study because of its recent elimination success – exemplified by the achievement of official certification, by WHO in 2010, of freedom from malaria – and because details of the country's successful fight against malaria have not yet been made available in the public domain. The main authors of the study have been closely involved in the national malaria elimination efforts over the past two decades and the WHO certification process for Turkmenistan in 2009–2010. They are familiar with the country and its health system, and with the wealth of malaria-related information collected and analysed as part of the certification requirements.

Data collection and analysis methods for the case-study are elaborated in Annex 1.

Malaria in the WHO European Region

After the remarkable success of the WHO Global Malaria Eradication Programme that was launched in 1955, including the achievement of malaria-free status in almost all countries of the WHO European Region, the malaria situation deteriorated in the 1990s (*1–6*). There was a massive return of malaria into areas of Central Asia and the Transcaucasian countries of the WHO European Region, and the disease assumed epidemic proportions in Tajikistan and in Turkey. This deterioration was the result of changes in political and economic conditions, the post-Soviet economic collapse, military conflicts, mass population migration, extensive development projects, degradation of the public health system, and the near or complete discontinuation of malaria prevention and control activities (*1–3, 5*).

The malaria-affected Member States of the WHO European Region joined the Roll Back Malaria initiative launched by the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP), WHO and the World Bank in 1998; with rapid scale-up and sustained efforts, they achieved a marked reduction in the levels of transmission and of malaria morbidity *(7, 8)*. In 2005, these countries all endorsed the Tashkent Declaration, *The Move from Malaria Control to Elimination (9)*.

A new regional elimination strategy was put in place, with the ultimate goal of interruption of *P. falciparum* malaria transmission in Central Asia by 2010 and the elimination of local transmission of malaria in the entire WHO European Region by 2015 *(10)*.

In 2007, the WHO European Region held a meeting in Ashgabat, Turkmenistan, to assess the progress achieved towards malaria elimination *(11)*. Steady progress was reported for the entire Region, including a 14-fold reduction in the reported overall number of malaria cases – from 37 173 to 2679 – during the period 1999–2006, and a reduction in *P. falciparum* transmission, with the annual number of the local cases in Tajikistan falling from a peak of 831 in 2000 to 28 in 2006 *(11, 12)*. It was concluded that all countries affected by autochthonous malaria would be able to proceed with malaria elimination as planned and that, by 2010, Armenia and Turkmenistan would be able to achieve elimination of *P. vivax* transmission, and Tajikistan elimination of *P. falciparum* transmission.

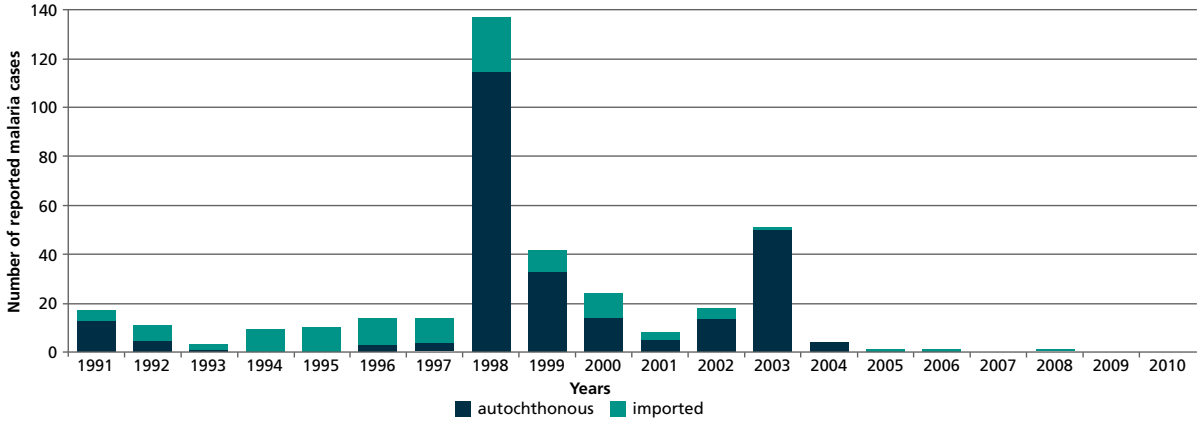
The scaling up of malaria control efforts in the WHO European Region has indeed resulted in progress towards malaria elimination as planned, made possible by long-term and predictable funding and by wide coverage with interventions, including close cross-border collaboration and strengthened surveillance and monitoring. Only 58 indigenous malaria cases were reported in 2011, down from the peak of 90 712 cases in 1995. Armenia and Turkmenistan have achieved WHO certification of their malaria-free status, and the last case of autochthonous *P. falciparum* malaria in the Region was reported in 2008 *(12, 13)*.

Malaria in Turkmenistan

Turkmenistan is one of the Central Asian countries where malaria was eliminated in the 1960s only to return in the 1990s in the wake of the break-up of the former Union of Soviet Socialist Republics (USSR) and subsequent geopolitical and economic events in the region (*5*, *6*, *14*, *15*); it declared its independence in 1991. Enormous efforts and substantial funding were needed to set up and implement malaria control and elimination programmes, scale up antimalaria activities, combat outbreaks in 1998–1999 and 2002–2003, and finally achieve the goal of malaria elimination (Figure 1). Turkmenistan was certified malaria-free by WHO in 2010 – the first country to achieve this goal in the WHO European Region since the 1970s *(16, 17)*.

This case-study presents an analysis and evaluation of the malaria situation in Turkmenistan, the containment of outbreaks and the processes required to achieve malaria elimination in the country. It covers reasons for the deterioration of the malaria situation, the main interventions used to cope with the ensuing epidemics, best practices of epidemiological surveillance and control, and lessons learnt. The study describes an example of contemporary, evidence-based elimination strategies and policies, applied in a case of reintroduction of malaria transmission followed by a successful effort to reach malaria elimination. It also highlights the strong political commitment and the mobilization of human resources that were needed to reach the elimination goal.

Figure 1. Reported malaria cases in Turkmenistan, 1991–2010



Source: CISID (Centralized Information System for Infectious Diseases), Ministry of Health and Medical Industry

COUNTRY BACKGROUND

Geography, population and economy

Turkmenistan is situated in Central Asia, to the east of the Caspian Sea. Its capital is Ashgabat. Some 80% of its area of 488 100 km² is covered by the Karakum Desert *(18)*. Turkmenistan shares borders with Afghanistan, the Islamic Republic of Iran, Kazakhstan and Uzbekistan, of which only Afghanistan still has a significant malaria problem in the border areas. The Kopet Dag mountain range along the south-western border with the Islamic Republic of Iran reaches an altitude of 2912 metres. The only other areas of significant elevation are the Great Balkan Range in the west of the country (Balkan Province) and the Koytendag Range on the south-eastern border with Uzbekistan (Lebap Province) (Figure 2).

The climate is hot and arid. From May to September daytime air temperatures exceed 40 °C, peaking in July. As a result, the environmental conditions for malaria transmission exist mainly in oases and around water bodies, and agricultural development is based entirely on artificial irrigation *(18, 19)*. A great part of the irrigated land is planted with cotton and rice; the country is among the world's 10 major cotton producers. To satisfy the water supply needs for industries, and primarily for agriculture and farming, Turkmenistan uses the waters of the Amu Darya – the largest Central Asian river – and other Turkmen rivers, as well as a system of artificial canals. The canals include the 1375-km Karakum Canal, which skirts the Karakum Desert, carrying water westwards from the Amu Darya and has a system of water reservoirs, and the Turkmen Canal which supplies water to the northern regions of the country. There are also large subterranean water reserves and the Altyn Asyr Lake is being constructed in the centre of the Karakum Desert.

Demographic data for Turkmenistan are presented in Annex 2. The country is multi-ethnic, with more than 100 ethnic groups (Turkmens 77%; Uzbeks 9.2%; Russians 6.7%; others 7.1%). In 2009, the population was 5.1 million, 49% of whom were living in urban areas *(20)*. The country is very unevenly populated: most people live in cities, in oases and around water bodies. Average population density in desert and mountainous areas is 1 person/km²; in areas of artificial irrigation this figure rises to more than 100 people/km². The most densely populated area – and the area where the last malaria cases occurred in 2004 *(18)* – is the estuary of the Murgab River, with more than 240 inhabitants per km².

The administration division, political organisation and economy are presented in Annex 3.

Turkmenistan is increasingly exploiting its natural gas reserves, which are the fourth largest of any country in the world. It also has large reserves of oil, iodine, bromine, sulfur, etc. Gas and oil industries are leading branches of the economy: the energy potential is estimated at 45 billion tons of oil equivalent, corresponding to one-fifth of the world's deposits of gas and oil. The most developed sectors of industry include fuel and energy, chemistry and construction *(18, 19)*.

According to World Bank data, the gross domestic product (GDP) of Turkmenistan in 2009 was US$ 19 947 368 421, corresponding to a GDP per capita of US$ 3903. The country is classified as a "lower middle income country" *(21)*. Adjusted for purchasing power parity (PPP), the gross national income per capita is US$ 7490 *(22)*. The following services and commodities are provided free of charge by the Government to the population: gas, electricity, water, table salt, education and a wide range of health services. Charges for telephone services and public transport are nominal.

Health system and population health profile

The health system in Turkmenistan has three components *(23)*:

- The Ministry of Health and Medical Industry (MOHMI), with its:
    - Primary health care institutions, pharmaceutical services and other institutions such as hospitals, outpatient clinics, pharmacies and research centres established under other ministries, agencies and Government bodies and organizations.
- Some nongovernmental organizations, such as the Trade Union of the Medical Profession, National Red Crescent Society and others that provide health services.

Primary health care services in urban and rural areas are provided by municipal "health houses", which offer: diagnostic procedures; treatment of the most common illnesses and injuries; curative and preventive measures against parasitic and other diseases; immunization; community awareness raising and health education; and mother-and-child health protection measures. The health houses play an essential role in the detection and follow-up of malaria patients.

The public health care delivery system is structured in accordance with the administrative and geographical division of the country at primary *etrap* (district), intermediate *velayat* (province), Ashgabat city and central (republican) levels. At each administrative level there is a network of hospitals, health centres, infectious disease isolation units, laboratories, etc., as well as sanitary epidemiological services, which are responsible for communicable disease control including antimalaria interventions.

Per capita government expenditure on health exceeded US$ 100 in 2005. A broad range of services is provided free of charge to patients, including all services related to communicable and vector-borne diseases such as malaria.

Figure 2. Map of Turkmenistan

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Global Malaria Programme (GMP)
World Health Organization

World Health Organization

Health care policies are presented in Annex 4 and the main health indicators in Annex 5. Overviews of health care service facilities and basic hospital resource indicators are presented in Tables 1 and 2 below.

Turkmenistan ranked 102nd on the UNDP Human Development Index country listing in 2011, at a medium level of human development *(24)*. WHO provides the following population health profile for Turkmenistan for 2009 *(25)*:

- life expectancy at birth: 63 years (60 for men and 67 for women);
- under-five mortality rate: 45 deaths per 1000 live births;
- maternal mortality rate: 77 per 100 000;
- leading causes of death: cardiovascular disease (27%), neuropsychiatric disease (13%), parasitic and other infectious diseases (9%), respiratory infections (9%), trauma (8%).

Table 1. Health care service facilities in Turkmenistan in 2010

Health care service facilities	Number
Central-level facilities	40
Provincial and Ashgabat city health facilities	214
District and city-level facilities	55
Village health houses and health centres	1 643
Municipal health houses	26

Source: Statistical department, Ministry of Health and Medical Industry

Table 2. Basic hospital resource indicators

Indicator	Value
Number of hospitals per 100 000 population	2
Number of hospital beds per 100 000 population	433
Average stay in hospital (days)	10

Source: Statistical departement, Ministry of Health and Medical Industry, reference *19*

HISTORY OF MALARIA AND MALARIA CONTROL

Parasites and vectors

In the past, *Plasmodium vivax*, *P. falciparum* and *P. malariae* have all been reported in Turkmenistan. Since 1960, only *P. vivax* has been transmitted in the country. The principal malaria vectors are *Anopheles pulcherrimus* and An. superpictus; a third vector, An. hyrcanus, possibly plays a minor role in certain circumstances (Annex 6).

Pre-control

Malaria has been known in Turkmenistan since ancient times, under the name of *gyzzyrma* or *ystma*. It ranked among the principal infectious diseases of Turkmenistan and was a major burden for the rural population *(18, 19)*. It is said that malaria was particularly prevalent in the Middle Ages and that in the 14th century Timur Lenk[1] combated it by killing people suffering from fever in the city of Merv (now Mary).

In the late 19th and early 20th centuries, malaria was still an important health problem in Turkmenistan. Archival records show that, in the Merv district, nearly 90 000 persons had malaria in 1896 and that some 20 000 died of the disease in 1896–1897. At that time, malaria swept whole villages. From 1904 onwards malaria subsided, emerging again during the First World War (1917 – 1922). At the time there were no drugs or resources for large-scale interventions against the disease (*14*, *15*, *18*, *19*, *26*).

Initial control efforts

In the 1920s, limited control efforts were initiated. Malaria posts were established in Bayram-Aly, Dashoguz, Kerky and Charjow (now Lebap province) and in Kara-Kala district (now Makhtumkuly district). In 1923, major land reclamation work was undertaken in the Murgab River valley, water reservoirs were treated with petrol against mosquito larvae, and quinine was distributed to the population, contributing to a reduction of the disease in Merv city and its outskirts.

From 1930 onwards the problem was addressed more broadly and systematically. A number of specialized institutions were established to combat malaria, including the Tropical Institute, 21 malaria control posts and 101 malaria units, staffed by malariologists, entomologists and other specialists. Large-scale vector control was initiated, using oiling of water reservoirs, widespread spraying with DDT, deployment of *Gambusia affinis* larvivorous fishes in the Murgab and Amu Darya river basins, in-filling of unused water reservoirs and use of mosquito nets. This was combined with mass drug administration (MDA) of the population in the active malaria foci – every individual was treated with antimalarial medicines regardless of whether they had a current or recent malaria infection. These interventions led to a substantial fall in the malaria burden.

In 1937, mass screening followed by treatment of detected cases was started. Nearly 128 000 people were examined by microscopy in 1938, of whom 7800 (about 6%) were positive. In the same year, 78% of the registered patients were given anti-relapse treatment using primaquine. It has been reported that malaria prevalence was reduced by 47% between 1937 and 1941 *(19)*. Many data from that period were lost in 1948 in the massive earthquake that destroyed Ashgabat, the old capital city of Turkmenistan.

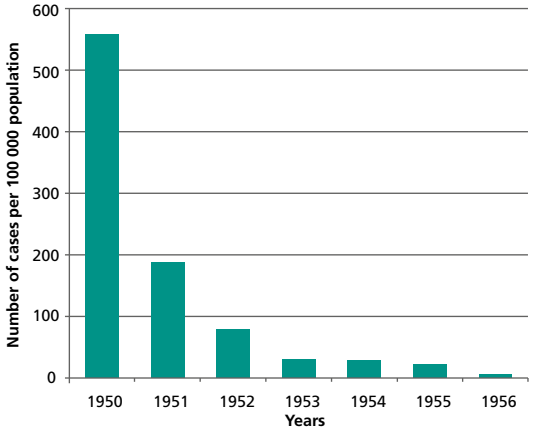
Initial elimination efforts

In the years following the Second World War, the USSR set the goal to "eliminate malaria as a mass disease", including in the Turkmen Soviet Socialist Republic.

[1] Also known as Tamerlane: conqueror and ruler of an area from Turkey to Mongolia (1336–1405).

Malaria surveillance and control were scaled up. By that time, the antimalaria network in Turkmenistan included 42 malaria control stations, 23 malaria posts staffed by *feldshers*[1] and 332 quinine distribution posts. A system for one-year follow-up of all malaria patients was established, which included monthly blood testing at dispensaries. Large-scale antimalaria interventions led to a dramatic reduction in the malaria burden (see Figure 3): the annual morbidity rate dropped from 558 per 100 000 population in 1950 to 3.4 per 100 000 population in 1956, and elimination was achieved by 1961. However, Turkmenistan was not certified by WHO as malaria-free, because the country was at that time a part of the USSR, which still included some endemic areas.

