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MALARIA OUT NOW

CONCEPT FOR ACHIEVING HIGH MALARIA IMMUNISATION RATES

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CONCEPT FOR ACHIEVING HIGH MALARIA IMMUNISATION RATES

-Bachelor Thesis-

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By

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Abstract

The need for malaria vaccine and effective strategy for reaching and administering them to the most vulnerable population residing in the malaria endemic regions of the world has prompted many scientist, research institutions and donor organisations worldwide to form a community that declared an all-out war against malaria. The goal of developing a long lasting effective vaccine against the disease, which claims the lives of a million people annually, to either complement or replace the already existing strategies against the disease that are not affordable by the majority of the vulnerable population is the driven force behind this goal.

The need for socio-cultural strategy to motivate those living in malaria endemic areas, whose ways of living are diverse and complex, to actively participate in a malaria immunisation programme should a successful malaria vaccine be available was the main reason to developing the socio-cultural health promotional model.

This work has with the support of current scientific findings through systematic review of health and medical journal databases as well as the websites of research organisations, developed a socio-cultural health promotional model to guide donors or NGOs, researchers, governments, health organisations and health authorities as to how to overcome the stumbling blocks that the complexity of culture, belief or value system and ethnicity might pose to the malaria immunisation programme should a licensed malaria vaccine be available; in order to achieve high malaria immunisation coverage.

Zusammenfassung

Das Bedürfnis nach einem Sumpffieber(Malaria)-Impfstoff und effiziente Strategien für die Erreichung und Verabreichung des Impfstoffs an die gefährdetste Bevölkerungsgruppe in den endemischen Regionen der Welt hat viele Wissenschaftler, Forschungsinstitutionen und Geberorganisationen weltweit angeregt, eine Gesellschaft zu gründen, welche eine kompromisslose Kampfansagen gegen das Sumpffieber ausgerufen hat. Die Entwicklung von einem langfristig wirksamen Impfstoff gegen diese Krankheit, die das Leben von einer Million Menschen jährlich kostet, soll die bereits existierenden Strategien gegen die Krankheit, welche sich viele der gefährdeten Bevölkerungsgruppe nicht leisten können, ergänzen oder gar ersetzten, dies ist das oberste Ziel von der ‚malaria vaccine community'.

Das Bedürfnis nach einer soziokulturellen Strategie um die Bewohner der Malaria endemischen Gebiete, mit mannigfachen und komplexen Lebenswegen, zu motivieren, damit sie sich aktiv an dem Malaria Impfprogramm beteiligen, sobald ein erfolgreicher Malaria Impfstoff verfügbar ist, war der Hauptgrund für die Entwicklung des soziokulturellen Gesundheitsförderungsmodells.

Diese Arbeit hat mit Unterstützung von aktuellen wissenschaftlichen Befunden durch die systematische Prüfung der gesundheitswissenschaftlichen und medizinisch relevanten Zeitschriftendatenbanken sowie den Internetseiten von Forschungsorganisationen, ein sociokulturelles und gesundheitsförderndes Modell als Wegweiser für Geber oder Nicht-Regierungsorganisationen (NROs), Forschern, Regierungen, Gesundheitsorganisationen und Gesundheitsbehörden entwickelt. Nur wenn Stolpersteine, welche eine Komplexität von Kultur, Überzeugungen, Wertesystemen und Ethnizität beinhalten, auf dem Weg zur Erreichung von höheren Malaria Impfraten, falls ein lizenzierter Malaria-Impfstoff verfügbar wird, überwunden werden, kommen wir der Erreichung des Ziels von flächendeckender Malaria-Impfung näher.

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1 Background

Since the discovery of the fact that malaria is caused by a one-celled Plasmodium by scientists in 1880, there have been many attempts to curb this infectious disease out of the history of mankind. Eighteen years later the transmission of malaria was attributed by scientists to the Anopheles mosquito. [U.S. Department of Health and Human Services, 2002]

Today malaria is still known to be the most important of the parasitic diseases of humans with 107 countries and territories having areas of risk of transmission which contains close to about half of the world's population (3.3 billion people) with about 250 million malaria cases and nearly one million deaths each year, the most vulnerable people are those residing in the poorest countries of the world. [World Health Organisation, 2009; Breman et al., No Date]

This eagerness to battle this disease has pushed on the United Nation (UN) and its sub-organisations like World Bank (WB) and the International Monetary Fund (IMF), to mention but a few, pursue this goal in the Millennium Development Goals (MDGs) Report 2008. In this report, the UN sets its sixth target to combat the most dangerous infectious diseases like HIV/AIDs, Malaria and other diseases. [United Nation, 2008, p. 28]

The Bill and Melinda Gates Foundation have also taken the fight against Malaria to heart and are working round the clock to eradicate this disease in the long-run. The battle against the disease was won for nearly half a century ago in wealthy nations but it has changed from a disease affecting major parts of the globe to one affecting only poor countries. [Bill & Melinda Gates Foundation, 1999-2009a]

In its goal to reducing Malaria deaths by 2015, the Bill & Melinda Gates Foundation said they are funding a range of effective malaria treatment and prevention methods because they believe it can save lives if channeled to the people most in need. [Bill & Melinda Gates Foundation, 1999-2009a]

Although many well-wishers around the globe like the World Bank, World Health Organisation(WHO), the Governments of the United Kingdom, Canada, Norway and Germany, the UN Population Fund, UNAIDS, UNICEF, the GAVI Alliance, the Bill & Melinda Gates Foundation, the German-based GTZ, the African Development Bank, the Global Fund to Fight AIDs, Tuberculosis and Malaria and the UN Development Group, individually or in cooperation with one another, are geared towards fighting this infectious disease either through sponsoring prevention programmes or the development of vaccine against the disease; many questions still remain unanswered as to which concept or approach to em-

ploy in reaching the target group should the vaccine be available in order to achieve a higher impact rate of the vaccination. [African Health News, 2008]

However, assessing the effect of alternative strategies on vaccination coverage is not an easy task since the interaction of many factors that influence the vaccination uptake rate like cultural, historical and political factors that influence attitudes towards healthcare, as well as educational background and the accessibility of health services are eminent. [Nuffield Council on Bioethics 2007, p. 58]

The conflict of interest that mostly mares efforts in eradicating malaria are mostly due to the lack of intercultural competences on the side of the well-wishers and the donor-receiving partner or nation. This was manifested during a signing of an International Health Partnership (IHP) agreement by the Ethiopian minister for health - Honorable Dr. Tedros Adhanom when the partners were addressed as follows: “In Ethiopia, we recognise harmonization – which basically means the need to make aid more effective by supporting national plans rather than imposing external priorities and procedures – as a major challenge to the achievement of our objectives in health.” [African Health News, 2008, p. 3]

Nevertheless evaluation of the cultural, moral and ethical values and policies serve some insight into the implications of different strategies. [Nuffield Council on Bioethics, 2007, p. 59]

This work is however, to look into the way of living of people residing in the tropical regions of the world widely affected by malaria and develop a concept that matches their social principles, ethical and moral values as well as educational and political demands in order to stimulate a higher participation in an immunisational programme against malaria should an effective vaccine be developed now or in the near future. In short, this work will serve as guiding principles for health scientist, donor organisations against malaria, governments of both the donor nations as well as donor-receiving nations, well-wishers and experts in public health field, who wish to understand the way of living of people in the tropics, find a maximum cooperation in public health campaigns or programmes so as to reach high malaria immunisation rates with anti-malaria vaccines.

Since the scope of tropical nations is wide, this research piece will attempt to develop concept that will base on the Ghanaian cultural example. The successful application of this concept will imply inferring the same approach in other African nations or better still other tropical regions of the world taking intercultural dimensions into consideration.

2 Methodology

A systematic literature search from databases such as Scribd, Cochrane and PubMed, World Health Organisation database, Lancet database, PATH Malaria Vaccine Initiative, Roll Back Malaria including other sources of scientific writing to assess the information needed for this research was conducted.

Literatures were reviewed to find out what has been done so far pertaining to anti-malaria vaccine development and which strategies are so far in place to assure the successful uptake rate of these vaccines. The literature review was limited to keywords like malaria, vaccines, immunisation and culture or ethic, malaria vaccine reuptake to mention but a few. APA style of referencing was selected as a referencing guide for this work and also the British way of writing.

Much focus was laid on whether any of the existing strategies took cultural, ethical, religious, educational and political factors into consideration while planning the strategies.

Based on the information gained a new concept is designed that takes the socio-cultural, theo-ethical and other vital aspects of the risk populations' way of living into consideration in order to assure positive and promising rates of immunisation should an effective malaria vaccine be developed now or in the near future.

3 Definitions and Information

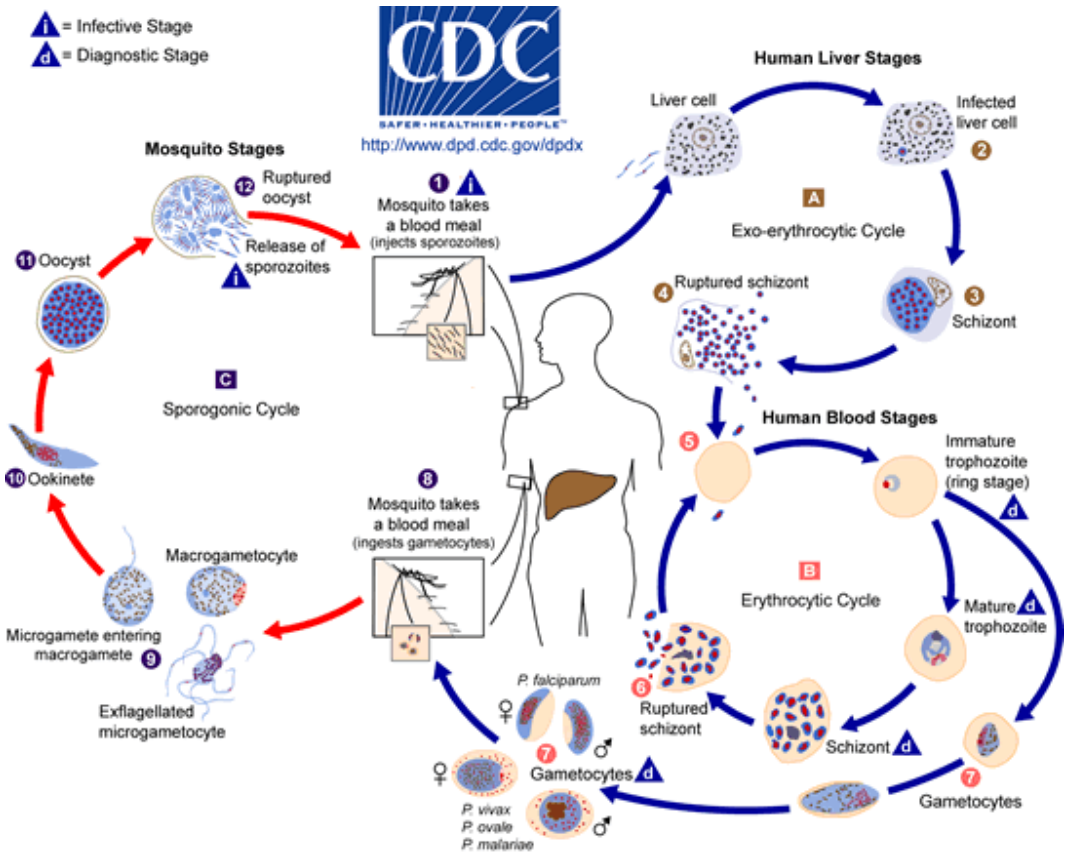
3.1 Malaria

According to the U.S. Department of Health and Human Services (2002, p.1) malaria is a disease caused by a parasite that lives part of its life in humans and part in mosquitoes.
It is a biologically complex disease caused by a protozoan parasite that carries out its life cycle in humans and the Anopheles mosquito. The parasite attacks the human immune system, making the system weaker in fighting the disease. [NIAID & NIH 2008 April, p. 1]

3.1.1 Causes and mode of Transmission

Approximately 156 species of Plasmodium exist which infects various species of vertebrates. There are four species that produce the human malaria and these are P. vivax, P. falciparum, P. malariae and P. ovale which utilizes humans as a natural intermittent host. The most common species throughout the tropics and subtropics which has the most lethal strain is the Plasmodium falciparum. [Scribd 2008, p. 1; CDC Disivion of Parasitic Diseases, 2009]

