

## Research Article

# The Local Elimination of Malaria within 5 Years in Jambiani, East Coast of Zanzibar and Early Detection of Imported Malaria Cases

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### Abstract

**Introduction:** Malaria remains a major public health concern. Since 2000, Zanzibar has been participating in a community based malaria control project and it is our aim in this paper to present the results of this malaria control strategy in Jambiani on the east coast of Zanzibar and plan to avoid resurgence of malaria, based on detecting imported malaria cases.

**Methods:** The malaria control strategy was focused primarily on prevention through vector control, such as annual indoor residual spraying of all houses and the use of personal preventive methods such as bed nets and mosquito repellents. Control strategy at a later stage also included the use of effective case management and medication.

**Results:** The prevalence incidence dropped from 1452 930 per 1000 inhabitants in 1995/1999 to 10 per 1000 inhabitants in 2004 and further to (Confidential Interval (CI) 1379-1524) to 0.2 per 1000 inhabitants in 2007 ( $P < 0.001$ ). Only a single case of malaria was seen that year. After the elimination period and during the maintenance period between 2006/7-2015, malaria prevalence incidence stayed at a mean level of 21 new detected cases of malaria per 1000 persons year (CI 20-22) during the last decade which were mainly imported cases. No complicated malaria or mortality due to malaria was diagnosed at any time during the last 10 years.

**Discussion:** Malaria prevention using insecticide-treated bed nets and twice annually indoor residual house spraying may be the best available option to almost completely eliminate malaria locally within 57 years as shown in this study. The strategy used in Jambiani can be a lesson for other areas in how to control malaria.

### Introduction

Malaria remains a major public health concern. According to the World Malaria Report 2015, the global incidence of the disease was estimated at 214 million cases (range 149-303 million) and there were an estimated 438,000 deaths (range 236,000-635,000) in 2015 worldwide. About 88% of these cases occur in Sub-Saharan Africa, with rural areas that have poor access to health services being the most affected [1,2]. The presence of malaria in an area requires a combination of high human population density, high mosquito population density and high rates of transmission from

humans to mosquitoes and from mosquitoes to humans. If any of these is lowered sufficiently, the parasite will eventually disappear from that area, as was the case in North America, Europe and much of the Middle East [3]. Malaria control strategies primarily comprise of prevention through vector control, such as indoor residual spraying or the use of personal preventive methods such as bed nets and mosquito repellents followed by chemoprophylaxis. Case management and medication is also another form of effective control. The implementation of these strategies has been supported by donor funding and the commitment of governments and partners from many countries [4].

The mosquito is a vector of malaria, and mosquito control is an effective way of reducing its incidence. In many developing countries there is variable success in vector control using insecticide-treated bed nets and indoor residual spraying with dichlorodiphenyltrichloroethane or other agents [2,5]. Mosquito nets create a protective barrier against malaria-carrying mosquitoes that bite at night. This helps to keep mosquitoes away from people and significantly reduce infection rates and transmission of malaria amongst pregnant women [6]. However the nets are not a perfect barrier and cover remains insufficient [7]. The treatment of malaria depends on the severity of the disease (Table 1).

The Treatment of Malaria Depends on The Severity of the Disease
*Uncomplicated malaria may be treated with a 3 days course oral Chloroquine for non- <i>falciparum</i> malaria and an oral Artemisinin-based combination, highly effective against <i>Plasmodium falciparum</i> .
*Complicated or severe falciparum malaria with a high parasite count, where more than 2% of red blood cells are parasitized, should be treated with intravenous Quinine or Artesunate Therapy until the patient is well enough to continue with oral therapy.

