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Malaria: A backyard enemy

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Abstract
Malaria is an acute fever illness that affects people and is spread by female Anopheles mosquitoes, which bite humans to spread the *Plasmodium parasite*. Among the five parasite species that cause malaria in humans are *Plasmodium falciparum* & *P. Vivax*, the two most hazardous types. *P. falciparum* is the most prevalent and dangerous *Plasmodium parasite* just on the continent of Africa. *P. Vivax* is the most prevalent malaria parasite from outside sub-Saharan Africa. Malaria's earliest symptoms, such as fever, headache, & chills, might be mild and difficult to identify. Ten to fifteen days after the infected insect bite, they normally manifest. Malaria Without treatment, *P. falciparum* malaria can progress to severe illness and mortality in less than 24 hours. Vector management is an essential component of malaria prevention, control, and extermination strategies because of its high effectiveness in preventing infection and reducing disease transmission. The two main treatments are indoor residual spraying and insecticide-treated nets (ITNs) (IRS). Chemoprevention is the term used to describe the administration of medications, either alone or in combination. Infestations of malaria and the consequences that result are avoided.

Keywords: Malaria, plasmodium, vector-borne disease, zoonoses

1. Introduction
The female mosquitoes of the species Anopheles that have been infected with the *Plasmodium parasite*s that cause malaria will bite a human victim. Malaria continues to be the biggest cause of death worldwide, although undesirable results can be avoided with early diagnosis and prompt treatment. While malaria occurs as an imported disease from endemic places in the industrialised world, it is the most prevalent disease across Africa and several countries of Asia. China employed the sweet sagewort herb to cure malaria fever in the 2nd century BC. Quinine wasn't utilised as a malaria preventative until much later. The fight to eradicate malaria began on a global scale around 1955, although Croatia announced 1964 as the year of success. A global malaria control programme is run by the World Health Organization, with an emphasis on strengthening primary healthcare locally, early disease detection, prompt treatment, and preventing disease. Malaria is not as prevalent as it was five years ago. However, there's been an upsurge in malaria cases globally during the past few years. It is making progress towards the WHO's goals, but that rate of change has slowed [1].
A microscopic protozoon from the *Plasmodium* species family, which includes multiple subspecies, is the cause of malaria. Human illness is caused by some Plasmodium species [2-5]. An internal parasite of the genus Plasmodium that builds up malaria pigments (an insoluble metabolite of hemoglobin). Parasites on several vertebrates, some in tissue and others in red blood cells. Five of the 172 Plasmodium species that exist can infect people.
Globally, malaria reportedly afflicted 219 million people and was responsible for 435,000 fatalities in 2017. More than a century of international work and study has gone into bettering malaria prevention, diagnosis, and treatment, and as a result, the burden of morbidity and mortality has increased. The most prevalent illness in Africa and other Asian nations with the greatest number of native cases is malaria. The fatality rate from malaria varies from 0.3-2.2% globally and from 11–30% in areas with tropical climates where severe forms of the disease are present. The incidence of malaria pathogen infections has risen since 2015, according to several research [3, 4].
The five species that can infect people. *P. Malariae*, *P. falciparum*, *P. Vivax*, *P. Ovale*, and *P. Knowlesi* are among them. The zoonotic malaria *P. Knowlesi* is known to exist in South-East Asia. Humans are rarely infected by other animals [5-8]. Malaria (Latin for Malus aer—bad air) is a disease that is brought on by all of the Plasmodium species that have been mentioned.

Likewise, the morphology and biology of every species are the same [9]. The sexual and asexual phases of the Plasmodium life cycle, which involves mosquitoes as the vectors and vertebrate hosts as the hosts, are both exceedingly complex. The sexual stage of the parasite's life cycle occurs in the vectors, mosquitoes. Humans, the intermediate host for malaria, go through the asexual phase of their life cycle [9, 10]. Only female Anopheles mosquitoes carry the human malaria virus. The infection, disguised as a sporozoite, enters the animal blood after being bitten by one of these infected female mosquitoes and, after 30 min of blood flow, permeates the hepatic [11]. The first stage of Plasmodium asexual reproduction takes place in the hepatocytes, then the erythrocytes. All Plasmodium species cause erythrocytes to rupture [12, 13]. *P. vivax* and *P. malariae* are the most prevalent species in Europe and the Americas while *P. falciparum* is the most prevalent species in Africa. Malaria is regarded as the most pervasive illness in Africa, according to Cartwright and Biddis [14]. A tiny protozoon from the Plasmodium species family that includes multiple subspecies is the cause of malaria [14].