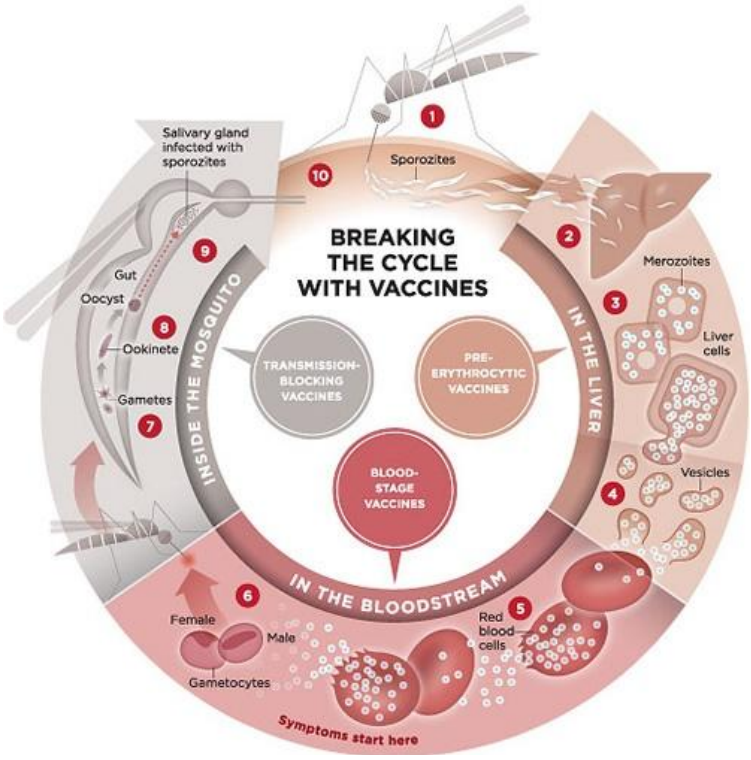
Figure 1: Life cycle of malaria



Source: CDC

The transmission of the malaria parasite (life cycle) involves two host. The female malaria-infected Anopheles mosquito inoculates sporozoites into its human host during a blood meal (see: step 1). The liver cells are infected by the sporozoites (see: step 2) which mature into schizonts (see: step 3) which in turn burst and release merozoites (see: step 4).
After the initial stages in the liver (exo-erythcytic schizogony, see: step A), the parasite experiences an asexual multiplication in the erythrocytes (erythrocytic schizogony, see: step B). Merozoites in turn infect red blood cells (see: step 5). The ring stage trophozoites develop into schizonts, which burst bearing merozoites (see: step 6). Some parasites differentiate into sexual erythrocytic stages known as gametocytes (see: stage 7). Clinical manifestations of the disease are as a result of blood stage parasites.
Moreover, the gametocytes (male: microgametocytes and female: macrogametocytes) are swallowed by an Anopheles mosquito during a blood meal (see: stage 8). The parasite multiplies itself in the mosquito in a process known as sporogonic cycle (see: stage C). The microgametes penetrate the macrogametes generating zygotes while in the stomach of the mosquito (see: stage 9). The zygotes in turn become motile and elongated known as ookinetes (see: stage 10), which invade the midgut wall of the mosquito where they develop into oocysts (see: stage 11). The oocysts grow, burst, and release sporozoites (see: stage 12), which make their way to the mosquito's salivary glands. Finally the sporozoites are inoculated through a bite into a new human host which perpetuates the malaria life cycle (see: stage 1). [CDC Disivion of Parasitic Diseases, 2009]

Figure 2: Disrupting the cycle with a vaccine



Source: PATH Malaria Vaccine Initiative

In other words after a single sporozoite (the parasite form inoculated by the female mosquito) of Plasmodium falciparum invades a liver cell, the parasite grows in 6 days and produces 30,000-40,000 daughter cells (merozoites) which are released into the blood when the liver cell ruptures. In the blood, after a single merozoite invades a red blood cell, the parasite grows in 48 hours and produces 8-24 daughter cells, which are released into the blood when the red blood cell ruptures. [CDC Disivion of Parasitic Diseases, 2009]

However, many biological and environmental factors determine the character of malaria in a given location. Although nearly all the people who live in the endemic regions are exposed to infection continuously but those from amongst them who survive malaria in childhood build up some gradual immunity. In regions where the infection is low, people are not immuned because they are rarely exposed to the disease – this makes them more proned to the epidemic. [U.S. Department of Health and Human Services, 2002, p. 6]

Furthermore rainfall in many tropical areas yields and expands breeding ground for malaria that is why cases increase during the rainy season. Mosquitos need to live longer for the parasites to complete their development within them, therefore, environmental factors that affect the survival of the mosquito can influence malaria incidence. Plasmodium parasites are affected by temperature as they cannot dwell in low humidity which drastically hinders their development, for as the temperature drop their development slow down. For instance the P. vivax stops developing when the temperature falls below 60°F and P. falciparum by somewhat higher temperature. [U.S. Department of Health and Human Services, 2002, p. 6]

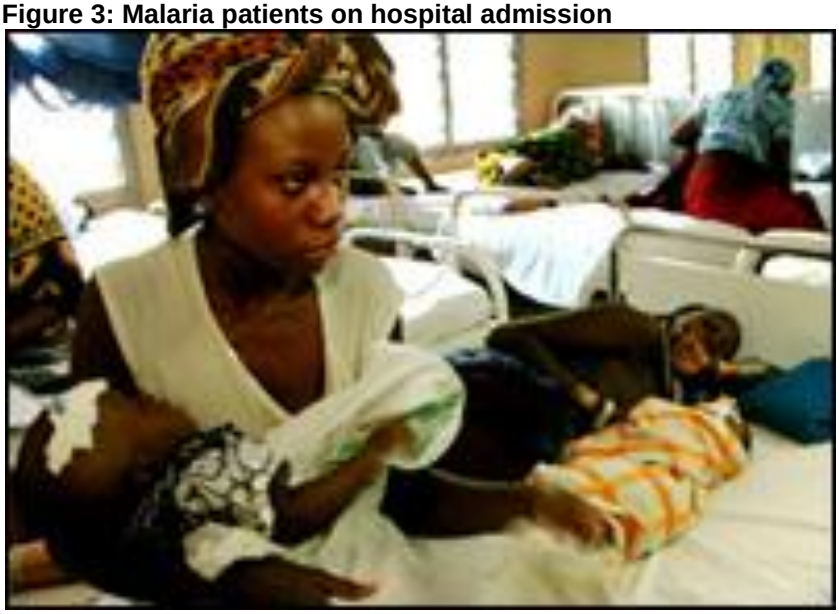
3.1.2 Symptoms and Burden

It is mostly difficult to depict at first sight whether a person has contracted malaria as the symptoms first appear some 10 to 16 days after the infectious mosquito bite coincide with the bursting of infected blood cells. By infection of many red blood cells and its breakage at the same time, malaria attacks can recur at regular time periods – every 2 days for P. vivax malaria and P. ovale, and every 3 days for P. malariae. Suspicion of malaria attack should be endorsed by clinical examination and in most cases confirmed with laboratory tests before certainty is arrived at. [CDC 2007; U.S. Department of Health and Human Services, 2002, p. 8]

Symptoms differ from parasite to parasite inoculation, for instance, with P. vivax malaria, the patient may feel fine between attacks and even when not treated the paroxysms subside in few weeks. However a patient with P. falciparum malaria is likely to feel miserable even between attacks and when not treated may lead to death. Plasmodium falciparum is so virulent due to the fact that it can infect red blood cells in all stages of development leading to high parasite levels in the blood. In contrast, Plasmodium vivax parasites infect

only young red blood cells which mean the number of parasites in the blood does not reach the same high levels as seen in P. falciparum infection. [U.S. Department of Health and Human Services, 2002, p. 8-9]

Figure 3: Malaria patients on hospital admission



Source: WHO

Nevertheless there are symptoms that should be taking into account. The first of which most often are fever, chills, sweats, headaches, muscle pains, nausea and vomiting although they are not often specific and are also found in other diseases such as “flu” and common viral infections. Likewise the physical findings such as elevated temperature, perspiration and tiredness are often not specific. [CDC, 2007]

In severe cases of malaria caused by Plasmodium falciparum, clinical findings have shown that confusion, coma, neurological focal signs, severe anemia and respiratory difficulties are more striking and may increase the suspicion index for malaria. [CDC, 2007]

However Dillip et al. (2009, p.1) said that convulsion is one of the major signs of severe malaria among children under five years which could lead to serious complications or death.

Apart from the physiological ill-health burden of the disease, malaria causes a significant economic havoc in high-rate areas reducing the Gross Domestic Product (GDP) by as much as 1.3% in highly endemic countries which in a long-run aggregates in a substantial differences in GDP between countries with and without malaria, especially in Africa. [World Health Organisation, 2009d]

Personal and public expenditure are in most cases results of malaria’s health costs for prevention and treatment. In countries much affected by the disease, up to 40% of public health expenditures, 30% to 50% of inpatient hospital admissions and up to 60% of

outpatient health clinic visits are results of it. Most unfortunately the disease unfairly affects poor people who are unable to afford treatment or have limit access to health care facilities and keeps families and communities in the endemic areas in a downward spiral of poverty. [World Health Organisation, 2009d]

3.1.3 Existing Strategies for Malaria Prevention and Groups against Malaria

The Roll Back Malaria (RBM) has spearheaded a global action against malaria with its partners to achieve the goal of reducing morbidity and mortality associated with malaria by the year 2010 and 2015 and in the long run eradicating it. In its global action against the disease, the RBM developed a three-component strategic plan that involves: control (first scaling up appropriate intervention for population at risk and then sustaining control over

Table 1: Strategies against malaria by endemic area

Strategy / Area	Population at risk and attitude	Donor perspective	Prevention	Diagnosis and treatment
Africa	• Children under 5 and pregnant women most vulnerable • Majority of country • Common disease: part of daily life	• Some funds for subsidized ITN, IPT, ACT, etc	• ITN subsidies • IPT with SP piloted • Lower focus on spraying and clean-up	• First line varies (CQ, SP and Amodiaquine) facing resistance • Shift to ACTs • Limited diagnostic equipment
SE Asia	• Adults and children • Biggest problem in border areas • Focus of local govt	• Wealthier countries less reliant on donor support	• Residual spraying in selected districts • Use of larvivorous fish to control vector	• Rapid diagnosis / presumptive treatment based on geography • High resistance; some must use ACT first line
South America	• Adults and children • Biggest problem in border areas • Perceived to be "under control"	• Wealthier countries less reliant on donor support	• Spraying & clean-up in high risk/border areas • No ITN, indoor spray due to outdoors-resting vector	• Faster response from diagnostic facilities • Species specific treatment • Goal: treatment within 24 hours

Source: The Boston Consulting Group

time), elimination (reducing to zero all locally-acquired infections) and Research (continuous research for new and effective tools as well as inform policy and improved operational implementation of strategies) which should be started at national level by individual nations and supported internationally. This was intended as individual countries are best positioned to know which actions are appropriate for combating the disease since the population at risk, the level of transmission, the degree to which interventions are in place and the health system's capacity are best known to them. The international community only serves as a partner in supporting and providing tools for the individual countries. [Roll Back Malaria, No Date]

Internationally, tools and methods of fighting or preventing malaria differs as geographical, socioeconomic, theo-cultural, ethical and political factors decides the approach towards

fighting malaria. But generally african nations focus on prevention while their counterparts in more developed nations focus on early diagnosis and treatment (see table 1). [The Boston Consulting Group, 2005, p. 20]

The Bill and Melinda Gates Foundation (1999-2009$_b$) work with partners around the globe and support efforts to speed up malaria research, expand access to life-saving drugs and prevention methods and advocates for greater action through the following approaches:

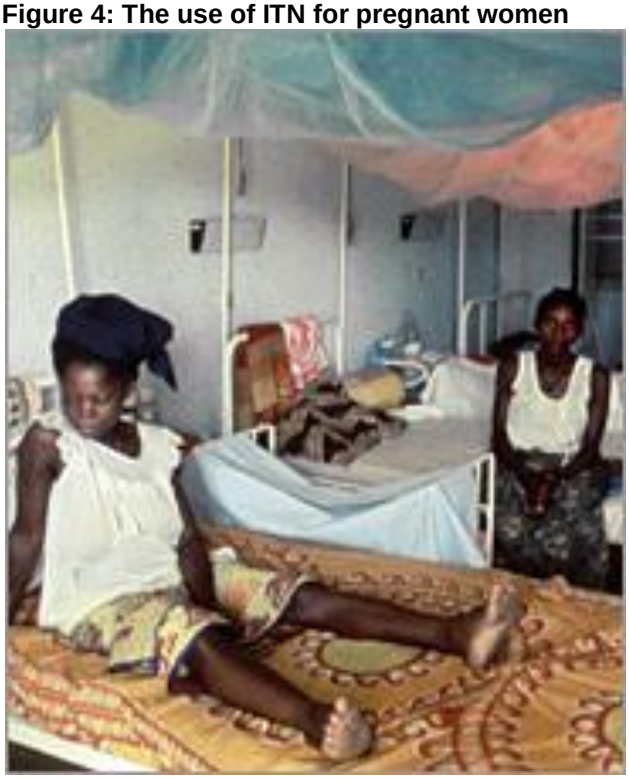
Develop malaria vaccines and other new prevention strategies, develop new malaria drugs, Develop improved methods for mosquito control, expand access and funding for malaria control and develop public awareness about malaria and advocate for effective research and control.

3.1.4 Anti-Malaria Programmes/Therapies: Achievement and Shortfalls

The WHO in its 2008 report stated that, the combination of tools and methods for fighting malaria currently includes long-lasting insecticidal nets (LLIN) and artemisinin-based combination therapy (ACT) supported by indoor residual spraying of insecticide (IRS) and intermittent preventive treatment in pregnancy (IPT).

A new United Nations report has estimed that about 40% of people living in malaria endemic areas in Africa now have access to long-lasting Insecticide-treated mosquito nets (LLINs) [African Health News, 2008, p. 1]

Figure 4: The use of ITN for pregnant women



Source: WHO

The American based CDC always advise travelers to malaria-proned areas on its website, to take care of the following precautions: usage of mosquito repellent, keeping arms and legs covered, staying indoors beginning at dusk and throughout the night (the feeding time of the Anopheles mosquitoes) and sleeping under mosquito nets. Most importantly travelers should try to prevent themselves prior to travelling to these areas by taking antimalaria drugs. [U.S. Department of Health and Human Services, 2002, p. 15]

Breman et al (No Date, p. 418) were of the opinion that malaria can only be conquered by full coverage, access to and use of antimalarial services by affected groups; rapid and accurate diagnosis; prompt and effective patient management (thus diagnosis, treatment, counseling and education as well as referal); judicious use of insecticides to kill and repell the mosquito vector includimg the use of insecticide treated mosquito nets (ITNs); and control of epidemics.

However, Cairns et al (2008, p.8) said intermittent preventive treatment also provides a considerable protection against malaria and anaemia for short periods even in areas where there is intense seasonal transmission. It will be logical to implement the IPT strategy at the time where malaria incidence is at its peak since the protection of the IPTI does not last long.

