



## Source details

### Malaria Journal

Open Access ⓘ

Scopus coverage years: from 2002 to Present

Publisher: Springer Nature

ISSN: 1475-2875

Subject area: [Immunology and Microbiology: Parasitology](#) [Medicine: Infectious Diseases](#)

Source type: Journal

CiteScore 2021

5.2



SJR 2021

1.307



SNIP 2021

1.277



[View all documents >](#)

[Set document alert](#)

[Save to source list](#) [Source Homepage](#)

[CiteScore](#) [CiteScore rank & trend](#) [Scopus content coverage](#)

#### i Improved CiteScore methodology ✕

CiteScore 2021 counts the citations received in 2018-2021 to articles, reviews, conference papers, book chapters and data papers published in 2018-2021, and divides this by the number of publications published in 2018-2021. [Learn more >](#)

CiteScore 2021 ▼

$$5.2 = \frac{9,512 \text{ Citations 2018 - 2021}}{1,821 \text{ Documents 2018 - 2021}}$$

Calculated on 05 May, 2022

CiteScoreTracker 2022 ⓘ

$$4.6 = \frac{7,245 \text{ Citations to date}}{1,565 \text{ Documents to date}}$$

Last updated on 05 August, 2022 • Updated monthly

### CiteScore rank 2021 ⓘ

Category	Rank	Percentile
Immunology and Microbiology Parasitology	#20/68	71st
Medicine Infectious Diseases	#100/295	66th

[View CiteScore methodology >](#) [CiteScore FAQ >](#) [Add CiteScore to your site ↗](#)

## About Scopus

[What is Scopus](#)  
[Content coverage](#)  
[Scopus blog](#)  
[Scopus API](#)  
[Privacy matters](#)

## Language

[日本語版を表示する](#)  
[查看简体中文版本](#)  
[查看繁體中文版本](#)  
[Просмотр версии на русском языке](#)

## Customer Service

[Help](#)  
[Tutorials](#)  
[Contact us](#)

---


## ELSEVIER

[Terms and conditions](#) ↗ [Privacy policy](#) ↗

Copyright © [Elsevier B.V](#) ↗. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

We use cookies to help provide and enhance our service and tailor content. By continuing, you agree to the [use of cookies](#) ↗.



also developed by scimago:  SCIMAGO INSTITUTIONS RANKINGS

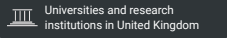
**SJR** Scimago Journal & Country Rank

Home Journal Rankings Country Rankings Viz Tools Help About Us

**Alzheimer's disease report**  
 Clarivate - Market research  
 Acute Myeloid Leukemia - Landscape & Forecast - Disease Landscape & Forecast

[OPEN](#)

## Malaria Journal

<p><b>COUNTRY</b></p> <p>United Kingdom</p> 	<p><b>SUBJECT AREA AND CATEGORY</b></p> <p>Immunology and Microbiology              ↳ Parasitology</p> <p>Medicine              ↳ Infectious Diseases</p>	<p><b>PUBLISHER</b></p> <p>BioMed Central Ltd.</p>	<p><b>H-INDEX</b></p> <p style="font-size: 2em;"><b>109</b></p>
<p><b>PUBLICATION TYPE</b></p> <p>Journals</p>	<p><b>ISSN</b></p> <p>14752875</p>	<p><b>COVERAGE</b></p> <p>2002-2021</p>	<p><b>INFORMATION</b></p> <p><a href="#">Homepage</a></p> <p><a href="#">How to publish in this journal</a></p>

**Research Reports**

Clarivate - Market research


Disease landscape and forecast market report


clarivate.com

[OPEN](#)

**SCOPE**


Malaria Journal is aimed at the scientific community interested in malaria in its broadest sense. It is the only journal that publishes exclusively articles on malaria and, as such, it aims to bring together knowledge from the different specialities involved in this very broad discipline, from the bench to the bedside and to the field.


 Join the conversation about this journal



Impact factor 7.87, low cost

[Open](#)

 IJSDR Research Journal



**Impact factor 7.87, low cost**

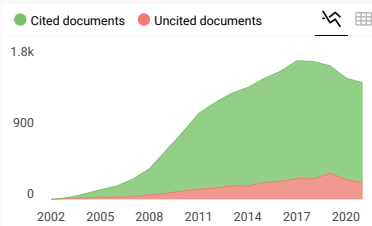
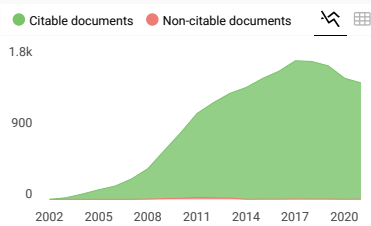
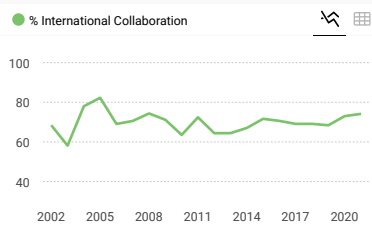
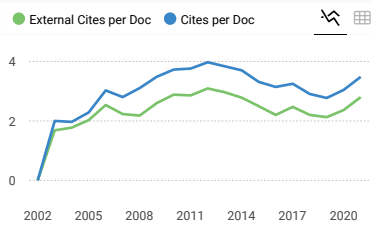
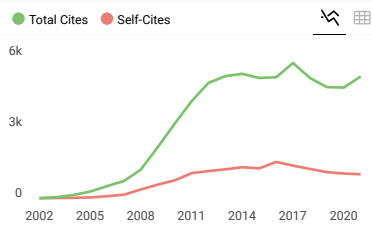
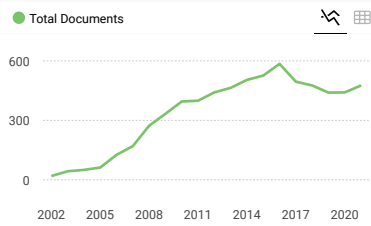
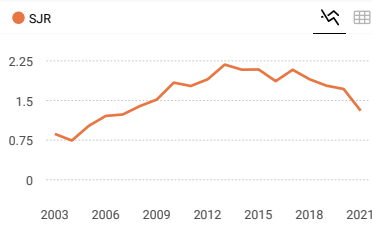
**Open**

IJSDR Research Journal

FIND SIMILAR JOURNALS

options

<p>1 <b>Tropical Medicine and Health</b> GBR</p> <p><b>49%</b> similarity</p>	<p>2 <b>Journal of Tropical Medicine</b> EGY</p> <p><b>43%</b> similarity</p>	<p>3 <b>American Journal of Tropical Medicine and Hygiene</b> USA</p> <p><b>36%</b> similarity</p>	<p>4 <b>Tropical Parasitology</b> IND</p> <p><b>36%</b> similarity</p>	<p>5 <b>Journal of Vector Borne Diseases</b> IND</p> <p><b>35%</b> similarity</p>
---	---	--	--	---



**Malaria Journal**

← Show this widget in your own website

Q1 Infectious Diseases  
best quartile

SJR 2021  
1.31

powered by scimagojr.com

Just copy the code below and paste within your html code:  
`<a href="https://www.scimagojr.com" >`

**SCImago Graphica**

Explore, visually communicate and make sense of data with our **new data visualization tool.**



Metrics based on Scopus® data as of April 2022.