Figure 3. Malaria incidence rate per 100 000 population in Turkmenistan, 1950–1956



Source: Ministry of Health and Medical Industry

Prevention of reintroduction, 1961–1990

From 1961 to 1990, Turkmenistan had no problems with malaria. To prevent the reintroduction of malaria transmission, a vigilance system was set up in accordance with the recommendations of the WHO Global Malaria Eradication Programme. All public health care institutions were involved. The activities were carried out under the supervision of the Sanitary Epidemiological Service (SES) of the MOHMI; they included epidemiological surveillance directed at early detection of any malaria case, timely response (immediate radical treatment, epidemiological investigation of every case and new focus), malaria screening of risk groups and vector control interventions if needed, training of medical personnel, health education, etc.

Between 1961 and 1969, isolated malaria cases were registered almost every year, mainly at the border with Afghanistan. Few of these cases were imported. However, there were also autochthonous cases, classified as "introduced" (first-generation local transmission), indicating ongoing local transmission, albeit on a limited scale and in limited areas. During this period, two parasite carriers and 30 malaria patients were registered; 29 of the patients were classified as local cases, of which four were the result of blood transfusion. Of the remaining 25 patients, 22 lived close to the border with Afghanistan, where malaria prevalence was high. It was assumed that these infections were introduced (Table 3). Unfortunately, detailed epidemiological information on the two asymptomatic, four induced and remaining 25 autochthonous cases that were reported in the 1960s is unavailable.

Isolated imported cases continued to be registered in the 1970s *(18)*. In the 1980s, however, malaria importation increased dramatically, mostly in the capital Ashgabat and in Lebap and Mary provinces; this was attributed to the return of demobilized troops from Afghanistan (Figure 4) *(12)*. The SES responded with prompt detection, treatment and follow-up of patients for 2 years. The development of malaria epidemics was prevented at the time: only five isolated autochthonous cases were registered in 1989 and none in 1990 *(12)*. Most of the cases were detected in the southern Mary and Lebap provinces bordering Afghanistan, known for their high level of receptivity (foothills, oasis areas, water bodies) and vulnerability (cross-border population migration).

[1] A health care professional who provides various medical services in the Russian Federation and other countries of the former Soviet Union, mainly in rural areas.

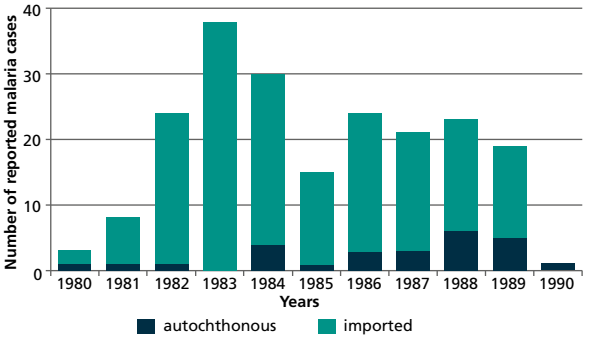
Table 3. Reported malaria in Turkmenistan, 1961–1969

Reported malaria cases 1961–1969			
32			
Patients with clinical symptoms			Parasite carriers without clinical symptoms
30			2
Locally acquired cases		Imported cases	
29		1	
Infections due to mosquito-borne transmission		Infections subsequent to blood transfusion (assumed induced cases)	
25		4	
Patients living on Afghan border (assumed introduced cases)	Patients living elsewhere in Turkmenistan (assumed indigenous cases)		
22	3		

Source: references *18, 19*

P. vivax is the only malaria parasite known to have been transmitted in the country since 1960. The last indigenous case of *P. malariae* was detected in 1988 in a 76-year-old woman. Indigenous *P. falciparum* was eliminated before 1960, probably in the late 1950s. Single cases of *P. falciparum* importation from Africa were observed in 1980 and in 1981 in Lebap, and two more in Ashgabat in 1988. In 1982, one falciparum case was imported to Bayramaly from Afghanistan. No secondary cases occurred on any of these four occasions *(27)*.

Figure 4. Reported malaria cases in Turkmenistan, 1980–1990



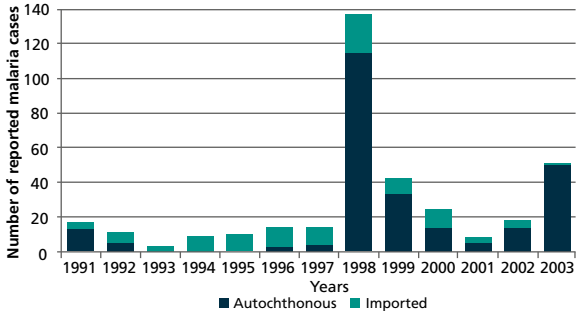
Source: Centralized Information System for Infectious Diseases (CISID)

Outbreaks and their control, 1991–2003

In the 1990s, after the independence of Turkmenistan, the country's malaria situation gradually worsened. The reported data for this period are summarized in Figure 5.

Altogether, 78 cases of *P. vivax* were registered over the period 1991–1997, 51 of them imported. Autochthonous cases, considered sporadic, were registered every year. Following changes in the malaria potential of the country's southern border areas, two outbreaks occurred, in 1998–1999 and in 2002–2003 (*5*, *12*, *14*, *15*, *18*, *19*, *28*).

Figure 5. Reported malaria cases in Turkmenistan, 1991–2003



Source: Ministry of Health and Medical Industry

1998–1999 OUTBREAK

In 1998, the malaria situation in Turkmenistan took a dramatic turn for the worse: 137 malaria cases were registered in the country, 115 of them locally acquired cases of vivax malaria, including 108 cases (93.9% of all autochthonous cases and 78.8% of all cases reported in 1998) in Gushgy (now Serhetabad) district of Mary province, mainly among military personnel. The Gushgy/Serhetabad outbreak occurred in a military training camp located near the border with Afghanistan. Because of the remote location and absence of local indigenous sources of infection, the national malaria programme assumed initially that the malaria infections were caused by infected mosquitoes from Afghanistan where there were still highly endemic settlements. Moreover, the radical treatment of detected cases and vector control interventions were delayed at the start of the outbreak because of the lack of antimalarial drugs and insecticides.

The following year, asymptomatic carriers – mainly demobilized military personnel – spread the infection from the first active focus in Gushgy/Serhetabad to all provinces of the country and to Ashgabat city, resulting in internal importation. However, intensified surveillance resulted in this internal importation being followed by local transmission only in Atamurat district in Lebap province where two indigenous cases were registered (Table 4, Figure 2). In the initial focus in Gushgy/Serhetabad, another five local cases were detected in 1999. Among the total 33 locally acquired cases in 1999, three occurred in children under 14 years of age (*1–3*, *14*, *15*, *18*, *19*, *29*). That same year there was also importation of malaria infections from abroad: nine imported cases, originating from Afghanistan, Azerbaijan, Tajikistan and Uzbekistan, were registered in the Lebap, Ahal and Balkan provinces and in Ashgabat city.

To contain the malaria outbreak, the most severe since 1960, and to prevent further spread of malaria throughout the country, in late 1998 and 1999 MOHMI mobilized the SES and general health facilities to take urgent measures and strengthen the epidemiological surveillance and control of malaria in the area. The WHO Regional Office for Europe provided technical assistance and financial support to the country *(14)*. A plan of action for malaria control and prevention for the period 1999–2001 was developed and approved by a decree issued by MOHMI *(30)*. The main strategic areas and activities are summarized in Table 5.

The antimalaria interventions that were initiated in late 1998 resulted in containment of the epidemic and a significant reduction in malaria morbidity within the foci. The number of autochthonous cases in the country fell dramatically, from 115 in 1998 to 33 in 1999 to 14 single autochthonous cases in 2000. Ten imported cases were also reported in 2000. By 2001, there were only five indigenous (presumed introduced) cases in two districts of Lebap province, in addition to three imported cases from Azerbaijan, Tajikistan and Uzbekistan, detected in the cities of Ashgabat, Atamurat and Turkmenabat. The year 2002, however, saw the start of a new outbreak in Mary province.

Table 4. Overview of reported local malaria cases in 1999

Province	Number of cases			Population characteristics
	Total	Indigenous	Internal importation: acquired in Mary province and detected in non-endemic areas	
Ashgabat city	4	0	4	3 military personnel; 1 unemployed person
Ahal	4	0	4	1 military officer; 1 construction worker; 2 unemployed persons
Balkan	1	0	1	1 construction worker
Dashoguz	4	0	4	3 military and demobilized military personnel; 1 unemployed person
Lebap	15	2	13	13 military and demobilized military personnel; 2 children under 14 years
Mary	5	5	0	3 military personnel; 1 unemployed person; 1 child under 14 years
Total	33	7	26	22 military and demobilized military personnel; 8 adults (workers, officers, unemployed); 3 children under 14 years

Source: CISID (Centralized Information System for Infectious Diseases, Ministry of Health and Medical Industry)

Table 5. Strategy to contain the malaria outbreak in 1998–1999

Strategic approach	Activities[a]
Eliminating the sources of infection	• Timely case detection through ACD and PCD, followed by radical treatment using chloroquine for 3 days and primaquine for 14 days. ACD was carried out through daily house-to-house visits in all malaria foci, and was combined with mass blood surveys among residents of the home villages and co-workers of identified malaria cases • Prompt and comprehensive investigation of every case and focus • Interseasonal prophylactic treatment with 14 days of primaquine for all residents of the active foci and others (army personnel, oil workers) who had been exposed to the transmission risk
Integrated, evidence-based (i.e. guided by foci investigations) vector control	• Full IRS coverage of all active foci • Larviciding (using mainly fish, and sometimes oil) to reduce mosquito density and longevity • Reducing the number of breeding places through environmental measures (mainly infilling of non-productive water bodies) • Reducing human-vector contact through housing improvements • Use of locally manufactured mosquito nets
Prevention for the population in the foci	• Seasonal chloroquine prophylaxis during the malaria transmission season • Health education • Increased community awareness and engagement of the whole population in malaria elimination and prevention

Source: Ministry of Health and Medical Industry

a. ACD = active case detection; PCD = passive case detection.

2002–2003 OUTBREAK

The second malaria outbreak in Mary province in 2002–2003 proved to be the last outbreak in Turkmenistan before certification of malaria-free status in 2010. Three districts of the province were primarily affected – Yoloten, Serhetabad and Tagtabazar; the latter two border Afghanistan. Important lessons were learned during this episode, as described below *(18, 19)*.

Analysis of data indicated that the index case of the 2002–2003 epidemic probably became infected at the border with Afghanistan. The result was an outbreak in Yoloten, with secondary cases in other parts of Mary province *(18, 19)*. The outbreak was detected in early April 2003 when malaria was diagnosed in an oil and gas worker living in Yashlyk farm (*Dayhanbirleshik* – farmers' association), Yoloten district, Mary province. Infection had probably occurred in the previous year because the case was detected before the onset of the 2003 transmission season. Subsequent investigation revealed that two housewives at the same farm had been diagnosed with malaria during the 2002 transmission season, but that there had apparently been no follow-up action when these cases were reported.

Case detection and containment efforts were stepped up in 2003. A total of 16 brigades were engaged in conducting active case detection by daily house-to-house visits in all malaria foci in the villages; radical treatment with chloroquine and primaquine of the patients detected with malaria; epidemiological investigation of cases and foci; full IRS coverage in all transmission foci; larviciding; and raising of community awareness regarding malaria.

In 2003, a total of 50 autochthonous cases of *P. vivax* malaria, as well as one imported case, were detected in Turkmenistan through passive and active case detection (PCD, ACD). Eight patients had clinical manifestations; the rest *(43)* were reported as asymptomatic carriers, detected through ACD.

All but two of the 50 autochthonous cases were registered in four districts of Mary province – Yoloten *(30)*, Tagtabazar *(11)*, Serhetabad *(4)*, Turkmen Gala *(2)* - and in Mary city *(1)*; they included 43 adults and five children *(17)*. Most cases (31/48) were detected among workers from oil and gas exploration companies; other population groups were affected only in Yoloten (15/30) and Serhetabad (2/4) (Tables 6 and 7). Six cases were detected through ACD among family members of malaria patients. The other two autochthonous cases were detected in Ahal and Lebap provinces.

The intensified programme actions were successful: the outbreaks were contained and the foci cleared up. The last four autochthonous cases in Turkmenistan were registered in 2004. Three of these were detected in Mary province in February/March 2004 before the onset of the transmission season and probably resulted from transmission during 2003. The fourth case was detected in Ahal province in an area that is considered non-endemic; the patient had previously (in 2003) been in Tagtabazar, Mary province – an active malaria focus in 2003 – and the national programme reasonably assumed that the infection had been contracted there *(18)*.

Table 6. Distribution of cases detected in 2003 in Mary province by district and occupation

Districts	Total cases	Oil and gas workers	Others
Yoloten	30	15	15
Serhetabad	4	2	2
Tagtabazar	11	11	0
Turkmen-Gala	2	2	0
Mary city	1	1	0
Total	48	31	17

Source: reference *18,19*

Table 7. Overview of malaria cases reported in 2003 in Mary province

Total malaria cases in 2003: 49	Patients with clinical symptoms: 6	Parasite carriers detected through ACD: 43
Classification of cases	5 local 1 imported from Afghanistan	43 local
Population characteristics	Oil and gas workers – 2 Others – 4 (2 adults, 2 children aged 6 months and 10 years)	Oil and gas workers – 29 Others – 14 (11 adults, 3 children)

Elimination of malaria, 2004–2010

After the improvement in the malaria situation in 2004, and in line with the EURO malaria elimination strategy (*9–11*, *31–33*), the Government of Turkmenistan decided to reorient the malaria programme towards eliminating the last foci and preventing reintroduction. In 2005, the President of Turkmenistan signed the Tashkent Declaration – *The Move from Malaria Control to Elimination (9)*. There was strong political commitment in the country to maintaining interruption of malaria transmission through large-scale elimination interventions aimed at improving the health of the people. An elimination strategy and a plan of action centred on intense malaria surveillance were developed and implemented (*34–36*). In May 2007, a joint MOHMI–WHO meeting was organized in Ashgabat to launch the malaria elimination campaign in Turkmenistan (Figure 6) *(27)*.

Figure 6. Participants of the MOHMI/WHO meeting on launching the malaria elimination campaign in Turkmenistan, May 2007, Ashgabat

The operations of the elimination campaign were broader in scope than those conducted during the epidemics and were applied nationwide. The strategic directions of the national plan of action are summarized in Table 8.

Case detection and management were given special attention in the strategy. The peripheral general health services (including *feldshers* and the physicians and nurses of health houses) were central to the case detection effort. Vigilance was reinforced throughout the country, so that all patients with fever, anaemia and/or other suspect symptoms and/or with a suspect history of travel to malaria endemic country were examined for malaria as soon as they contacted the health services. Active case detection was pursued through household visits in provinces affected in the recent past by malaria. Visits were conducted weekly during the transmission season and every 2 weeks out of season, even in urban areas, with blood sampling and examination of all febrile and suspected individuals.

In the following years, only cases imported from endemic countries were reported: in 2005, 2006 and 2008 from Azerbaijan, Uzbekistan and Pakistan, respectively (Figure 7). No malaria cases were registered in 2009 or 2010 *(12, 37)*. The country requested official certification of its malaria-free status in 2009, and the certification process was launched. The conclusion of the first consultative mission of the WHO team for certification of malaria elimination in Turkmenistan, 18–25 November 2009, was positive *(38)*. A subsequent certification mission of independent malaria experts concluded that "the available data and information,

observations and analyses indicate beyond reasonable doubt that malaria transmission in Turkmenistan had been interrupted" and stated "with full confidence that the national health system, as it is, will be able to prevent the reintroduction of malaria to Turkmenistan" *(19)*. In 2010, Turkmenistan was certified by WHO as a malaria-free country *(16, 17)*.