3.2 Immunisation, Vaccination and Vaccines

A process by which a person or an animal becomes protected against a disease is termed as immunisation; in other words, it is a process of inducing immunity by administering an antigen (vaccine) to enable the immune system to prevent infection or illness which its faced with the infectious agent. This term is often used interchangeably with vaccination or inoculation. [PATH Malaria Vaccine Initiative, 1995-2009]

Immunisation is a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to avert over 2 million deaths each year. It happens to be one of the most cost-effective health investments, with proven strategies that make it accessible to even the most hard-to-reach and vulnerable populations. It is administered in the natural environment of the vulnerable populace without having to change their way of living. [World Health Organisation, 2009b]

However, vaccination is referred to the injection or introduction of a killed or weakened infectious organism in order to prevent disease whereas a vaccine is a preparation, which stimulates an immune response that can prevent an infection or create resistance to an infection. [PATH Malaria Vaccine Initiative, 1995-2009]

Figure 5: Immunisation and Vaccination

Source: CDC

3.2.1 World History of Immunisation and Vaccination

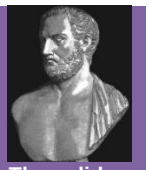
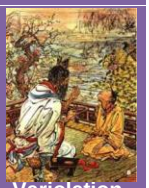
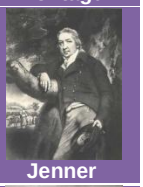
People who survive certain diseases were known, long before anyone had heard of bacteria and virus, to be immuned from those diseases. In other words, people who experience a disease were noticed not to catch the same kind of disease again. An observation was made by the historian Thucydides (see table 2) as far back as 429 BC, that survivors of the smallpox plague in Athens did not become re-infected with the disease. [NHS Immunisation Information, 2008]

Table 2: Milestone in Immunisation

Year/Period	What happened?
429 BC	Thucydides notices smallpox survivors did not get re-infected
900 AD	Chinese practise variolation
1700s	Variolation reaches Turkey and rest of Europe
1796	Edward Jenner: from variolation to vaccination
1803	Royal Jennerian Institute founded
1870s	Violent opposition to vaccination
1880s	Louis Pasteur - sheep trials and rabies
1890	Emil from Behring discovers basis of diphtheria and tetanus vaccines
1920s	Diphtheria, tetanus, pertussis (whooping cough) and BCG (against tuberculosis) vaccines widely available
1955	Polio immunisation programme begins
1956	WHO launch global drive to eradicate smallpox
1980	Smallpox eradicated
2008	Prof. Harald zur Hausen awarded Nobel Prize in Physiology or Medicine
2008	HPV immunisation programme begins

Source: NHS Immunisation Information, 2008 **Illustration:** E. Ramani

Table 3: Renowned personalities in immunisation's history

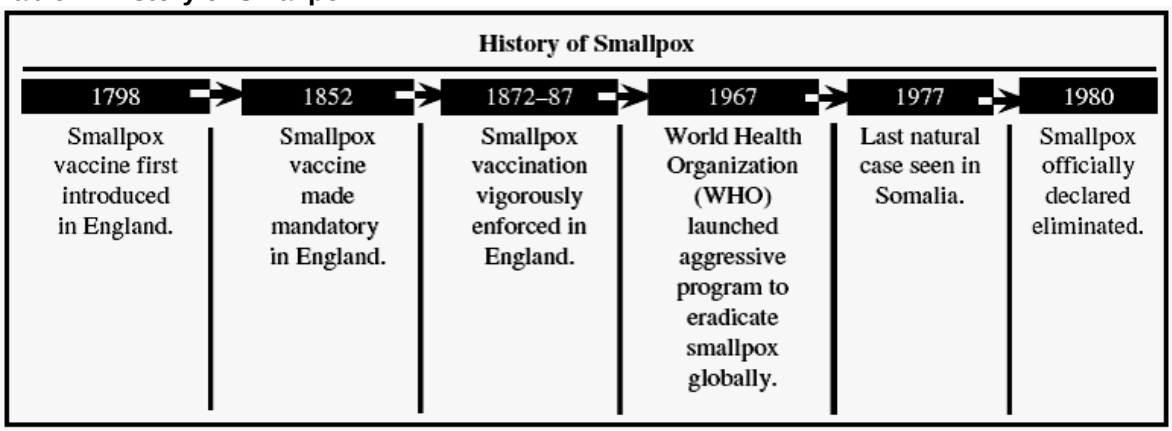
Picture	Achievement(s)
 Thucydides	Historian who notices immunity from disease after first infection.
 Variolation in China	Practice of variolation in China where healthy people are exposed to the smallpox by putting it under their skin or by inserting powdered scabs from smallpox pustules into the nose.
 Montagu	A poet and wife of a British ambassador to Turkey who brought encouraged inoculation through variolation to England through her letters.
 Jenner	Made a breakthrough from variolation to vaccination by deliberately infecting a boy called James Phipps with cowpox from an infected cow. When the boy recovered Jenner injected him with smallpox under his skin and the boy did not catch smallpox.
 Pasteur	Pasteur confirmed that infectious diseases were caused by micro-organisms. He grew cultures of bacteria and found that ageing cultures were too weak to cause disease in experimental animal. He used this method in developing a vaccine against rabies.
 Zur Hausen	Made the link that human papillomaviruses (HPV) caused cervical cancer and this discovery led to the development of the now available vaccine.

Source: NHS Immunisation Information, 2008 **Illustration:** E. Ramani

3.2.2 Health Revolution and Major Epidemics

Health revolution did not come about just like political revolution did, but might have started in the first half of the nineteenth century and still ongoing today. Some of the improvements were crystal clear like the control of major epidemics for instance, the disappearance of smallpox and malaria in the state of Illinois. Other improvements, like the

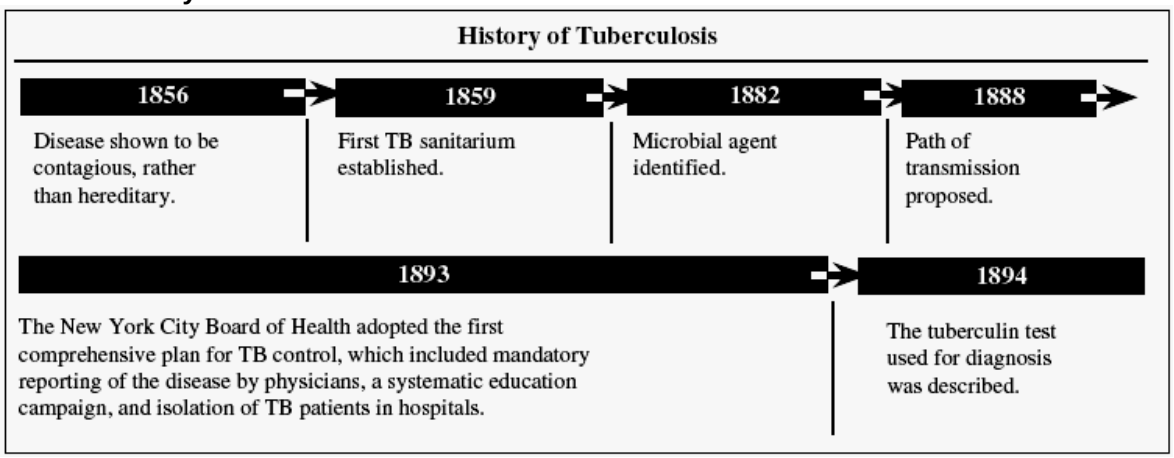
Table 4: History of Smallpox



Source: Aiello, Larson & Sedlak, 2008, p. S120

control of non-epidemic diseases were slow and difficult to identify and are recognised only by examining the broader picture years after the event had occurred. It is however, worth noticing that the health revolution though did not eliminate all disease, suffering or misery; because people still get sick and die up to date, but has recorded the following achievements: changes in average age of death, increased life expectancy at every age and significantly lower the chance of a given person dying in a given year from a given cause. [Aiello, Larson & Sedlak, 2008, p. S116]

Table 5: History of Tuberculosis



Source: Aiello, Larson & Sedlak, 2008, p. S124

3.2.3 Effects of Vaccination and Immunisation

Although it is vital to promote vaccination since many scientific evidence supports it, its benefits and risk have to be assessed very well before making a move. The consideration could be made from two different perspectives: first in relation to oneself and secondly in relation to other people. From the first perspective most people accept vaccines where the incidence of infectious disease is high but lower risk of vaccines, for many people express concern about the side effects of vaccination as harmful and dangerous. Some say it

“causes more health problems than it solves”, others say “many of the diseases for which people are vaccinated were already coming under control through improved sanitation, health care and measures such as quarantine”. [Nuffield Council on Bioethics, 2007, p. 55]

Vaccines must be carefully scrutinized before they are introduced into the health system. Strategies and criteria like appropriateness for the control of disease in question, efficacy and safety of the vaccine, its compatibility with other antigens, adequate and affordable supply and the ability to be delivered into the system. [Moree & Ewart, 2004, p. 251]

Nevertheless, immunisation is considered seen to be one of the greatest success stories of public health. Disease like Smallpox has been made history and polio is on the verge of also being a history. In the Americas and Europe endemic measles transmission has been eradicated through immunisation. [NLM Gateway. A Service of the U.S. National Institutes of Health, 2002]

According to the World Health Organisation’s estimates, immusation programmes have reduced annual deaths of measles, neonatal tetanus and pertussis in the year 2000 by 1.7 million, 767,000 and 636, 000 respectively in comparison to the pre-immusation era. From 1988 to 2001, paralytic polio cases have been reduced from an estimated 350,000 to fewer than 500 respectively. These achievements were mainly due to the widespread use of highly effective vaccines. Global immunisation coverage rates during the first year of life in year 2000 were 86% for BCG, 81% for DPT, 82% for polio and 80% for measles. Some of the great immunisation successes have been achieved in developed nations and with much effort the same could be said of the developing world in the near future, sooner or later. [NLM Gateway. A Service of the U.S. National Institutes of Health, 2002]

3.3 Culture and Religion

Culture is one of the corner stones of many civilizations and group of people but most of the time misunderstood and misused. There have been many attempts to define culture in the past, for instance, the Federal Republic of Germany in 1970 tried defining culture as not only the creation of art specific to certain group of people but also the involvement of daily activities [Felgner, Grassau & Froese, 2001, p. 22]. Despite the increased opportunity for dialogue, mankind is still faced with misunderstanding leading to the destabilisation of economies, peace, security and development as well as the creation of conflicts.

This misunderstanding had led the UNESCO member countries on the occasion of the “World Conference on Cultural Policies” held in Mexico City on the 6th day of August, 1982 to formulate what came out to be a unified attempt in defining culture. Culture was defined in the declaration as involving the whole complex of distinctive spiritual, material, intellec-

tual and emotional features that characterize a group or society. Moreover, it includes arts and letters of that group as well as its mode of life, the fundamental rights of the human being, value systems, traditions and beliefs; the document declares further that, it is culture that gives man the ability to reflect upon himself. [UNESCO, 1982]

Culture, in simple terms, therefore refers to the way a group of people or society lives and it encompasses the following: language, thought, arts and sciences, religion or spirituality, social activity and interaction, to mention but a few. [Roshan Cultural Heritage Institute, 2001]

Language has been and is still the most sophisticated medium of expression and the oldest human institution. However religion or spirituality has been the carrier of value system within a society and transmitted through generations for the inner well-being of human beings mostly expressed through language and actions. Moreover, thought describes the manner in which a group of people perceive, interpret and understand the world around them [Roshan Cultural Heritage Institute, 2001]. Thereby knowing what culture is and how a group of people in a specified population think and act, react or respond to situations, the norms and codes of ethics of these groups is an immense gift to get to understand them and propagate health accordingly. However, the inability to deal with the above mentioned vital parts of culture sensitivity means a failure for health promotion.

3.4 Health Promotion in Ghana

Health is defined, by the WHO, as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. This applies to all people irrespective of gender, cultural, religious, ethnic or geographical background. Health might be perceived as cumulative and need to be promoted throughout the life of a population or a person so as to ensure that the full benefits are enjoyed in later years. However, good health is a basic requirement for the maintenance of an acceptable quality of life in all societies. [World Health Organisation, 2001, p. 10]

Health Promotion however, is a process of enabling people to increase control over their health and its determinants thereby improving their health in the short or long run. [World Health Organisation, 2006, p. 3]

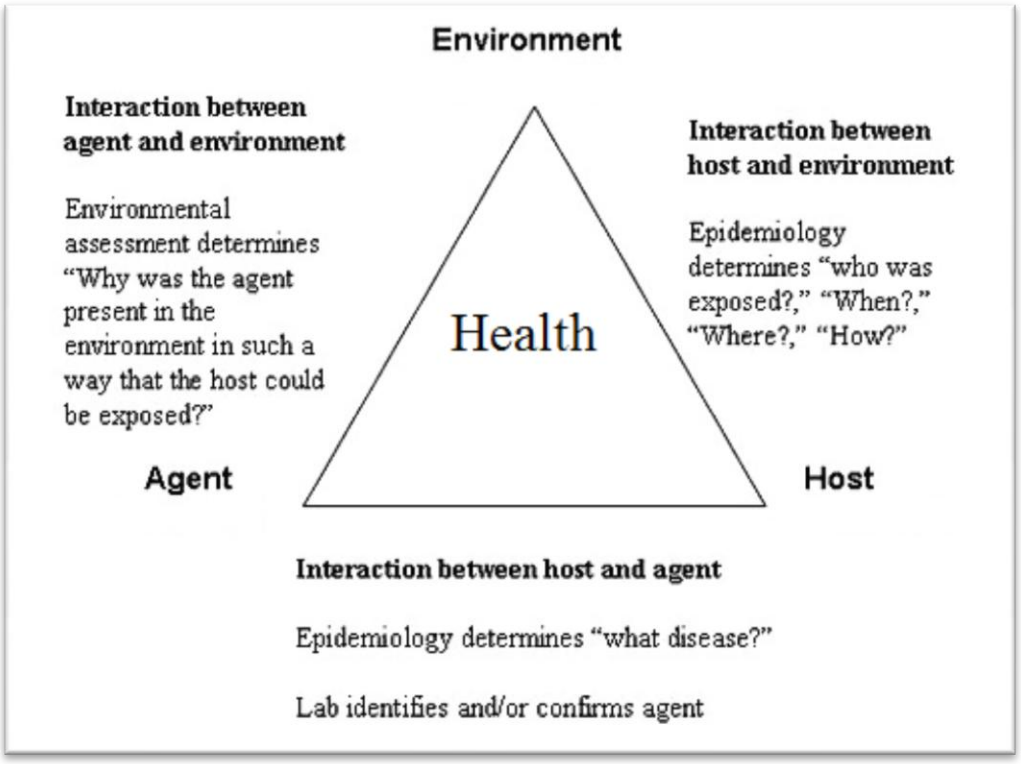
Ghana has been involved in many efforts in promoting health of the most vulnerable in society which called for the hosting of the “International Forum on Health: A Conditionality for Economic Development” that took place in Accra, Ghana in December 1991. This health promotional forum resulted in the “Accra Declaration on Health” and for the “WHA resolution WHA45.24 on health and development”. This edged member states to take specific measures in improving the health status of the most vulnerable population groups.

