



# **Malaria in Dar es Salaam: A Situational Assessment and Proposals for CDI**

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This report is part of the Cambridge Development Initiative's (CDI) Student Innovation department research program for the academic year 2020/21. CDI's mission is for students to act as catalysts of impactful, Tanzanian-owned and-led innovations for sustainable development. The Student Innovation department provides research to help support future CDI projects to achieve this.

The CDI Research paper series has brought together students to produce collaborative, peer-reviewed and cross-disciplinary research focused on practical issues affecting vulnerable communities in Dar es Salaam. This series would not have been possible without the efforts of the volunteer student researchers and staff at CDI who have worked tirelessly during their academic year to produce these papers. Additional thanks must also go to the academics and alumni of the University of Cambridge who provided their expertise in the reviewing process, and also to CDI's partners at Kite Dar Es Salaam for their support throughout.

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## Abstract

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This paper will explore malaria, a disease that is endemic in Tanzania. Each year, 10 to 12 million people contract malaria in Tanzania and 80,000 die from the disease, most of them children. Early diagnosis is key in preventing deaths by malaria, and therefore we believe that it is necessary to train people in Dar es Salaam to identify malaria symptoms and to administer effective treatment. This paper will explore the various signs and symptoms of malaria and ways to identify them, as well as looking at methods to increase awareness about these in Dar es Salaam. This will involve research into new methods of saliva testing. Additionally, the paper will discuss ways to avoid contracting malaria, including the effective use of mosquito nets. Finally, this paper will look at the different treatments for malaria such as artemisinin-based combination therapy (ACT), as well as mentioning the importance of rational drug therapy to prevent the emergence of resistant strains and giving recommendations for the Cambridge Development Initiative with regards to ways in which to tackle malaria in Dar Es Salaam.

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## 1. A History of Malaria in Tanzania

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Although malaria is a global public health risk, Africa is disproportionately burdened by its ongoing prevalence. Of the 229 million cases of malaria reported globally every year, some 94% of them originate in Africa (World Health Organisation, 2020). Additionally, within Africa, Tanzania has the third largest population at risk of contracting malaria, after only Nigeria and the Democratic Republic of the Congo (Makundi et al., 2007). This means that of the 37.4 million people who call Tanzania home, approximately 90% are at risk of contracting malaria, leading to between 10 and 18 million cases of malaria in the country per year, and between 80,000 and 120,000 annual deaths from the disease (Makundi et al., 2007). Although the number of children dying from malaria per year globally has halved over the last decade, children under five still remain twice as likely to contract the disease and are at a much higher risk of death. Of the 400,000 global annual malaria deaths, 67% are young children (World Health Organisation, 2020). Other key groups which are at a heightened risk are pregnant women and HIV/AIDS patients, of whom there are presently 1.7 million in Tanzania (UNAIDS, 2019).

As well as posing a risk to public health, malaria jeopardises domestic economic development. Malaria consumes 3.4% of Tanzania's annual gross domestic product (GDP), constituting an annual cost of \$240 million (Makundi et al., 2007). The disease's economic consequences have been observed in Tanzania (then Tanganyika) since at least the late 1890s, when the colonial German government implemented various measures to mitigate transmission with the aim of maximising the colony's economic output. After the territory was annexed by the British Empire in 1916, efforts were made to eradicate the disease under the Pare-Taveta scheme, however the programme was suspended following Tanzanian independence in 1961 (Makundi et al., 2007).

Knowledge of malaria itself in Dar es Salaam is satisfactory. However, there is nevertheless inadequate awareness of key aspects of malaria prevention, including treatment dosages. For example, a study showed that only 65% of rural medical aides (RMAs) could remember the correct dose of chloroquine, a medication used to treat malaria, for an adult. In addition, there are issues with the supply of chloroquine, with only 15% of drug dispensaries in Dar es Salaam having a supply of the medication at the time of the study. Furthermore, there have been cases where patients have been prescribed a variety of malaria treating drugs simultaneously. This is a problem because it can result in the rapid emergence of resistant strains and can also prolong the duration of the illness according to a study by Massele et al (1993).