 **Endang Sawitri** 4 years ago

Is it likely that I am given the opportunity to include articles

 reply

#### Leave a comment

Name

Email

(will not be published)

Submit

The users of Scimago Journal & Country Rank have the possibility to dialogue through comments linked to a specific journal. The purpose is to have a forum in which general doubts about the processes of publication in the journal, experiences and other issues derived from the publication of papers are resolved. For topics on particular articles, maintain the dialogue through the usual channels with your editor.

Developed by:



Powered by:

Scopus

Follow us on @ScimagoJR

Scimago Lab. Copyright 2007-2022. Data Source: Scopus®

EST MODUS IN REBUS

Horatio (Satire 1, 1, 106)

[Edit Cookie Consent](#)

# Malaria Journal

Paul John Huggan, Chin Hin Ng, Jennifer Ho, Raymond Tzer Pin Valentine Lin and Jean-Marc Chavatte

## Articles

- [Search by keyword](#)
- [Search by citation](#)

## 484 result(s) within Volume 17 of Malaria Journal

### 1. [A systematic review of transfusion-transmitted malaria in non-endemic areas](#)

Transfusion-transmitted malaria (TTM) is an accidental *Plasmodium* infection caused by whole blood or a blood component transfusion from a malaria infected donor to a recipient. Infected blood transfusions directl...

Authors: Federica Verra, Andrea Angheben, Elisa Martello, Giovanni Giorli, Francesca Perandin and Zeno Bisoffi

Citation: *Malaria Journal* 2018 17:36

Content type: Research Published on: 16 January 2018

- [View Full Text](#)
- [View PDF](#)

### 2. [A case of blackwater fever with persistent \*Plasmodium falciparum\* parasitaemia detected by PCR after artemether–lumefantrine treatment](#)

Blackwater fever is a complication of malaria infection consisting of a syndrome of febrile intra-vascular haemolysis with severe anaemia and intermittent passage of dark-red to black colour urine. Despite num...

Authors:

Citation: *Malaria Journal* 2018 17:35

Content type: Case report Published on: 16 January 2018

- [View Full Text](#)
- [View PDF](#)

### 3. [Increased \*Plasmodium chabaudi\* malaria mortality in mice with nutritional iron deficiency can be reduced by short-term adjunctive iron supplementation](#)

Iron deficiency is the most widespread nutrient deficiency and an important cause of developmental impairment in children. However, some studies have indicated that iron deficiency can also protect against mal...

Authors: Filip C. Castberg, Lasse Maretty, Trine Staaloe, Casper Hempel, Erik Clasen-Linde, Lars Hviid and Jørgen A. L. Kurtzhals

Citation: *Malaria Journal* 2018 17:34

Content type: Research Published on: 16 January 2018

- [View Full Text](#)
- [View PDF](#)

### 4. [Preventing malaria in the Peruvian Amazon: a qualitative study in Iquitos, Peru](#)

In Peru, despite decades of concerted control efforts, malaria remains a significant public health burden. Peru has recently exhibited a dramatic rise in malaria incidence, impeding South America's progress to...

Authors: Ian Newell, Connie Wiskin, James Anthoney, Graciela Meza and Gilles de Wildt

Citation: *Malaria Journal* 2018 17:31

Content type: Research Published on: 16 January 2018

- [View Full Text](#)
- [View PDF](#)

### 5. [Poor response to artesunate treatment in two patients with severe malaria on the Thai–Myanmar border](#)

Malaria has declined dramatically along the Thai–Myanmar border in recent years due to malaria control and elimination programmes. However, at the same time, artemisinin resistance has spread, raising concerns...

Authors: Aung Pyae Phyo, Kyaw Kyaw Win, Aung Myint Thu, Lei Lei Swe, Htike Htike, Candy Beau, Kanlaya Sriprawat, Markus Winterberg, Stephane Proux, Mallika Imwong, Elizabeth A. Ashley and Francois Nosten

Citation: *Malaria Journal* 2018 17:30

Content type: Case report Published on: 15 January 2018

- [View Full Text](#)
- [View PDF](#)

### 6. [The inverted cup device for blood transfer on malaria RDTs: ease of use, acceptability and safety in routine use by health workers in Nigeria](#)

Malaria rapid diagnostic tests (RDTs) are becoming widely adopted for case management at community level. However, reports and anecdotal observations indicate that the blood transfer step poses a significant c...

Authors: Sandra Incardona, Magoma Mwancha-Kwasa, Roxanne R. Rees-Channer, Audrey Albertini, Joshua Havumaki, Peter Chiodini, Wellington Oyibo and Iveth J. Gonzalez

Citation: *Malaria Journal* 2018 17:29

Content type: Research Published on: 15 January 2018

- [View Full Text](#)
- [View PDF](#)

### 7. [Changes in malaria epidemiology in Germany, 2001–2016: a time series analysis](#)

German surveillance data showed a sharp rise of malaria cases in 2014 and 2015 due to the increased arrival of refugees from malaria endemic countries. A time series analysis of data from 2001 to 2016 was perf...

Authors: Sabine Vygen-Bonnet and Klaus Stark

Citation: *Malaria Journal* 2018 17:28

Content type: Research Published on: 15 January 2018

- [View Full Text](#)
- [View PDF](#)

### 8. [Identification and characterization of areas of high and low risk for asymptomatic malaria infections at sub-village level in Ratanakiri, Cambodia](#)

Malaria elimination needs a concentration of activities towards identification of residual transmission foci and intensification of efforts to eliminate the last few infections, located in so-called 'malaria h...

Authors: Lies Durnez, Myrthe Pareyn, Vanna Mean, Saorin Kim, Nimol Khim, Didier Menard, Marc Coosemans, Tho Sochantha and Vincent Sluydts

Citation: *Malaria Journal* 2018 17:27

Content type: Research Published on: 15 January 2018

- [View Full Text](#)
- [View PDF](#)

### 9. [Use of epidemiological and entomological tools in the control and elimination of malaria in Ethiopia](#)

Malaria is the leading public health problem in Ethiopia where over 75% of the land surface is at risk with varying intensities depending on altitude and season. Although the mortality because of malaria infec...

Authors: Abebe Animut and Bernt Lindtjorn

Citation: *Malaria Journal* 2018 17:26

Content type: Review Published on: 12 January 2018

- [View Full Text](#)
- [View PDF](#)

#### 10. [State-dependent domicile leaving rates in \*Anopheles gambiae\*](#)

Transmission of *Plasmodium* greatly depends on the foraging behaviour of its mosquito vector (*Anopheles* spp.). The accessibility of blood hosts and availability of plant sugar (i.e., nectar) sources, together with...

Authors: Simon P. W. Zappia, Alex M. Chubaty and Bernard D. Roitberg

Citation: *Malaria Journal* 2018 17:25

Content type: Research Published on: 12 January 2018

- [View Full Text](#)
- [View PDF](#)

#### 11. [Genetic diversity of three surface protein genes in \*Plasmodium malariae\* from three Asian countries](#)

Genetic diversity of the three important antigenic proteins, namely thrombospondin-related anonymous protein (TRAP), apical membrane antigen 1 (AMA1), and 6-cysteine protein (P48/45), all of which are found in...