1.1 History of Malaria

It is thought that malaria outbreaks have existed since the dawn of humanity. It is the most prevalent sickness that has caused numerous fatalities and is even suspected of being to blame for major military losses and the disappearance of several nations [15]. Both the Ebers Papyrus and ancient Chinese medical history from 2700 BC contain the earliest mention of malaria [2]. Malaria claimed the life of military tycoon Alexander the Great [15]. The fact that George Washington, Albrecht Dürer, Cesar Borgia, and Christopher Columbus were all affected by this illness is proof that it existed at all social strata [16, 17]. Although malaria and its signs were a common occurrence for the ancient people, the fever which would strike patients was often linked to different supernatural powers and vengeful gods. Thus, it is said that both the Canaanite Zebub (also known as "Beelzebub" or "the master of the fly") and the Ancient egyptian deity Nergal was shown as stylised two-winged insects [17]. Hippocrates, who lived in the fourth century BC, associated this illness with the evaporation from wetlands, which when inhaled led to the illness. This description fully disregarded the illness' demonic origins. Up until Laveran found the disease's cause in 1880, this idea persisted [18]. The first time parasites were discovered in the blood of malaria victims was by French military surgeon Laveran, for which he was awarded the Nobel Prize of 1907 [19].

1.2 The diagnostic tests (History)

If untreated, malaria can persist for three to five years and, depending on the underlying cause, may recur. Relapse in *P. Vivax* and *P. ovale* infections can occur months or years after the original infection due to the hypnozoites in hepatocytes or the persistence of merozoites in the blood. In Southeast Asia, vivax malaria relapse is also frequent following *P. falciparum* infection. Relapse cases were noted in *P. falciparum* infestations, which can quickly produce a high parasitemia and cause erythrocyte destruction [20, 21]. Children, pregnant women, immuno-compromised patients, and those with splenectomies are particularly susceptible to plasmodium infection, as are healthy individuals who have never had contact with *Plasmodium*. Clinical observations should always be supported by a malaria laboratory result. Giemsa-stained blood film light microscopy is the method of choice for diagnosing malaria. In many areas of sub-Saharan Africa, this approach is not available because to a shortage of suitable staining supplies and skilled professionals. It is feasible to identify an infection with 10-100 parasites per litre of blood, depending on professional experience and the specificity of the approach. A negative result in patients who have symptoms does not rule out malaria; however, if the illness is still suspected, smears should be performed three times at intervals of 12–24 hours [22-24]. Immunofluorescence antibody testing has historically been used to diagnose malaria utilising serologic tests (IFA). IFA takes a lot of time and is arbitrary. Rapid Diagnostic Tests (RDT) for the identification of antigens in the blood can confirm the presence of parasite antigens. These tests can be carried out without the use of any electrical apparatus or any specialised knowledge or abilities. The RDTs are currently advised by the who to be the first test of choice in all parts of the world where malaria is endemic. Depending on the chosen antigens included in the test, the accuracy of the antigens test varies. 50–100 parasites per litre (PfHRP2) to 100 parasites per litre for various RDTs [25-28]. In 2007, the FDA authorized the first RDT test. It is advised that microscopic blood analysis be used to corroborate the outcomes of all RDT tests [29].