It also called, among other things, for the establishment of the WHO Multidisciplinary Task Force on Health and Development which should take care of searching for alternative funding mechanisms to assist countries in evaluating the interaction of health status and economic development strategies. [World Health Organisation, 2009]

4 Epidemiological Roadmap

To better understand health problems, there is the need to know what epidemiology is and its contribution towards providing better fundamentals of know-how as to how health problems occur, those affected and what measures to take in curbing such a problem. Epidemiology was lately defined in 2001 as “the study of the distribution and determinants of health related states or events in specified populations, and the application of this study to the control of health problems.” [Ahrens, Krickeberg & Pigeot, 2005, p. 4]

Figure 6: Epidemiological Triangle



Source: CDC EHS-Net

Hennekens and Buring in 1987 assumed that since the occurrence of disease in populations is not by chance it is determined by causal and preventive factors. These factors have to be searched for systematically in populations defined by place, time or otherwise. The epidemiological triangle is mostly employed in describing the interrelationship of factors that relate to host, agent and environment. The variation of these three factors (see fig. below) will either increase or decrease the disease frequency, added Mausner and Bahn in 1974. [Ahrens, Krickeberg & Pigeot, 2005, p. 1]

4.1 Worldwide

Malaria is considered to be one of the most challenging and severe public health problems worldwide and a leading cause of death and disease in several developing econo-

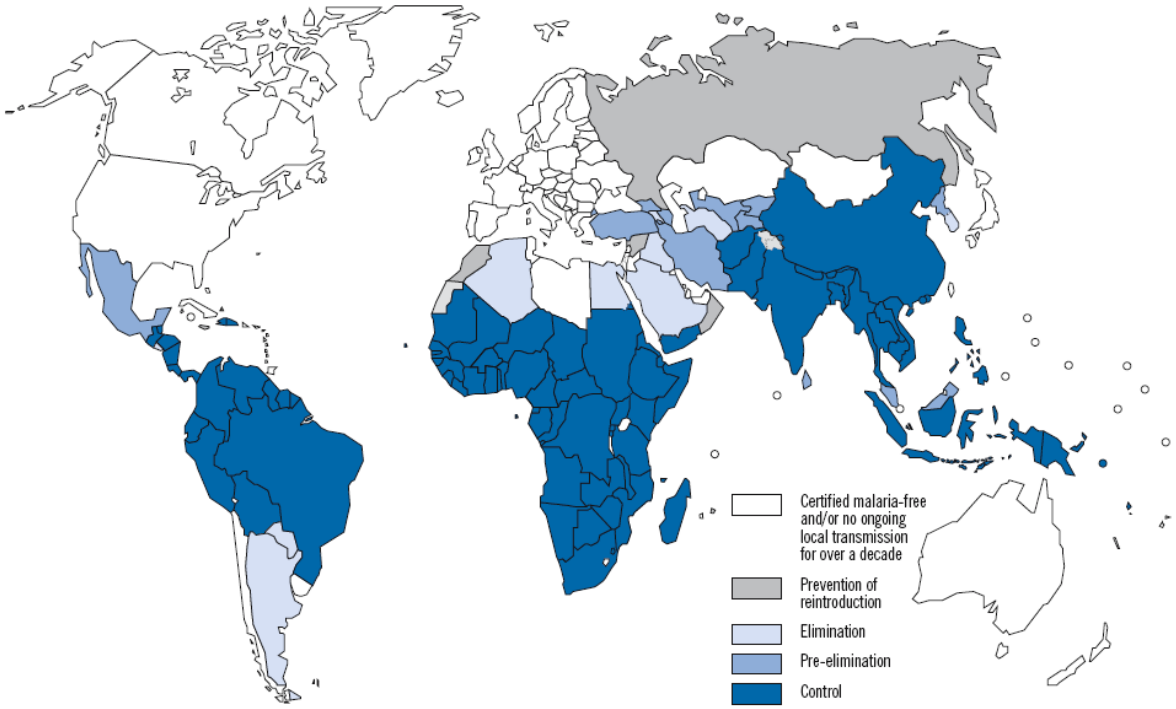
mies, infringing its punishment mostly on pregnant women and young children. [CDC Division of Parasitic Diseases, 2004]

Table 6: Area and Population at Risk of P. falciparum Malaria in 2007

Region	Area (million km²)	PAR at *Pf*API ≥0.1‰ pa (billion)	PAR at *Pf*API <0.1‰ pa (billion)	Total PAR (billion)
AFRO	18.81	0.60	0.01	0.61
AMRO	8.23	0.04	0.05	0.09
EMRO-EURO	5.06	0.09	0.10	0.19
SEARO-WPRO	8.04	0.66	0.82	1.48
Globe	40.14	1.39	0.98	2.37

Source: Guerra et al., 2008 Legend: ‰, per thousand.

Figure 7: Malaria-free countries and malaria-endemic countries in phases of control, pre-elimination, elimination and prevention of reintroduction, end 2007



Source: World Malaria Report 2008, p. 9

The World Health Organisation (2009) in its World Health Statistical Report said an estimated 3300 million people were at risk of malaria and some 1200 million were in the high-risk category (thus living in areas with more than one reported case of malaria per 1000 population per year).

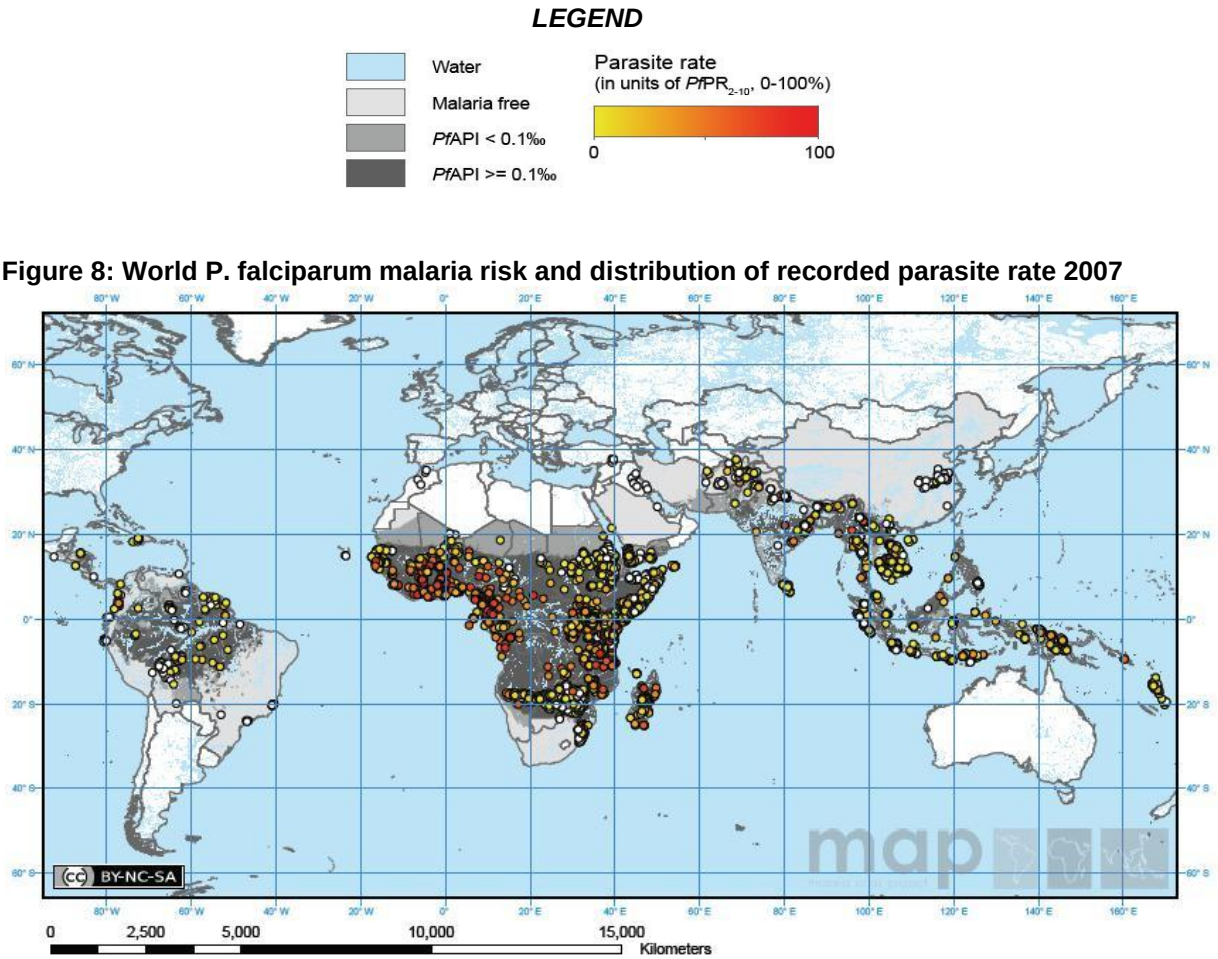


Figure 8: World P. falciparum malaria risk and distribution of recorded parasite rate 2007

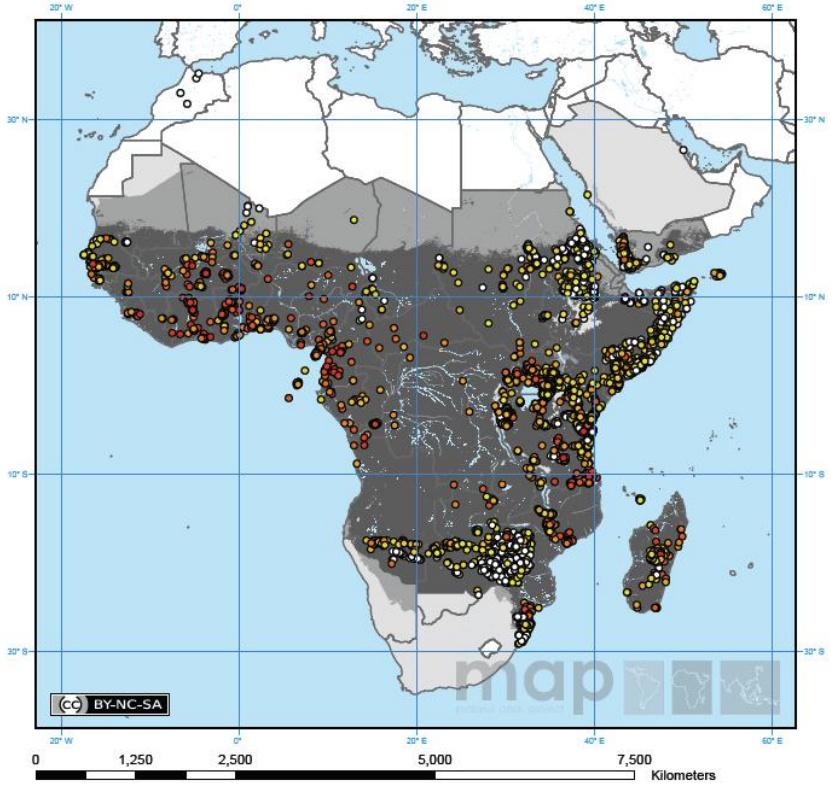
Source: Malaria Atlas Project (MAP)

Although it is early to register global changes in impact, twenty seven nations, including five in Africa, have reduced reported cases of the disease and/or death resulting from it by up to 50% between 1990 and 2006. [World Health Organisation, 2009c, p. 11]

It is worthy of notice that 41% of the world's population reside in malaria transmission zones like parts of Africa, Asia, Middle East, Central and South America as well as Hispaniola and Oceania. However, in parts of Africa with high transmission of malaria; an estimated 990,000 people died of the disease in 1995, which implies over 2700 deaths per day or 2 deaths per minute. [CDC Division of Parasitic Diseases, 2007]

Malaria was however recorded to be the 4th cause of death in Children in developing countries in the year 2002 after perinatal conditions, lower respiratory infections (pneumonia) and diarrheal diseases. The disease accounted for 10.7% of all child deaths in developing countries. [CDC Division of Parasitic Diseases, 2007]

Figure 9: African P. falciparum risk and distribution of recorded parasite rate 2007



Source: Malaria Atlas Project (MAP)

4.1.1 Risk Groups and Consequences

Many research findings points to children aged under five and pregnant women as the most vulnerable dying of malaria or suffering the consequences of this disease in endemic regions of the world. The availability of insecticide-treated mosquito nets reduces the risk of being a victim of malaria enormously. [World Health Organisation, 2009e]

UNICEF (2008, p.6) said in its report card on maternity that, around 50 million pregnant women are vulnerable to malaria each year and up to 25% cases of severe maternal anaemia are attributed to malaria with also nearly 20% of low birthweight in babies.