Authors: Suttipat Srisutham, Naowarat Saralamba, Kanlaya Sriprawat, Mayfong Mayxay, Frank Smithuis, Francois Nosten, Sasithon Pukrittayakamee, Nicholas P. J. Day, Arjen M. Dondorp and Mallika Imwong

Citation: *Malaria Journal* 2018 17:24

Content type: Research Published on: 11 January 2018

- [View Full Text](#)
- [View PDF](#)

#### 12. [Diagnostic challenges of prolonged post-treatment clearance of \*Plasmodium\* nucleic acids in a pre-transplant autosplenectomized patient with sickle cell disease](#)

Autosplenectomy, as a result of sickle cell disease, is an important risk factor for severe malaria. While molecular methods are helpful in providing rapid and accurate infection detection and species identifi...

Authors: Paul M. Luethy, Sean C. Murphy, Annette M. Seilie, Yingda L. Xie, Chuen-Yen Lau, John F. Tisdale, Matthew M. Hsieh, Jessica L. Reinhardt, Anna F. Lau and Gary A. Fahle

Citation: *Malaria Journal* 2018 17:23

Content type: Case report Published on: 10 January 2018

- [View Full Text](#)
- [View PDF](#)

#### 13. [Attractive toxic sugar baits for controlling mosquitoes: a qualitative study in Bagamoyo, Tanzania](#)

Malaria elimination is unlikely to be achieved without the implementation of new vector control interventions capable of complementing insecticide-treated nets and indoor residual spraying. Attractive-toxic su...

Authors: Marta Ferreira Maia, Frank Chelestino Tenywa, Hannah Nelson, Athumani Kambagha, Abigail Ashura, Ibrahim Bakari, Deogratis Mruah, Aziza Simba and Ally Bedford

Citation: *Malaria Journal* 2018 17:22

Content type: Research Published on: 10 January 2018

- [View Full Text](#)
- [View PDF](#)

#### 14. [Malaria programme personnel's experiences, perceived barriers and facilitators to implementing malaria elimination strategy in South Africa](#)

South Africa has set an ambitious goal targeting to eliminate malaria by 2018, which is consistent with the United Nations Sustainable Development Goals' call to end the epidemic of malaria by 2030 across the ...

Authors: Khumbulani Welcome Hlongwana, Benn Sartorius and Joyce Tsoka-Gwegweni

Citation: *Malaria Journal* 2018 17:21

Content type: Research Published on: 10 January 2018

- [View Full Text](#)
- [View PDF](#)



Greater Mekong Region was targeted not later than 2030. The relevance of molecular and s...

Authors: Myat Htut Nyunt, Than Naing Soe, Thinzar Shein, Ni Ni Zaw, Soe Soe Han, Fauzi Muh, Seong-Kyun Lee, Jin-Hee Han, Ji-Hoon Park, Kwon-Soo Ha, Won Sun Park, Seok-Ho Hong, Myat Phone Kyaw and Eun-Taek Han

Citation: *Malaria Journal* 2018 17:6

Content type: Research Published on: 5 January 2018

- [View Full Text](#)
- [View PDF](#)

30. [\*\*Factors associated with willingness to take up indoor residual spraying to prevent malaria in Tororo district, Uganda: a cross-sectional study\*\*](#)

Indoor residual spraying (IRS) is an efficient method of preventing malaria in homes, and community willingness to take up IRS is critical to its success. The first phase of IRS was conducted in Tororo district...

Authors: Ignatius Wadunde, Arthur Mpimbaza, David Musoke, John C. Ssempebwa, Michael Ediau, Doreen Tuhebwe, Yeka Adoke and Rhoda K. Wanyenze

Citation: *Malaria Journal* 2018 17:5

Content type: Research Published on: 5 January 2018

- [View Full Text](#)
- [View PDF](#)

31. [\*\*Socio-demographic and household attributes may not necessarily influence malaria: evidence from a cross sectional study of households in an urban slum setting of Chennai, India\*\*](#)

Household and environmental factors are reported to influence the malaria endemicity of a place. Hence, a careful assessment of these factors would, potentially help in locating the possible areas under risk t...

Authors: Shalu Thomas, Sangamithra Ravishankaran, Aswin Asokan, N. A. Johnson Amala Justin, T. Maria Jusler Kalsingh, Manu Thomas Mathai, Neena Valecha and Alex Eapen

Citation: *Malaria Journal* 2018 17:4

Content type: Research Published on: 5 January 2018

- [View Full Text](#)
- [View PDF](#)

32. [\*\*Status of insecticide resistance in malaria vectors in Kwale County, Coastal Kenya\*\*](#)

The strategy for malaria vector control in the context of reducing malaria morbidity and mortality has been the scale-up of long-lasting insecticidal nets to universal coverage and indoor residual spraying. Th...

Authors: Caroline W. Kiuru, Florence Awino Oyieke, Wolfgang Richard Mukabana, Joseph Mwangangi, Luna Kamau and Damaris Muhia-Matoke

Citation: *Malaria Journal* 2018 17:3

Content type: Research Published on: 5 January 2018

- [View Full Text](#)
- [View PDF](#)

33. [\*\*Submicroscopic malaria cases play role in local transmission in Trenggalek district, East Java Province, Indonesia\*\*](#)

Trenggalek district is a hypoendemic malaria area with mainly imported cases brought by migrant workers from islands outside Java. During malaria surveillance in 2015, no malaria cases were found microscopical...

Authors: Heny Arwati, Subagyo Yotoprotonoto, Etik Ainun Rohmah and Din Syafruddin

Citation: *Malaria Journal* 2018 17:2

Content type: Research Published on: 5 January 2018

- [View Full Text](#)
- [View PDF](#)

34. [\*\*Extensive diversity in the allelic frequency of \*Plasmodium falciparum\* merozoite surface\*\*](#)

## [\*\*proteins and glutamate-rich protein in rural and urban settings of southwestern Nigeria\*\*](#)

Nigeria carries a high burden of malaria which makes continuous surveillance for current information on genetic diversity imperative. In this study, the merozoite surface proteins (*mSP-1*, *mSP-2*) and glutamate-rich...

Authors: Roland I. Funwei, Bolaji N. Thomas, Catherine O. Falade and Olusola Ojurongbe

Citation: *Malaria Journal* 2018 17:1

Content type: Research Published on: 2 January 2018

- [View Full Text](#)
- [View PDF](#)



Search

Explore journals  
Menu

Get published

About BMC

Login

# Malaria Journal

[Home](#) [About](#) [Articles](#) [Collections](#) [Submission Guidelines](#)

About

Contact

**Editorial Board**

# Editorial Board

## Editor-in-Chief

Prof Marcel Hommel, *University of Liverpool, UK*

## Associate Editors

Dr Elizabeth Ashley, *Lao-Oxford-Mahosot Hospital- Wellcome Trust Research Unit, Vientiane, Lao PDR*

Prof Quique Bassat, *ISGlobal, Barcelona, Spain*

Dr Adam Bennett, *Path, USA*

Dr Sara Canavati, *Save the Children US, USA*

Dr Chris Drakeley, *London School of Hygiene and Tropical Medicine, UK*

Prof Ananias Escalante, *Inst for Genomics and Evolutionary Medicine, Temple University, USA*

Dr Hans-Peter Fuehrer, *University of Veterinary Medicine, Vienna, Austria*

Prof Michelle Gatton, *Queensland University of Technology, Australia*

Dr John E Gimnig, *Centers for Disease Control, USA*

Prof Michael Good, *Griffith University, Australia*

Dr Louisa Messenger, *The London School of Hygiene & Tropical Medicine, UK*

Dr Bruno Pradines, *IHU Méditerranée Infection, France*

Dr Tanya Russell, *James Cook University, Australia*

Dr Larry Slutsker, *Path, USA*

Prof Marcel Tanner, *Swiss Tropical Institute, Switzerland*

Prof Maxine Whittaker, *James Cook University, Australia*

## Editorial Board

Dr Mohammad Shafiul Alam, *International Centre for Diarrhoeal Disease Research, Bangladesh*

