

Reliability of Rapid Diagnostic Tests in the Diagnosis of Malaria amongst Children attending the Outpatient Department of the Tetteh Quarshie Memorial Hospital in the Akuapem North District of the Eastern Region of Ghana

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Abstract

Treatment of malaria, with the appropriate diagnostic tool, helps to reduce morbidity and mortality in children. The absence of resources and inadequate labor in emerging countries like Ghana make malaria microscopy difficult. The Rapid Diagnostic Test kit (RDT) remains unpopular despite its availability and ease of use because of limited research on its effectiveness leading to over-prescription of antimalarial drugs. This study shows how reliable the malaria diagnostic test is. Out of 132 children were recruited in all into the study with more females (59.1%) than males (40.9%). 35 (26.5%) of children who were recruited tested positive for Plasmodium falciparum with the Malaria rapid diagnostic test cassette while 97 (73.5%) children tested negative for Plasmodium falciparum with the malaria diagnostic test cassette. In Malaria Microscopy, 35 (26.5%) children tested positive while 97 (73.5%) tested negative for malaria parasites. Out of the 35 children who tested positive, RDT picked 33 as positive and 2 as negative (sensitivity = 94.3%). While out of the 97 that tested negative for microscopy, RDT picked 94 as negative and 3 as positive (specificity= 96.9%). The positive predictive value and negative predictive values are 91.7% and 97.9%, respectively. This clearly shows the Rapid Diagnostic Test (RDT) is an effective diagnostic tool for the testing of malaria in children in the Akuapem North District in the Eastern Region of Ghana.

Keywords: Histidine-rich protein 2 (HRP2), Malaria, Out Patient Department (OPD), Rapid Diagnostic Test (RDT).

Introduction

Malaria is one of the life-threatening parasitic diseases transmitted to people through the bites of infected adult female *Anopheles* mosquitoes. It is caused by *Plasmodium* parasites [1]. Currently, five parasite species are known to human malaria, and 2 of these species – *P. falciparum* and *P. vivax* – present the highest threat. *Plasmodium falciparum* which is the most common malaria parasite in Africa causes most malaria-related deaths worldwide. *Plasmodium vivax*, on the other hand, is the main malaria parasite in countries outside sub-Saharan Africa [2].

According to the World Health Organisation (WHO), there was a decline in malaria-related mortality globally by 37% in 2016. Additionally, the African region persists in having an unduly high proportion of the global burden of malaria. In 2017, the region recorded 92% of malaria cases and 93% of malaria mortality [2]. Globally, the WHO approach to malaria control efforts are based on vector control and improved diagnosis and treatment of patients with clinical malaria [3]. However, to a very large extent, accurate and early diagnosis of malaria is the main determinant of malaria management and treatment. Improving case management and

reducing malaria morbidity and mortality rates can be achieved by using malaria rapid diagnostic tests (MRDTs) [4, 5]. RDTs were employed in 75% of all diagnostic testing used to evaluate suspected malaria cases in Africa [2]. In Ghana and all of Africa, RDTs are now first choice diagnostic tools for malaria diagnosis. Various malaria RDTs available capture at least four target antigens which include *P. falciparum* histidine-rich protein 2 (HRP2) and lactate dehydrogenase (LDH), and the pan-plasmodial aldolase and LDH [6].

The most widely used RDT is PfHRP2. Histidine-rich protein 2 (HRP2) is an antigen-specific to *P. falciparum*. Though it is highly abundant and heat stable, it is still detectable in the blood for up to a month after malaria parasite clearance [7]. In addition, PfHRP3, which is structurally similar to PfHRP2, has been shown to cross react with certain monoclonal antibodies directed against PfHRP2 [8]. It has further been demonstrated that PfHRP2 based RDTs can produce false-positive results when the circulating HRP2 antigen persists even after antimalarial treatment, and false – negative results when parasitaemia levels fall below around 200 parasites/ μ L which is the detection limit for most RDTs which are commercially available [9].