About five years ago, the WHO pointed that, thirty million women resident in malaria-endemic regions of Africa become pregnant making malaria a threat for them and their would-be babies. Malaria in pregnancy is the main cause of the deaths of up to 200, 000 newborn babies in Africa. These women are particularly susceptible as a result of reduction in their immunity to malaria which further exposes them to the risk illness, Anaemia and death. However, maternal malaria calls for the risk of spontaneous abortion, stillbirth, premature delivery and low birth weight which happens to be the leading cause of child mortality. [World Health Organisation, 2003]

4.1.2 Sub-Saharan Africa

According to the World Health Statistics released in this year, malaria in 2006 accounted for 104 deaths out of 100,000 populations in the Africa region. [World Health Organisation, 2009c, p. 56].

The World Malaria Report 2008 showed that out of 109 malaria-endemic countries of the world, 45 where located in the African region yet the coverage of all interventions in 2006 was far lower in most African countries than the 80% target set by the World Health Assembly. Since a journey of thousand miles begins with a step, a number of five African nations have been able to report sufficient IRS coverage to protect at least 70% of people vulnerable to malaria. Although it is difficult to evaluate clearly the impact of interventions and progress made so far against malaria in most African nations; at least seven out of fourty-five with relatively small populations have recorded reduction in malaria cases and deaths by 50% or more between 2000 and 2006 or 2007 through good surveillance and high intervention coverage. [World Health Organisation, 2008, p. vii]

4.1.3 Ghana compared with Kenya and African Average

In current Nation Master Worlds' malaria rating, Guinea was ranked first on the list of countries with high malaria cases per 100,000 population with 75,386 cases. Ghana was raked 8th with 15,344 cases and Kenya 44th with 545 cases. [Nation Master, 2003-2009a]

Table 3 shows that, Ghana has much cases and mortality attributable to malaria than Kenya. Irrespective of this fact, infant mortality in Kenya is higher than that of Ghana. Slightly more children in Kenya receive antimalarial treatment against fever but Ghana provides many children with the Insecticide Treated mosquito Nets (ITNs) whereas the

Table 7: Comparing health indicators of Ghana and Kenya

Nation	Malaria cases per 100000	Malaria mortality rate per 100000	Under 5 mortality rate per 1000 live births	Infant mortality rate	Under-5 children receiving antima-larial treat-ment for fever (%)	Under-5 children sleeping under ITNs (%)	%-tage of 1 year olds immu-nised against TB	Under-5 children under-weight for age (%)
Ghana	15,344	109	115	52.22	61	22	91	13.9
Kenya	545	74	121	62.62	65	6	91	16.5
African avera-ge	NA	104	145	NA	36	14	NA	NA

Source: Nation Master & World Health Statistics 2009 Illustrated by: E. Ramani

availability of these nets for children in Kenya is not worth a mention. However children in Kenya are slightly underweight as compared to their counterparts in Ghana.

5 Malaria Vaccine Development

When in 1987 a group of scientist fused a genetically engineered version of an evasive circumsporozoite protein, in a Belgian laboratory, that gave malaria its deadly edge on human immune system to a surface antigen molecule; there was jubilation with the hope that the disease could be written in the history books [Alsop, 2009, p. 104]. This step, although not enough to eradicate the disease, it has set the foundation and gave hope to many scientists who up to date are researching tirelessly in making the dream of developing an effective vaccine against the disease a reality. But unfortunately the disease still wages war against the many millions of the poor that reside in the tropical rain-belts of the world and continue to claim higher records of morbidity and mortality.

There is recently an accelerated effort towards malaria vaccine development which began last decade. The enthusiasm to work round the clock in developing a malaria vaccine was shadowed by capital interest of profit making due to lack of traditional market, few developers and technical complexity involved in developing any vaccine against the malaria parasite. However current surge in increased funding, greater awareness and advances in science and vaccine technologies have revamped the field of research into developing effective and reliable malaria vaccine. [PATH Malaria Vaccine Initiative, 1995-2009b]

The accelerated need for developing malaria vaccine has spurred on many organisations worldwide to think over the availability and accessibility of these antimalaria vaccines in the developing world should an effective one be developed. Bill and Melinda Gates Foundation as well as the World Health Organisation in cooperation with other stakeholders, since the era of their championing the course of making this dream a reality, have sponsored many national, international and NGOs willing to make the fight against malaria their aim. PATH Malaria Vaccine Initiative, Malaria Vaccine Initiative and Roll Back Malaria came into being through such support and since then have been making effort in developing an anti-malaria vaccine or rethinking about strategies to curb the disease off human history. [PATH Malaria Vaccine Initiative, 2006]

Vaccine development has shown major achievements in health promotion or medical history and can similarly do wonder today in the case of malaria vaccine development. Major epidemics such as smallpox, tuberculosis, whooping cough, measles, diphtheria, rubella and polio held the world in doubt and confusion as they were major causes of morbidity and mortality in the past especially in the case of the latter. Aiello, Larson and Sedlak (2008, p. S120-S124) said „although it's estimated that smallpox caused as many as 20% of all deaths in London in the late 1790s, mortality declined rapidly with the availability of smallpox vaccines. " The discovery of a vaccine against smallpox marked an important milestone in the world history, since for the first time a disease has been deliberately eradicated with a vaccine. The most progressive health achievement was the control of Tu-

berculosis which was once the leading cause of deaths and for sure one leading endemic cause of adult mortality in Western Europe and the U.S. through the 1800s, among epidemics of cholera, malaria, smallpox and yellow fever. However, England and Wales recorded a drastic reduction in deaths attributable to tuberculosis by more than 50% from 1838 to 1900 and by further 99% since 1900. Due to poverty or lack of adequate immunisation strategy to address the problem of tuberculosis and malaria in developing nations, these diseases have continued to be a trouble in these nations and have created high-risk groups in most nations of the world.

There is the urgent need for a malaria vaccine to relieve the human suffering associated with the parasitic disease that kills more than one million people, most of them African children, every year. Although many interventions like usage of drugs, insecticide-treated bed nets and other strategies are in use for reducing the impact of malaria; the disease still remains a tenacious adversary. However a great public health achievement of modern times would be the development of a safe, effective and affordable malaria vaccine to close the vacuum left by other interventions. This desire has moved researchers, funders and others in the malaria vaccine community to change the focus of the community by not only publishing their work, but also developing a viable product (malaria vaccine) that can salvage millions of lives across the globe. [PATH Malaria Vaccine Initiative, 2006, p. 3]

In an effort to make similar global health achievements like in the case of malaria just like it was done with smallpox, tuberculosis and polio; the worlds' leading health organisations have developed a global strategy for accelerating the development and licensing of a highly effective malaria vaccine. The plan was tagged "Malaria Vaccine Technology Roadmap" which calls on the malaria vaccine community thus scientist, funding organisations, policy experts and national and global decision makers to develop an effective vaccine that prevents severe disease and death caused by Plasmodium falciparum, the most deadly form of the malaria parasite. The road map has the following clear-cut goals: "developing and licensing a first-generation vaccine by 2015 with 50 percent protective efficacy against severe disease and death that would last longer than one year" and also "developing a malaria vaccine by 2025 that would have a protective efficacy of more than 80 percent against clinical disease and that would provide protection for longer than four years." [PATH Malaria Vaccine Initiative, 1995-2009c]

Collins and Barnwell (2008) were of the opinion that a successful malaria vaccine used in conjunction with other control interventions would help reduce and eventually eliminate the considerable global diesase burden caused by malaria.

However, two recent studies by Philip Bejon and Salim Abdulla and their colleagues, answered the call for urgent need of malaria vaccine, in that, their findings manifest a vital

promise for being deployed in malaria-control programmes [Moorthy, Smith und Kieny, 2009, p. 1411]

The identification of many different antigens as potential target for malaria vaccine development is already a good news for the malaria vaccine community and the people living in malaria endemic areas aound the globe. Repetitive sequence of four amino acids in the circumsporozoite antigen on the surface of the sporozoite of Plasmodium falciparum, arguably the most vital of the human malaria, is the basis for the RTS,S vaccine. After extensive studies involving human volunteers, a potential protective efficacy of about 40% was recorded, by combination usage of the vaccine with an effective adjuvant therapy. However, a number of field studies have indicated that this vaccine could have an efficacy rate of about 30% against clinical malaria and about 40% against new cases of infection in endemic areas.The RTS,S vaccine is the first malaria vaccine candidate to manifest significant protection in laboratory and field-based clinical surveys. [Collins & Barnwell, 2008, p. 2599]

On a phase 2b safety and efficacy trial by Bejon et al, it was found that RTS,S vaccine combined with other adjuvant like AS01E (thus RTS,S/AS01E vaccine), administed to 800 children of 5 to 17 months of age in Kenya and Tanzania was associated with few severe adverse effects than the control rabies vaccine. Generally, an adjusted 60% efficacy rate against all episodes of P. falciparum clinical malaria with anticircumsporozoite antibody titers detectable in more than 99% of the recipients of the RTS,S/AS01E vaccine was recorded by Moorthy, Smith and Kieny (2009, p.1411) reported an efficacy against all clinical episodes of malaria to be 56% (95% CI 31-72%) upon an average of 8 months' follow-up after the third vaccine dose was administed [Collins & Barnwell, 2008, p. 2599]

Moreover, Abdulla and colleagues' trial in 340 infants was designed to assess whether the malaria vaccine administed simultaneously with other vaccines from the Expanded Programme on Immunisation (EPI) interfered with immune responses to other vaccines. The infants were giving the RTS,S/AS02 or hepatitis B vaccine simultaneously with diphteria and tetanus toxoid, whole-cell pertusis and conjugated Haemophilus influenzae type b vaccines. The results was that, the malaria vaccine worked safely together with other vaccines when adminsited and could mininise the cost of immunisation. [Moorthy, Smith & Kieny, 2009, p. 1411]

Anyway, the RTS,S vaccine is the first to reach phase 3 of the test in 2009 which signals indeed a hopeful beginning in the fight against this disease. [Collins & Barnwell, 2008, p. 2600]

6 The Concept and Approaches

Upon relentless effort by philanthropists, health and donor organisations worldwide to make malaria burden part of the history books as it was done with smallpox, tuberculosis and polio to mention but a few, it will be a failure not to be able to reach the most vulnerable population living in malaria endemic areas should the malaria vaccine be successfully developed; mainly due to the neglect of the culture, value systems, norms and beliefs of the people. These factors happened to be the most central institutions of every mankind.

A report from Alsop (2009) of Kenya highlighted some of the challenges that volunteers and field workers for immunisation will face which mostly are culturally or belief motivated stumbling blocks and could only be neutralized or if possible eliminated by looking into the sensitivity of culture and beliefs and tackling them right from their sources in order to ensure safety and security for the field workers and in the long-run achieve the anticipated high malaria immunisation coverage. The report stated “Young, bright, and likeable, Mwadondo was among dozens of field workers hired by scientists to monitor a few dozen participants in an earlier trial of RTS,S around Junju. Late one night in November, Mwadondo was called to visit a sick child. As he returned home, a group of men snatched him from the dark footpath, stole his clothing, and slipped a noose around his neck, before dragging him miles into the forest and abandoning him there. “It is a study participant’s parent who did it”, Mwadondo said. “They said I brought a person who take the blood from their children to the devils and that is what contributed to what happened.” ”

Again a study conducted in the Eastern Region of Ghana by Brugha and Kevany (1996) showed that irrespective of the door-to-door visits by field workers if the father never gives the “go-ahead” then the immunisation coverage would be impaired. In a situation where the trust and consent of fathers is sought for, massive participation by children and women will definitely be secured.

Every immunisation strategy has its pros and cons but the socio-cultural approach is a win-win strategy for the donor organisations as well as the vulnerable population, as it clears the clouds of doubt, misperception, distrust, fallacies and ignorance about immunisation and also about the population of the endemic areas. This is because taking the culture, norms and beliefs of people into consideration and acting according to expectation means showing respect, understanding and regard for their ways of living and vice versa.

Brugha and Kevany (1996, p. 521-522) also discovered that home visiting strategy is advantageous as it has the potential of raising immunisation coverage levels to nearly 90%, obtaining accurate baseline immunisation coverage levels, allowing identification of vacuums of low coverage, the compilation of population registers for health care programmes and establishment of personal contacts to fathers to convince them to actively

and constructively get involved in the health care of their children. This strategy however, is much cost-effective were there are many population concentrated in one catchment area.

Furthermore Bhuiya, Bhuiya and Chowdhury (1995) outlined reasons that significantly affect the acceptance of immunisation among children which are among other things proximity to health facility, frequency of health worker's visit, mother's mobility, education, age, gender of child, ownership of radio, economic condition of household and region of residence.

Moreover in trying to set the records straight, the Ethiopian minister for health, Honorable Dr. Tedros Adhanom, said international or donor organisations should not impose foreign ways on receiving nations but allow the local populace to decide on suitable and cultural sensitive approach to whatever problem like in the case of harnessing donor resources [African Health News, 2008, p. 3]. This is a signal to the fact that, allowing the authorities of a nation located in endemic areas to be part of planning and implementing a programme is undeniable. Many culture experts have cried out about mostly neglecting what is central to the thoughts of many ethnicities of the world due to misunderstanding what culture stands for.