Dr Nicholas Anstey, *Menzies School of Health Research, Australia*

Dr Anupkumar Anvikar, *National Institute of Biologicals, Ministry of Health and Family Welfare, India*

Dr Sarah Auburn, *Menzies School of Health Research, Australia*

Dr Leonardo Basco, *Institut de Recherche pour le Développement, France*

Prof M. Asim Beq, *Aqa Khan University, Pakistan*

Prof Ron Behrens, *London School of Hygiene and Tropical Medicine, UK*

Dr Peter Billingsley, *Sanaria Inc, USA*

Prof Zbynek Bozdech, *Nanyang Technological University, Singapore*

Dr Teun Bousema, *London School of Hygiene & Tropical Medicine, UK*

Dr Cindy S Chu, *University of Oxford, UK*

Prof A. P. Dash, *Asian Institute of Public Health University, India*

Prof. Cristiana Ferreira de Brito, *Laboratory of Malaria, Institute Rene Rachou/Fiocruz, Brazil*

Dr J. Brian de Souza, *London School of Hygiene and Tropical Medicine, UK*

Prof Delmiro Fernandez-Reyes, *University College London, UK*

Dr Michal Fried, *NIH, USA*

Dr Friedrich Frischknecht, *University of Heidelberg, Germany*

Dr Sophie Githinji, *Kenya National Malaria Control Program, Kenya*

Dr Iveth J González, *Terre des Hommes, Switzerland*

Dr Matthew Grigg, *Menzies School of Health Research and Charles Darwin University, Australia*

Dr Steven A. Harvey, *Johns Hopkins University Bloomberg School of Public Health, USA*

Dr Manuel Hetzel, *Swiss Tropical and Public Health Institute, Switzerland*

Dr Deus Ishengoma, *National Institute for Medical Research, Tanzania*

Dr Simon Kariuki, *Kenya Medical Research Institute/Centre for Global Health Research, Kenya*

Dr Catherine Lavazec, *Université Paris Descartes, France*

Prof Sylvie Manguin, *Institute of Research for Development, France*

Dr Rose McGready, *Shoklo Malaria Research Unit, Thailand*

Prof Wuelton Marcelo Monteiro, *Universidade do Estado do Amazonas, Brazil*

Prof Olaf Mueller, *University of Heidelberg, Germany*

Prof Manuel Alfonso Patarroyo, *Universidad del Rosario, Colombia*

Prof Wendy Prudhomme O'Meara, *Duke University School of Medicine, USA*

Prof Michael Ramharter, *Medical University of Vienna, Gabon*

Dr Julian C Rayner, *Wellcome Trust Sanger Institute, UK*

Prof Sarah Reece, *University of Edinburgh, UK*

Dr Adam Richards, *George Washington University, USA*

Prof Philip Rosenthal, *University of California, San Francisco, USA*

Prof Dennis Shanks, *Australian Army Malaria Institute, Australia*

Prof Carol Sibley, *University of Washington, USA*

Dr Andre Siqueira, *FIOCRUZ, Brazil*

Dr Ole Skovmand, *Intelligent Insect Control, France*

Dr Danielle Stanistic, *Institute for Glycomics, Griffith University, Australia*

Dr David Sullivan, *Johns Hopkins Malaria Research Institute, USA*

Dr Gote Swedberg, *University of Uppsala, Sweden*

Prof Din Syafruddin, *Hasanuddin University, Indonesia*

Dr Ambrose Talisuna, *University of Oxford-KEMRI-Wellcome Trust Program, Kenya*

Dr Julie Thwing, *Centers for Disease Control and Prevention, USA*

Prof Takafumi Tsuboi, *Ehime University, Japan*

Dr Neena Valecha, *National Institute of Malaria Research, India*

Dr Lorenz von Seidlein, *MORU Mahidol University, Thailand*

Prof Diane Wallace Taylor, *University of Hawaii, USA*

Dr Marian Warsame, *University of Gothenburg, Sweden*

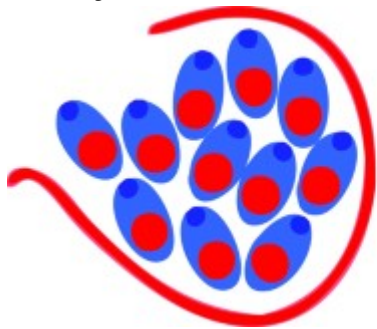
Dr Sam Wassmer, *London School of Hygiene & Tropical Medicine, UK*

Dr Michael White, *Institut Pasteur, France*

Dr Danny Wilson, *The University of Adelaide, Australia*

Dr Colin Wright, *University of Bradford, UK*

Dr Dejan Zurovac, *KEMRI/Wellcome Trust Collaborative Programme, Kenya*



**MALARIA  
JOURNAL**

[Submit manuscript](#)

---

[Editorial Board](#)

---

[Instructions for Editors](#)

---

[Contact Support for Editors](#)

---

[Sign up for article alerts and news from this journal](#)

---

**Follow**



# Malaria Journal

## Annual Journal Metrics

ISSN: 1475-2875

### Citation Impact

3.469 - [2-year Impact Factor \(2021\)](#)

3.570 - [5-year Impact Factor \(2021\)](#)

Submission enquiries: [ayesha.siddiqka@springernature.com](mailto:ayesha.siddiqka@springernature.com)

1.225 - [Source Normalized Impact per Paper \(SNIP\)](#)

General enquiries: [info@biomedcentral.com](mailto:info@biomedcentral.com)

1.718 - [SCImago Journal Rank \(SJR\)](#)

### Speed

48 days to first decision for all manuscripts (Median) [Support and Contact](#)

59 days to first decision for reviewed manuscripts only (Median)

[Receive BMC newsletters](#)

[Accessibility](#)

[Leave feedback](#)

### Usage

Manage article alerts  
3,813,083 downloads (2021)

[Press center](#)

[Careers](#)

5,737 Altmetric mentions (2021)

[Language editing for authors](#)

[Scientific writing for authors](#)

[More about our metrics](#)

[Follow BMC](#)



By using this website, you agree to our [Terms and Conditions](#), [California Privacy Statement](#), [Privacy statement](#) and [Cookies policy](#). [Manage cookies/Do not sell my data](#) we use in the preference centre.

## SPRINGER NATURE


© 2022 BioMed Central Ltd unless otherwise stated. Part of [Springer Nature](#).

RESEARCH

Open Access



# Submicroscopic malaria cases play role in local transmission in Trenggalek district, East Java Province, Indonesia

Heny Arwati<sup>1\*</sup> , Subagyo Yotoprano<sup>1</sup>, Etik Ainun Rohmah<sup>2</sup> and Din Syafruddin<sup>3,4</sup>

## Abstract

**Background:** Trenggalek district is a hypoendemic malaria area with mainly imported cases brought by migrant workers from islands outside Java. During malaria surveillance in 2015, no malaria cases were found microscopically, but some cases were positive by PCR. Therefore, a study was conducted to prove that local malaria transmission still occur.