Figure 7. Officially reported malaria cases in Turkmenistan, 2004–2010

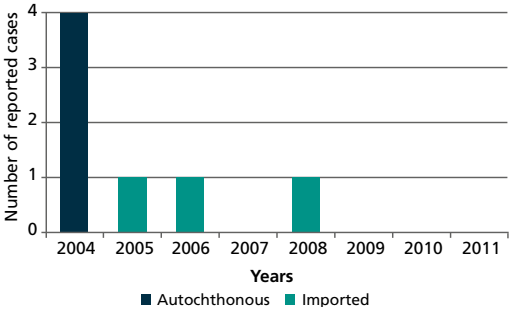


Table 8. Strategic directions of the national plan of action for elimination of malaria in Turkmenistan, 2007

Strategic approach	Sample activities
Case detection and management	• Active and passive case detection • Reporting, notification and registration in a national register • Epidemiological investigation and classification of malaria cases and foci. • Quality assurance of malaria laboratory diagnosis • Radical treatment of malaria patients and parasite carriers • Chemoprophylaxis for risk groups • Cases and foci recording • Data collection and analysis
Monitoring of determinants of the malaria situation	• Analysis of meteorological data • Analysis of sociodemographic situation (human migration, economic activities) • Determination of the malaria potential and zoning of the territory by malaria infection risk
Mosquito monitoring and control and operational research on vector control	• Entomological surveillance of vectors and breeding sites • Hydro-engineering works and preventive supervision of the construction and operation of irrigation facilities • Enhancement of the vector control measures that are safe for the environment such as use of *Gambusia* larvivorous fish • Provision of supplies to the population – locally manufactured bed nets and repellents, to protect against mosquito bites • Operational research on efficacy of larvivorous fish for vector control and comparison with other vector control methods
Training of health personnel on malaria diagnosis, treatment, epidemiology, entomology and prevention	
Public health education and community mobilization	
Monitoring and evaluation of the effectiveness of the interventions undertaken	
Interagency and intersectoral integration and coordination of antimalaria interventions	
Active cooperation with neighbouring countries (Afghanistan, Islamic Republic of Iran and Uzbekistan) on malaria-related matters – participation in cross-border meetings on malaria, exchange of information and planning of joint activities	

Source: Ministry of Health and Medical Industry

Prevention of reintroduction, 2010 onwards

In preparation for the certification of malaria elimination in 2010, Turkmenistan drew up a comprehensive national plan for prevention of reintroduction. This is supported by MOHMI commitment and financing as well as by intersectoral cooperation *(39)*; state funding for prevention of malaria reintroduction in 2010 amounted to US$ 578 182. The strategic directions of the national plan are summarized in Table 9. Compared with the earlier elimination plan, *(2007)*, the emphasis shifted to prevention of malaria in travellers and of the consequences of malaria importation into the country. No further indigenous cases have been reported in the country despite continuing transmission in neighbouring Afghanistan.

Table 9. Strategic directions of the national plan for prevention of reintroduction of malaria in Turkmenistan, 2010

Strategic approach	Sample activities
Malaria surveillance	• Early detection of each local and imported case • Registration and timely mandatory notification of SES • Epidemiological investigation of each malaria case and foci • Strengthening EQA of laboratory diagnosis of malaria
Efficient case management	• Free examination and treatment services for malaria patients regardless of citizenship and residency status • Free malaria prevention services, including malaria chemoprophylaxis, for all individuals arriving from, or leaving the country for, endemic areas • Ensuring appropriate supply and stock of antimalaria drugs, equipment, laboratory reagents and other reserves
Continuing vector surveillance activities	• Monitoring of breeding sites and of major changes in environmental parameters
Vector control activities	• Ensuring availability of larvivorous fish hatcheries and distribution of fish in *Anopheles* breeding sites
Strengthening cross-border collaboration	• Developing cross-border collaboration strategy • Conducting targeted activities jointly with representatives of neighbouring countries (meetings, conferences, sharing of information and experience)
Maintaining malaria expertise	• Upgrading training for specialists involved in malaria prevention
Maintaining epidemic preparedness	• Ensuring appropriate supply and stock of insecticides in case of an outbreak • Ensuring appropriate supply of antimalaria drugs • Ensuring appropriate supply of laboratory reagents and consumables for malaria diagnosis
Establishing routine epidemiological observation of the most at-risk groups such as seasonal workers, foreign students, residents of border territories, military personnel and tourists	
Malaria examination of students from endemic areas on their arrival	
Scaled-up passive case detection and examination for malaria in case of fever	
Improving operation of sanitary–quarantine points for the performance of anti-epidemic measures on the border with Afghanistan and other neighbouring countries	
Enhancing health education	

FACTORS CONTRIBUTING TO CHANGES IN THE MALARIA SITUATION, 1990–2010

Why did malaria re-emerge and an outbreak occur in the 1990s?

Despite its elimination success in the early 1960s, Turkmenistan continued to experience sporadic malaria transmission in its southern border areas with Afghanistan: at least 22 such cases were reported in the period 1961–1969, isolated cases were reported in subsequent years, and 25 autochthonous cases were reported in 1989–1990. Importation of parasites into the country increased in the late 1980s with the return of demobilized troops from Afghanistan, followed by the break-up of the former Soviet Union.

As a rule, the likelihood of re-establishment of malaria transmission in any one area varies as a function of vulnerability (parasite importation pressure) and receptivity (the likelihood that imported parasites will be locally transmitted). If either of these two factors is zero, transmission will not occur. A retrospective analysis of the situation in Turkmenistan shows that there had been a gradual increase in both the receptivity and the vulnerability of the country during the late 1980s.

RECEPTIVITY

Receptivity is very low in the arid parts of Turkmenistan (the Karakum Desert and areas in the north-western part of the country), and in practice these areas have been always free of malaria. Highlands above 1500–2000 metres are also generally considered malaria-free *(14, 18, 19)*. Elsewhere, however, malaria vectors are still present, and the former malarious areas of the country remain receptive to resumption of transmission.

Relatively higher receptivity existed in the following areas *(19)*:

- foothills, where streams are natural breeding sites of *An. superpictus* and where agricultural development may create additional water bodies suitable for breeding;
- plains areas with suitable water bodies, such as occur in oases, irrigation areas and along canals and other man-made water management systems.

The following factors contributed to the increased receptivity of some areas of the country:

- Scaling up of construction and projects for exploitation of major water resources. In the 1980s and 1990s, 18 large reservoirs were constructed in the area near the Karakum Canal and river basins (8 on the Murghab River; 3 on the Tedzhen River; 3 on the Atrek River; and 4 on the Karakum Canal); the extensive filtration ponds associated with these reservoirs became breeding places for anopheline mosquitoes. The density of malaria vectors increased dramatically as a result of the intensive breeding of *Anopheles* in filtration ponds.
- Increased irrigation and expansion of the land under rice cultivation. Land improvements for farming, especially for growing rice, as part of major agricultural irrigation projects led to increased receptivity, especially in Lebap and Dashoguz provinces.

VULNERABILITY

The malaria importation threat for Turkmenistan came mainly from Afghanistan, now the only neighbouring country with endemic areas on its immediate border. Turkmenistan's border with Afghanistan also marked the southern border of the former USSR. This area was therefore tightly controlled and population movements

were restricted. In the late 1980s, the time of dissolution of the USSR, vulnerability increased as a consequence of increased movement of infected populations (originating especially in Afghanistan). Military camps located near Turkmenistan's border with Afghanistan were also at risk of infections that were transported across the border by mosquitoes. The resulting increase of malaria importation in the 1980s and 1990s was followed by a rise of autochthonous cases.

Analysis of the epidemiological information on the outbreaks indicates that the two main contributing factors were:

- Exposure of people living/working close to the border (mainly military personnel and gas and oil workers) to bites by infected mosquitoes originating from Afghanistan where malaria is still endemic. This situation applies to Mary province where 50% of nationwide malaria autochthonous cases were registered in 1999–2004 although there were only two imported cases.
- Introduction of malaria as a consequence of importation by infected individuals. Lebap province where 16 imported and 40 autochthonous cases were registered in 1999–2004 is a good example.

PROGRAMME FACTORS

Certain programmatic factors also played an important role in the deterioration of the malaria situation and the spread of local malaria transmission. For many years after elimination only isolated cases of malaria were detected, with no epidemiological consequences; the malaria surveillance system grew weaker as a result and was unable to respond in a timely manner to the increased vulnerability and receptivity in the country. This was reflected in delayed diagnosis and treatment as well as reporting, especially in rural areas. The 1998–1999 outbreak was recognized by the health authorities only after a delay. In addition, there was a lack of drugs (chloroquine and primaquine) to treat the first cases, and an insufficient supply of insecticides for vector control interventions at the beginning of the outbreak. As the first cases among military personnel were not promptly identified and properly treated, and vector density was not rapidly reduced, it can be assumed that local transmission occurred not only in the military camp but also among the local rural population. Moreover, demobilized soldiers with asymptomatic infections imported malaria into other provinces. This summary underlines the importance of maintaining both a high level of malaria vigilance and a system of malaria epidemic preparedness following malaria elimination.

Why did an outbreak occur in 2002–2003?

The most probable source of infection for the autochthonous cases detected in July 2003 in Yoloten was the index case, a 27-year-old oil and gas worker and a resident of Yashlyk Farm in Yoloten district. He fell ill twice – in July 2002 (hospitalized at the Yoloten district hospital with a diagnosis of pneumonia) and in March 2003 (hospitalized at the Yoloten district hospital again, with acute fever) – yet was not examined for malaria on either occasion. A laboratory diagnosis of *P. vivax* was not established until 8 April 2003, after the patient had been transferred to Ashgabat. In all probability, this was a case of *P. vivax* relapse of an infection contracted in 2002. The person should have been considered to be at high malaria risk given his regular professional travel close to the border with Afghanistan. In September and October 2002, malaria was diagnosed in two women from Yashlyk Farm who had no travel history, yet no specific actions were taken by malaria surveillance and general health services and only inadequate measures were applied. It is possible that this latter transmission was overlooked by the local health facilities and therefore not reported to the central level. Only after the diagnosis in Ashgabat in early April 2003 of relapsing vivax malaria in the Yoloten index case was a swift and comprehensive epidemic response started.

Subsequent epidemiological investigation and ACD in Mary province in April and May 2003 revealed another 48 persons who had contracted malaria without being detected and reported earlier. They included one acute malaria case and six asymptomatic cases among

14 members of the family of the index case. In addition, two more asymptomatic cases were detected in the same village. Epidemiological investigation of settlements near the home of the index case revealed another eight asymptomatic carriers in the six villages of Bereket, Yashlik, Pagtachalik, Tokai, Atchapar and Rahat. Two of the infected persons were employees of the Ymambaba branch of the oil and gas exploration company. Another 11 employees of the same branch of the company were identified as asymptomatic carriers in Yoloten on Enish Farm and S. Niyazov Farm. The index case was a likely source of infection for his colleagues at the oil and gas company as well for the other cases detected in the district. However, it cannot be excluded that some oil and gas workers may have contracted the infection while working at the border. In all, 3535 persons at higher risk were examined during the investigations.

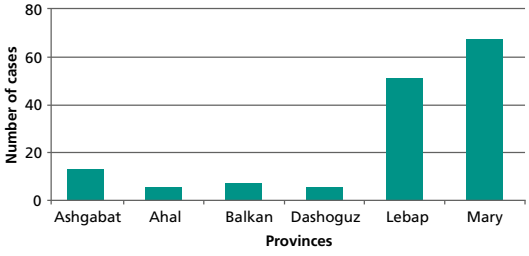
The epidemiological investigation of the outbreak revealed that, in 2002–2003, a large number of oil and gas workers were regularly moving between the two vulnerable border districts (the Tore-Shih well in Tagtabazar district and the Berdiklich well in Serhetabad district) and the highly receptive Yoloten district, which thereby also became vulnerable. The main office of the oil exploration company was situated in the area of the rest house in Ymambaba, 15 km from the administrative centre of Yoloten. The total strength of the company was 610 workers, who worked 15-day shifts in the area bordering Afghanistan.

Which populations were most affected by malaria?

The most detailed epidemiological information is available for the 150 malaria cases that were detected in Turkmenistan between 1999 and 2010. All cases were due to *P. vivax*.

As seen in Figure 1, the annual number of both indigenous and imported cases gradually declined over the period 1999–2010. A total of 120 autochthonous cases and 30 imported cases were officially registered. Most indigenous and imported cases (118, 79%) were reported from the two south-eastern provinces: Mary bordering Afghanistan, and Lebap bordering Afghanistan and Uzbekistan (Figure 8). Sixty (50%) of the autochthonous cases occurred in Mary province, while more than one-third of local cases (51, 34%) occurred in Lebap province (Figure 9). Lebap was most affected by malaria importation: more than half (54%) of all imported cases were detected there (Figure 10; *18*, *19*).

Figure 8. Total malaria cases by administrative territory, 1999–2008



Source: reference *18*

Figure 9. Autochthonous malaria cases by administrative territory, 1999–2004

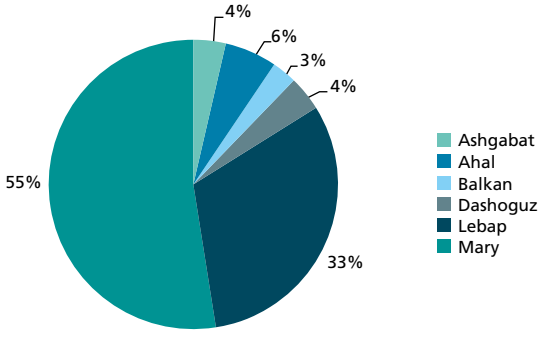
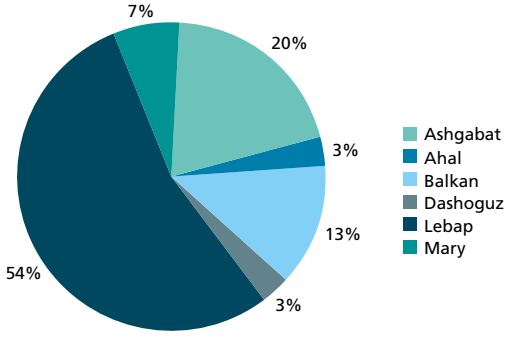
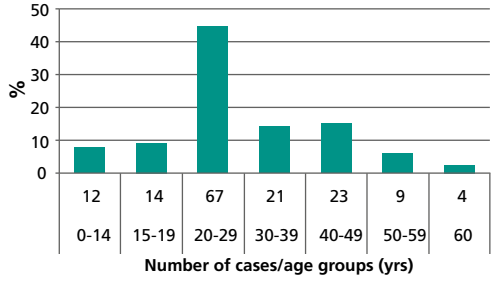


Figure 10. Imported malaria cases by administrative territory, 1999–2008



The most affected age group were the 20–29-year-olds at 45% of the total (Figure 11). The majority of cases were in males (85%) and in rural residents (78%) *(18, 19)*. That a high percentage of the malaria cases occurred in young adult males in rural areas is explained by their occupations and worksites: the malaria outbreaks affected military personnel (1998–1999) and oil and gas workers (2002–2003) – the only population groups to regularly stay overnight in rural areas of Turkmenistan close to the border with Afghanistan. Rural farming communities who may occasionally visit the border areas were affected to a lesser extent and mainly in the course of local outbreaks.

Figure 11. Distribution of malaria cases by age group, 1999–2008



Source: reference *18*

It is striking that many of the cases detected in 2003 were reported as asymptomatic. This phenomenon was observed not only in the oil and gas workers who frequently stayed overnight in border areas but also in the local population in the border areas with Afghanistan, making pre-existing immunity an unlikely explanation given Turkmenistan's long history of very low malaria transmission. The seasonal timing of the ACD could explain the absence of symptoms in some cases, since many infections could have been in the clinical incubation stage, just before the start of the transmission season. This may also have been a reporting issue: the health staff who carried out ACD may not have elicited, or reported, the full clinical history for every person who was given a malaria diagnostic test during the outbreak investigation.