## 2. Identifying the Problem

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Although methods for preventing, diagnosing and treating malaria have all improved dramatically in recent years, particularly in Dar es Salaam, we believe that awareness and general knowledge of each of these can be improved, both among the general population and among medical professionals. It has been observed that it is the young population - ages 5 to 25 - who are most affected by the illness, with malaria being identified as a major impediment to economic, academic and vocational productivity in people within this age groups (De Castro et al., 2004). Simultaneously, there is an observed issue with medical professionals themselves, who have been seen to prescribe the incorrect medicines when treating malaria patients. As previously mentioned, a study undertaken showed that the knowledge of rural medical aides (RMAs) with regards to the symptoms of malaria and appropriate drugs to prescribe was inadequate. Additionally, 'only 30% of patients and 20% of shoppers knew the correct dose of chloroquine for adults' (Massele et al, 1993), suggesting that the management of malaria in Tanzania is inadequate from a medical standpoint.

Another issue is that of testing, which can exacerbate issues pertaining to treatment. For example, one study suggested that in as many as 18% of cases, an individual patient could receive a positive polymerase chain reaction test but a negative research microscopic test, making it difficult to discern whether anti-malarial treatment was appropriate or not (Strøm et al., 2013). This could have severe implications, potentially resulting in the overuse of anti-malarial drugs due to a mis- or an over-diagnosis, or misdiagnosed patients never receiving the correct treatment (Strøm et al., 2013). Particularly in children, such diagnostic complications could well result in death.

This paper will thus explore each of these problems as well as potential solutions that the Cambridge Development Initiative (CDI) could deploy in response to malaria in Dar-es-Salaam.

### 3. The Signs and Symptoms of Malaria

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Malaria can prove difficult to diagnose since its initial symptoms are often mild and are flu-like in nature, with the primary indicators being a high temperature (38C or more), headaches, vomiting, muscle pains, and diarrhoea (National Health Service UK, 2018). After this, symptoms may intensify, with these initial symptoms being accompanied by excessive sweating and fatigue. In serious cases, this may devolve into life-threatening complications, such as breathing problems and organ failure (National Health Service UK). In the long-term, malaria can also amplify the development of other health complications, including chronic cognitive impairment in sufferers of both mild and severe malaria (Fernando et al., 2010). Either way, the longer that malaria is left untreated, the more likely it is to cause complications and comorbidities (Fernando et al., 2010).

Malaria does have certain unique indicators, however, that can be helpful in early diagnoses. The vomit induced by malaria is a green-yellow colour, differentiating it from most other gastro diseases with which malaria could be confused. Additionally, malaria can cause jaundice (i.e. a yellow discolouration of the skin) as a result of the destruction of red blood cells. Promoting awareness of these more distinct initial symptoms could help individuals more easily recognise malaria in its early stages in themselves and others, increasing the likelihood that they seek a test if such symptoms emerge.

Early diagnosis of malaria is therefore key to circumventing high mortality rates and a heightened incidence of long-term complications. Since malaria in its early stages can be difficult to differentiate from other diseases, it is imperative that a cheaper, quicker and more accessible method of diagnosis is made more widely available. Rapid diagnostic tests (RDTs) are increasingly being used to supplement blood smear microscopy, the most widely used method of testing in Tanzania (Strøm et al., 2013). This is an important development, and one that is supported by several prominent NGOs including the World Health Organisation (WHO), however it is also one in need of greater quality control. The WHO recommends that all circulated RDTs should meet three minimum requirements: (1) an at least 75% “panel detection score” for low parasite density samples from the product testing evaluation panel, (2) a false positive rate of less than 10%, and (3) fewer than 5% invalid tests (World Health Organisation, 2019). However, in Tanzania, guidelines and messaging regarding RDTs remain inconsistent, while the quality and accuracy of both the blood smear microscopy tests used to supplement RDTs and the RDTs themselves was occasionally impaired by poor practice among healthcare professionals (McMorrow et al., 2008). Therefore, although RDTs have been a crucial development in the fight against malaria, they can remain ineffective. Most RDTs also require the collection of blood samples which is a potentially invasive practice and one that is unpopular among younger children. Bloodless malaria testing is therefore an option that we believe should be further explored and considered by healthcare professionals in Dar-es-Salaam.