With the appropriate diagnostic tool, Treatment of malaria helps to reduce morbidity and mortality in children. The absence of resources and inadequate labor in emerging countries like Ghana make malaria microscopy difficult yet, the Rapid Diagnostic Test kit (RDT) remains unpopular despite its availability and ease of use, but because of limited research on its effectiveness has to lead to over-prescription of antimalarial drugs.

Materials and Methods

Study Site

The study was carried out at the Tetteh Quarshie Memorial Hospital, which is located in the Akuape m North District of the Eastern Region of Ghana. The Akuapem North District

lies between longitude 0° 00° E and 0° 20° E of Greenwich Meridian and latitude 5° 51° and 6° 10° north of the equator. The District shares boundaries with four other Districts within the Eastern Region and one in the Greater Accra Region. The four Districts are Suhum Kraboa Coaltar in the West, New Juaben in the North West, Yilo Krobo in the North East and Akuapem South on the South side. Dangbe West in the Greater Accra Region shares boundary with the District in the Southwest. Originally created as an ordinary district assembly in 1988 from the former Akuapem District; until it was elevated to municipal district assembly status on 15 March 2012 by two distinct seasons, the mean annual rainfall is 1270mm (50in). The mean temperature is 23.88°C (75°F). Rainfall pattern has two maximals from May to July and September to November. Minor Dry Season is in August and Major Dry Season is from December to February. The peak malaria transmission coincides with major rains, while the dry season has low rates of malaria infection [10].

Inclusion Criteria

Children between the ages of 1 to 8 years attending the outpatient department (OPD).

Exclusion Criteria

Children above 8 years and below 8 years who are on admission were excluded from the research.

Laboratory Procedures

A total of 132 children age range 1-8 years attending the OPD were screened for malaria using a rapid diagnostic test kits (RDTs HRP 2) which was followed by malaria microscopy at the medical laboratory department of the Tetteh Quarshie Memorial Hospital located in the Akuapem North district in the Eastern region of Ghana . Malaria rapid test cassettes were labeled with patient ID (name and pathological number). Then the fourth finger was disinfected and allowed to air dry before the finger was pricked and the first drop of blood wiped off with dry cotton. A Capillary tube was used to draw the

whole blood specimen and transferred into the well-marked(S) sample on the cassette. Result is read within a minimum of 15 minutes and maximum of 20 min (per manufacturer’s instructions). The test results was then documented.

Thick and thin blood films were made, thin-film fixed with methanol, thin and thick film stained with 10% Giemsa and examined for malaria parasites. Parasite density was measured

as the number of parasites per 200 leucocytes on a thick film and converted into parasites per microliter of blood based on the participants total white cell count obtained at enrolment. Both positive and negative slides were randomly selected and read by an independent microscopist as a quality control check. Two hundred high power fields of the thick films were examined at $\times 100$ oil immersion magnification before assigning a negative result.