Control of the 1998–1999 outbreak

In 1998, in addition to the changed receptivity and vulnerability some programmatic factors – delayed diagnosis, treatment and reporting of malaria cases, especially in rural areas – also played a role in the occurrence of the outbreaks. There was also a lack of drugs (chloroquine and primaquine) to treat the first cases in 1998 and an insufficient supply of insecticides for vector control interventions at the beginning of the outbreak. The subsequent rapid mobilization of the specialized and general health services and the massive scaling up of control and surveillance activities in late 1998 and 1999 in the affected areas were ultimately critical to containing the outbreaks.

An integrated approach brought about the prompt containment of the outbreaks and clearing up of the foci through a two-step process. The interventions that immediately followed recognition of the outbreak, implemented with the technical and financial assistance of WHO, can be summarized as follows *(14, 15)*:

- The risk groups were identified as the military personnel located close to the border with Afghanistan, where the first malaria cases were registered, and the population of nearby settlements. The first interventions, concerned with eliminating the source of infection and interrupting transmission, were thus concentrated on the military camp and surrounding villages.
- Intensive case-finding, through daily house-to-house visits in affected areas and a mass blood survey among military personnel and the local population, allowed the sources of infection to be identified. In 1999, in the initial focus in Mary province, five new cases were diagnosed (three among military personnel and two– a child and an adult – in local residents) (Table 4). The scaled-up nationwide surveillance system led to the detection of 26 additional cases in other provinces – the result of internal importation from the initial case – and of two indigenous cases in Lebap province.

- Radical treatment of all detected patients – those with clinical symptoms and those with asymptomatic infection – was carried out, enabling elimination of the sources of infection.
- Comprehensive epidemiological investigation by SES of all cases and foci provided timely information for planning future activities in the malaria foci, containment of the outbreak and prevention of the spread of transmission.
- Indoor residual spraying contributed to the reduction of transmission in the new malaria foci.

A complex of activities was subsequently put in place, including the following main interventions *(14, 15)*:

- Upgrading and capacity building of the SES staff – epidemiologists, parasitologists, laboratory technicians – were undertaken. Four lots of training on malaria surveillance, laboratory diagnosis and control were conducted for 75 specialists, seminars for vector control staff were held in all regions, and five additional positions were opened in the SES parasitology department.
- Laboratories were upgraded. New microscopes, reagents and consumables for malaria diagnosis were provided to the main diagnostic centres by WHO.
- Confirmation of all suspected malaria cases by microscopy became compulsory.
- There was epidemiological investigation of all confirmed malaria cases and foci using standardized epidemiological records.
- Reporting of malaria had been mandatory since Turkmenistan was part of the USSR, so strict and timely notification and reporting were reinforced.
- Passive case detection and active case detection (by regular household visits in affected areas) were scaled up.
- Stocks of chloroquine and primaquine for the radical treatment of malaria patients and for chemoprophylaxis were provided to SES at national and provincial level with the financial assistance of WHO.
- During the transmission season, the SES carried out seasonal, weekly chemoprophylaxis with chloroquine of 3000 fixed-term military personnel stationed in the active malaria foci, as well as of the approximately 6000 residents of active foci.
- Interseasonal (February-March) prophylaxis with primaquine (14 days) for the population of active foci was carried out under the strict supervision of primary health care staff and SES.
- Reinforcement of entomological surveillance included: identification and mapping of all mosquito breeding sites within a 3-km radius of any affected settlement; identification of vector species and development of a list of the main species in all areas; and monitoring of mosquito bionomics and density.
- Special provincial teams were established, appointed by MOHMI decree, to carry out the following vector control activities:
  - IRS of buildings in an area of 960 000 m^2.
  - larviciding of surface water bodies in an area of 960 000 m^2.
  - draining or infilling of all small and economically unprofitable water reservoirs.
- Large-scale health education was conducted.

There was strict monitoring and supervision of the coverage and performance of all interventions by SES and MOHMI.

Importantly, after containment of the outbreak, the activities of the national malaria control programme were continued. Training and retraining of epidemiologists, parasitologists, laboratory staff and entomologists were conducted with technical assistance from WHO. Efforts were made to keep the whole complex of surveillance and vector control activities, as well as vigilance, at a high level, and a regular supply of antimalarial drugs and insecticides was maintained, with a stock being kept in SES at central and provincial levels.

Control of the 2002–2003 outbreak

In 2002, it took an entire transmission season for Turkmenistan to realize the seriousness of the renewed outbreak of malaria in the country. Urgent interventions then followed the detection of the index case in early 2003 *(18, 19)*.

A total of 16 teams, comprising epidemiologists, parasitologists, entomologists, etc., were engaged in the containment. They were assisted by three teams of laboratory technicians. The emergency interventions carried out upon recognition of the outbreak focused on immediate blocking of transmission and can be summarized as follows:

- The activities for prompt case-finding concentrated on the family members of the index patient, on the people at his place of work and on the residents of the village. In all malaria foci in the villages, daily house-to-house visits with temperature-taking were organized. The same activities were carried out in the territory covered by the oil and gas exploration company.
- Mass blood surveys were carried out and included the 602 oil and gas exploration workers and 2566 villagers in Yoloten district, 189 persons in Serhetabad district and 178 people in Tagtabazar district. The surveys detected 48 additional cases that were investigated and radically treated.
- All malaria patients and carriers were hospitalized and received radical treatment with chloroquine and primaquine, with follow-up for 2 years.
- All oil and gas workers and villagers of affected settlements (1578 in Yoloten district, 347 in Serhetabad district, 1791 in Tagtabazar district) received interseasonal primaquine treatment and seasonal chloroquine prophylaxis.
- The comprehensive case investigations carried out by epidemiologists in the brigades contributed to the timely identification of foci, comprehensive investigation, mapping, recording, and conducting of interventions.
- Entomological investigation of foci in the territory was carried out to reveal the presence of malaria vectors.
- All transmission foci were fully covered with IRS.
- Vector control activities were supported by larviciding of 136 temporary and permanent mosquito breeding sites in villages and 26 breeding sites at the provincial headquarters of the oil and gas exploration company, as well as labour camps near the oil and gas wells in the Afghanistan border area.
- Public awareness was raised through lectures, mass media and other means.

The interventions undertaken were in time to largely curb transmission: in 2004 only three cases occurred, two of which were in children aged 11 and 16 years. Based on the date of detection, in February, of these cases, they could be attributed to the transmission having taken place in 2003. Subsequently, refresher courses were organized for laboratory technicians and orientation courses on malaria for the various categories of personnel engaged in implementation of antimalaria activities, including medical staff from Defence and Border Guards. This complex of activities succeeded in containing the outbreak and prevented exportation of malaria outside Mary province.

Elimination of malaria, 2004–2010

After the late detection and subsequent containment of the Mary outbreak in 2003, MOHMI decided to take action to strengthen the malaria control system. Priority was given to strengthening malaria surveillance carried out through the primary health care services. From 2004 onwards, malaria elimination was tackled in a multi-faceted manner, with considerable administrative skill, sufficient government financing and continued political support. This comprehensive approach was adopted to eliminate the source of infection, reduce transmission by vectors and provide health education and preventive measures to the populations affected. The strategies, interventions and supportive mechanisms are described below.

EPIDEMIOLOGICAL SURVEILLANCE AND CONTROL ACTIVITIES

One of the early core activities of the elimination programme was to strengthen and upgrade the existing malaria surveillance system (Annex 7) and mechanisms, so as to provide reliable information for programme management and reports of progress to key public health decision-makers, professionals and health care workers as a basis for evidence- based decisions on necessary action.

The backbone of the revitalized malaria epidemiological surveillance in the country was the document *Guidelines for the organization of malaria surveillance in Turkmenistan (40)*, published in pursuance of Decree No. 137, dated 20 November 2005. Two additional guidelines for the peripheral level were developed with WHO technical assistance: *Malaria epidemiological surveillance protocol (standard operating procedure – SOP)* and the MOHMI's *Clinical protocol for malaria treatment and protocol for malaria epidemiological surveillance (41)*. The main aspects of these documents and the interventions undertaken in accordance with their guidance are summarized below.

Special attention was given to ACD and PCD. Vigilance was reinforced, so that all patients with fever, anaemia and/or other suspect symptoms and/or with a suspect history of travel were examined for malaria as soon as they contacted the health services. Household visits, allowing ACD, were carried out weekly during the transmission season and every 2 weeks out of season, even in urban areas, with blood sampling and examination of all febrile and suspected individuals.

Blood sampling for malaria was based mainly on clinical indications or on epidemiological indicators (a visit to a malaria-endemic country or to a local focus, family members, neighbours or work colleagues of a case, etc.) and this practice continues. Data show that blood sampling in 2005–2009 was correctly targeted. The national annual blood examination rate (ABER) was relatively low (1.1–1.9%) for 2005–2009 but increased gradually over time (Table 10) *(19)*. However, in areas of high receptivity and vulnerability – Lebap and Mary provinces – ABERs were higher, reaching 1.6% and 2.5% respectively and 3.7% in Mary in 2009 (Table 10). Rates were highest in the high-risk districts, for example, Serhetabad and Yoloten in Mary province, as well as Mary city, where ABERs in 2009 were 6%, 13.7% and 7.3% respectively (Table 11), indicating that the health facilities in these areas maintained high malaria vigilance. Laboratory examinations related to the regular household visits and epidemiological investigations of cases resulted in efficient case detection.

PREVENTION OF IMPORTED MALARIA AND ITS CONSEQUENCES

Once transmission had been interrupted, more attention was paid to identifying imported cases. Analysis revealed the major role of imported malaria in the epidemiology of malaria in Turkmenistan. The border with the highly-malaria endemic regions in Afghanistan presented the greatest epidemiological risk and a legislative and regulatory framework was developed to address this issue. Special measures were undertaken at the border sanitary quarantine points, where medical staff questioned all persons coming from Afghanistan regarding their general health, fever, diarrhoea, etc., performed a brief clinical examination and checked axillary temperature. Slides were taken from all individuals with fever and with a history of recent fever. Details of all individuals who crossed the border in either direction were entered in a registry, and information on the exact destination in Turkmenistan of each person was sent to the relevant district and to the national SES. Health education on various disease risks, including malaria, was given to all those who crossed the border. Transport vehicles were treated with insecticides.

At the Experimental Production Centre in Ashgabat, an outpatient consulting room on tropical diseases was established to provide medical advice, including malaria prevention, for travellers. For chemoprophylaxis against *P. falciparum,* mefloquine, atovaquone–proguanil and doxycycline are recommended.

MANAGEMENT OF DISEASE

The malaria treatment protocol is regularly updated according to WHO recommendations; the most recent update was issued in 2009 as *Clinical protocol for malaria treatment and protocol for malaria epidemiological surveillance (41)*. Vivax malaria was radically treated with chloroquine

and primaquine, as before, but the protocol reflected a policy shift from chloroquine to artemisinin-based combination therapy or quinine for the treatment of imported *P. falciparum* malaria. Hospitalization and treatment of all patients remained free of charge. The regular provision of antimalarial drugs by the central level continued, and a stock of drugs was kept at central and provincial levels during the malaria elimination period.

Table 10. Annual blood examination rates by province and year, 2005–2009

Year	Province	Blood slides examined	Annual blood examination rate (%)[a]
2005	Ashgabat city	4 186	0.7
	Ahal	8 084	1.1
	Balkan	727	0.2
	Dashoguz	4 242	0.4
	Lebap	16 702	1.6
	Mary	23 041	2
	Nationwide	56 982	1.1
2006	Ashgabat city	5 005	0.9
	Ahal	6 813	0.9
	Balkan	666	0.2
	Dashoguz	4 690	0.4
	Lebap	16 746	1.6
	Mary	24 753	2.1
	Nationwide	58 673	1.2
2007	Ashgabat city	6 929	1.2
	Ahal	6 862	0.9
	Balkan	608	0.2
	Dashoguz	5 259	0.5
	Lebap	16 750	1.6
	Mary	29 258	2.5
	Nationwide	65 666	1.3
2008	Ashgabat city	9 946	1.7
	Ahal	6 142	0.8
	Balkan	1 981	0.5
	Dashoguz	7 424	0.7
	Lebap	18 006	1.7
	Mary	32 025	2.7
	Nationwide	75 524	1.5
2009	Ashgabat city	12 131	2.1
	Ahal	8 909	1.2
	Balkan	3 806	0.9
	Dashoguz	9 239	0.8
	Lebap	16 277	1.5
	Mary	43 965	3.7
	Nationwide	94 327	1.9

Source: Reference *19*

a. The rate was calculated on the basis of the provincial population figures, as follows: Ashgabat city – 569 438; Ahal – 741 852; Balkan – 405 463; Dashoguz – 1 108 762; Lebap – 1 070 088; Mary – 1 171 631; *Nationwide – 5 067 234*.

Table 11. Annual blood examination rate in Mary province, 2009

Locality	Mid-year population	Blood slides examined	Annual blood examination rate (%)
Mary city	128 056	9 418	7.3
Bayramaly city	53 306	3 642	6.8
Bayramaly	117 361	1 989	1.7
Wekilbazar	129 332	1 886	1.4
Garagum	43 982	770	1.7
Serhetabat	25 996	1 561	6
Yoloten	101 247	13 937	13.7
Mary	142 131	1 129	0.8
Murgap	119 976	1 768	1.5
Oguzhan	29 843	682	2.3
Sakargage	120 378	2 505	2.1
Tagtabazar	69 787	2 319	3.3
Türkmengala	90 236	2 359	2.6
Total	1 171 631	43 965	3.7

Source: reference *19*

FIELD (EPIDEMIOLOGICAL) INVESTIGATIONS, RECORDING AND REPORTING, FLOW OF INFORMATION, DATA PROCESSING, ANALYSIS AND USE

The timely epidemiological investigation of every malaria case and focus was given particular attention by the local SES parasitologists, epidemiologists and entomologists through the completion of a special unified recording form (Annex 8). The form includes basic but essential information that allows conclusions to be reached about the place and time of malaria contraction. On the basis of epidemiological data collected, a case definition and focus categorization are established according to WHO definitions (*31*, *33*, *42*, *43*). All forms were kept at district SES, with copies being sent to the central level. The foci were monitored and classified and a focus "passport" was kept up to date – focus recording form with mapping of every focus that was maintained by SES (Annex 9). A system for timely notification, reporting and recording was established using standard reporting forms (malaria has been a notifiable disease in Turkmenistan since Soviet times). Analysing the reporting system during the development of this case-study revealed certain shortcomings, such as a discrepancy between the number of cases reported annually to EURO and the information presented in the country report for certification in 2010, which may be explained by the insufficient data collected during initial epidemiological investigations of some cases *(12, 18, 19)*. Registers of malaria cases and foci were developed and maintained at SES central and peripheral level. Detailed information on case definitions, each patient's history, examination, diagnosis and treatment, as well as on foci categorization and transition, was collected in those registers.

VECTOR (ENTOMOLOGICAL) SURVEILLANCE

The national territory and neighbouring areas were stratified by levels of receptivity according to the results of entomological monitoring. Entomological surveillance, carried out by the SES entomological staff, was intensified not only in the areas of former outbreaks but also in all areas with higher malariogenic potential. A permanent record ("passport") was established for each water body, with relevant maps, and was regularly and systematically updated. In risk areas there were (still used nowadays) sentinel sites for adult mosquito monitoring, which was/is performed regularly in the

transmission season; if the mosquito density is high, larval control is strengthened. A database on *Anopheles* mosquitoes, their bionomics and density was maintained by district SES entomologists.

VECTOR CONTROL ACTIVITIES

Vector control activities were designed to reduce: the life span of female mosquitoes to less than the time required for development of sporozoites (by IRS); larval density (by use of larvivorous fish or application of oil – no specific chemical larvicides were used); and human-vector contact (by use of mosquito nets). Programme staff focused on reducing and preventing transmission in residual or new active foci.

Indoor residual spraying was carried out in case of an active focus or an epidemiologically worrying situation; a variety of pesticides were used, mostly pyrethroids (see Table 12). Stocks of insecticides were provided by the Government and maintained by MOHMI at central and district levels.