The promotion of a greater general knowledge of the symptoms of malaria should also be a key aim of CDI. Due to primary research restrictions as a result of the COVID-19 pandemic, this paper is unable to include precise data on the current extent of this general knowledge, however it is the recommendation of the authors of this paper that this research is conducted by CDI. As mentioned above, the mild and flu-like nature of malaria symptoms makes it a difficult disease to recognise and diagnose, although some more distinct symptoms, namely yellow-green vomit and a yellow discolouration of the skin, do exist. By disseminating knowledge of malarial symptoms and running programmes that promote testing at the first signs of malaria-like symptoms, particularly among populations who have been identified as high-risk, CDI could help increase early treatment and thus further reduce the mortality and morbidity of malaria in Dar-es-Salaam.

## 4. Bloodless Malaria Testing

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Key to promoting a more widespread use of malaria tests in Dar-es-Salaam would be the more widespread adoption of bloodless malaria testing, a less invasive and more agreeable form of testing, especially for young children who are the demographic most at-risk of developing severe cases of malaria.

In Tanzania, the current gold-standard for malaria testing involves the collection of blood smear samples that are then microscopically examined for the presence of malaria-causing *Plasmodium* parasites (Gitta and Kilian, 2019). However, recent research has suggested that parasite or pathogen biomarkers of malaria can enter other bio-fluids, specifically urine and saliva, presenting a potential alternative to blood sample testing (Tao et al., 2019). Preliminary studies have suggested that salivary testing boasts many advantages that blood testing lacks. For example, salivary tests are easier to administer independently or at home, particularly among young children (Tao et al., 2019). Additionally, salivary tests have a much lower infection risk due to the absence of sharp objects in the collection process, are less likely to clash with cultural taboos, and make it easier to gather a sufficient quantity of fluid in a single collection than taking a finger-prick for a blood smear sample (Tao et al., 2019). Furthermore, initial research suggests that salivary tests may be more successful at identifying low-density malaria infections which is crucial in eliminating endemic malaria, a goal particularly pertinent in Dar es Salaam where malaria is less common than in the rest of Tanzania (Tao et al., 2019).

Although bloodless malaria testing is certainly a promising development, it is also a relatively new technology that still requires further research to determine its efficacy, accuracy and applicability compared to methods of diagnosis that are currently being used. Any transition to bloodless malaria testing would require systemic shifts in medical practice in Dar-es-Salaam, necessitating the purchase of new, specialised laboratory equipment and the retraining of medical staff to use said equipment (Aninagyei et al., 2020). Therefore, although the promotion of bloodless malaria testing would make malaria testing more accessible, particularly for young children, and therefore easier to diagnose in its earliest stages, the role that the CDI will be able to play in the exploration and wider deployment of bloodless malaria testing is unclear at this stage. This is particularly true as a result of the high cost that such an initiative would potentially necessitate. CDI's role in this field is therefore likely to be somewhat limited, although CDI and KITE may be able to collaborate with NGOs or scientific research groups currently working in Dar-es-Salaam to promote bloodless malaria testing, potentially in a research, community outreach, engagement and other support capacity. Identifying such potential partners and options for collaboration is therefore an additional recommendation of this paper.

## 5. Preventative Measures to Reduce Malarial Infections

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Due to this uncertainty surrounding the immediate potential of promoting bloodless malaria testing in Dar-es-Salaam and therefore of broader initiatives regarding early diagnosis, programmes seeking to mitigate the prevalence and severity of malaria in Dar-es-Salaam are likely the best option for CDI involvement. This is a field that is already well researched and well promoted in Dar-es-Salaam, meaning that the CDI's role would most likely be in supplementing existing programmes. The National Malaria Control Program (NMCP)'s *National Malaria Strategic Plan 2014-2020* is the most recent government document outlining long-term plans for eradicating endemic malaria and promotes the creation of “an enabling environment where individuals and household members are empowered to minimize their own malaria risk” through integrated malaria vector control (USAID, 2019). Presently, one of the most popular and most effective methods of individual/household malaria vector control is the use of insecticide-treated mosquito nets (ITNs), a strategy at the locus of many current government-sponsored plans and initiatives (Mboera et al., 2007). As of 2011, approximately 91.2% of Tanzanian households owned ITNs (Kramer et al., 2017). The Global Malaria Program at the World Health Organisation has almost promoted the use of indoor residual spraying (IRS) in households as one of the most effective methods of preventing malaria transmission.