Antigens identified with the RDT test are known to persist in the bloodstream after antimalarial therapy, however the presence of these antigens changes. Less than 10% should be the false-positive rates [30]. In the eight rounds of testing, several RDTs found malaria at a low parasite density (200 parasites/L), had low false-positive rates, and could identify infections with either *P. falciparum* or *P. Vivax* or both [30]. *P. Vivax* had low false-positive rates, ranging between 5% and 15%. On the other hand, *P. falciparum* has false-positive rates that range from 3 to 22% [30, 31]. If the parasite concentration is low or if changes in the parasite antigen's synthesis affect the RDT's ability to detect the parasite, good RDTs may occasionally produce false-negative results. Another approach for detecting malaria is the polymerase chain reaction (PCR). In terms of detecting malaria, this method is both more sensitive and precise than any other traditional methods. It has a detection limit of 1 parasite/L. The presence of parasite nucleic acid is confirmed by a PCR test [32-36]. In endemic areas, PCR results are frequently not available quickly enough to be helpful in diagnosing malaria. However, in labs that may not have microscopists on staff, this technique is most effective for identifying Plasmodium species after confirmation by microscope or RDT test. The monitoring of individuals on antimalarial medication can also benefit from PCR [36, 37]. Indirect methods are used to demonstrate the presence of antibodies to the substances that cause malaria. These methods are used to study people, including blood donors and expecting moms, who might or might not have had malaria. The method is based on an immunofluorescent assay or an ELISA test (IFA). The IFA is accurate and precise, yet it cannot be applied to a huge number of samples, and the results are opinions. For serological testing, ELISA assays are used more commonly. For the patient to receive the best care and to stop the spread of the virus within the community, a prompt and accurate malaria diagnosis is crucial.

2. Treatment of Malaria

A plant known as Qinghai (Latin: *Artemis annua*) was used to treat malaria in China as early as the second century BC [38]. The cinchona drug against malaria was made first from bark of the Cinchona (Latin: *Cinchona succirubra*), which was taken over by the Spanish invaders in Peru much earlier, in the 16th century. The active component quinine, which had been employed for so many years in the post-exposure prophylaxis and therapy of malaria, was extracted from this plant by French scientists Pierre Joseph Pelletie and Joseph Bienaimé Caventou in 1820. Artemisinin, a name that has become synonymous that has proven to be particularly effective in treating malaria, was first isolated from the plant Artemisia annua by a team of Chinese researchers headed by Dr. Youyou Tu in 1970 [39]. The two essential antimalarial drugs currently in use, artemisinin from the herb Qinghao (*Artemisia annua* L, China, 4th century), and quinine from Cinchona, are both derived from plants whose pharmacological significance has been known for millennia (South America, 17th century). Quinine is among the most potent antimalarial medications on the market right now, along with artemisinin [39, 40].

The majority of artemisinin-related medications currently being used are serotonergic drugs, which are triggered by degradation to the intermediate dihydroartemisinin. Drugs containing artemisinin display their antimalarial activity by creating the radical through a peroxide bond [40-42]. In order to assure a high incidence of *P. falciparum* malaria cure and stop the spread of drug resistance, the World Health Organization (WHO) advises using artemisinin-based combination treatments (ACT). Due to widespread resistance to amodiaquine, sulfadoxine-pyrimethamine, and chloroquine, ACT treatments are employed. There is a tonne of room for more investigation because of the distinctive structure of artemisinins. The elucidation of pharmacological targets and methods of action, the enhancement of pharmacokinetic characteristics, and the discovery of a younger generation of antimalarial drugs against Plasmodium strains are all given considerable attention [42]. Dichlorodiphenyltrichloroethane (DDT) was first created in 1874 while Othmer Zeidler was a Ph.D. student in chemistry. DDT had no utility at the time and was only a wasteful chemical [43]. In 1939, Paul Müller from Switzerland found that DDT has an insecticide effect. At the conclusion of World War II, DDT was first employed to combat malaria. Due to DDT's early effectiveness during World War II, other chlorinated hydrocarbons were soon introduced and used extensively to combat diseases spread by mosquitoes [43]. Malaria has been recognised with five Nobel Prizes: 2015 saw Youyou Tu. Ronald Ross was awarded the Nobel Prize of 1902 for his discovery of the role that mosquitoes play in the biology of a pathogens that cause malaria. Charles Louis Alphonse Laveran, who has already been discussed, received the Nobel Prize in 1907 for his discovery of the causal agent [44, 45]. It was awarded to Julius Wagner-Jauregg in 1927 for his work using pyrotherapy to induce malaria as a cure for paralytic dementia. For the chemical pesticide formula dichlorodiphenyltrichloroethane, Paul Müller won it in 1947.