**Table 1:** The Treatment of Malaria.

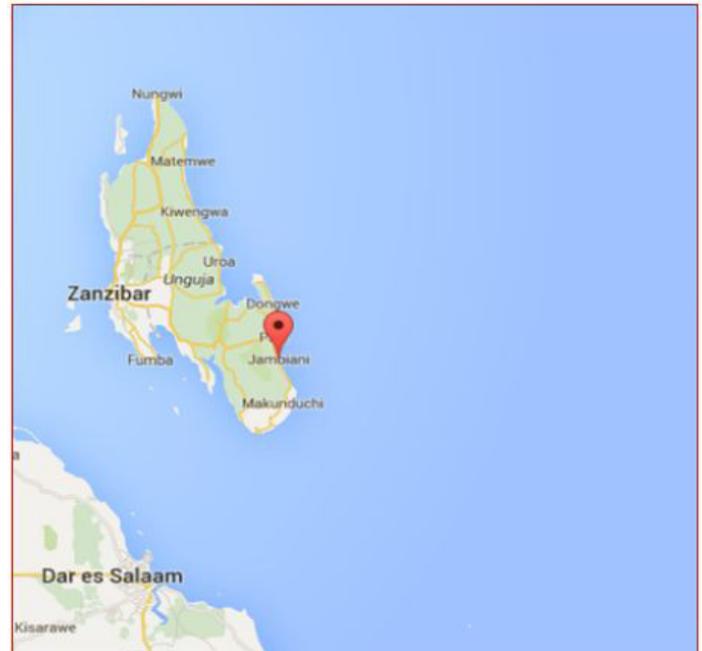
Artemisinin-based combination is highly effective against *Plasmodium falciparum*, the most prevalent and lethal malaria parasite [1] and has made a substantial contribution in reducing the burden of malaria in Sub-Saharan Africa. A study conducted in the province of KwaZulu-Natal in South Africa showed that the use of Artemisinin-based combination therapy decreased mortality due to malaria by 97% [8]. Similarly, in Zanzibar, a decline by 52% in mortality due to malaria among children under five years old was observed after implementing an Artemisinin-based combination therapy [9]. Zanzibar has been participating in a malaria control project since 2000 and in this paper we aim to present the results of this malaria control strategy in Jambiani on the east coast of Zanzibar. It is our aim in this paper to present the results of this malaria control strategy in Jambiani on the east coast of Zanzibar and plan to avoid resurgence of malaria, based on early detection of imported malaria cases.

## Methods

**Design of the study.** The study took the form of a retrospective data analysis of malaria trends from 1995 to 1999 and a prospective data analysis of malaria patients, seen by the only small health centre in Jambiani from 2000 to 2015. The centre collects health information routinely in annual reports from health facilities and compiles the data on a yearly basis. Since 2000, Zanzibar has been one of the governments participating in a malaria control project with vector control, such as annual indoor residual spraying of houses and advocating the use of personal preventive methods such as bed nets for pregnant women/children and mosquito repellents. In Zanzibar, indoor residual spraying of dichlorodi-

phenyltrichloroethane has been applied. Methods of interventions used details the following: the spraying of all houses in Jambiani twice annually between the period of 2000-2005; the spraying of all houses in Jambiani annually between 2006-2015; bed nets for all children under five and pregnant women and health education.

**Setting.** Jambiani is located on the east coast of Zanzibar about 80km east from the capital city, Zanzibar town (see map Zanzibar/Jambiani).



In the previous century the inhabitants mainly practised fishing and seaweed farming and kept small livestock for a living. There were only local roads available. In 1999 the first hotel was built and in 2006 a tarmac road opened the area for tourists. In 2008 there were 15 hotels which increased to about 40 by 2015.

The health centre provides preventive and curative health services to the population of inhabitants living in Jambiani. During the year 2000, campaigns were started to protect the community against malaria in Zanzibar. All activities in the district were carried out under the supervision of the community health nurse coordinator, trained in primary health care. Health education of the community played an important part in keeping malaria eliminated in combination with the annual spraying of houses, bed nets for all under five year olds and all pregnant women. If positive cases were reported, the health malaria team was checking and looking out for any small outbreak of malaria. Households where individual cases of malaria were diagnosed were sprayed again, together with all neighbouring houses. The health centre managed any uncomplicated malaria cases within Jambiani. Diagnosis and treatment of malaria in the local health centre was free of charge.