**Methods:** The adult villagers were invited to the house of the head of this village to be screened for malaria using aseptic venipuncture of 1 mL blood upon informed consent. Thin and thick blood films as well as blood spots on filter paper were made for each subject. The blood films were stained with Giemsa and the blood spots were used to extract DNA for polymerase chain reaction (PCR) amplification to determine the malaria infection. In addition, the history of malaria infection and travel to malaria endemic areas were recorded. Entomologic survey to detect the existence of anopheline vector was also conducted.

**Results:** Of the total 64 subjects that participated in the survey, no malaria parasites were found through microscopic examination of the blood films. The PCR analysis found six positive cases (two *Plasmodium falciparum*, one *Plasmodium vivax* and two mixed infection of both species), and two of them had no history of malaria and have never travelled to malaria endemic area. Entomologic survey using human bait trap detected the existence of *Anopheles indefinitus* that was found to be positive for *P. vivax* by PCR.

**Conclusions:** The results indicated that although we did not find any microscopically slide positive cases, six PCR positive subjects were found. The fact that 2 of the 6 malaria positive subjects have never travelled to malaria endemic area together with the existence of the vector confirm the occurrence of local transmission of malaria in the area.

**Keywords:** Migrant workers, PCR positive malaria, Local transmission

## Background

Malaria is caused by the protozoan genus *Plasmodium* and transmitted by female *Anopheles* mosquito. Malaria in Indonesia remains an important health burden. Indonesia has committed to eliminate malaria in the whole country by 2030, with phased target by region depending upon malaria endemicity [1]. East Java Province, a hypoendemic area in Java Island recorded 334 cases of imported malaria and three death of malaria during 2016,

but no indigenous cases. The Trenggalek district has targeted to achieve malaria elimination in 2019 [2]. Until 2017, all districts except Trenggalek have been certified to be free from malaria. The inhabitants of Trenggalek frequently travel outside Java Island for temporary working purposes, and usually present with malaria infection upon their return to the district [3].

More than 10 years ago, Trenggalek district was a hyperendemic area with high transmission of malaria. There has been malaria outbreaks in 2006, 2007 and 2008 in three villages [4], but the malaria cases then decreased in 2012 to 2013, from 326 to 155 cases [5]. Recently, the malaria situation has changed significantly.

\*Correspondence: arwatiheny@yahoo.com

<sup>1</sup> Department of Parasitology, Faculty of Medicine, Universitas Airlangga, Campus A, Jalan Prof. Moestopo No. 47, Surabaya 60131, Indonesia  
Full list of author information is available at the end of the article



Trenggalek district became a hypoendemic area with mainly imported cases brought by migrant workers from outside islands. This was demonstrated by the data in the third consecutive years in 2014, 2015 and 2016, when 77, 91, 52 malaria cases, respectively, were reported and all were imported cases. Until April 2017, there were 10 cases reported, all of which were imported cases [6]. The last suspected indigenous patient was found in 2012 with fever in Pandean Primary Health Centre (PHC) of Dongko, but was microscopically negative. Since then, malaria cases in the district were always imported cases [7] of migrant workers returning from outside islands. The present study aims to determine the existence of indigenous malaria cases and local transmission of malaria in the Trenggalek district.

The discovery of asymptomatic malaria carriers in former migrant workers of some villages of Pandean PHC was very surprising. Villagers looked healthy, but malaria parasites were found on their blood films. Asymptomatic malaria cases are not listed in the malaria data of health centre, as they did not feel sick and did not seek any medication [8]. Parasitaemia in asymptomatic malaria usually is very low [9] and can reach submicroscopic level that are unlikely to be detected by a well-trained microscopists [10, 11]. Submicroscopic malaria, therefore, potentially plays role as a silent reservoir [10], and can contribute to disease transmission [11], especially if suitable *Anopheles* mosquitoes exist in the environment.

## Methods

### Study site

The survey was done in a village of Salamwates, Dongko subdistrict, Trenggalek district, East Java Province. Trenggalek district is situated on the South-West of Surabaya, the capital city of East Java Province. This district is located at 111°24'–112°11' east longitude and 7°63'–8°34' south latitude, and bordered by Tulungagung district to the east, Indonesian Ocean to the south, Pacitan and Ponorogo districts to the west, Ponorogo and Tulungagung districts to the north. The district is a tropical region with dry and rainy seasons. The rainy season occurs in September–April, while the dry season in May–August. Average rainfall is 17.4 mm/year. The anomaly in climate causes a prolonged rainy season. Salamwates village belongs to field of activity of Pandean Primary Health Centre (PHC) and located on the highest plain in hilly area of Dongko subdistrict, which reaches 848 m above sea level with an average rainfall of 11 mm/year. The total population of Trenggalek district is 762,853 and the majority of them work as subsistence farmers. The village where the study was conducted includes an area of 12.63 km<sup>2</sup> with total population of 7252 [12].

### Physical examination and blood sampling

The adult villagers aged from 18 years old were all invited to the house of the head of the village and were asked their consent for malaria blood screening. Upon written informed consent, they will be examined physically for any malaria symptoms. The data on age, sex, history of travel to malaria endemic areas, and history of malaria infection were also recorded. The travel history was needed to trace whether the infection was imported or local. Physical examination included measurement of body temperature and existing clinical symptoms. One mL of blood was drawn by venipuncture to prepare thin and thick blood films for parasite detection and identification, and dried blood spots on filter paper for polymerase chain reaction (PCR) amplification.

### Microscopic examination of blood films

Microscopical detection and identification of malaria parasites was carried out on Giemsa-stained thin and thick blood films. Detection was declared negative when as many as 100 fields with 100× objective magnification had been examined, but no parasites were found [13]. Examination was performed by two experienced field microscopists independently and re-read by third microscopist at the Laboratory of Parasitology, Faculty of Medicine, Universitas Airlangga.

### Parasite species identification from blood samples by PCR

Identification of parasite species was performed using a single-step PCR with slight modification. Briefly, DNA was isolated from blood spot using Qiagen DNA isolation kit (Qiagen, Tokyo-Japan) according to the manufacturer's protocol. DNA was then stored at – 80 °C until used. Single step PCR was targetted against the 18S small subunit ribosomal RNA (ssu rRNA) gene of *Plasmodium vivax* and *Plasmodium falciparum*. Briefly, 5 µL of DNA template were mixed with PCR master mix (Biorad, Singapore) and the three primers in one tube. Primers and PCR condition were as described [14]. Single step PCR resulted in 266 bp of band that is specific for *P. vivax* and 346 bp specific for *P. falciparum*. Other species were not targetted in this research, since only those two species were always recorded for years in study area [7].

### Mosquito collection and species identification

Mosquito collection was done during dry season in June 2015. The method of collection was as described [15]. Adult mosquitoes were caught using human bait indoor. A volunteer villager stayed inside a double net-trap that consisted of an inner net of 1.2 × 1.2 × 2 m and outer net of 3.2 × 3.2 × 2 m. Mosquitoes which land on nets were caught using mouth-operated aspirator. In addition, human landing catch (HLC) was conducted hourly from

18.00 to 24.00 o'clock with 15 min rest, following previous experience where the vast majority of the *Anopheles* came to the house at this time. Captured mosquitoes were put into containers and labelled. Identification of mosquito species was carried out in the Department of Parasitology, Faculty of Medicine, Universitas Airlangga, using key identification [16, 17].