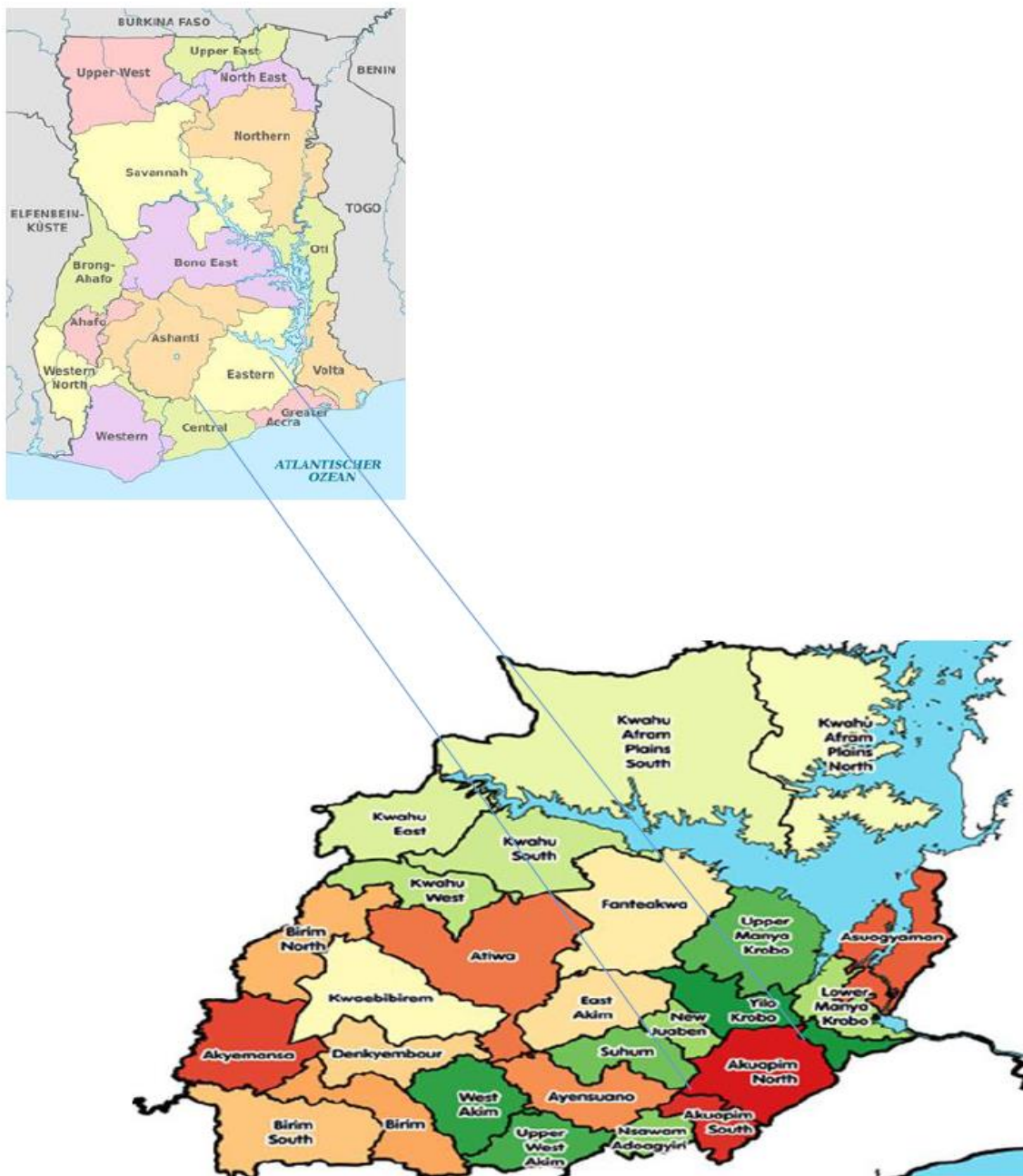


Figure 1. Regional Map of the Eastern Region showing the Akuapem North District of Ghana

Results and Discussion

132 children were recruited in all into the study with more females (59.1%) than males (40.9%) and this could be the reason that women in that district will normally stay out with their daughters in the evening in the name of teaching them the basic roles of a woman (girl child) in the family usually exposing them to mosquitoes. 35 (26.5%) of children who were recruited tested positive for Plasmodium falciparum with the Malaria rapid diagnostic test cassette, while 97 (73.5%) children tested negative for

Plasmodium falciparum with the malaria diagnostic test cassette.

In Malaria Microscopy, 35 (26.5%) children tested positive while 97 (73.5%) tested negative for malaria parasites. Out of the 35 children who tested positive, RDT picked 33 as positive and 2 as negative (sensitivity = 94.3%). While out of the 97 that tested negative for microscopy, RDT picked 94 as negative and 3 as positive (specificity = 96.9%). The positive predictive value and negative predictive values are 91.7% and 97.9%, respectively.