## Data

The community health nurse collected information routinely in the laboratory of the health centre. Annual reports from this health facility were sent to the Ministry of Health which compiles the data on a yearly basis. Malaria was diagnosed by the microscopic examination of blood using blood films. Since 2010 antigen-based rapid diagnostic tests have also been developed as modern techniques to detect the parasite's DNA. Individual-level data was not available and consequently data on age or sex distribution was not provided.

Malaria prevalence incidence rates were calculated using the mid-year population, which was estimated from population data based on the 2012 census and assuming a 3% annual population growth each year. The incidence of malaria per 1000 people was calculated per year. The prevalence of malaria is defined as the number of malaria cases in a population at a given point in time (sometimes referred to as "Point Prevalence") per 100.000 population. The prevalence of malaria per 1000 people was calculated per year.

## Data Analysis

The Chi square test was used to compare trends in malaria incidence in Jambiani during these periods and the 95% confidence interval was used.

## Definitions

- The incidence of malaria is defined as the number of malaria cases in a population at a given point in time per population.
- The prevalence is the proportion of cases in the population at a given time
- Malaria is a febrile infectious disease transmitted by an infected female Anopheles mosquito, caused by parasitic protozoan's belonging to the Plasmodium type.
- Parasitaemia is a condition in which parasites are present in the blood.

## Results

The completeness of data in the local hospital was 100% during the study period.

## Population

According to the last population census in 2012, the estimate of inhabitants in Jambiani was 6060 people. The number of malar-

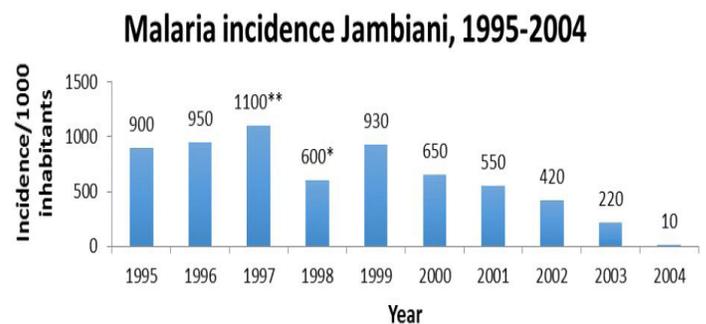
ia infections in Jambiani, diagnosed and confirmed by microscopy of blood smears in the laboratory during the period 1995-2015 as prevalence per 1000 inhabitants, is presented in (Figure 1).

## Number of malaria cases

In the period before the project started, between 1995-1999, there were 26.677 cases of malaria detected, annual mean 5335 cases (CI 5068-5602). After the elimination period and during the maintenance period between 2007-2015, malaria incidence stayed at a mean level of 21 per 1000 persons (CI 20-22) during the last decade which were mainly imported cases. No complicated malaria or mortality due to malaria was diagnosed at any time during the last 10 years.

## Incidence

The number of malaria infections in Jambiani, diagnosed and confirmed by microscopy of blood smears in the laboratory during the period 1995-2005 as incidence per 1000 inhabitants, is presented in (Figure 1).



**Figure 1:** Period 1995 - 2004.

In 1998\* less rainfall than normal caused a dry year with fewer local pools and less malaria than in 1997\*\* which had a long wet season. In the period of elimination between 2000-2005, with twice annually indoor residual spraying, the incidence of confirmed malaria cases decreased from 930 per 1000 in 1999 (CI 849-1001) to 10 per 1000 inhabitants in 2004. The incidence of malaria per 1000 inhabitants during the maintenance period between 2005-2015 is presented in (Figure 2), between 2000-2006, there were a total of 11.930 cases diagnosed, annual mean 1704 (CI 1619-1789). After the elimination period and during the maintenance period between 2007-2015 a total of 195 cases with non-complicated malaria were seen, annual mean 21.7 (CI 20.6-22.8). The incidence first dropped to 0.1 per 1000 population in 2007 (P<0.001). Only a single case of malaria was seen in 2007.