Figure 10: A Kenyan health worker examines a child for signs of malaria

Source: Alsop, 2009

However, a common red indian adage says "to get to understand sombody, one should for some days put his/herself in the shoes of the person". Putting oneself in the shoe of the other implies getting to know their ways, understand their way of perception, norms and beliefs in order not to infringe on their rights of existance. Neglecting these values,

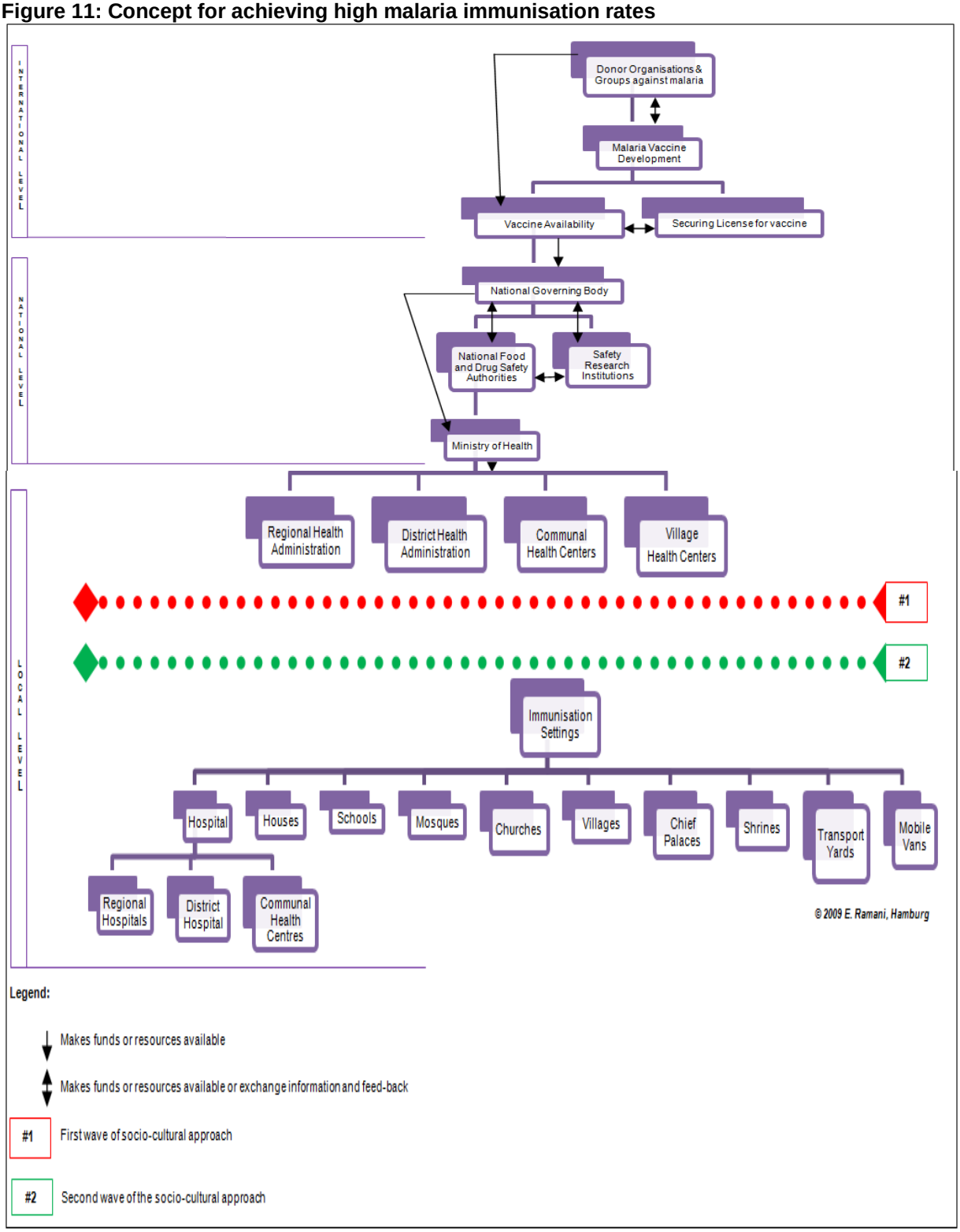
due to ignorance or inferiorlity complex, means deciding for the failure of a project or programme thereby dashing the hopes of attaining high malaria immunisation rates.

In the light of finding a suitable strategy for addressing the burden of malaria in endemic areas which are culturally, religiously or spritually and ethically diverse; the idea of developing a concept that considers the perception and ways of living of the vulnerable population in order to achieve high malaria coverage rates was born.

Although vaccination has made an enormous achievements in health and medical history, yet still, there are some groups that pose against it due to certain reasons. The voice of these groups should not be left unattended to, for that need to be explained. Some of these allegations, like deformity due to vaccination, infections due to vaccination and hidden side effects of vaccination that manifest after some time period are worth mentioning. These allegations when shown in documentaries help demotivate people and strengthen their decisions against immunisation, Field workers should, however, be equiped with adequate information to explain these allegations and clear them in order to gain trust of the local people should questions regarding such allegations be asked.

The concept “socio-cultural health promotional model” is to address the vacuum that leads to the failure or minimum uptake rates of immunisation by paying more attention to the socio-cultural institutions and their structures in malaria endemic areas of the world. Since considering the entire areas of malaria endemicity of the globe withing the time frame of this reaserch is unrealistic, the concept was based on approaches based on the ghanaian cultural example but could be inferred on other endemic regions should it prove to be successful.

Figure 11: Concept for achieving high malaria immunisation rates



Source: E. Ramani

Table 8: Approaches to the socio-cultural health promotion model

LEVEL	ORGAN OR ACTIVITY	APPROACH
International	Donor organisations and groups against malaria	Donation of resources and funds to research institutions whose aim is to research into malaria vaccine development. Also share information with those research institutions and finally receive the vaccine for distribution to various national governments.
	Malaria vaccine development	The research institutions work round the year to develop an effective and efficacious malaria vaccine. Share information with their donors and when a reliable vaccine is found, submit it to their donors.
	Vaccine availability and licensing	The research institutions develop the vaccine and submit it for safety examination and licensing to health organisations. After licensing, the research institutions provide the vaccines for distribution to the WHO or other anti-malaria organisations.
National	National governing bodies	The national governing bodies receive the vaccine from the WHO or other anti-malaria donor organisations. Also the safety of the vaccines are tested and proved by the various national governments through their various food and drug administration, safety research institutes or consumer protection organisations.
	National food and drug safety & Safety Research Institutes	These bodies work hand-in-hand over ensuring the safety of the received vaccine samples before giving “green light” for their utilisation or application.
	Ministry of Health	The ministry upon getting the “go ahead” signal prepares them for distribution at the various health administrations like the regional health admin-

		istrations, district health administrations, communal health centers and village health centers. Also the MOH orders the consent-seeking of the various local institutions or structures in a form of traditional product promotion traditionally, culturally and religiously/spiritually conform.
	Regional health administration, district health administration, communal health administration & village health centers	These health institutions at the local level of the malaria endemic societies receive the order to begin canvassing for the support of their various local authorities, religious/spiritual and political leaders, youth and women empowerment groups, etc. Afterwards these institutions in conjunction with the health ministry commence the immunisation advert and campaign.
Wave #1	1st socio-cultural approach	In the first phase of immunisation promotion, the various local health administration starts canvassing for the acceptance of the malaria vaccine and immunisation among the local communities by personally contacting the heads of those societies. Heads of local, traditional, religious/spiritual, political and gender advocacy groups. Since the respect for leaders like chiefs/queens, imams, pastors, fetish priests, political leaders, transport unions leaders, markets chairpersons/ladies, leaders of women empowerment groups in the case of Ghana is the order of the day; which can be said of most

		developing societies that unfortunately happened to be plagued with malaria due to geographical local in the tropics and poverty; the consent of these leaders should be won and their support for the immunisation secured. Once they accept the move and promise to actively participate in the immunisation campaign, their subjects or kinsmen/women will have no doubt in sending their wives and children to participate in the immunisation.
Wave #2	2nd socio-cultural approach	After the support of the heads of the local, traditional, religious/spiritual, transport yards, youth groups, women advocacy groups have been secured, then starts the formation of immunisation teams which is culturally diverse and mixed-up with field workers, specialist, volunteers, national service personal* if possible from each of the cultural/religious groupings so as to avoid doubt and mistrust. If members of the immunisation teams could not be formed to represent at least one of the persons from any religious or cultural groupings, at least a health personal who is intercultural gifted and know the local people, understand their language and traditions should be part of the team to command respect and trust.

		Once this wave of approach is addressed, then the preparation for the immunisation day can begin.
MOH & Regional health administration, district health administration, communal health administration & village health centers.	Immunisation day & settings I	The ministry of health in cooperation with the local health administrations should fix an immunisation day. This day should be culturally and religiously/spiritually conform in order not to draw an excuse from any ethnic, religious or traditional group. When immunisation date is set to the interest of the MOH and its sub-local administrations without taking the taboos, regard and prohibition of a traditional area, ethnic group and religious/spiritual group associated with days of the week or political party time table; there is bound to be massive fall-out on the immunisation day. When the norms, ethics, traditions and taboos of these groups pertaining to days of the week are considered before setting the day for the immunisation, there will be a massive attendance or participation or turn-out. The immunisation date should be set with one or two months interval to allow for media advertisement and public education on the malaria vaccine and the need for immunisation.
Regional health administration, district health administration, commun-	Immunisation day & settings I (Immunisation centers)	There should be immunisation center in the best proximity to each of the following settings or even located within their premises or

al health administration & village health centers		boundaries to encourage people participate: Hospital (regional and district hospital as well as communal health centers), houses, schools & tertiary institutions, mosques, churches, villages, chief palaces, market places, sports stadium, shrines, transport yards, industrial areas and mobile vans. The use of the immunisation vans is to reach out to those living in far distance places or those places that have no means of transport.

Source: E. Ramani

Implementing the approaches in table 8 will guarantee a significant uptake of malaria immunisation rates in endemic areas. Most of the time organisations struggle for years to find remedies to health problems that cause high morbidity and mortality but upon arriving at a solution for those problems, their efforts are not recognised or welcomed by the suffering population due to the fact that, the most vital aspect of their existence is neglected. Donor organisations, scientist and researches alike must integrate the socio-cultural aspect of their target populations right from the planning stage of searching for solutions to health problems especially in the case of malaria where its victims are from almost each part of the globe and are culturally, religiously/spiritually diverse.

7 Conclusion and Discussion

Malaria is known by almost everybody in the endemic region as dangerous and one of the major causes of morbidity and mortality. Many health ministers have tagged it as a “disease of poverty”. The same is accrued from the fact that most of the vulnerable people have either little or no resources to purchase items for prevention, knowledge about the spread of this disease and also due to the diverse make-up of the ways of living in those regions of the world.

Many diseases that took high toll on the lives of mankind have been made history but malaria still remains a hinge on the necks of the many that reside in the tropical regions or tropical rainforest of the world. In the light of finding ways of minimizing the burden of this disease many prevention strategies like the use of Insecticide Treated Nets (ITNs) or long-lasting Insecticide-treated mosquito nets (LLINs), Indoor Residual Spraying (IRS) and intermittent preventive treatment in pregnancy (IPT) to mention but a few, have been adapted by many and have proven to be the effective preventive measures so far but yet majority of the most vulnerable have no access to these resources.

However, the goal of the malaria vaccine community is to find an everlasting solution to this public health problem. However, developing a vaccine that last for a period of years against the disease will alleviate the suffering of the many that wish to lead a life free of this “slow but sure killer” but yet crippled by the destiny of poverty. The good news for the nations and communities suffering the pangs of malaria is that, a vaccine – RTS, S and an adjuvant AS01E had successfully undergone the phase 2 of its trial and even the phase 3 this year. Sooner or later a malaria vaccine that will either reduce or even eradicate the burden of malaria will be available as the malaria vaccine community is working round the clock to see this dream come true.

Many studies have proving that researchers mostly face a cultural stumbling block in testing vaccine candidates in the wake of myths, taboos, traditional beliefs, religious or spiritual influences that have engulf the thoughts and sense of living for subjects of those cultures but there is no cause for alarm as these could be addressed through socio-cultural strategies like this work outlines since humans are “social beings”. Getting to know a culture is winning the trust of those living that culture. Again intercultural guided communication skills could be the tool to remove the barriers which among other things are ignorance, opposition and turning down offer of immunisation by donor organisations.

Moreover, many allegations against vaccination should always be head and necessary information to level these allegations found to counteract them and clear the atmosphere of doubt, fear and misconception that rumours might cause. Information about the many advantages and health achievements that vaccination and immunisation have brought mankind should be distributed and the target population educated on those.

Scientific experience has shown that, when the consent of key people in societies is sought for, the subjects of those key figures are bound to trust any programme that will be planned for them. Especially in family settings, it will be difficult to get a full participation of a household without the consent of the family father. Furthermore the neglect of traditions, beliefs and norms of a group automatically implies problems for immunisation teams but consideration of those and addressing them according to the guidelines laid by the “socio-cultural health promotional model” will mean security for the team members and an uptake in the malaria immunisation coverage rates.

Achieving high malaria immunisation rates demands doing proper local marketing for the malaria vaccines, when developed, and following the cultural sensitive steps in overcoming the impediments that socio-cultural blocks might lay. If this is not done, all the efforts made by donor organisations as well as the malaria vaccine community might be nullified unless the vaccine is promoted through an approach that regards the tradition, culture, religion, code of ethics and norms of the target population.

8 Summary

The need for malaria vaccine and effective strategy for reaching and administering them to the most vulnerable population residing in the malaria endemic regions of the world has prompted many scientist, research institutions and donor organisations worldwide to form a community that declared an all-out war against malaria which claims the lives of more than a million people annually. Much focus was laid on the worse type of malaria parasite – Plasmodium falciparum which is the major cause of high rates of morbidity and mortality in Sub-Saharan Africa.

In the light of finding ways of minimizing the burden of this disease many short term prevention strategies like the use of Insecticide Treated Nets (ITNs) or long-lasting Insecticide-treated mosquito nets (LLINs), Indoor Residual Spraying (IRS) and intermittent preventive treatment in pregnancy (IPT) are in use and have proven to be effective but yet majority of the most vulnerable have no access to these resources. The goal of the malaria vaccine community is, however, to find an everlasting solution to this public health problem by developing a vaccine that last for a period of years against the disease. The successful trial of the malaria vaccine candidate – RTS, S and an adjuvant is a sign that sooner or later in the near future an effective vaccine against the disease will be available. But the question still remains - “how could high immunisation rates be achieved?”.