According to national reporting, there has been no IRS since 2005 *(18, 19)* as there have been no more cases or active foci in the country. The use of larvivorous fish, however, has continued. Turkmenistan has extensive experience with larviciding *(44)* and uses several species of larvivorous fish, especially *Gambusia affinis*, in water basins, including rice fields (Table 13). In high-risk Mary province, a large area is targeted and totally covered; coverage in Dashoguz, which includes the Amu Darya delta, needs improvement. At national level, more than 99% of areas targeted for larval control were treated by fish; the use of oil was minimal. No chemical larvicides were used after the first malaria elimination in 1961 (*18*, *19*).

It is worthy of note that mosquito nets have been made locally for generations and traditionally widely used; long-lasting insecticide-treated nets have not been promoted in the country.

IMPROVEMENT IN LIVING STANDARDS AND PERSONAL PROTECTION

In recent years, living standards in Turkmenistan have improved. Better housing and the use of air-conditioning (by about 50% of households, even in the villages) may have contributed to the reduction in the country's malaria risk.

In some districts the health services actively promote and distribute a synthetic pyrethroid insecticide vaporizer, Raptor®, which may also be helpful in reducing malaria risk, although there is a lack of data. However, these devices may add to the selection pressure on anophelines to develop pyrethroid resistance, so routine monitoring of insecticide resistance is increasingly important.

Table 12. Indoor residual spraying activities, 2000

Province[a]	Households that should be treated		Households actually treated[b]		Coverage achieved (%)	Insecticides used		
	Number	Area (m^2)	Number	Area (m^2)		Insecticide	Dose (g/m^2)	Amount
Ashgabat	215	10 750	199	9 797	91.1	Propoxur	1	3 l
						Fenthion	1	2.5 l
						Cyfluthrin	0.05	0.2 kg
Ahal	4 761	357 075	4 667	350 000	98	Propoxur	1	100 l
						Fenthion	1	50 l
						Cyfluthrin	0.05	10 kg
Balkan	3 745	269 640	3 558	256 176	95	Propoxur	1	90 l
						Fenthion	1	75 l
						Cyfluthrin	0.05	4.6 kg
Dashoguz	3 822	324 870	3 707	315 095	97	Propoxur	1	82 l
						Fenthion	1	93 l
						Cyfluthrin	0.05	17 kg
Lebap	7 523	677 070	7 147	643 230	97	Propoxur	1	151 l
						Fenthion	1	149 l
						Cyfluthrin	0.05	17 kg
Mary	6 957	619 173	6 957	619 173	100	Propoxur	1	149 l
						Fenthion	1	150 l
						Cyfluthrin	0.05	16 kg
Total	27 023	2 258 578	26 235	2 193 471	97.2			

Source: references *18*, *19*

a. Average household area is estimated as: 50 m^2 in Ashgabat, 75 m^2 in Ahal, 72 m^2 in Balkan, 85 m^2 in Dashoguz, 90 m^2 in Lebap, and 89 m^2 in Mary.

b. Two cycles of IRS (April, August) were conducted.

Table 13. Larval control by oil-based and biological larviciding, 2009

Province	Surface of *Anopheles* reservoirs targeted (ha)	Surface of *Anopheles* reservoirs treated (ha)	Coverage (%)	Treated with oil-based larvicides (ha)	Treated with fish (ha)	Note
Ashgabat	65	65	100	4	61	Oil products
Ahal	19	19	100	-	19	
Balkan	17	17	100	2	15	Oil products *Alburnoides, Poecilia reticulata*
Dashoguz	938	398	42	-	398	Grass carp, *Gambusia*
Lebap	459	459	100	-	459	*Gambusia*, stone moroko
Mary	876	876	100	-	86	*Gambusia*, stone moroko, *Varicorhinus capoeta*
Total	2 374	1 834	77	6	1 828	

Source: references *18, 19*

HEALTH EDUCATION ACTIVITIES

To increase community awareness and participation in malaria prevention practices, a number of information, education and communication (IEC) and behaviour change communication (BCC) materials were developed and handed over to SES for distribution to communities (Figure 12). The emphasis of these materials was on schoolchildren who can spread the information within their families, military personnel and residents of settlements situated near the border, i.e. the groups that had been most affected by the epidemics and were at risk of infection. Community awareness sessions were conducted for inhabitants of the settlements found to be active malaria foci, during which the printed IEC/BCC materials were also distributed. The public health IEC work, including malaria prevention issues, was also channelled through school curricula and mass media.

A plan for preventing the reintroduction of malaria, built on the experience accumulated during the process of eliminating transmission, was also developed and subsequently endorsed *(39)*.

Figure 12. Examples of public health education products for community awareness work among different population groups

CAPACITY BUILDING

The national malaria programme was coordinated and conducted by the Sanitary Epidemiological Service (SES) of MOHMI (for organizational details, see Annex 7), and especially:

- at national level by the Epidemiology and Parasitology Department of the MOHMI and the EPC, which includes a parasitology department with a reference laboratory and an outpatient tropical disease clinic;
- by five provincial *(velayat)* SESs and one in the city of Ashgabat; and
- by 64 town and district *(etrap)* SESs.

It should be noted that the parasitology departments with a laboratory at provincial and district SES are responsible for the surveillance and control of all parasitic diseases, including malaria.

The general health services and other relevant ministries and organizations were also involved in the activities of the malaria programme. After the independence of Turkmenistan in 1991, many of these bodies had been understaffed; some Russian specialists left the country and there was a loss of personnel. Once it was understood that well-qualified personnel were crucial for the success of the campaign, SES facilities were upgraded.

The malaria control programme benefited from an upgrading of health facilities, including recruitment and training of staff, provision of equipment and transport (microscopes, computers, cars). A wide-scale continuous education programme, reaching more than 1400 health personnel, was instituted for training/retraining of malaria programme staff, including parasitologists, epidemiologists, laboratory specialists, entomologists, clinicians and general practitioners, over a 4-year period (Table 14, Figure 13).

In January 2010, the following SES staff were directly engaged in antimalaria interventions:

- 44 parasitologists and 57 assistant parasitologists;
- 9 laboratory specialists and 54 laboratory assistants with secondary medical education;
- 41 entomologists and 51 assistant entomologists;
- 193 spray operators.

Table 14. Number of malaria-trained health staff in different fields, 2005–2009

		Number of malaria trained staff by years					
Specialists in		2005	2006	2007	2008	2009	Total
Parasitology	Higher education	33	41	29	34	45	182
	Secondary education	52	61	44	59	55	271
Entomology	Higher education	28	42	34	40	55	199
	Secondary education	47	45	47	54	66	259
Laboratory diagnostics	Higher education	19	30	17	55	78	199
	Secondary education	27	30	36	84	119	296
Total		206	249	207	326	418	1 406

Source: Ministry of Health and Medical Industry

Figure 13. Training course on laboratory diagnosis of malaria for the SES staff conducted by WHO EURO consultants, Ashgabat, 2008

LABORATORY SUPPORT FOR SURVEILLANCE, EQA/EQC

Laboratory diagnosis of malaria was performed at hospitals, outpatient facilities, polyclinics and laboratories of the SES. By 2009, the country had 227 laboratories where blood was examined for malaria *(18)*.

A microscopy quality assurance system, involving double-checking of 10% of all negative slides and confirmation of all positive slides at intermediate and national levels, was introduced in Turkmenistan in Soviet times. However, in the years immediately after the collapse of the Soviet Union, quality assurance was not fully operational. This problem was addressed during the containment of epidemics and the system was subsequently strengthened and monitored by MOHMI. The malaria reference laboratory at the EPC in Ashgabat, the national coordinator of the external quality assurance (EQA) system, was upgraded. In 2009, Turkmenistan passed legislation – *National Programme for External Quality Assurance/Control (EQA/C)* – on laboratory diagnosis, which functions at all levels according to the endorsed SOP *Protocol for the external quality control of malaria diagnostics*. A programme to further strengthen the quality of malaria diagnosis was also developed during a round-table workshop, "Quality Standards of Laboratory Tests", organized by MOHMI with support from WHO and held in Ashgabat in 2009.

The EQA/EQC involves double-checking 10% of all negative slides (and, in principle, all positive slides, but there had been none since the last case in 2008) at the next higher level. In practice, this means that 10% of slides examined at district- and hospital-level laboratories are double-checked at the laboratories of the provincial SES. Of the slides that are examined at provincial SES laboratories, 10% are subsequently checked at the national reference laboratory (NRL) of the EPC's parasitology department in Ashgabat.

In addition, there is supervision of laboratories. Every laboratory is visited twice a year; the NRL laboratory supervises the provincial laboratories, which in turn supervise the lower-level laboratories. When necessary the NRL supervises all laboratories.

The NRL participated successfully in an international EQA scheme that involves:

- cross-checking of positive and some proportion (usually 2–3%) of negative malaria slides examined in the NRL over a defined period (usually one year) by an internationally accredited independent diagnostic laboratory; and
- blind blood slides are sent to the NRL by the same internationally accredited independent diagnostic laboratory for making a diagnosis – presence of malaria parasites, *Plasmodium* species and parasite density. It is accompanied by a short epidemiological and clinical story.

There is a complex evaluation of the quality of laboratory work, including the proportion of the correct

slide readings, quality of slide preparation and staining, and formulation of results. On the basis of a score system developed by the international laboratory, the NRL's results are reported as a percentage score. If that score exceeds 80%, the NRL receives a certificate for quality of laboratory diagnosis of malaria, valid for one year.

INTERSECTORAL COLLABORATION

The Government recognized that the problem of malaria is one that goes beyond health alone and that achievement of malaria programme goals required the involvement of a variety of institutions and agencies. In 2005, the Chairman of the Cabinet of Ministers of Turkmenistan therefore approved several documents governing intersectoral collaboration; these addressed the structure of the Interagency Coordination Committee, distribution of responsibilities between the various organizations, and plans of action.

Related activities include collaboration with:

- Provincial and district administrations (*khyakimliks*), for implementation of provincial/district malaria elimination action plans (early detection, diagnosis, hospitalization and treatment, hydro-engineering measures, establishment of fish hatcheries and introduction of fish into water reservoirs, sanitation in the inhabited localities, and public awareness work).
- The Ministry of Defence, in providing information on malaria cases to the MOHMI for inclusion in its analyses.
- Immigration services, in providing detailed information to the Department of Parasitology on people arriving in the country from malaria-endemic countries. In early 2009, a "Health Care and Migration" round-table discussion, organized by MOHMI with support from the WHO Country Office, was held in Ashgabat. The discussion was attended by all national stakeholders: – health care services, migration service, border service, education, tourism, economic development, and the mass media.
- The Ministry of Fishery, on the establishment of hatcheries of larvivorous fish.
- Oil and gas companies, on the provision of waste oil for larviciding of mosquito breeding sites.
- Tourism agencies, on providing health advice on malaria prevention, chemoprophylaxis and measures to protect against mosquito bites to nationals leaving for malaria-endemic countries.
- Construction companies and oil companies that import labour, on providing health information on the risk of malaria, ensuring free access to diagnostic and treatment facilities for staff from malaria-endemic countries, and maintaining high vigilance.

CROSS-BORDER COOPERATION

As Turkmenistan borders malaria-endemic countries (Afghanistan, the Islamic Republic of Iran and Uzbekistan), developing cross-border collaboration was a top priority. The country took part in the cross-border meetings that were organized by EURO in Uzbekistan *(1999)*, Azerbaijan *(1999, 2000) (26)*, Uzbekistan *(2005)*, Tajikistan *(2006)*, Afghanistan *(2007)*, Turkmenistan *(2007) (11)* and Turkey *(2008) (45)*. Representatives of the ministries of health of the three neighbouring malaria-endemic countries also took part in some of those meetings (2005, 2007 and 2008) and the issues of cross-border malaria risk and collaboration were discussed. A cross-border cooperation meeting between officials of the ministries of health of Turkmenistan and Afghanistan was held in 2009, with support from WHO. Absolute commitment to the Tashkent *(2005)* Declaration and the Kabul *(2006)* Declaration (Health for All, Health by All: Communicable Diseases Recognize No Borders) was emphasized, as was the determination to continue strategic partnership for malaria control and elimination and to coordinate implementation of antimalaria interventions *(46, 47)*.

LEGISLATION AND REGULATION

To ensure consistency in policies and strategies and successful implementation of the malaria control programme, MOHMI developed and issued – in 2005, 2008 and 2009 – a number of specific decrees, regulations and guidelines related to malaria elimination. (*34–36*, *39–41*). All these documents were elaborated with the technical assistance of EURO and were in line with WHO recommendations (*9*, *10*, *31*, *33*, *42*, 48–*50*). The most important aspects of these documents are summarized above in the explanation of the different fields of interventions.

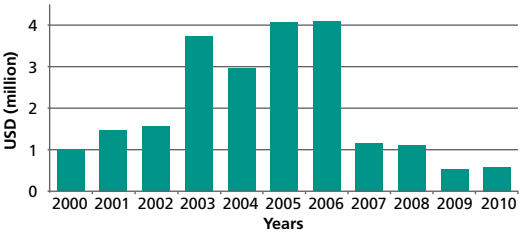
Cost of malaria elimination

Financial data for the Turkmenistan malaria elimination efforts are available for the decade 2000–2010. The start-up financing of the *Plan of action of prevention of reintroduction of malaria* is considered in these allocations. Starting at about US$ 1 million in the year 2000, the Government budget increased to US$ 1.5 million by 2002 and continued to rise thereafter, exceeding US$ 4 million per year in 2005–2006 (Figure 13). This increase was related to the containment of the Mary outbreak in 2003 and the subsequent elimination activities of the national malaria programme. A total of US$ 10.5 million from the national budget was allocated for malaria elimination in 2005–2008. Over this period, EURO provided in-kind technical assistance and support. From 2007 onwards, the Government budget was reduced, to end at around US$ 0.5 million in 2010, the year the country was certified malaria-free. Expenditure per head of population started at US$ 0.22 per year in 2000, reached US$ 0.86 per year in 2005 and dropped to US$ 0.10 and US$ 0.11 in 2009 and 2010 respectively (Figure 14). In 2009, there was also financial support through the WHO country budget (US$ 300 000) for planning, training, administration and overheads, communication and advocacy, and monitoring and evaluation (Table 15).

A comparison of the Government budget breakdowns for 2009 and 2010 shows that funding of malaria surveillance activities was maintained after malaria elimination (Table 15, Figures 13–15). In both years, an essential part of the allocation went to human resources and technical assistance, to ensure that parasitology personnel could maintain malaria surveillance at a satisfactory level, even though their priority had now become surveillance of parasitic diseases other than malaria. Of the Government malaria budget for 2010, 11–20% was spent on staff training, a good indicator of MOHMI efforts to maintain high levels of professional qualification. It should also be noted that the Government budget covered activities of the *Plan of Action to Prevent Re-Introduction of Malaria Transmission*; for example, there were allocations for maintaining the stock of drugs, insecticides and diagnostics. Some resources for communication and advocacy, as well as for monitoring and evaluation of activities, were also planned.

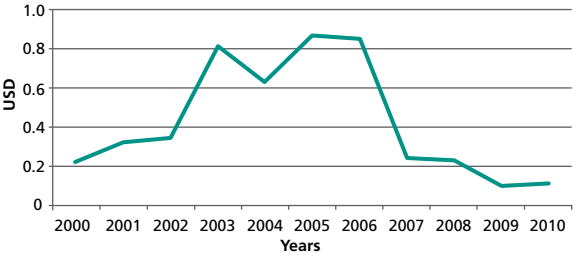
Apart from the contributions from WHO, the entire malaria expenditure for 2009–2010 (US$ 1 095 301) was covered by the Government.