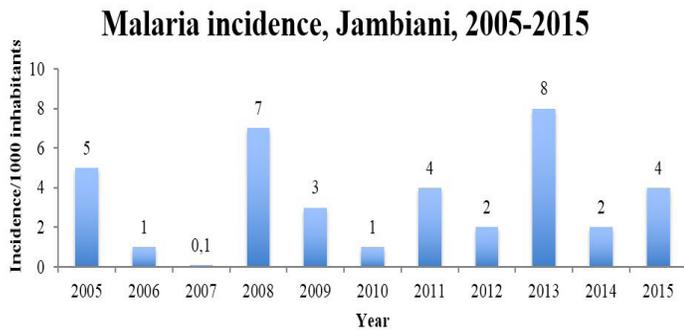


Figure 2: Period 2005-2015.

## Population and Prevalence

According to the last population census in 2012, the estimate of inhabitants in Jambiani was 6060 people. The prevalence of confirmed malaria cases decreased from 1452 per 1000 in 1995 (CI 1379-1524) to 10 per 1000 inhabitants in 2005 and to 0.2 per 1000 population in 2007 ( $P < 0.001$ ), when only a single case of malaria was diagnosed. It stayed at a mean level of 21 per inhabitants (CI 20-22) during the last 8 years. No complicated cases of malaria were seen, no quinine was needed; for those patients with uncomplicated malaria seen at the outpatient department of the health centre, oral treatment was given to cure the patients. No mortality due to malaria was recorded at any time during the last 8 years.

## Additional Information to (Figure 1)

\*1997 long wet season, wet year. \*1998 short periods of rainfall, dry year. In 2008 a small outbreak of malaria was noticed, probably due to less use of bed nets, because people thought that malaria was gone in 2007. In 2013 a small outbreak of infection with malaria was diagnosed when Sau Inn Hotel burned down. Two swimming pools were infested with *Anopheles* mosquitoes. Spraying of pools and community control of the pool water also cleared this problem. Education for both health care providers and residents to reinforce the importance of using preventive measures. During the last 8 years, no complicated cases of malaria were seen, no quinine was needed; for those patients with uncomplicated malaria seen at the outpatient department of the health centre, oral treatment was given to cure the patients. No mortality due to malaria was recorded at any time during the last 8 years.

## Limitations

Only primary data was analysed in this study, seen and observed by one of the authors (HO). This has affected the good data quality, related to precision and the completeness during the data reporting period. The study period of 20 years may be considered short compared to the period used in other studies. However, previous similar studies using five-year data have provided valid re-

sults [6]. During the last 8 years some other factors such as migration, socioeconomic conditions, level of knowledge, community attitudes and practices of malaria control may have influenced the changes in the low incidence of malaria that were seen during the last decade. Yet no local transmission has been observed and no complicated malaria was seen anymore. Individual-level data was not available and consequently data on age or sex distribution was not provided.

## Discussion

Since 2000, Zanzibar has been participating in a community based malaria control project. Malaria transmission has declined dramatically in Zanzibar in recent years as result of the malaria control program [11]. Our data study in Jambiani showed a same, significant and almost complete reduction in locally acquired malaria cases, as observed from 2000 to 2015. After 5 years of local eradication the malaria incidence dropped to 10 per 1000 inhabitants; only a single case of malaria was seen in 2007 in Jambiani. Before preventative action was taken in this holo-endemic area, malaria reached a incidence was high as one can see in our study of around 900 cases per 1000 persons in the period 1995-1999. In 1998 less rainfall than normal caused a dry year with fewer local pools and less malaria than in 1997 which had a long wet season. Our findings of a high incidence of malaria in the nineties is in agreement with other holo-endemic coastal areas where yearly malaria attacks were observed in all villages [12] and especially amongst children in Tanga where a high prevalence of 78% malaria parasitaemia was found [12]. After 7 years of eradication the malaria prevalence dropped to almost 0, only a single case of malaria was seen. The last 8 years (2006-2015) an average annual prevalence incidence of 321 cases per 1000 population was seen, mainly imported. In 2008 a small outbreak of malaria was recorded, probably due to less use of bed nets. Health education was given to reinforce the importance of using preventive measures. Nowadays almost all houses use their mosquito bed nets and is an important part of malaria elimination; I nowadays almost all houses use their mosquito bed nets.