#### Sporozoite detection in *Anopheles* mosquito

After the wings and legs were removed, DNA was isolated from the head and thoracic parts using Qiagen DNeasy isolation kit (Qiagen, Tokyo, Japan) following the manufacturer's protocol. Primers used for PCR amplification was based on small subunit ribosomal RNA and PCR conditions used for parasite species identification from *Anopheles* mosquito were same as those used to identify the parasites from blood [16].

## Results

#### Demographic characteristic of the subjects

Total number of subjects participated in this study were 64, consisted of 37 male and 27 female, and aged between 18 and 90 years old. The youngest participant was 18 years old. No subjects show clinical symptoms of malaria (Table 1). Other clinical symptoms were fever due to common cold, cough, back and joint pain, nausea and bloated stomach. Based on the history of malaria infection and travel to malaria endemic areas outside Java Island, the subjects were grouped into four groups;

**Table 1** Characteristic of subject during blood sampling in Salamwates villages, Trenggalek district

	Number (%)	Total
Sex		
Male	37 (57.8)	64
Female	27 (42.19)	
Ages (years old)		
18–60	64 (100)	64
Clinical symptoms of malaria	None	
Other physical symptoms		
Fever	1 (1.56)	
Headache	32 (50.00)	
Nausea and bloated	14 (21.88)	
Tingling hands	2 (3.12)	
Stomachache, diarrhoea	4 (6.25)	
Neck/nape pain	9 (14.06)	
Joint pain	8 (12.50)	
Back pain	1 (1.56)	
Itching	2 (3.12)	
Pale/anemic	12 (18.75)	
Splenomegaly	1 (1.56)	

Group-1 consisted of 18 (28%) individuals who have previously been infected with malaria and have previously travelled to malaria endemic areas. Group-2 consisted of 2 (3.1%) persons who have previously been infected with malaria, but have never travelled to malaria endemic areas. Group-3 had 9 (14%) individual who have never been infected with malaria, but have previously travelled to malaria endemic areas. Group-4 consisted of 35 (54.7%) individuals who have never been infected with malaria and have not travelled to malaria endemic areas (Table 2).

#### Microscopic detection of the blood films

Microscopic examination of 64 blood films showed that none of the subjects carried parasites. Analysis using PCR revealed 6 subjects (9.38%) were positive, 3 of which from the Group 1, where one subject was infected with *P. falciparum* and two subjects carried mixed infections of *P. falciparum* and *P. vivax*. Historically, all the three positive persons used to be infected with malaria and had travelled to malaria endemic areas in Kalimantan Island. One subject from the Group-3 was infected with *P. vivax*. The other two subjects infected with *P. falciparum*, were from Group-4 who had never previously been infected with malaria nor travelled to malaria-endemic areas (Table 2).

#### *Anopheles* identification and sporozoite detection

Only one sample of *Anopheles* mosquito was caught and identified as *Anopheles indefinitus*. By PCR, it was found to carry parasite DNA of *P. vivax* (Fig. 1).

## Discussion

The Government of Indonesia in 2009 has set out a plan to eliminate malaria in the entire archipelago by 2030, with different timelines in each island according to malaria endemicity. The island of Java and Bali were set out to eliminate malaria in 2014 and are currently intensifying efforts to prevent re-introduction of malaria in districts that have been certified to be free of transmission. In such areas, active malaria surveillance with supervised radical cure for vivax cases, monitoring of migrant people and mapping of *Anopheles* vector were advised.

Trenggalek is the only district in East Java Province that has not been certified for malaria elimination due to the constantly reported malaria cases and, therefore, the study was conducted as a part of the efforts to assess the malaria transmission in the area. The district has reported no malaria cases in the PHC since 2014 except for the imported cases. This study also found no malaria cases in the microscopic screening of 64 subjects. However, further PCR analysis revealed a relatively high submicroscopic malaria cases (9.38%). Submicroscopic malaria

**Table 2 History of malaria infection and traveling to endemic areas of the subjects in outside Java Island and microscopy examination**

Group	History of malaria infection–traveling to endemic malaria areas	Total (%)	Species of <i>Plasmodium</i>	
			Number and species	Total (%)
1	Ever–ever	18 (28.1)	1 Pf, 2 mix	3 (4.69)
2	Ever–never	2 (3.1)	0	0 (0)
3	Never–ever	9 (14.1)	1 Pv	1 (1.57)
4	Never–never	35 (54.7)	2 Pf	2 (3.13)
	Total	64 (100)		6 (9.38)

Pf, *Plasmodium falciparum*; Pv, *P. vivax*; mix, Pf and Pv

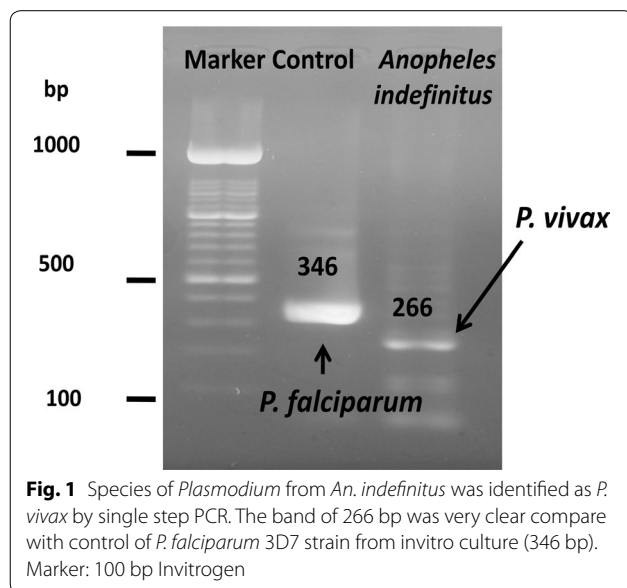
cases have been reported in many studies previously [7, 24]. Based on the previous history of malaria infection and travel to malaria endemic areas, it is highly likely that all six cases, particularly with those with *P. falciparum*, were originated through indigenous transmission.

Submicroscopic and asymptomatic malaria have been reported, not only in high transmission regions in Ghana [18], Kenya [19], Thailand [20] and Bangladesh [21], but also in hypoendemic and low transmission of malaria, such as in Solomon Island [22] and Uganda [23]. Numerous submicroscopic infections reported, both in low [9, 22, 23] and high [24] endemic settings, in adults only [9, 24] or in all age groups [25], and involved *P. falciparum*, *P. vivax* [9, 25], *Plasmodium malariae*, *Plasmodium ovale* [26], and *Plasmodium knowlesi* [27]. The prevalence of submicroscopic malaria infection varied widely in each malaria region. Submicroscopic malaria is common in adults, in low endemic settings and in chronic infections [11]. The prevalence of submicroscopic malaria is > 5%

in Ethiopia [26], and 72.9% in Solomon Islands [28], and may also occur in pregnancy [29]. Low-density of parasites in submicroscopic parasite carriage in hypoendemic areas can be a reservoir of infection and may contribute to sustaining transmission in areas with low or very low transmission intensity (under ~ 5%) [30], because they are gametocyte producers [9, 22, 29] and responsible of transmission.