In order to address these question, a systematic review of articles on malaria was made by searching through databanks like scribd, Cochrane, WHO database, Lancet database, PubMed, Malaria Journal, British Medical Journal and the websites of some malaria vaccine community members like Roll Back Malaria, PATH Malaria Vaccine Initiative etc. for with keywords like malaria, vaccine, malaria vaccine, strategies against malaria and so on.

This work has with the support of current scientific findings, developed a socio-cultural health promotional model to guide donors or NGOs, researchers, governments, health organisations and health authorities on how to overcome the stumbling blocks that the complexity of culture, belief system, gender question, value system and ethnicity might pose to the malaria immunisation programme should a licensed malaria vaccine be available; in order to achieve high malaria immunisation coverage.

9 Table and Figure Reference

9.1 Figures

9.2 Tables

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11 English and German Declarations

11.1 Authenticity Declaration

I hereby declare that this work is produced solely by me and through my own effort without the help of any foreign individual and only the given sources and supporting materials were used. Words produced verbatim were quoted and their sources accredited.

Signed in Hamburg on 14th September, 2009

Signature:……..

11.2 Eidesstattliche Erklärung

Hiermit versichere ich, dass ich die vorliegende Arbeit ohne fremde Hilfe selbstständig verfasst und nur die angegebenen Quellen und Hilfsmittel verwendet ha-be. Wörtlich oder dem Sinn nach aus Werken entnommene Stellen sind unter Angabe der entsprechenden Quellen kenntlich gemacht.

Hamburg den 14.09.2009

Unterschrift:.....

12 Appendix

12.1 Populations at low and high risk of malaria, and estimates of cases and deaths by NMCP Report and WHO 2006

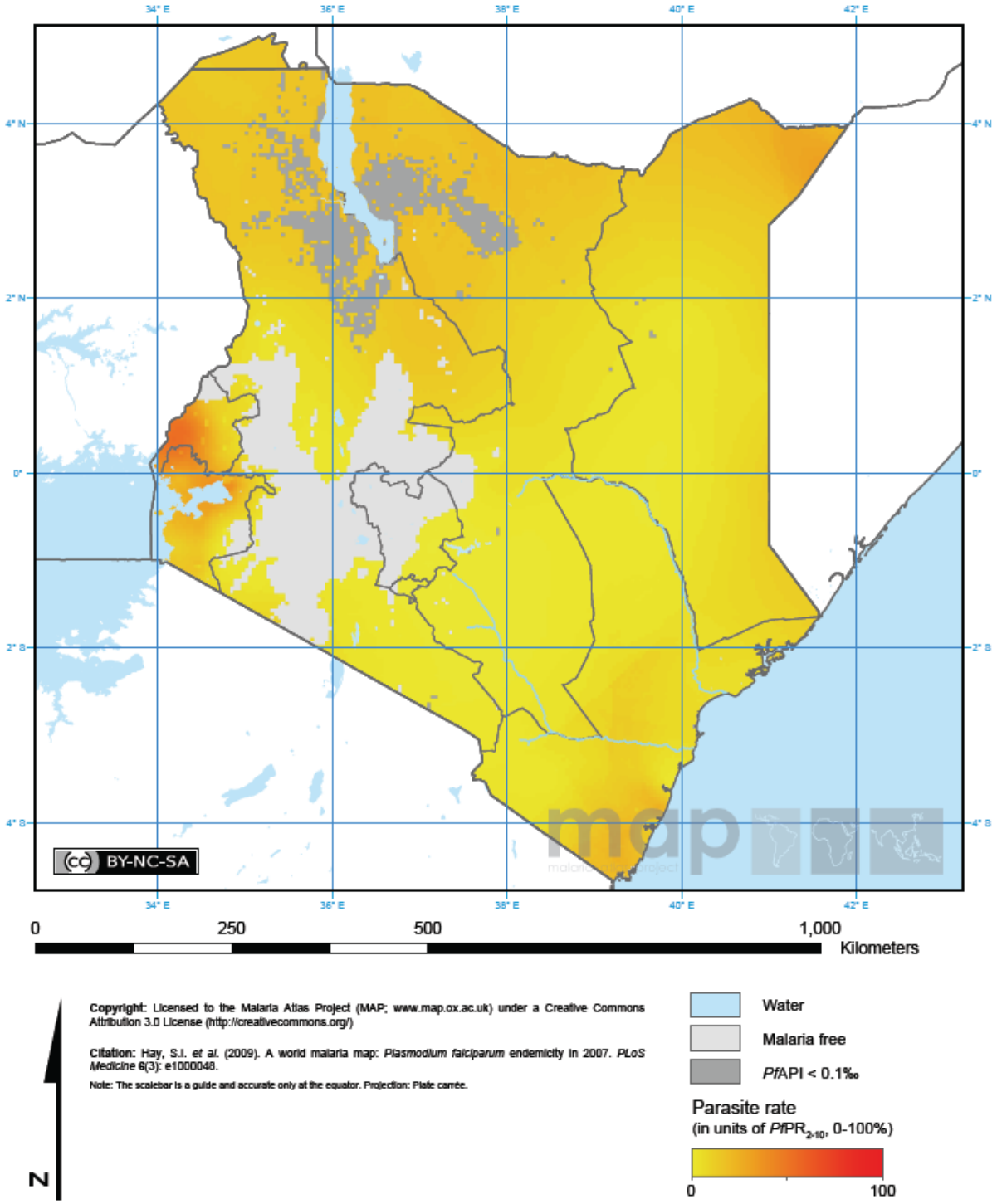
POPULATION AT RISK (MILLIONS)	POPULATION	% ANY RISK	TOTAL AT RISK	LOW RISK	HIGH RISK	HIGH RISK (AS % OF ANY RISK)
Africa	774	84	647	61	586	91
Americas	895	15	137	76	61	45
Eastern Mediterranean	540	55	295	230	66	22
Europe	887	2	22	19	2	11
South-East Asia	1 721	77	1 319	863	457	35
Western Pacific	1 763	50	888	833	54	6
World	**6 581**	**50**	**3 308**	**2 082**	**1 226**	**37**

CASES (THOUSANDS)	REPORTED	% FALCIPARUM	ESTIMATED	LOWER	UPPER	REPORTED/ESTIMATED (%)
Africa	83 618	98	212 000	152 000	287 000	36
Americas	1 042	29	2 700	2 400	3 200	39
Eastern Mediterranean	2 914	76	8 100	7 000	11 400	84
Europe	2	2	4	4	5	63
South-East Asia	4 338	56	21 000	19 000	29 000	20
Western Pacific	2 133	67	2 200	1 500	3 200	95
World	**94 048**	**92**	**247 000**	**189 000**	**327 000**	**37**

DEATHS (THOUSANDS)	REPORTED (ALL AGES)	REPORTED (% < 5 YEARS)	ESTIMATED (ALL AGES)	LOWER	UPPER	REPORTED/ESTIMATED (%)
Africa	156	88	801	529	1 126	20
Americas	0	29	3	2	3	8
Eastern Mediterranean	2	76	38	20	60	5
Europe	0	0	0	0	0	0
South-East Asia	2	35	36	24	50	5
Western Pacific	1	40	4	2	6	33
World	**161**	**85**	**881**	**610**	**1 212**	**18**

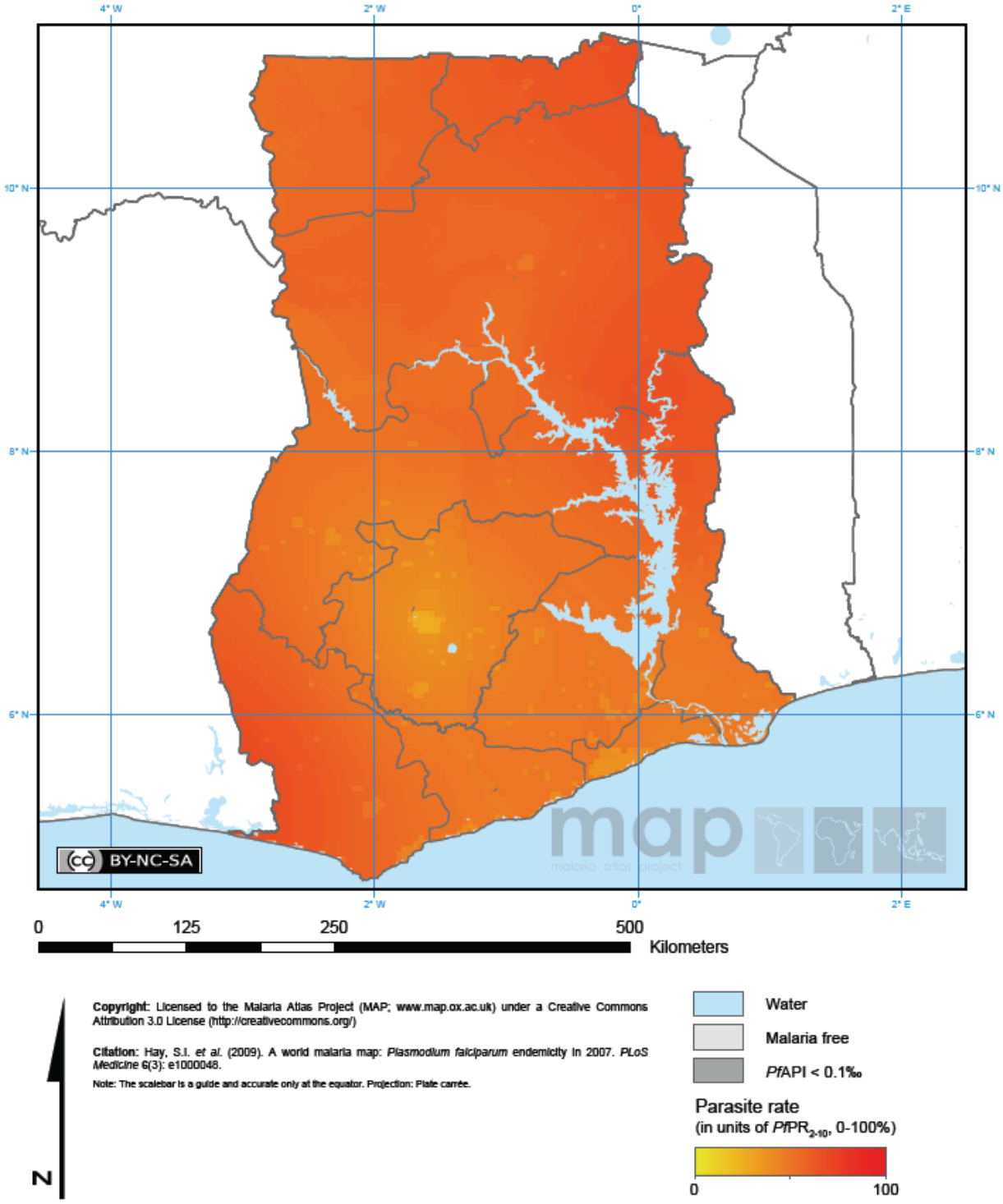
Source: World Malaria Report, 2008, p. 10

12.2 Distribution of Plasmodium falciparum malaria endemicity in Kenya



Source: Malaria Atlas Project (MAP)

12.3 Distribution of Plasmodium falciparum malaria endemicity in Ghana



Source: Malaria Atlas Project (MAP)

13 Glossary of malaria vaccine terms

13.1 A–F

adjuvant

a substance sometimes included in a vaccine formulation to enhance or modify the immune-stimulating properties of a vaccine.

Anopheles

the genus of mosquito that transmits malaria.

antibody

an infection-fighting protein molecule in blood or secretory fluids that tags, neutralizes, and helps destroy pathogenic microorganisms (e.g., bacteria, viruses) or toxins. Antibodies, known generally as immunoglobulins, are made and secreted by B-lymphocytes in response to stimulation by antigens. Each specific antibody binds only to the specific antigen that stimulated its production.

antibody-mediated immunity

immunity that results from the activity of antibodies in blood and lymphoid tissue (also called humoral immunity).

antigens

foreign substances in the body that are capable of causing disease. The presence of antigens in the body triggers an immune response, usually the production of antibodies. Antigens may be soluble substances, such as toxins and foreign proteins, or particulate, such as bacteria and tissue cells; however only the portion of the protein of polysaccharide molecule known as the antigenic determinant combines with antibody or a specific receptor on a lymphocyte.

arm

a group of participants in a clinical trial, all of whom receive the same treatment, intervention, or placebo. The other arm(s) receive(s) a different treatment.

attenuated

weakened or treated in such a way as to decrease the ability of a microorganism (such as parasite or virus) to cause infection or disease.

attenuated vaccine

a vaccine in which live bacteria or viruses are weakened through chemical or physical processes in order to produce an immune response without causing the severe effects of the disease. Attenuated vaccines currently licensed in the United States include measles, mumps, rubella, polio, typhoid, yellow fever, and varicella. Also known as a live vaccine. (Irradiated sporozoites delivered via mosquito bite to volunteers was an investigational attenuated vaccine. The ability of this method of

immunization to protect volunteers against challenge by infected mosquitoes is the basis for all current efforts to develop a malaria vaccine.)

B cells

small white blood cells that help the body defend itself against infection. These cells are produced in bone marrow and develop into plasma cells that produce antibodies. Also known as B-lymphocytes.

blood meal

blood taken from a human or other host by a mosquito.

booster

a second or later vaccine dose given after the primary dose(s) to increase the immune response to the original vaccine antigen(s). The vaccine given as the booster dose may or may not be the same as the primary vaccine.

CD

(cluster of differentiation) referring to cell surface molecules that are used to identify stages of maturity of immune cells, for example, CD4+ T cells.