In 2013 another small outbreak of infection with malaria was seen, when Sau Inn Hotel burned down. Shortly afterwards, two swimming pools were infested with *Anopheles* mosquitoes. Spraying of pools and community control cleared this problem. The overall decline in malaria prevalence incidence can be attributed to control efforts and not for instance to periods of exceptionally low rainfall, as was seen in 1997 and 1998 (see Table 1). So formerly a high malaria transmission area, Zanzibar is now targeting clearing of malaria. A major challenge is to avoid resurgence of malaria, the success of which includes maintaining high effective coverage of vector control interventions [13]. Since 2005 imported cases of malaria remained consistent and much higher than locally acquired cases, averaging between 1 and 50 cases per year. The

same problem was seen for example in the south-western region of China, where malaria decreased after China implemented a malaria elimination strategy in 2010. However, migrant workers returning from home after holidays, remained important contributors to cases of imported malaria [14].

The World Health Organization recommends parasitological confirmation of all malaria cases. Diagnosis by microscopy was the most commonly used method to detect the malaria parasite. Despite its widespread usage, diagnosis by microscopy alone suffers from two main drawbacks: many settings (especially rural) are not equipped to perform the test, and the accuracy of the results depends on both the skill of the person examining the blood film and the levels of the parasite in the blood. Since 2012, Tanzania has been implementing a phased rollout of malaria rapid diagnostic tests for routine use in all levels of care as one strategy to increase parasitological confirmation of malaria diagnosis [15]. Rapid diagnostic tests can even be used in the small health facilities where no laboratory is available, according to the national malaria control guidelines [4]. To improve the diagnosis of malaria, both microscopy and rapid diagnostic tests should be used in joint combination and quantification can be done to detect high risk cases (See Table 2).

<b>Rapid Diagnostic Tests (RDT)</b>	
<b>1</b>	First RDT is used as screening, can even be used in the small health facilities where no laboratory is available, according to the national malaria control guidelines in Tanzania.
<b>2</b>	A second RDT or Microscopy is used to confirm type of malaria-parasites
<b>3</b>	Microscopy should be used in joint combination and quantification can be done to detect high risk cases. Complicated Malaria = high parasite count, where more than 2% of red blood cells are parasitized (see Table 1 for treatment)

**Table 2:** To improve the diagnosis of Malaria.

Since the year 2000, a concerted campaign against malaria has led to unprecedented levels of intervention coverage across Sub-Saharan Africa [16]. After elimination, the process should be continued with focus on newly introduced cases of malaria. The single largest threat currently remains the risks posed by imported infections from the mainland of Tanzania. Since 2007 a small proportion of imported malaria has been observed mainly among malaria patients who were hotel staff and businessmen coming from the mainland of Tanzania after returning from their holidays. However local transmission is no longer observed. Jambiani has made achievements in eliminating malaria, with the incidence rate at historically its lowest level ever. Nevertheless, imported malaria has increased and poses a great threat to malaria elimination. To

achieve and maintain the elimination goal and prevent the re-introduction of malaria, an active surveillance system like in Jambiani needs to be wellis planned in Jambiani to check hotel staff after holidays, and managed to ensure timely case detection with prompt response targeted at the mobile and migrating population. The early diagnosis with laboratory confirmation and appropriate treatment using Artemisinin-based combination therapy as recommended by the national guidelines are the main factors that could have contributed to the decline in mortality due to malaria [17]. Travellers to malaria endemic areas are advised to adhere to chemoprophylaxis for malaria. However, the perceived side effects of malaria chemoprophylaxis often cause the traveller to refrain from taking these drugs. A compromise solution for this could be rapid diagnostic (self) test in combination with Artemether-Lumefantrine as a stand-by treatment. The results of this standby approach look promising [18].

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