In this study, the PCR-positive subjects were not treated as the diagnosis came late. Indeed, the untreated asymptomatic infection remains a major source of gametocytes for local mosquito vectors [31]. Management of submicroscopic malaria is currently still controversial as the treatment guideline still use laboratory confirmation either by microscopy or rapid diagnostic tests (RDT) as the point of care. Malaria infection with any density of parasite, asymptomatic or submicroscopic remains to be treated, because malaria infection have serious health and social consequences [32]. Drug treatment of asymptomatic and submicroscopic may be expected to increase the risk of clinical malaria upon reinfection [33], by interfering with immunity and trends to severe malaria [34]. In different studies, the duration of asymptomatic infection remained elusive [31]. The evidence from Colombia [35] and Peru [36] reported asymptomatic infection that cleared spontaneously within 14 and 7 days, respectively. In Africa, the duration of untreated submicroscopic infection in low endemic areas is even shorter [31].

The species of *An. indefinitus* was the only mosquito caught with the human bait collection method indoor and the single step PCR proved the parasite carriage of this species. This result confirmed that malaria transmission has occurred locally, and suggests that *An. indefinitus* is a malaria vector in the study area. Specimen of *An. indefinitus* had also been caught in 2011, in the areas of Pandean PHC, Trenggalek district, where two mosquitoes of this species were found to rest on the wall inside a house. The research found that this species was dominantly zoophylic, since they were able to catch 94% of



*An. indefinitus* with cow bait [37]. In district in West Java Province, a coastal area, *An. indefinitus* was caught both indoors and outdoors [38].

In this study, 2 of 6 submicroscopic malaria cases were found in individuals who had never previously been infected nor travelled to outside islands. Together with the analysis of the mosquito vector in the area, that confirms *An. indefinitus* as a vector of *P. vivax*, it was concluded that the submicroscopic malaria cases in Trenggalek district play a role in the local transmission of malaria. Apart from the findings presented, this study has several limitations, particularly the relatively small number of subjects who participated in this study, relative to the total population of the village, the difficulty to include children and the very limited number of *Anopheles* that could be collected.

In conclusion, malaria submicroscopic cases is relatively frequent in Trenggalek and this may be representative of many of the remaining malaria endemic foci in Java. Therefore, regular active malaria surveillance and supervised radical cure for vivax malaria cases, monitoring of the migrant workers, vector surveillance and vector-based interventions are mandatory to prevent reintroduction of malaria. Community participation either through village malaria workers to report visitors, or control of *Anopheles* breeding sites has also been demonstrated to contribute significantly to malaria elimination programmes.

#### Authors' contributions

HA designed the study, prepared and examined blood smears, performed PCR, compiled data and wrote the article. SY performed examination of the subjects of the research and analysed the data. SY and EAR performed catching and identification of *Anopheles* mosquitoes. DS discussed and reviewed the manuscript. All authors read and approved the final manuscript.

#### Author details

<sup>1</sup> Department of Parasitology, Faculty of Medicine, Universitas Airlangga, Campus A, Jalan Prof. Moestopo No. 47, Surabaya 60131, Indonesia. <sup>2</sup> Entomology Study Group, Institute of Tropical Diseases, Universitas Airlangga, Campus C, Jalan Ir. Soekarno, Surabaya 60115, Indonesia. <sup>3</sup> Eijkman Institute for Molecular Biology, Jalan Diponegoro 69, Jakarta 10430, Indonesia. <sup>4</sup> Department of Parasitology, Faculty of Medicine, Hasanuddin University, Makassar, Jalan PerintisKemerdekaan Km 10, Makassar 90245, Indonesia.

#### Acknowledgements

We would like to thank all participants for their willingness to participate in this study. We gratefully acknowledge head and staffs of Department of Health of Trenggalek district as well as head and staffs of Pandean Primary Health Center, especially Drg. Poppy Hidayat and her staffs.

#### Competing interests

The authors declare that they have no competing interests.

#### Consent for publication

Written informed consent was obtained from study subjects for participation in the study and for publication of this report. Consent and approval for publication was also obtained from Research Institutes and Innovations of Universitas Airlangga in Surabaya city, Indonesia.

#### Ethics approval and consent to participate

All subjects provided the written informed consents to participate in this study. All documents for ethics approval as well as proposal of the research have been reviewed by the Ethics Committee of Faculty of Public Health, Universitas Airlangga as described on the Ethical Approval No. 325-KEPK.

#### Funding

This research was supported by DIPA DITLITABMAS funds from Ministry of Research, Technology and High Education of Republic of Indonesia Number 519/UN3/2015.

#### Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 20 April 2017 Accepted: 19 December 2017

Published online: 05 January 2018

#### References

1. Ministry of Health of Republic of Indonesia. Strategic plan 2015–2019. Indonesia National Malaria Control Programme. 2014.
2. Dinas Kesehatan Propinsi Jawa Timur Tahun 2015. Profil Kesehatan Provinsi Jawa Timur. 2016, p 18–9. **(In Indonesian)**. [http://www.depkes.go.id/resources/download/profil/PROFIL\\_KES\\_PROVINSI\\_2015/15\\_Jatim\\_2015.pdf](http://www.depkes.go.id/resources/download/profil/PROFIL_KES_PROVINSI_2015/15_Jatim_2015.pdf). Accessed 25 Aug 2017.
3. Tribun Jatim.com. Trenggalek adalah Kabupaten Terakhir di Jawa Timur yang Belum Bebas Malaria, Bagaimana bisa? 2017. **(In Indonesian)**. <http://jatim.tribunnews.com/2017/03/15/trenggalek-adalah-kabupaten-terakhir-di-jawa-timur-yang-belum-bebas-malaria-bagaimana-bisa>. Accessed 25 June 2017.
4. Surya. Lima Kecamatan di Trenggalek Endemis Malaria. Senin, 14 Desember 2009, 17:01. **(In Indonesian)**. <http://surabaya.tribunnews.com/2009/12/14/lima-kecamatan-di-trenggalek-endemis-malaria>. Accessed 25 Aug 2017.
5. Badan Pusat Statistik Kabupaten Trenggalek. Kabupaten Trenggalek dalam angka. 2014. p. 191. **(In Indonesian)**. [http://bappeda.trenggalek-kab.go.id/img\\_video/997742Kabupaten-Trenggalek-Dalam-Angka-2014.pdf](http://bappeda.trenggalek-kab.go.id/img_video/997742Kabupaten-Trenggalek-Dalam-Angka-2014.pdf). Accessed 25 Aug 2017.
6. Humas Kabupaten Trenggalek. Sertifikat Eliminasi Malaria Trenggalek Tinggal Menunggu Penilaian Kemenkes. <http://humassetda.trenggalek-kab.go.id/berita/april/751-sertifikat-eliminasi-malaria-trenggalek-tinggal-menunggu-penilaian-kemenkes>. Accessed 25 Aug 2017.
7. Data Malaria of Pandean Community Health Center. Puskesmas Pandean. 2017. **(In Indonesian)**.
8. Arwati H, Kusmartisnawati P, Dachlan YP. Asymptomatic malaria in Trenggalek District, East Java Province as revealed by microscopic examination and single step PCR. *Folia Medica Indonesiana*. 2013;49:150–4.
9. Alves SP, Gil LH, Marrelli MT, Ribola PE, Camargo EP, Pereira LH. Asymptomatic carriers of *Plasmodium* sp. as infection source for malaria vector mosquitoes in Brazilian Amazon. *J Med Entomol*. 2005;42:777–9.
10. Okell LC, Ghani AC, Lyons E, Drakeley CJ. Submicroscopic infection in *Plasmodium falciparum*-endemic populations: a systematic review and meta-analysis. *J Infect Dis*. 2009;200:1509–17.
11. Laishram DD, Sutton PL, Nanda N, Sharma VL, Sobti RC, Carlton JM. The complexities of malaria disease manifestations with a focus on asymptomatic. *Malar J*. 2012;11:29.
12. Pemerintah Kabupaten Trenggalek. Geografi. <http://www.Trenggalekkab.go.id>. Accessed 20 June 2016.
13. WHO. Microscopic diagnosis of malaria. Geneva: World Health Organization; 2010.
14. Patsoula E, Spanakos G, Sofianatou D, Parara M, Vakalis NC. A single-step PCR-based method for the detection and differentiation of *Plasmodium vivax* and *P. falciparum*. *Ann Trop Med Parasitol*. 2003;97:15–21.
15. Maekawa Y, Sunahara T, Dachlan YP, Yotopranoto S, Basuki S, Uemura H, et al. First record of *Anopheles balabacensis* from western Sumbawa Island, Indonesia. *J Am Mosq Control Assoc*. 2009;25:203–5.