If methods of preventing malaria transmission are already well-sponsored and well-researched in Tanzania, CDI may nevertheless be able to provide a useful role in ensuring that individuals and household members feel empowered enough to combat malaria in their own homes, in accordance with government plans (USAID, 2019). It is recommended that CDI initially develops an understanding of general knowledge surrounding preventative measures through the distribution of a survey in Dar es Salaam. This survey should gather both qualitative and quantitative data on the current situation. However, based upon preliminary secondary findings, the authors of this paper believe it is likely that campaigns distributing important information around the safe and proper use of domestic anti-malarial technologies, such as ITNs and IRS, will be of much benefit.

## 6. Methods of Increasing Awareness

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Besides preventative measures that need to be put in place to decrease the prevalence of malaria in Dar es Salaam, it is also important to increase the general awareness of the disease. This includes information about how it spreads, signs and symptoms, and what to do if someone is suspected to have malaria. Additionally, it is important to promote awareness about the importance of finishing a complete round of anti-malarial treatment, even after symptoms have abated, as failing to do so can lead to resistance building up which will damage efforts to eradicate the disease. This can be supported by relevant health institutions in Tanzania having the ability and responsibility to follow-up on patients regarding their treatments. As one report by Mathania, Kimera and Silayo suggests, 'knowledge of mosquito feeding behaviour is key to improvements in control approaches' (Mathania et al., 2016). Without this, it will be difficult to reduce the prevalence of malaria in Tanzania. Another study states that 'those having poor knowledge about malaria have poor treatment seeking behaviour' (Naing et al., 2017).

There are several methods of increasing awareness of malaria that could be adopted in Dar-es-Salaam. These can be adapted to suit different age groups, as it is likely that young people will be unable to process more complex language surrounding the disease. Awareness can be raised amongst the younger generation through teaching. Ways to prevent malaria, signs, symptoms and treatments can be ingrained into the curriculum, allowing children to become more aware of the disease. This information can be taught in a variety of ways, but it is likely that visual aids would be the most effective as young children are more likely to engage with this material.

When it comes to older generations, it is likely that it will be somewhat more difficult to increase awareness of malaria. This is because they might have grown up surrounded by malaria and will likely already have thoughts and ideas about its transmission, but these might not always be scientifically proven. As culture and tradition is a key part of societies, there might therefore be little scope for change in these thoughts and ideas, if they are embedded in tradition. A study conducted in Tanzania suggests that 'while the elders have high status in the society, their lack of knowledge of malaria may impact the care-seeking pattern of their families' (Spjeldnæs et al., 2014). Therefore, it is likely that the ideas of the older generation are passed down to the younger generations. This might become an issue as it means that awareness surrounding malaria is unlikely to change. The suggest way to combat this is through discussions with community leaders, who will have an influence on others in their community, as well as ensuring engagement with traditional ideas surrounding malaria.

## 7. Malaria Treatment Methods

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Malaria is often treated through the prescription of drugs that kill the malarial parasite. There are various treatment methods available to combat malaria. However, access to these is often restricted due to costs of production and upkeep. This research paper will discuss the main method of treating malaria: Artemisinin Based Combination Therapy, often shortened to ACT, Rational Drug Therapy and the rational use of medicines in Tanzania.

### 7.1 Artemisinin Based Combination Therapy (ACT)

Artemisinin based combination therapy (ACT) is a malaria treatment that combines two or more drugs that work simultaneously to destroy the malaria parasite. It is the preferred and recommended treatment for the main strain of malaria that is prevalent. Artemisinin based compounds are used alongside drugs such as lumefantrine, mefloquine, amodiaquine, sulfadoxine/pyrimethamine, piperaquine and chlorproguanil/dapsone. It is important to ensure that both drugs are used in order for the treatment to be effective. Lumefantrine or amodiaquine is generally used for uncomplicated malaria, whilst artesunate, artemether and quinine are used to treat complicated or severe malaria. Anti-malarial drugs such as sulfadoxine pyrimethamine are suitable for use on pregnant women. 'Prophylactic drugs' could potentially be used in the case of an outbreak or acute rise in the number of malaria cases in Dar Es Salaam. This might occur after periods of intense rainfall, as these are optimal conditions for malaria spreading mosquitoes. Children under the age of five would benefit from this as a pre-emptive and preventive measure the most as they are most at risk. ACTs are preferred due to their high efficacy as well as their rapid response. It is also unlikely that resistance will form to ACTs, making them the preferred drug treatment for malaria. However, working to resolve barriers to access due to cost is necessary in order for ACTs to be used effectively in Tanzania.