Figure 13. State funding for malaria interventions by year, 2000–2010



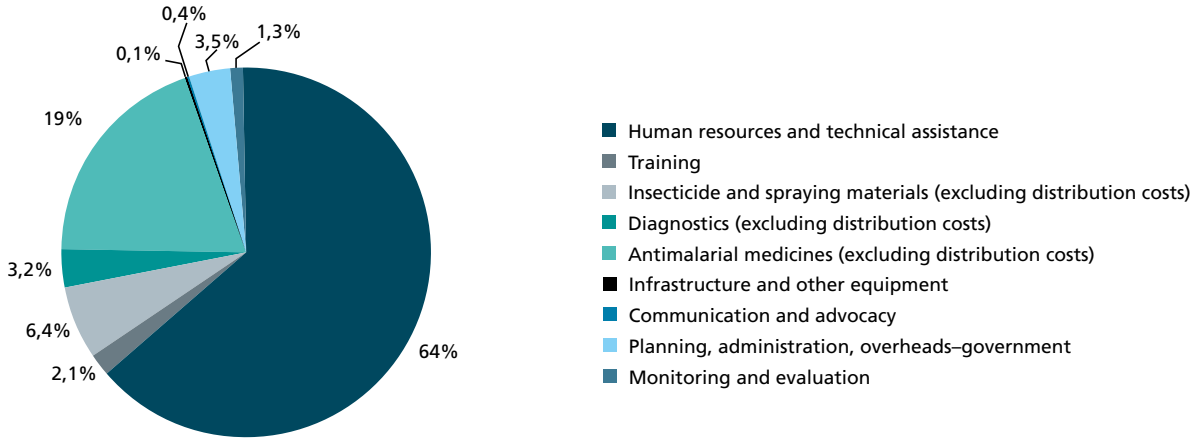
Source: Ministry of Health and Medical Industry

Figure 14. State funding for malaria interventions by year, per capita, 2000–2010



Source: Ministry of Health and Medical Industry

Figure 15. Government expenditure breakdown, 2010



Source: Ministry of Health and Medical Industry

Table 15. Expenditure breakdown, 2009–2010

	Expenditure (US$) by			
	Government		WHO	
Expenditure category	2009	2010	2009	2010
Human resources and technical assistance	441 883	368 236	-	-
Training	-	12 000	64 000	-
ITNs (excluding distribution costs)	-	-	-	-
Insecticide and spraying materials (excluding distribution costs)	-	36 742	-	-
Diagnostics (excluding distribution costs)	18 538	18 538	-	-
Antimalarial medicines (excluding distribution costs)	56 698	112 339	-	-
Procurement and supply management costs (transport, fees, etc.)	-	-	-	-
Infrastructure and other equipment	-	500	-	-
Communication and advocacy	-	2 058	25 250	-
Planning, administration, overheads	-	20 210	52 600	-
Monitoring and evaluation	-	7 559	171 492	-
Total	517 119	578 182	313 342	-

Source: Ministry of Health and Medical Industry

LESSONS LEARNED AND DRIVERS OF CHANGE

From the late 1990s onwards, control measures and socioeconomic development in Turkmenistan have reversed the malaria receptivity and vulnerability that had built up over the preceding decades.

Problems and constraints overcome

After the elimination of malaria in 1961, malaria surveillance activities were given special attention and maintained at a sufficient level for many years. In the 1990s, however, the SES system failed to respond adequately to the increased malaria receptivity and vulnerability; a degree of neglect resulted in delayed diagnosis of malaria cases, with subsequent outbreaks. Once this weakness was recognized, the SES promptly scaled up surveillance and control activities to contain the outbreaks, prevent further spread of malaria in the country and interrupt malaria transmission.

Although malaria control and elimination in Turkmenistan were generally good, a shortage of qualified staff proved to be a challenge, especially at the provincial and district levels of the SES network, with many Russian specialists leaving the country after the independence of Turkmenistan. Understanding the key role of human resources, MOHMI upgraded its SES system and set about capacity building to fill the gap – new specialists were appointed and extensive training was undertaken.

Comprehensive strategies applied

Turkmenistan adopted a complex approach to malaria control and elimination, combining scientifically sound and evidence-based strategies, practices and tools. The interventions were directed to the three main components of the epidemiological process: the source of infection, the mode of transmission and the healthy population, formulated by Gromashevski, 1942 *(51)*. The aim was to eliminate the source of infection by timely and complete case detection and radical treatment, by prompt and comprehensive investigation of every case and focus, as well as to control the vector through reducing its density and longevity, the number of breeding places and the extent of human-vector contact. The measures taken brought about prompt containment of outbreaks and clearing up of foci.

Several aspects of the Turkmenistan approach merit special mention:

- Intensive, active case-finding through daily house-to-house visits by mobile teams and primary health care facilities in all malaria foci, as well as mass blood surveys carried out among villagers and co-workers related to malaria cases, led to early detection and radical treatment of cases and thus to timely elimination of sources of infection and limitation of local transmission. Regular household visits by the local primary facilities in active foci is a well-established practice, with the aim of conducting ACD. This approach, based on fever screening, is widely used among EURO Region countries facing malaria problems, and was applied on daily basis during the outbreaks, and once every one to two weeks in all active foci during the transmission season. Screening of the population at higher risk was also performed (family members, population in the active foci, co-workers of a case) and led to the detection of parasite carriers, especially in 2003. PCD is performed at primary level, usually by family doctors at health houses who are well-informed about malaria. The high level of vigilance towards malaria should be specially mentioned as well as malaria examination of all febrile patients seeking medical assistance in affected regions.

- Significant success was achieved in reducing the number of sources of infection through strictly monitored radical treatment of each case with chloroquine and primaquine, as well as interseasonal prophylaxis with primaquine and seasonal chemoprophylaxis with chloroquine for the population of active foci. These three interventions reduced the likelihood of development of gametocytes in the peripheral blood of people who had, or may have, been infected and thus of transmission. Disease management is well set up in Turkmenistan; malaria treatment is free of charge and regular supplies of drugs are provided by the Government.
- Through comprehensive case investigations, all new active and potential foci were identified and investigated promptly, permitting appropriate planning and the implementation of control measures. Well-organized and efficient processing of information by the SES provides timely case registration and notification and regular flow of information to the upper levels of the system, as well as a feedback loop back to lower levels. This enables rapid analysis of the situation and prompt, evidence-based decision-making by the responsible authorities. It should be stressed that case-based surveillance has been conducted in Turkmenistan for years. Epidemiological investigation of every new case and focus is carried out by SES staff; a case record form is completed and a focus record form ("passport") – with detailed information, mapping, focus transition and classification – is maintained. All of this information is critical for the timely initiation of interventions if needed, and correct determination of their type, scope and period of application.
- Integrated vector control was guided by the results of foci investigations, and included full IRS coverage and larviciding where appropriate. Entomological surveillance is conducted by SES. It includes annual identification and mapping of all potential and actual breeding sites, use of representative sentinel sites for monitoring larval control, determination of larval and adult densities, and identification of *Anopheles* species. A permanent record ("passport") is maintained for each water body; it is regularly updated and its status is reviewed weekly. Vector control is well-designed and carried out through: larval control by physical measures (larvivorous fish, or oil); IRS whenever an active focus or an entomologically worrying situation is identified; and use of locally produced (untreated) mosquito nets. Air-conditioning and other personal protection measure are widely used. The last round of IRS was carried out in 2005.
- The outbreak control activities benefited greatly from temporary mobile teams of specialists (epidemiologists, parasitologists, entomologists, clinicians and laboratory technicians) being assigned to conduct the urgent measures in affected areas. This ensured a rapid response and good coverage and performance, including prompt case detection, case and focus investigation, and IRS coverage.

Upgraded and motivated NMCP staff

National coordination of the malaria programme is the responsibility of the MOHMI State Sanitary Epidemiological Service at national, provincial and district levels. It is supervised by the Deputy-Minister of Health. Activities are conducted by SES, primary health care services and other institutions, all of which played an integral part in the programme interventions. The existence of the specialized SES network, with substantial expertise in malaria control and elimination, appears to have been a critical factor in achievement of the goals. Over the years, SES has proved to be a strong and reliable system for the surveillance and control of infectious and parasitic diseases, including malaria.

There is a strong laboratory support in the country. Recently upgraded laboratories provided prompt and accurate parasitological diagnosis of malaria. A system of cascade training contributed to better professional qualifications among laboratory staff and improved expertise in malaria diagnostic microscopy; rapid diagnostic tests have never been used because of the relatively low number of malaria cases and the existence of reliable microscopic diagnosis. All malaria cases

in Turkmenistan are microscopically confirmed. The internationally certified National Reference Laboratory of Parasitic Diseases Diagnosis is responsible for the national EQA programme, cross-checking 10% of negative slides and confirming all positive ones, as well as monitoring and evaluating the work of the laboratories using a special check-list. As a participant in an international EQA programme, the NRL holds certificates for the good quality of laboratory diagnosis of malaria. One of the key components of surveillance – namely, malaria laboratory diagnosis – was thus clearly reliable, meaning that delays, or failure, in the identification of cases were averted.

Strengthening collaboration and community mobilization

Turkmenistan undertook many activities to strengthen intersectoral and international collaboration in the field of malaria, as well as to improve health education of the population and community mobilization.

Strong political commitment

The high level of political commitment to and governmental support for the national malaria programme are worthy of special attention. The Government of Turkmenistan provided strong support for the containment of the malaria outbreaks and for malaria elimination efforts. Malaria control and elimination interventions were supported by policies and strategic plans, decrees and guidelines that were endorsed by the Cabinet of Ministers and MOHMI. Throughout, the activities of the national malaria control programme were adequately funded, mainly by the Government, and sufficient funding continues to be provided for prevention of the reintroduction of malaria.

WHO support

Support from the WHO Regional Office for Europe appears to have been important for the country in containing outbreaks and conducting a malaria elimination programme. The prompt response with technical and financial assistance at the beginning of the outbreaks may well have facilitated the rapid containment. Turkmenistan also benefitted from a WHO consultancy in developing strategies (National Strategic Plan for Malaria Elimination in Turkmenistan (2008–2010)), plans (National Plan of Action to Prevent Re-Introduction of Malaria Transmission in Turkmenistan for 2010–2015), and guidelines. Continuing financial and technical assistance was provided by WHO to help the country move towards its stated elimination goals, and finally to certify the country as malaria-free. The concomitant EURO move towards region-wide elimination provided an enabling environment. Turkmenistan hosted the WHO Meeting on progress achieved with Malaria Elimination in the WHO European Region with the participation of WHO EMRO representatives in November 2007 (Figure 16). Achievements and experiences on malaria elimination were reported and shared between countries and regions.

Figure 16. Participants of the WHO EURO meeting on progress achieved with malaria elimination in the WHO European Region, Ashgabat, 2007

In conclusion we can say that all the systems and activities mentioned above indicate that in Turkmenistan there is a strong NMCP that was able to promptly contain the epidemics upon detection, and ultimately interrupt resurgent malaria transmission. The national health system, and in particular the well-organised peripheral surveillance system were, following some initial lapses, able to respond comprehensively to identified outbreaks and demonstrated a solid expertise in conducting antimalarial interventions.

Outlook for the future

Factors that reduced the receptivity of once malarious areas include durable solutions such as the permanent infilling or draining of mosquito breeding sites, as well as higher living standards and the improvement of human habitations. Factors that reduced malaria vulnerability include the continuing strict control of population movements on the border with Afghanistan, the medical observation of people coming from Afghanistan by the border sanitary quarantine points staff with a special attention to febrile persons, and the collaboration of the military and the oil and gas industry in the elimination efforts. Malaria risk in Turkmenistan's other neighbouring countries is declining dramatically, further reducing the importation risk. In general, the number of travellers from other countries, including malaria-endemic countries, entering Turkmenistan has been very limited and this is reflected in the minimal malaria importation in the past few years.

Now that the local transmission of malaria has been interrupted, all efforts are directed towards preventing the reintroduction of malaria. Turkmenistan has developed an appropriate plan of action and the relevant activities are funded by the Government. It is crucial that epidemiological surveillance of malaria is maintained at a satisfactory level to ensure prompt detection and treatment of cases, as well as timely response to any emergency.

Drivers of change to take into account in the coming years may be summarized as follows:

- The malaria potential (which combines information on receptivity and vulnerability) indicates that wide-scale reestablishment of transmission in the country is unlikely; however, a higher epidemiological risk persists in the areas bordering Afghanistan.
- The impact of malaria imported from other countries on resurgence of local transmission is currently minimal but might increase in the future, for instance with increased population exchange with the Indian subcontinent.
- The development of water resources is continuing, and water surface areas of reservoirs may increase in some areas with the extension of the Turkmen River and construction of the Altyn Asyr Turkmen Lake, which has extensive affluent drainage canals. Any delays in diagnosis and treatment of imported vivax malaria in receptive territories, including the settlements in the river valleys and oases, would mean a risk of malaria reintroduction in these geographical areas.

CONCLUSIONS

This case-study demonstrates that malaria resurgences can be reversed and malaria elimination ultimately achieved through strong political commitment; adequate funding (largely domestic); correct policies, strategies and guidelines; well-developed systems, especially laboratory and surveillance; rapid response capacity; technical assistance; and – perhaps most importantly – domestic human resource capacity to run an intelligent and comprehensive malaria control and elimination programme.

In Turkmenistan there is a strong NMCP that was able to promptly contain the epidemics upon detection, and ultimately interrupt resurgent malaria transmission. The national health system, and in particular the well-organised peripheral surveillance system were, following some initial lapses, able to respond comprehensively to identified outbreaks and demonstrated a solid expertise in conducting antimalarial interventions.

The experiences of Turkmenistan show the risks of programme slippage and inattention and prove that there are ultimately no shortcuts to the control and elimination of malaria. The case-study also highlights the importance of continued funding for malaria activities, even in the absence of ongoing local transmission. Only in such an environment can the country maintain adequate vigilance and ensure timely responses to potential changes in receptivity and vulnerability, prompt detection of any malaria case, and preparedness for response actions when required. Turkmenistan has an ongoing duty, not only to its own people but also to its neighbours, to maintain this dedication to remaining malaria-free.

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ANNEX 1: DATA SOURCES AND METHODS APPLIED

Data were collected from the following sources for this case-study:

- **WHO**
  - Malaria-related materials in the WHO Registry and Archives collection of reports of technical missions, records, reports of EURO meetings, and other information on Turkmenistan up to 2011 were reviewed. The following two documents were found to be especially useful sources of information: *Elimination of malaria in Turkmenistan. National report for country certification (1)* and *Report on malaria control in Turkmenistan (2)*.
  - A literature review of WHO publications was carried out.
  - Country data reported to WHO/HQ and to EURO as part of the annual reporting cycle, including information submitted for the annual *World Malaria Report*, were reviewed.
- **Country data**, including:
  - Country publications and manuals.
  - MOHMI data – reports, laws, regulations, orders, guidelines, etc. National malaria control programme documentation, reports, registers of cases and foci, maps, guidelines.
  - *National Plan of Action to Prevent Re-Introduction of Malaria Transmission in Turkmenistan for 2010–2015,* adopted by the Cabinet of Ministers of Turkmenistan on 26 WOctober 2009 *(3)*.
  - *National Strategic Plan for Malaria Elimination in Turkmenistan (2008–2010),* approved by Decree of the Deputy Chairman of the Cabinet of Ministers of Turkmenistan, Ashgabat *(2008) (4)*.
  - The *National Programme "Malaria Prevention in Turkmenistan, 2005–2010,* approved by Decree of the Deputy Chairman of the Cabinet of Ministers of Turkmenistan, Ashgabat *(2005) (5)*.
  - SES reports, registers, etc.
- **Scientific publications** concerning malaria in Turkmenistan were identified using PubMed and Google and by screening scientific journals and other sources.
- **Authors' materials and data** collected during various EURO technical support missions in the country.

Data on the number of malaria cases by *Plasmodium* species, case category and year of reporting used in this case-study were based on information contained in the reports *Elimination of malaria in Turkmenistan. National report for country certification (1)* and *Report on malaria control in Turkmenistan (2)* and on EURO's *Centralized Information System for Infectious Diseases* (CISID) *(6)*. During the data processing, some discrepancies were detected between cases number for the years 1999–2003 reported by Turkmenistan to CISID *(6)* and those cited in the other two sources *(1, 2)*. It was established that a more precise analysis of malaria cases had been made by the local malaria programme staff in preparing the national report for country certification *(1)*, so for these particular years analysis was based on the information in the national report and in *Report on malaria control in Turkmenistan (1, 2)*.