16. Bonne-Wepster J. The Anopheline mosquitoes of the Indo-Austalian region. Amsterdam: JH De Bussy Publisher; 1953. p. 504.
17. O'Connor CT, Soepanto A. Kunci bergambar nyamuk Anopheles dewasa di Indonesia. Departemen Kesehatan Republik Indonesia. Direktorat Jenderal Pemberantasan Penyakit menular dan Penyehatan Lingkungan Pemukiman. 1999. **(In Indonesian)**.
18. Crookston BT, Alder SC, Boakye SC, Merill RM, Amuasi JH, Porucznik CA, et al. Exploring the relationship between chronic undernutrition and asymptomatic malaria in Ghanaian children. *Malar J*. 2010;9:39.
19. Bousema JT, Gouagna LC, Drakeley CJ, Meutstege AM, Okech BA, Akim IN, et al. *Plasmodium falciparum* gametocyte carriage in symptomatic children in western Kenya. *Malar J*. 2004;3:18.
20. Coleman RE, Sattabongkot J, Promstaporm S, Maneechai N, Tippayachai B, Kengluetcha A, et al. Comparison of PCR and microscopy for the detection of asymptomatic malaria in a *Plasmodium falciparum/vivax* endemic area in Thailand. *Malar J*. 2006;5:121.
21. Starzengruber P, Fuehrer HP, Ley B, Thriemer K, Swoboda P, Habler VE, et al. High prevalence of asymptomatic malaria in south-eastern Bangladesh. *Malar J*. 2014;13:16.
22. Harris I, Sharrock WW, Bain LM, Gray KA, Bobogare A, Boaz L, et al. A large proportion of asymptomatic *Plasmodium* infections with low and sub-microscopic parasite densities in the low transmission setting of Temotu Province, Solomon Islands: challenges for malaria diagnostics in an elimination setting. *Malar J*. 2010;9:254.
23. Roh ME, Oyet C, Orikiriza P, Wade M, Kiwanuka GN, Mwanga-Amumpaire J, et al. Asymptomatic *Plasmodium* infections in children in low malaria transmission setting, Southwestern Uganda. *Emerg Infect Dis*. 2016;22:1494–8.
24. Rek J, Katrak S, Obasi H, Nayebare P, Katureebe A, Kakande E, et al. Characterizing microscopic and submicroscopic malaria parasitaemia at three sites with varied transmission intensity in Uganda. *Malar J*. 2016;15:470.
25. Tadesse F, Pett H, Baidjoe A, Lanke K, Grignard L, Sutherland C, et al. Sub-microscopic carriage of *Plasmodium falciparum* and *Plasmodium vivax* in a low endemic area in Ethiopia where no parasitaemia was detected by microscopy or rapid diagnostic test. *Malar J*. 2015;14:303.
26. Dinko B, Oguike MC, Larbi JA, Bousema T, Sutherland CJ. Persistent detection of *Plasmodium falciparum*, *P. malariae*, *P. ovale curtisi* and *P. ovale wallikeri* after ACT treatment of asymptomatic Ghanaian school-children. *Int J Parasitol Drugs Drug Resist*. 2013;3:45–50.
27. Fornace KM, Nuin NA, Betson M, Grigg MJ, William T, Anstey NM, et al. Asymptomatic and submicroscopic carriage of *Plasmodium knowlesi* malaria in household and community members of clinical cases in Sabah, Malaysia. *J Infect Dis*. 2015;213:784–7.
28. Waltmann A, Darcy AW, Harris I, Koepfli C, Lodo J, Vahi V, et al. High rates of asymptomatic, sub-microscopic *Plasmodium vivax* infection and disappearing *Plasmodium falciparum* malaria in an area of low transmission in Solomon Islands. *PLoS Negl Trop Dis*. 2015;9:e0003758.
29. Cohee LM, Kalilani-Phiri L, Boudova S, Joshi S, Mukadam R, Seydel KB, et al. Submicroscopic malaria infection during pregnancy and the impact of intermittent preventive treatment. *Malar J*. 2014;13:274.
30. Okell LC, Bousema T, Griffin JT, Ouedrago AL, Ghani AC, Drakeley CJ. Factors determining the occurrence of submicroscopic malaria infections and their relevance for control. *Nat Commun*. 2012;3:1237.
31. Lin JT, Saunders DL, Meshnick SR. The role of submicroscopic malaria in malaria transmission: what is the evidence? *Trends Parasitol*. 2014;30:183–90.
32. Chen I, Clarke SE, Gosling R, Hamainza B, Killeen G, Magill A, et al. "Asymptomatic" malaria: a chronic and debilitating infection that should be treated. *PLoS Med*. 2016;13:e1001942.
33. Portugal S, Tran TM, Ongoiba A, Bathily A, Li S, Doumbo S, et al. Treatment of chronic asymptomatic *Plasmodium falciparum* infection does not increase the risk of clinical malaria upon reinfection. *Clin Infect Dis*. 2017;64:645–53.
34. White NJ. The consequences of treating asymptomatic malaria parasitemia. *Clin Infect Dis*. 2017;64:654–5.
35. Cucunubá ZM, Guerra AP, Rahirant SJ, Rivera JA, Cortés LJ, Nicholls RS. Asymptomatic *Plasmodium* spp. infection in Tierralta, Colombia. *Mem Inst Oswaldo Cruz*. 2008;103:668–73.
36. Branch OL, Casapia WM, Gamboa DV, Hernandez JN, Alava FF, Roncal N, et al. Clustered local transmission and asymptomatic *Plasmodium falciparum* and *Plasmodium vivax* malaria infections in a recently emerged, hypoendemic Peruvian Amazon community. *Malar J*. 2005;4:27.
37. Nusa RES, dan Rohmansyah WN. Fauna Nyamuk Anopheles di Wilayah Perbukitan Desa Pandean, Kab. Trenggalek dan Potensinya sebagai Vektor Malaria. In: Prasetyowati H, Hakim L, editors. Fauna Anopheles. Surabaya: Health Advocacy Yayasan Pemberdayaan Kesehatan Masyarakat dan Loka Litbang Ciamis. 2013. p. 37–49. **(In Indonesian)**.
38. Stoops CA, Rusmiarto A, Susapto D, Munif A, Andris H, Barbara A, et al. Bionomics of *Anopheles* spp. (Diptera: Culicidae) in a malaria endemic region of Sukabumi, West Java, Indonesia. *J Vector Ecol*. 2009;34:200–7.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at  
[www.biomedcentral.com/submit](http://www.biomedcentral.com/submit)