Figure 2. The Percentage of Male and Female Recruit attending the OPD

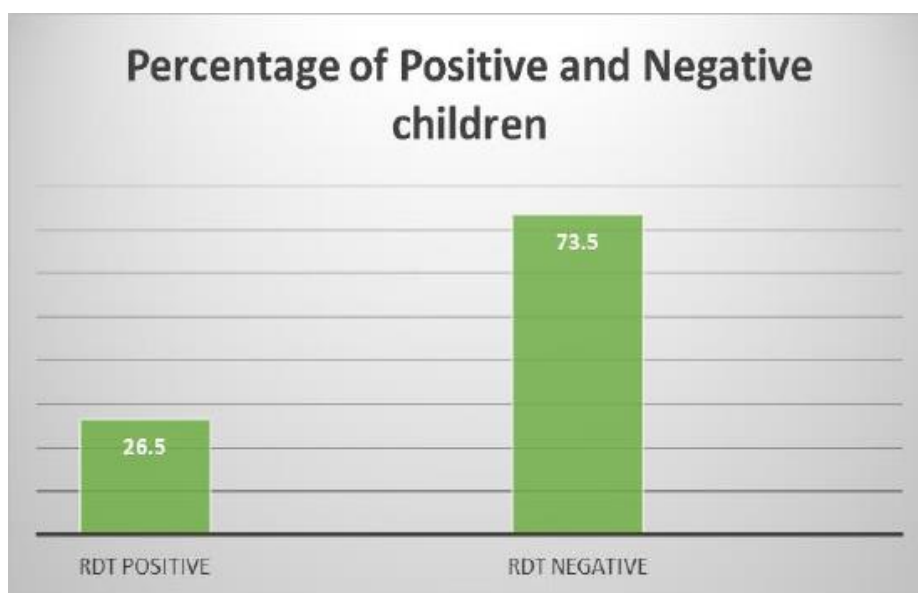


Figure 3. The percentage of Children who Tested Positive and Negative for RDT

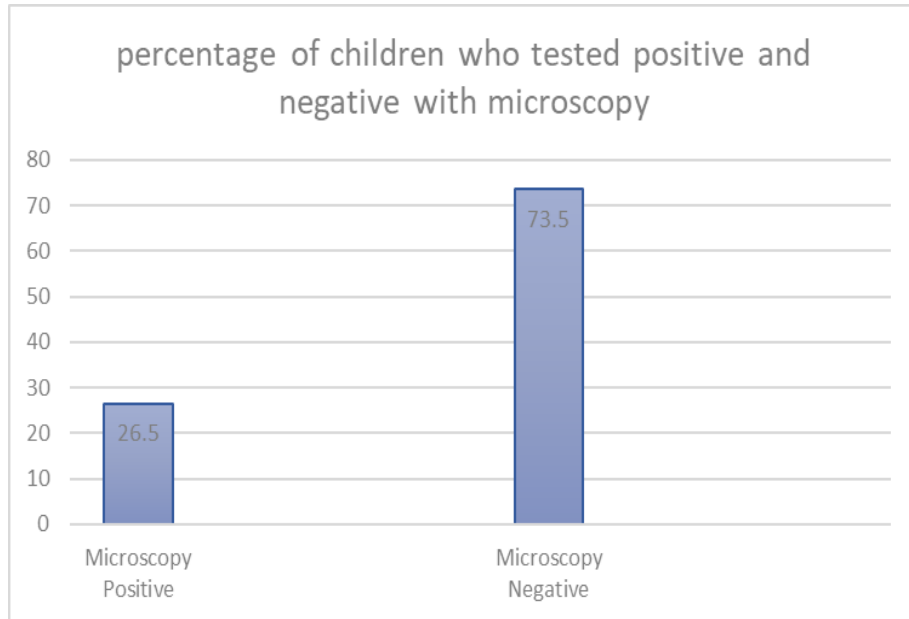


Figure 4. The Percentage of Children who Tested Positive and Negative with Malaria Microscopy

Conclusions

Rapid Diagnostic malaria for (RDT) is an effective diagnostic tool for testing malaria amongst children in the study population. Teaching Hospitals, District Hospitals, Health Centers, and Polyclinics should be encouraged to use it hand in hand with the “golden standard” microscopy to augment for the shortage of manpower in medical laboratory and also for the effective treatment of malaria to reduce the excessive administration of Antimalarial drugs to patients who present symptoms of malaria to health facilities.

Conflict of Interest

There is no conflict of interest.

Acknowledgment

I will like to express my gratitude to Dr. Charlse Brown of the University of Ghana and Alhaji Munkaila Ibrahim, the Head of the Medical Laboratory Department of the Tetteh Quarshie Memorial Hospital for their contribution towards this work.

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