### 7.2 Rational Drug Therapy

Rational drug therapy refers to the rational use of medicines. In other words, it promotes the distribution of medicines that the patient needs, for the correct duration and an appropriate dose. Irrational drug use is a major problem and is often caused due to a lack of knowledge surrounding treatment doses for malaria, as discussed earlier in this paper. Therefore, it is necessary to increase awareness of malaria treatments in order for rational drug therapy to take place. Irrational drug use can lead to wastage, but also resistance which is a major issue in Tanzania as it requires the development of new drugs which can be difficult to access and lead to high costs. Additionally, there have been discussions surrounding developing a vaccine to prevent malaria. This will be a significant step forwards in the fight against malaria in Tanzania. However, the vaccine has been plagued by the complex life cycle of the malaria parasite, as well as by our inadequate knowledge of how exactly our immune system, fights these parasites.

## 8. Recommendations for CDI

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We believe that CDI's efforts to combat malaria in Dar-es-Salaam would be best spent disseminating a broader general knowledge of the disease, its prognosis, its symptoms, and, most importantly, how to prevent malaria in the household through malaria vector control. As it is the young population (ages 5 to 25) who are most endangered by the disease and its long-term effects (both in terms of effects on health and on individual economic productivity), workshops in local schools should form the locus of the CDI's efforts to combat malaria. Targeted social media campaigns could also be integrated into our programme, allowing the CDI to interact indirectly with a larger section of the population. Both workshops and social media campaigns should focus on promoting good practice of already widespread domestic malaria prevention technologies such as ITNs and IRS, for example how to properly clean, treat and install ITNs. This will ensure that we are supplementing already existing anti-malaria campaigns in Tanzania rather than attempting to supersede and supplant current programmes.

It is unclear how best the CDI could work with older populations to spread the same knowledge, although local traditional leaders provide one avenue through which this could be achieved. Either way, broader community initiatives that allow CDI to interact with a wider demographic would undoubtedly be beneficial, particularly since it is older generations who are most likely to be making the household decisions relating to domestic malaria prevention strategies. Social media campaigns are again potentially an effective way of doing this, although older generations are less likely to be frequent users of social media. Community workshops or door-to-door campaigns could therefore also be considered to ensure that information surrounding malaria prevention in the household is reaching those who are in the best position to act on said information.

In the long-term, we would also like to see bloodless malaria testing increasingly used as the preferred means of diagnosis in Dar-es-Salaam. CDI is, unfortunately, not currently in a position to integrate bloodless malaria testing due to the cost and specific scientific expertise this would require. However, a long-term partnership with an NGO or scientific research organisation operating in Dar-es-Salaam that is currently researching the deployment of bloodless malaria testing could be beneficial, with CDI's role in such a potential relationship being to increase awareness and understanding of bloodless malaria testing at the grassroots level. This is, admittedly, a more ambitious and less immediately applicable goal, however it is nonetheless not one that should be immediately discarded and is a policy that has the potential to lead to a more widespread change in approaches to malaria treatment and prevention.

## 9. Conclusions

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This paper has outlined some of the key issues surrounding malaria in Tanzania and Dar es Salaam in particular, including problems such as its disproportionate impact on children and the lack of knowledge surrounding the disease. This situational assessment has highlighted the fact that in order to reduce the prevalence of malaria, it is important to ensure a community awareness of ways that the disease can be transmitted and of preventative measures that can be taken to avoid its transmission. Traditional thoughts surrounding malaria were also briefly touched upon, and we believe that ensuring that scientifically accurate views are able to be disseminated through traditional networks will play a key role in the work that the CDI and KITE are able to undertake on the ground in Dar Es Salaam. The work that the CDI will be able to undertake may be limited due to factors such as finances, scientific expertise, COVID-19 and the resources available in Tanzania. However, we believe that the involvement of CDI and KITE on the subject of malaria prevention and response will have a positive impact on reducing the prevalence of the disease in Dar Es Salaam regardless.

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