CD4+ T lymphocyte

immune cell that carries a marker on its surface known as "cluster of differentiation 4" (CD4). Also known as helper T cells, CD4+ T cells help orchestrate the immune response, including antibody responses as well as killer T cell responses.

CD8+ T lymphocyte

immune cell that carries the "cluster of differentiation 8" (CD8) marker. CD8 T cells may be cytotoxic T lymphocytes or suppressor T cells.

cell-mediated immunity (cellular immunity)

the immune response coordinated by helper T cells and CTLs. This branch of the immune system targets cells infected with microorganisms such as viruses, fungi, and certain bacteria.

challenge

in vaccine experiments, the deliberate exposure of an immunized animal or person to the infectious agent.

CTL (cytotoxic T lymphocyte)

immune system cell that can destroy cancer cells and cells infected with viruses, fungi, or certain bacteria. CTLs, also known as killer T cells, carry the CD8 marker. CTLs kill infected cells, whereas antibodies generally target free-floating organisms in the blood.

cytoplasm

the living matter within a cell (excluding the nucleus) that is responsible for the function of the cell (for example, protein synthesis).

cytotoxicity

degree to which a substance is poisonous to cells.

DNA (deoxyribonucleic acid)

the double-stranded, helical molecular chain found within the nucleus of each cell. DNA carries the genetic information that encodes proteins and enables cells to reproduce and perform their functions.

DNA vaccine (nucleic acid vaccine)

direct injection of a gene(s) coding for a specific antigenic protein(s), resulting in direct production of such antigen(s) within the vaccine recipient in order to trigger an appropriate immune response.

effector arm

the part of the immune system that recognizes and responds to infection.

efficacy

in vaccine research, the ability of a vaccine to produce a desired clinical effect, such as protection against a specific infection or disease, at the optimal dosage and schedule in a given population. A vaccine may be tested for efficacy in Phase 3 trials if it appears to be safe and shows some promise in smaller Phase 1 and 2 trials.

ELISA (enzyme-linked immunoabsorbent assay)

a blood test that detects antibodies to a specific antigen (foreign substance in the body) based on a reaction that leads to a detectable color change in the test tube.

endemic

the continual, sometimes low-level presence of disease in a community.

epidemic

the occurrence of disease within a specific geographical area or population that is in excess of the normal level.

epidemiology

the study of the frequency and distribution of disease in human populations.

epitope

a specific site on an antigen that stimulates specific immune responses, such as the production of antibodies or activation of immune cells.

erythrocyte

a type of red blood cell.

etiology

origin or cause.

exposure

contact with infectious agents (e.g., bacteria, parasite, and virus) in a manner that promotes transmission and increases the likelihood of disease.

expression system

in genetic engineering, the cells into which a gene has been inserted to manufacture desired proteins.

functional antibody

an antibody that binds to an antigen and has an effect that can be demonstrated in laboratory tests.

13.2 G–L

gametocytes

precursors of the sexual forms of the malaria parasite, which release either male or female gametes within the stomach of the mosquito.

gene

a unit of genetic material (DNA); a segment of DNA encoding a protein molecule; a segment of DNA that contains the information for a specific function.

genome

the complete set of genes present in a cell, parasite, or virus, for example.

helper T cell

lymphocyte bearing the CD4 marker. Helper T cells are the chief regulatory cells of the immune response. They are responsible for many immune system functions, including turning antibody production on and off.

hemoglobin

the oxygen-carrying part of the red blood cell.

hepatocyte

liver cell.

host

a plant or animal harboring another organism.

hypnozoite

a form of the malaria parasite that remains inactive within the liver and can produce relapses.

immune complex

the result of a reaction between an antigen and a specific antibody. This combination of antigen bound by antibody may or may not cause adverse effects in a person.

immune response

the reaction of the immune system to foreign substances.

immune system

the complex system (network of specialized cells and organs) in the body responsible for fighting disease. Its primary function is to identify foreign substances in the body (bacteria, viruses, fungi, or parasites) and develop a defense against them. This defense is known as the immune response. It involves production of protein molecules called antibodies to eliminate foreign organisms that invade the body.

immunity

natural or acquired resistance provided by the immune system to a specific disease. Immunity may be partial or complete, specific or nonspecific, long lasting or temporary. Immunity is indicated by the presence of antibodies in the blood and can usually be determined with a laboratory test.

immunization

the process by which a person or animal becomes protected against a disease; the process of inducing immunity by administering an antigen (vaccine) to allow the immune system to prevent infection or illness when it subsequently encounters the infectious agent. This term is often used interchangeably with vaccination or inoculation.

immunogen

a substance capable of provoking an immune response. Also called an antigen.

immunogenicity

the ability of an antigen or vaccine to stimulate immune responses.

incidence

the rate of occurrence of some event, such as the number of individuals who get a disease divided by a total given population per unit of time.

incubation period

the time from contact with infectious agents (bacteria, viruses, fungi, or parasites) to onset of disease.

IND (investigational new drug)

The pre-approval status of an experimental drug or biologic (e.g., vaccine)after the US Food and Drug Administration (FDA) agrees that it can be tested in people

(generally done in order to collect sufficient data for licensure). "IND" often refers to the application to obtain this pre-approval status.

infectious

capable of spreading disease. Also known as communicable.

informed consent

an agreement signed by prospective volunteers for a clinical research trial that indicates their understanding of (1) why the research is being done, (2) what researchers want to accomplish, (3) what will be done during the trial and for how long, (4) what risks are involved, (5) what, if any, benefits can be expected from the trial, (6) what other interventions are available, and (7) the participant's right to leave the trial at any time.

IRB (institutional review board)

a committee of physicians, statisticians, community advocates, and others that reviews clinical trial protocols before they can be initiated and is responsible for monitoring the safety of clinical trials at that institution. IRBs ensure that the trial is ethical and that the rights of participants are adequately protected.

larvae

immature wingless forms of insects such as mosquitoes.

leukocyte

a white cell of the blood.

live-vector vaccine

a vaccine that uses a non-disease-causing organism (virus or bacterium) to transport foreign genes into the body, thereby stimulating an effective immune response to the foreign products. This type of vaccine is important because it is particularly capable of inducing CTL activity.

lymphocytes

small white blood cells that help the body defend itself against infection. These cells are produced in bone marrow and develop into plasma cells, which produce antibodies. Also known as B cells.

lysis

bursting (and thereby death) of a cell.

13.3 M–R

macrophage

a large cell that helps the body defend itself against disease by surrounding and destroying foreign organisms (such as viruses or bacteria).

memory cell

memory cells are a subset of T cells and B cells that have been exposed to specific foreign substances (antigens) and can then proliferate (recognize the antigen and divide) more readily when the immune system re-encounters the same antigens.

merozoite

the form of the malaria parasite that invades human red blood cells; one of the organisms formed by multiple fission of a sporozoite within the body of the host during the asexual phase of reproduction of a malarial plasmodia and other sporozoa.

MHC (major histocompatibility complex)

the gene cluster that controls certain aspects of the immune response. Among the products of these genes are the histocompatibility antigens, such as HLA class I antigens, which are present on every cell with a nucleus and serve as markers to distinguish self from non-self.

microencapsulated

surrounded by a thin layer of biodegradable substance referred to as a microsphere. A means of protecting a drug or vaccine antigen from rapid breakdown. Microencapsulation may also enhance an antigen's absorption and the immune response to that antigen.

monoclonal antibody

custom-made, identical antibody that recognizes only one epitope of an antigen.

monocyte

a large white blood cell in the blood that ingests microbes or other cells and foreign particles. When a monocyte passes out of the bloodstream and enters tissues, it develops into a macrophage.

monovalent vaccine

a vaccine that contains only one antigen.

mucosal immunity

resistance to infection across the mucous membranes. Mucosal immunity depends on immune cells and antibodies present in the linings of respiratory tract, reproductive tract, gastrointestinal tract, and other moist surfaces of the body exposed to the outside environment.

mucous membrane

the lining of certain cavities, such as the nose and mouth and intestinal tract, that produces a protective layer of mucus.

nucleus

the central controlling body within a living cell, usually a spherical unit enclosed in a membrane and containing genetic codes for maintaining life systems of the organism and for issuing commands for growth and reproduction.

oocyst

a parasite stage within the mosquito, produced by the union of male and female gametes.

pandemic

an epidemic occurring over a very large area.

parasite

an animal (or plant) that must live on or in an organism of another species, from which it draws its nourishment.

parenteral

administered intravenously or by injection. For example, medications or vaccines may be administered by injection into the fatty layer immediately below the skin (subcutaneous), or into the muscle (intramuscular). Medications, but not vaccines, can also be administered into a vein (intravenously).

pathogen

an organism (e.g. bacteria, viruses, parasites, and fungi) that cause disease in human beings.

pathogenesis

the origin and development of a disease. More specifically, it's the way a microbe (bacteria, virus, etc.) causes disease in its host.

pharmacokinetics

the processes of absorption, distribution, metabolism, and excretion of a drug or vaccine.

Phase 1 vaccine trial

a closely monitored clinical trial of a vaccine conducted in a small number of healthy volunteers. A Phase 1 trial is designed to determine the vaccine's safety and immunogenicity in humans, its metabolism and pharmacologic actions, and side effects associated with increasing doses.

Phase 2 vaccine trial

controlled clinical study of a vaccine to identify common short-term side effects and risks associated with the vaccine, to collect additional information on its im-

munogenicity, and to collect initial information on efficacy via live agent challenge of vaccinated volunteers. Phase 2 trials enroll some volunteers who have the same characteristics as persons who would be enrolled in an efficacy (Phase 3) trial of a vaccine. Phase 2 trials enroll up to several hundred participants and have more than one arm.

Phase 3 vaccine trial

large controlled study to determine the ability of a vaccine to produce a desired clinical effect on the risk of a given infection, disease, or other clinical condition at an optimally selected dose and schedule. These trials also gather additional information about safety needed to evaluate the overall benefit-risk relationship of the vaccine and to provide adequate basis for labeling. Phase 3 trials usually include several hundred to several thousand volunteers.

placebo

an inactive substance administered to some study participants while others receive the agent under evaluation, to provide a basis for comparison of effects.

Plasmodium

the genus of the parasite that causes malaria. The genus includes four species that infect humans: *Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae, and Plasmodium ovale*.

pre-erythrocytic

prior to entering red blood cells.

prevalence

the number of people in a given population affected with a particular disease or condition at a given time. Prevalence can be thought of as a snapshot of all existing cases at a specified time.

prime-boost

administration of one type of vaccine, such as a live-vector vaccine, followed by or together with a second type of vaccine, such as a recombinant subunit vaccine. The intent of this combination regimen is to induce different types of immune responses and enhance the overall immune response, a result that may not occur if only one type of vaccine were to be given for all doses.

priming

giving one vaccine dose(s) first to induce certain immune responses, followed by or together with a second type of vaccine. The intent of priming is to induce certain immune responses that will be enhanced by the booster dose(s).

prophylaxis

prevention of disease.

protein

a type of organic compound that is one of the major components of cells and tissues.

protocol

the detailed plan for a clinical trial that states the trial's rationale, purpose, vaccine dosages, routes of administration, length of study, eligibility criteria, and other aspects of trial design.

randomized trial

a study in which participants are assigned by chance to one of two or more intervention arms or regimens. Randomization minimizes the differences among groups by equally distributing people with particular characteristics among all the trial arms.

reactogenicity

the capacity of a vaccine to produce adverse reactions.

reagent

any chemical used in a laboratory test or experiment.

receptor

a molecule on the surface of a cell that serves as a recognition or binding site for antigens, antibodies, or other cellular or immunology components.

recombinant DNA technology

the technique by which genetic material from one organism is inserted into a foreign cell in order to mass-produce the protein encoded by the inserted genes.

resistance

the ability of an organism to develop strains that are impervious to specific threats to their existence. The malaria parasite has developed strains that are resistant to drugs such as chloroquine. The *Anopheles* mosquito has developed strains that are resistant to DDT and other insecticides.

RTS,S/AS01

Malaria vaccine candidate

13.4 S–Z

schizont

a developmental form of the malaria parasite that contains many merozoites.

species

organisms in the same genus that have similar characteristics.

sporozoite

the infectious form of the malaria parasite, which is injected into people by a feeding mosquito; a spore formed after fertilization; any of the elongated, nucleated cells by division of the encysted zygote of a sporozoon, which undergo multiple fission to give rise to merozoites.

statistical significance

the probability that an event or difference occurred as the result of the intervention (vaccine) rather than by chance alone. This probability is determined by using statistical tests to evaluate collected data. Guidelines for defining significance are chosen before data collection begins.

sterilizing immunity

an immune response that completely prevents the establishment of an infection.

strain

a genetic variant within a species.

stratification

separation of a study cohort into subgroups or strata according to specific characteristics.

surrogate marker

an indirect measure of disease progression.

T cell

white blood cell critical to the immune response. Among these are CD4+ T cells and CD8+ T cells.

T lymphocyte proliferation assay

a test used to measure the memory of T cells to antigens.

titer

the quantity of a substance required to produce a reaction with a given volume of another substance, or the amount of one substance required to correspond with a given amount of another substance.

vaccination

injection or introduction of a killed or weakened infectious organism in order to prevent the disease.

vaccine

a preparation that stimulates an immune response that can prevent an infection or create resistance to an infection.

vector

the organism, typically an insect, that transmits an infectious agent to its alternate host, typically a vertebrate; in human malaria, the vector of the parasite are mosquitoes, the "carriers" or "hosts" are humans. In vaccine research, a bacterium or virus that does not cause disease in humans and is used in genetically engineered vaccines to transport genes coding for antigens into the body to induce an immune response.

virulent

able to cause disease and characterized by rapid course or severity.

virus

a tiny organism that multiples within cells and causes disease such as chickenpox, measles, mumps, rubella, pertussis, and hepatitis. Viruses are not affected by antibiotics, the drugs used to kill bacteria.

Courtesy: PATH Malaria Vaccine Initiative