All data collected were epidemiologically analysed, with the aim of characterizing the malaria situation in different periods and the effect of interventions. Analysis used the main epidemiological parameters and indicators such as: annual number of cases (autochthonous and imported); malaria morbidity and mortality; distribution of cases by age, sex and other parameters; geographical distribution of malaria; number, category and transition of malaria foci; parasites and vectors.

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ANNEX 2: DEMOGRAPHIC DATA FROM THE UNITED NATIONS POPULATION DIVISION

Variable	Year/period	Value
Population (thousands)	2010	5.177
Population sex ratio (males per 100 females)	2010	97.1
Percentage aged 0–4 years	2010	10
Percentage aged 5–14 years	2010	19
Percentage aged 15–24 years	2010	21.6
Percentage aged 60 years or over	2010	6.1
Percentage aged 65 years or over	2010	4.1
Percentage of women aged 15–49 years	2010	56.4
Population growth rate (%)	2010–2015	1.25
Crude birth rate (live births per 1000 population)	2010–2015	20.8
Crude death rate (deaths per 1000 population)	2010–2015	7.4
Infant mortality rate (infant deaths per 1000 live births)	2010–2015	46.2
Life expectancy at birth, males/females (years)	2010–2015	62.4/70

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ANNEX 3: ADMINISTRATIVE DIVISIONS, POLITICAL ORGANIZATION AND ECONOMY

The national territory is divided into five provinces (*velayats*), 25 cities and towns and 50 districts (*etraps*), and villages (Figure 1). Apart from the cities, towns and villages, there are sparsely inhabited localities, such as cattle-breeding farms in the desert, field stations, halts and fishermen's settlements *(1, 2)*.

Governance is based on the division of power between legislative, executive and judicial branches. The Constitution of Turkmenistan determines the rights, freedoms and responsibilities of the citizens of the country, foreign nationals and stateless persons. Supreme state power and governance in Turkmenistan is exercised by the President, the Parliament, the Cabinet of Ministers and the Supreme Court. The local authorities are comprised of representative and executive bodies.

Turkmenistan has the fourth largest reserves of natural gas in the world. It also has large reserves of oil, iodine, bromine, sulfur and other minerals. Gas and oil industries are leading branches of the economy. The most developed sectors of national industry include fuel and energy, chemistry and construction *(1, 2)*.

From ancient times, the country has had well-developed agriculture based on irrigation, mainly cotton and rice growing, silkworm breeding, and cultivation and processing of valuable commodities such as liquorice. Turkmenistan is among the world's 10 major cotton producers.

Water supplies for industry and, primarily, for agriculture and farming are of major importance. To satisfy these needs, Turkmenistan uses the waters of the Amu Darya – the largest Central Asian river – and other rivers, as well as the main artificial canals – Karakum and Turkmen Canals.

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ANNEX 4: HEALTH CARE POLICIES

In 1995, Turkmenistan adopted the State Presidential Health Programme, intended to produce a radical improvement in health and an increase in life expectancy. In this connection, two important laws – *On the Health Care of Citizens* and *On Pharmaceutical Activity and Provision of Drugs* – were adopted in 2002 *(1, 2)*.

According to the Law *On the Health Care of Citizens*, the Government health policy aims to:

- ensure a single uniform state health care policy;
- recognize the right of the people to health care;
- design and implement state programmes for the development and improvement of the health care system (to meet the needs of the people);
- advocate and promote healthy life styles;
- strengthen human health and prevent diseases;
- provide for the sanitary, hygienic and epidemiological safety of people;
- ensure access to and free supply of the health benefits guaranteed by the State;
- provide effective, continuous and high-quality health services;
- ensure social protection of citizens;
- provide people with the specific medicines to treat and prevent infectious diseases, free of charge;
- develop state voluntary health insurance and improve health insurance systems;
- improve the economic basis of the health care system, create a health care service market and encourage development of the private health care delivery system;
- increase the cost-effectiveness of the health care services;
- strengthen the infrastructure of the health care system and develop the medical industry;
- create favourable conditions for the work of the health care facilities, irrespective of their type of ownership;
- improve health education systems, training, retraining and advanced training systems for health professionals and scientific researchers;
- improve the legislative framework of the healthcare system.

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ANNEX 5: MAIN HEALTH INDICATORS

Table A5.1 Main indicators on health economics in 2005

Indicator	Value
External resources for health as percentage of total expenditure on health	0.3
General government expenditure on health as percentage of total expenditure on health	66.7
General government expenditure on health as percentage of total government expenditure	14.9
Total expenditure on health as percentage of GDP	4.8
Out-of-pocket expenditure as percentage of private expenditure on health	100
Per capita government expenditure on health at average exchange rate (US$)	104
Per capita total expenditure on health at average exchange rate (US$)	156
Private expenditure on health as percentage of total expenditure on health	33.3
Social security expenditure on health as percentage of general government expenditure on health	6.1

Source: reference *1*

A broad range of services is provided free of charge. The size of, and procedure for, free health service provision is determined by the Cabinet of Ministers. At present, all services related to communicable diseases, including malaria, are free of charge.

The main health indicators are shown in Table A5.2 *(2)*.

Top ten causes of death data (Table A5.3) indicate that the major burden in Turkmenistan comes from non-communicable diseases *(3)*.

Table A5.2 Health indicators according to WHO data for 2010

Indicator	Value
Life expectancy at birth	Males: 60 Female: 67 Both sexes: 63
Adult mortality rate (per 1000 adults 15–59 years, both sexes)	298
Under-5 mortality rate (per 1000 live births, both sexes)	45
Maternal mortality rate (per 100 000 live births)	77

Source: reference *2*

Table A5.3 Top ten causes of death in Turkmenistan (2003)

Cause	Total death (%)
1. Ischaemic heart disease	28
2. Hypertensive heart disease	12
3. Lower respiratory infections	9
4. Cerebrovascular disease	5
5. Tuberculosis	4
6. Cirrhosis of the liver	3
7. Diarrhoeal diseases	3
8. Perinatal conditions	2
9. Self-inflicted injuries	1
10. Diabetes Mellitus	1

Source: Reference *3*

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ANNEX 6: PARASITES, VECTORS AND GEOGRAPHICAL DISTRIBUTION

In the past, three malaria species have been registered in Turkmenistan:

- *P. vivax* – in all areas;
- *P. falciparum* – mostly, in Charjow (now Lebap) province and Kara-Kala (now Makhtumkuly) district; and
- *P. malariae* – in various areas.

Since 1960, *P. vivax* has been the only malaria parasite known to be transmitted in the country. The last indigenous case of *P. malariae* was detected in 1988 in a 76-year-old woman. Indigenous *P. falciparum* was eliminated before 1960, probably in the late 1950s. Single cases of *P. falciparum* importation from Africa were observed in 1980 and in 1981 in Lebap, and two cases in Ashgabat in 1988. In 1982, one falciparum case was imported to Bayram Aly from Afghanistan. No secondary cases occurred in any of these instances *(1)*.

The important malaria vectors are *Anopheles pulcherrimus* and *An.superpictus*. A third vector, *An.hyrcanus* possibly plays a minor role in certain circumstances (*1–3*). In all, 11 species of the genus *Anopheles*, belonging to the subgenera *Anopheles (Ano.)* and *Cellia (C.)*, have been recorded in Turkmenistan:

An.(C.) pulcherrimus (Theobald, 1902)

An.(C.) superpictus (Grassi, 1899)

An.(Ano.) hyrcanus (Pallas, 1771)

An.(Ano.) algeriensis (Theobald, 1903)

An.(Ano.) artemievi (Gordeev et al., 2005)

An.(Ano.) barianensis (James, 1911)

An.(Ano.) claviger (Meigen, 1804)

An.(Ano.) maculipennis (Meigen, 1818)

An.(Ano.) martinius (Shingarev, 1926)

An.(Ano.) plumbeus (Stephens, 1824)

An.(C.) multicolor (Cambouliu, 1902)

The bionomics, distribution and epidemiological role of the three species that have been incriminated as malaria vectors in Turkmenistan are described below.

ANOPHELES PULCHERRIMUS

This species prevails in the lowlands of Turkmenistan, especially in areas subject to flooding from rivers and in the Karakum Canal zone. Its population dynamics closely follow the dynamics of water vegetation. The main breeding sites are Murgab, Tedjen and Etrek water storage reservoirs, drainage systems and relict lakes (Yaskha, Topyatan, Garategelek, Ketdeshor, Ainokol and Akrabat). The optimal temperature for larval development is in the range 30–35°C but temperatures up to 42°C are tolerated. Third-stage larvae overwinter in reservoirs that are not bottom-frozen. The first adult mosquitoes appear in April; numbers grow gradually and peak in July. Densities remain high through September and up to mid-October in Esenguly and Etrek districts. During daytime, mosquitoes choose to stay in cattle-sheds, animal tents, weeds, shrubs, pits and dry ditches. *An.pulcherrimus* is the main malaria vector in the plains of Turkmenistan.

ANOPHELES SUPERPICTUS

This species is abundant in mountainous and submontane regions. Larvae inhabit creeks, puddles, marshlands along small stone-bed rivers, streams and springs; overflows of *aryks* and *kahrizes* (irrigation ditches); and boreholes with clear well-warmed water containing calcium salts. In running water and deep reservoirs, such as the karst lakes of Köýtendag and the bathing pool in Germab, larvae are found in bunches of hair-like nematodes and thickets of aquatic plants. Larvae also live in warm sulfurous springs in various districts, including Ejery, Uzynsuw, Janahyr, Parhay, Archman, Kovata and Berzengy. The optimal temperature for larval development is 30–35°C, but larvae can survive in water up to 40°C. In the Kopetdag Mountains, this species is found as high as 2000 m above sea level and in Köýtendag up to 2500 m. The first larvae are observed in April; peak numbers are registered in the hottest months (June to August), when there are numerous breeding sites in the stone-beds of small rivers after the water level in the mountain rivers falls, and when water ponds appear as a result of irrigation. From early October onwards the larval population slumps because of the mass retreat of the female mosquitoes to hibernate. The endophilic *An.superpictus* is the main vector in the mountainous and submontane parts of Turkmenistan.

ANOPHELES HYRCANUS

This species is recorded in almost all districts. Its density is greatest near lowland rivers and the Karakum Canal, water storage reservoirs and lakes. Larvae inhabit marshlands with aquatic plants; irrigation and drainage-collector systems; filtration ponds of dams and canals; and rice fields. Adult mosquitoes leave their winter hibernation places in mid-March and populations peak in May. In the summer months, larvae disappear from the open outdoor reservoirs but survive in shaded reservoirs with dense vegetation, at an optimal temperature of 25–30°C. In September-October, larvae appear again in open outdoor water bodies. Adult mosquitoes are hydrophilic and rest in thickly vegetated habitats near their breeding sites. The species is of minor importance as a malaria vector because of its exophilic and exophagic habits.

Areas of malaria receptivity are the foothills, where streams are natural breeding sites of *An.superpictus* and where agricultural development creates additional suitable water bodies, as well as plains areas with suitable water bodies, such as occur in oasis and irrigation areas and along canals and other man-made water-management systems.

Large areas with an arid climate, such as the Karakum Desert and some regions in the north-west of the country, where few people live, have always been malaria-free. Highlands above 1500–2000 m are also generally considered to be malaria-free *(1, 2, 4)*.

After the elimination of malaria in 1961, most of the cases were registered in the southern provinces bordering Afghanistan – Mary and Lebap – known for their high level of receptivity (foothills, oasis areas, water bodies) and vulnerability (cross- border population migration).

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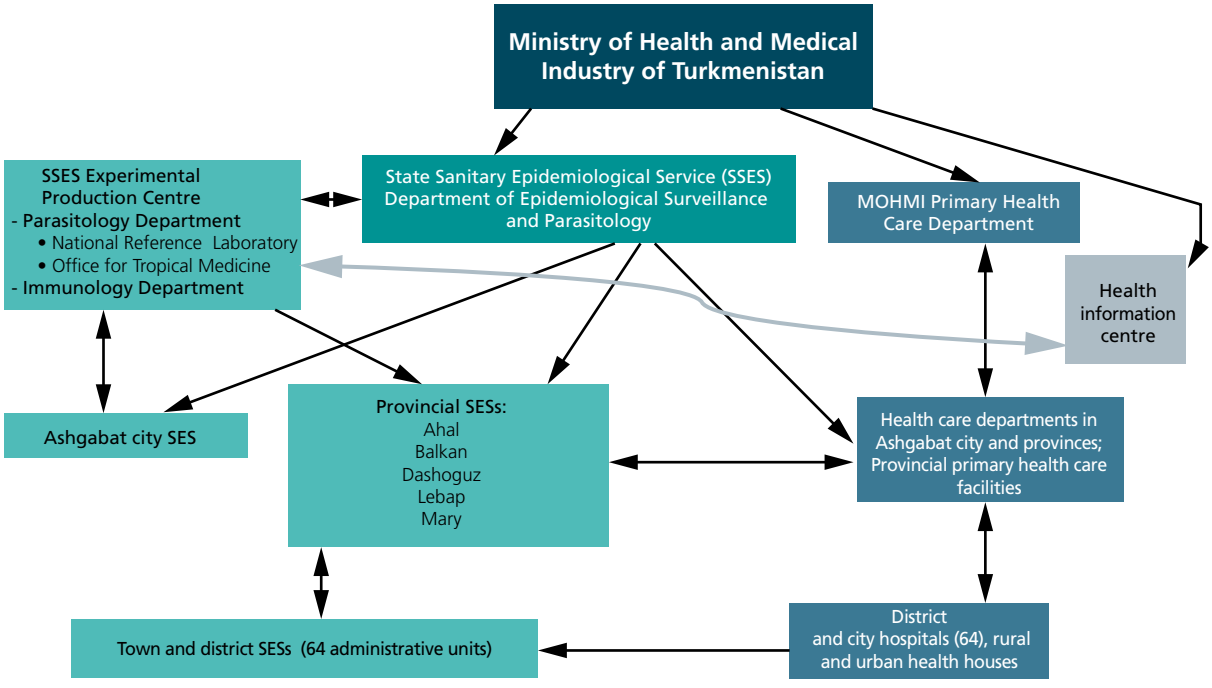
3. Zvantsov AB, Ejov MN, Artemiev MM. *Malaria vectors in CIS countries*. Copenhagen, WHO Regional Office for Europe, 2003.

4. Amangel'diev KA. Current malaria situation in Turkmenistan. *Meditsinskaia Parazitologiia i Parazitarnye Bolezni*, 2001, 1:37–39 [in Russian].

ANNEX 7: ORGANIZATION OF MALARIA CONTROL/ ELIMINATION WITHIN THE STRUCTURES OF MOHMI



ANNEX 8: STANDARD FORM FOR MALARIA AND OTHER COMMUNICABLE DISEASES CASE INVESTIGATION

Name of institution: Geokdepe Etrap SES

Epidemiological investigation card no. 1 **of infectious disease case/focus:** Malaria

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I. Patient data

1. Final diagnosis: first-time detected tertian malaria
2. Parasite type, species: P. vivax
3. Patient: local resident ☑ traveller ☐
4. Name: Annamyradov Gochmyrat
5. Sex: male ☑ female ☐
6. Date of birth: 18.10.1983
7. Home address: Geokdepe etrap, Kopetdag Street No. 26
   locality: urban ☑ rural ☐
8. Place of work, study, no. of child education institution: Telephone Communication Unit, Technician
9. Date of last attendance at place of work, study: 20.10.2004
10. Health facility at place of residence: Geokdepe Hospital
11. Notification of the case received (date, time): 20.10.2004 (brief message) 10:30 am
    oral (by telephone) ☑ written ☐
12. Referral from (institution): Patient presented personally at etrap hospital
13. Emergency notification diagnosis: malaria?
14. Main symptoms at early stage of disease: headaches, chills, high body temperature
15. Patient detected: through prophylactic examination ☐
    epidemiological survey ☐
    seeking professional health care ☑
16. Date and time of epidemiological investigation: 21.10.2004
    Date of observation completion: 4.11.2004

17. Date of onset of disease	18. Date of seeking medical care	19. Date of diagnosis and of emergency case notification	20. Date of hospitalization	21. Date of final diagnosis
12.10.2004	20.10.2004	21.10.2004	20.10.2004	21.10.2004

22. Place of hospitalization, transportation: Ahal Velayat Isolation (infectious disease) Hospital

23. Patient allowed to stay at home (reason): absence of epidemiological indications ☐
absence of clinical indications ☐
lack of hospital beds ☐
declined hospitalization ☐

24. Reason for late hospitalization: absence of epidemiological indications ☐
absence of clinical indications ☐
lack of hospital beds ☐
delay in seeking medical care ☐
delayed diagnosis ☐
declined hospitalization ☐

25. Laboratory examination: performed ☑ not performed ☐

26. Diagnosis confirmed

Only clinically		Date		Result of investigation
		1		
By laboratory examination	bacteriological test	2		
	microscopic examination	3	21.10.2004	P. vivax
	serological test	4		
	biochemical assay	5		
Other methods		6		

27. Date of last immunization (scheduled, by epidemiological indications, date, dose, drug, series):

Vaccination: Re-vaccination:

Missing data:			
Patient vaccinated:			
according to normal schedule	at wrong intervals between vaccinations	at wrong interval after disease	other violations of immunization schedule
Patient not vaccinated:			
because of medical indications	because of refusal	for other reasons	

II. Identification of infection source and transmission factors

28. Approximate date of infection: from 2003 to

29. Unusual circumstances or setting that might have affected the patient's infection: patient did military service in the malaria focus

Circumstances or setting	Location, address	Time period or date
Staying in a different inhabited locality	Tagtabazar	2003-2004
Visit to relatives, family		
Construction, agricultural or other work outside usual place of residence		
Recreation in natural environment (tourism, hunting, fishing, swimming, etc.)		
Recreation in a summer camp, summer cottage		
Stay in hospital		
Blood or plasma transfusion		
Medical manipulations (specify)		
Contacts with animals (birds)		
Water supply pipeline or sewerage damage		
Other		

30. Persons who might have been sources of infection (patients or suspected cases; convalescents, infection carriers, donors):

Full name	Diagnosis and clinical form of disease (or donor ship)	Place, time and nature of contact; address of donor	Examination/investigation results

31. Information about food and water consumed by patient that might have contributed to this disease (record only most probable factors):

Name of food; type of water source	Date and place of purchase	Date and place of consumption	Conditions of storage	Quality reported by patient or by other persons

SANITARY AND HYGIENIC CHARACTERISTICS OF LOCAL FOCI RELATED TO THIS PATIENT

A. By place of residence

32. Living conditions: separate apartment ☐ private house ☑
room in a communal apartment ☐ hostel ☐
hotel ☐ boarding-house ☐ other ☐

33. Density of occupation: *6* persons per room of m².

34. Water supply: water pipe ☑ water pump ☐
well (borehole, mineshaft) (communal, private) ☐ imported water ☐
open water reservoir ☐
Quality of water (as reported): *satisfactory*
Regularity of supply: *permanent supply*

35. Type of excreta disposal: sewerage system ☐ cesspit ☐
outhouse latrine ☐ other (specify) _____

36. Waste disposal: refuse chute ☐ sanitation car ☐ garbage recipient ☐
garbage container ☐ other _____

37. Sanitary status of: dwelling: *satisfactory* grounds: *satisfactory* toilet facility: *satisfactory*

38. Pediculosis: *no* Other insects: *no* Rodents: *no*

39. Other factors conducive to disease:

B. By place of work, study, education, rest and recreation, treatment

40. Name of organization and its organizational unit (shop, class, group, etc.) to which patient belongs _____
_____

41. Compliance with sanitary and hygienic standards and anti-epidemic requirements:

density of occupation_____

isolation_____

water supply_____

sewerage_____

sanitary maintenance_____

food storage_____

food cooking_____

42. Factors conducive to disease_____

43. Laboratory examination of materials collected from environment (including arthropoda):

Date	Name of object: arthropoda or animal species	Material	No. of samples	Type and result of examination

44. Specific and other types of prophylaxis of these persons (at the place of residence):

Reported to and date of report	Follow-up prophylaxis				Laboratory examination			Examination result
	Date	Drug	Dose	Series	Date	Result	Date received	

III. Interventions to eliminate the focus

45. Observation of persons who were in contact with the patient or who could be infected in the same settings:

Name	Age	Address	Place and nature of work	Immunization data	Type of restrictive measures

46. Measures of specific prophylaxis and examination of persons in organized groups:

Name of group	Address	No. of contacts	Subject to specific prophylaxis	Received specific prophylaxis	Laboratory examination		Detected		Date of detection
					Date	No. of persons	Sick	Asympto-matic	

47. Measures taken to interrupt infection transmission in foci:

Measures	type; drug	Frequency of measures		Implementers	Implementation control (incl. laboratory) and results
		At place of residence	At place of work, etc.		
Quarantine					
Current disinfection					
Final disinfection	Siperator	Daily	Daily	A. Charyev	S. Berdyev
Disinsection					

Patient hospitalized in: Ahal Velayat Isolation (infectious disease) Hospital

IV. Epidemiological investigation conclusions

1. Infection occurred in the territory of: Turkmenistan

2. Province: Mary 3. District (city): Tagtabazar

4. Inhabited locality (district, town): urban ☑ rural ☐

5. Most probable place of infection:

Unknown	Place of residence	Place of work	Pre-school	School	Summer child recreation center	Specialized educational institution	Construction group, rest and labor camp	In-patient hospital	Public eating facility	En route	Natural environment	Other places (military service)
01	02	03	04	05	06	07	08	09	10	11	12	+ 13

6. Probable source of infection:

Source unidentified	Human (full name)				Animal (species)				
	Patient with acute form of disease	Patient with chronic form of disease	Convalescent patient	Infection carrier	Domestic animals	Wild animals	Rodents	Birds	Other
01	+ 02	+ 03	04	05	06	07	08	09	10

7. Probable food factor of infection transmission:

Unidentified	Water				Drinks, juices	Milk	Cream, sour cream	Cottage cheese	Other dairy products	Meat products	Fish, seafood
	piped	well	open reservoir	waste							
01	02	03	04	05	06	07	08	09	10	11	12

Salads	Cooked hot foods	Other ready-to-serve foods	Fruits, vegetables, berries	Other	Social contact transmission	Respiratory transmission	Blood, plasma, serum	Animal raw products	Animal vectors	Other transmission factors *(mosquitoes)*
13	14	15	16	17	18	19	20	21	22	+ 23

8. Conditions related to infection:

Conditions undetermined	Untimely detection and isolation of the source	Over density	Breaking the rules of disinfection regime	Untimely immunization	Breaking of other rules of antiepidemic regulations	Visit to natural foci
01	02	03	04	05	06	+ 07

Breaking the rules of sanitary regulations in							Damages of water supply and sewerage systems	Neglect of private hygiene rules	Other circumstances
manufacturing of food products	storage and transportation	food cooking	sale of food products	raw stuff processing	handling of instruments	maintenance of premises			
08	09	10	11	12	13	14	15	16	+ 17

9. Disease in the focus:

A. At the place of residence: initial: ☐ successive: ☐

B. At the place of work, study, education, recuperation, treatment: initial: ☐ successive: ☐

Investigation conducted by: S. Berdiev, A. Charyev, S. Toporov

Date of card submission to the health statistics office: 26.10.2004

Signatures:

Epidemiologist S. Berdyev

Assistant epidemiologist A. Charyev

Other specialists S. Toporov

ANNEX 9: MALARIA FOCUS RECORD FORM ("PASSPORT")

City, district: *Tagtabazar Etrap*

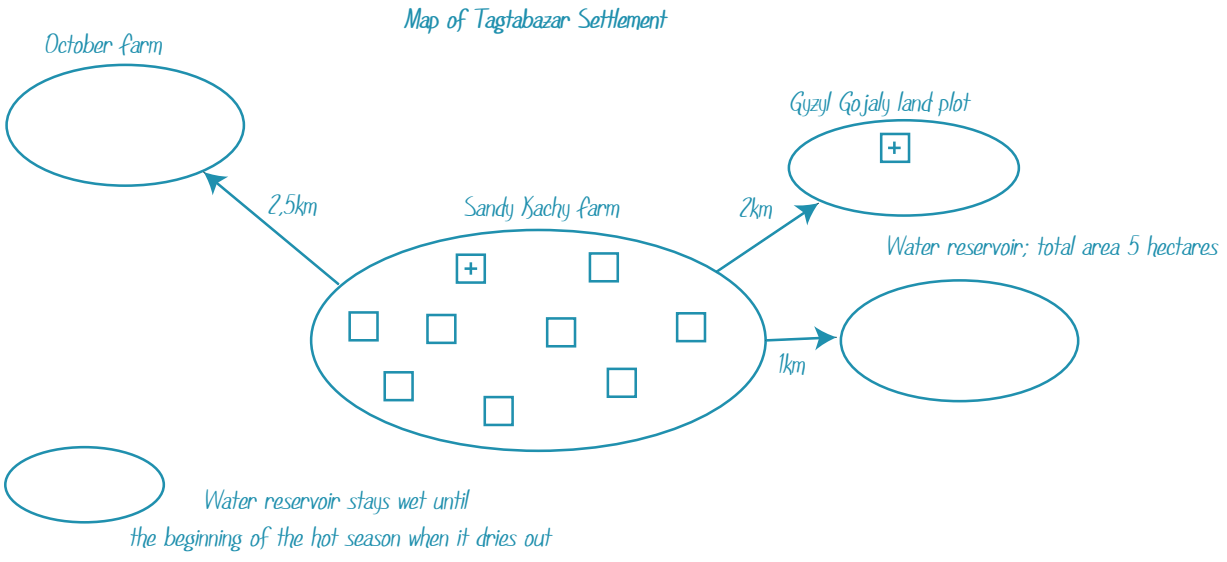
1. **Name of focus (inhabited locality):** *Tagtabazar Settlement*
2. **Closest inhabited localities related to focus:** *Gyzyl Gojaly land plot*
3. **Attendant healthcare facility:** *House of health in Tagtabazar*
4. **Vector species**: *Anopheles superpictus*
5. **Description of area and population**:
    1. **Receptivity**: rural ☐ urban ☑

       altitude, main geographical features, etc: *Elevation above sea level is 450 m. Population - 11 910 persons, about 35% of them children. There are 450 households. This inhabited locality has two permanent water reservoirs, 0.8 ha and 5 ha*
    2. **Vulnerability**: *Inside endemic region; close proximity to endemic region; near border with Afghanistan*
    3. **Population migration patterns:** *large numbers of temporary workers; presence of travellers from malaria-endemic countries, etc.*
6. **Geographical map of focus:** *focus and focus boundaries; location of health facilities; mosquito breeding sites marked for presence/absence of vector larvae; locations of households with registered malaria cases during past three years*

7. **Malaria cases in the focus by months**

Year	Population	Number of malaria cases in the focus by months												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1999														
2000														
2001														
2002														
2003														
2004							1							

8. Schematic map of the focus



9. Registered malaria cases in the focus by parasite species:

Year	Total	Malaria cases by *Plasmodium* species				
		P. vivax	***P. falciparum***	***P. ovale***	***P. malariae***	**Mixed**
1999						
2000						
2001						
2002						
2003						
2004	1	1				

10. Distribution of malaria by age groups:

Year	Total	Number of malaria cases by age groups (years)					
		0–1	**2–4**	**5–9**	**10–14**	**15–19**	**Above 19**
1999							
2000							
2001							
2002							
2003							
2004							1

11. Distribution of malaria cases by sex:

Year	Males		Females		Total
	Number	%	Number	%	
1999					
2000					
2001					
2002					
2003					
2004	1	100			

12. Distribution of malaria cases by population cohorts:

Year	Total number	Number of malaria cases by population cohorts						
		Non-organized children	Organized children	School students	Farm workers	Workers	Employees	Housewives
1999								
2000								
2001								
2002								
2003								
2004						1		

13. Number of blood slides for malaria testing:

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sept		Oct		Nov		Dec		Total	
	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive	Active	Passive
1999																										
2000																										
2001																										
2002																										
2003																										
2004												1														

14. Method of malaria case detection:

Year	Number of malaria cases		Total
	Active case detection	Passive case detection	
1999			
2000			
2001			
2002			
2003			
2004		1	

15. Detection of malaria cases by time between onset of disease and seeking medical care:

Year	Malaria cases detected by interval between the beginning of disease and seeking medical care (days)					Total
	1–3	4–7	8–14	15–30	>30	
1999						
2000						
2001						
2002						
2003						
2004		1				

16. Time between seeking medical care and malaria diagnosis:

Year	Time until diagnosis (days)						Total
	1	2	3	4	5	6	
1999							
2000							
2001							
2002							
2003							
2004	1						

17. Time between malaria diagnosis and hospitalization:

Year	Time between diagnosis and hospitalization (days)						Total
	1	2	3	4	5	6	
1999							
2000							
2001							
2002							
2003							
2004	1						

18. Interseasonal primaquine chemoprophylaxis:

Year	Population size	No. of persons subject to chemoprophylaxis	No. of persons covered with chemoprophylaxis	Coverage (%)	Drug name and dose	Start date	Completion date
1999	66346						
2000	67216	10 000	10 000	100	primaquine	01.10.2000	14.10.2000
2001	68340						
2002	69334						
2003	70210						
2004	71338	3 680	3 360	90.8	primaquine	01.10.2004	14.10.2004

19. Seasonal chemoprophylaxis:

Year	Population size	No. of persons subjected to chemoprophylaxis	No. of persons covered with chemoprophylaxis	Coverage (%)	Drug name and dose	Start date	Completion date
1999							
2000							
2001							
2002							
2003							
2004							

20. Dynamics of the foci status:

Year	Number of foci of the following categories					
	New potential	New active	Residual active	Residual non-active	Cleared	Restored
1999						
2000						
2001						
2002						
2003						
2004			1			
2005				1		
2006				1		
2007					1	

21. Indoor residual spraying (residential and non-residential premises):

Year	Insecticide	Date of IRS	No. of households	No. of sprayed households	Coverage (%)	Sprayed area (m^2)
1999						
2000						
2001						
2002						
2003						
2004	Siperator	June	450	450	100	110

22. Anophelogenic water reservoirs in, and within 3 km of, the inhabited locality, and larvicidal interventions:

Type of anophelogenic reservoir	Number of anophelogenic reservoirs	Total area (in hectares)	Date of *Gambusia* introduction	Total *Gambusia*-introduced area (ha)	Date of oil treatment	Total oil-treated area (ha)
Permanent						
Temporary						
Rice field						

23. Sanitary and hydro-engineering interventions:

Year	No. of anophelogenic reservoirs of no economic importance	Eliminated anophelogenic reservoirs of no economic importance		Total area of eliminated anophelogenic reservoirs of no economic importance		Total area of drainage and irrigation canals that need clearing (m^2)	Total area of cleared drainage and irrigation canals	
		Number	%	Area (m^2)	%		Area (m^2)	%
1999								
2000								
2001								
2002								
2003								
2004								

24. Measures for personal protection:

(a) Use of insecticide-treated nets

Year	Number of households	Population	Population coverage in absolute figures	Total number of mosquito nets used
1999				
2000				
2001				
2002				
2003				
2004				

(b) Use of non-treated nets

Year	Number of households	Population	Population coverage (%)	Total number of mosquito nets used
1999				
2000				
2001				
2002				
2003				
2004	450	11 671	98	

Remarks

The malaria focus record form is to be completed by the parasitologist/epidemiologist and the entomologist for an inhabited locality in which at least one malaria case has been registered in the past three years. The form is to be duplicated in the computerized database.

Parasitologist/epidemiologist: *S. Kurbangeldiyev*

Entomologist: **Date** *18.11.2004*

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

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ISBN 978 92 4 150430 0