Clinical trials for an antimalarial vaccine are now being conducted. Many efforts have been undertaken over the years to create preventive antimalaria vaccines that are both efficient and inexpensive. The last few years have seen the completion of many clinical trials. The creation of new malaria vaccines is currently undergoing clinical trials. The *P. Vivax* vaccine is the main problem, and further research is needed to find new vaccine candidates [46–48]. A successful antimalaria vaccine—one with efficacy more than 50%—has not yet been created, despite several decades of study in this field [49–51]. There are now 48 clinical studies with a Eudra CT strategy for plasmodium listed there in the European Union Clinical Research Register, 13 of which are ongoing diagnostic tests [52-54]. The best defence against malaria is to avoid being bitten by insects. In order to treat malaria, antimalarial medications that have developed from quinine are used. Malaria vaccinations are divided between pre-erythrocytic (sporozoite and hepatocytes stage), plasma, and transmitting vaccines based on their main effects [54]. Because the plasmodium is a complicated system with a complicated life cycle that can evade the immune system, developing a vaccine is highly challenging. The Plasmodium life cycle goes through morphological changes and displays antigenic diversity at various phases. Clinically tested drugs were largely ineffectual, according to the results [55]. But numerous researchers from all over the world are attempting to create a vaccination that is efficient [56–59]. Since medication, insecticide, and bed nets coated with pesticides have not been able to completely eradicate malaria, the World Health Organization considers the hunt for a vaccine to be one of the most significant research topics in public health (WHO).

For travel to endemic areas where malaria is prevalent, doxycycline is recommended. When ACT is not available or artesunate fails to treat severe malaria, it is often used in conjunction with quinine or artesunate to treat malaria. The inability of youngsters and pregnant women to take doxycycline is a drawback [29]. Aside from during the first three months of pregnancy, ACTs are advised for the malaria treatment due to *P. falciparum*'s widespread resistance to chloroquine. ACTs combine an antimalarial derivative that rapidly reduces parasitemia with a companion medication that kills any residual parasites over a longer period of time. Artesunate, atovaquone, dihydroartemisinin-piperaquine, artemisinin, and budesonide with sulfadoxine-pyrimethamine are the most frequently used ACTs.

The effectiveness of ACTs against all strains of *P. falciparum* was high until recently when treatment failure rates in several regions of Southeast Asia increased. An alternative non-artemisinin-based medication, atovaquone-proguanil, is beneficial for specific patients where therapy with conventional ACTs has failed. Although, because to the potential for the quick emergence of atovaquone resistance, it is not recommended for widespread implementation in endemic nations. Quinine is still effective despite requiring a lengthy course of therapy, being associated with a poor prognosis, especially by youngsters, and needing to be used in conjunction with another medication, such as amoxicillin or clindamycin. Except in cases of *P. Vivax* that is chloroquine-resistant, which calls for the administration of an ACT, straightforward *malaria, falciparum,* and *ovale* plasmodium are treated with chloroquine [60-62].

3. Malaria in European countries

Malaria outbreaks hit Europe in the 17th century and during the Roman Empire [63–64]. It was handled as any illness that people at the time experienced up only until 17th century. The treatments used, which included bloodletting, fasting, and bodily purging, were insufficient. The medical bark of both

the Cinchona tree, which contains quinine, was mentioned as the earliest effective antimalarial medication and was initially utilised either by Peruvian population [64]. It is thought that the treatment was introduced throughout Europe by Spanish Jesuit missionaries in the third decade of the 17th century [65].

The research of a small number of researchers has contributed to modern knowledge of malaria treatment. Gustave Laveran, and Giovanni Battista, Ronald Ross, Grassi are a few of the researchers. In the bloodstream of mosquitoes, Laveran, a military physician in Algerian, discovered the malaria-causing agents in November 1880 and determined that they were a type of protozoa [66]. Laveran discovered that protozoa, like bacteria, could have a parasitic lifestyle inside of humans and inflict sickness [66]. Approximately two decades later, or more specifically in 1898, an Indian military doctor named Ronald Ross made the discovery that infected mosquito saliva may transmit bird malaria, and the same year, an Italian scientist named Giovanni Battista Grassi established that mosquitoes can transmit malaria to people. Additionally, he demonstrated that only one species (Anopheles) of mosquitoes, not all mosquitoes, transmit malaria. Further investigation was made possible by this discovery. The global fight against malaria began in 1955. The programme was centred on the use of DDT to kill mosquitoes, and it encompassed regions of the U.S.A, South Asia, Carribean and the South Europe and that were susceptible to the disease, but only three African nations (Zimbabwe, Swaziland, South Africa). The WHO declared that plasmodium had been exterminated in Europe in 1975 and that all instances that had been documented had been brought there by immigrants [67, 68].

3.1 Croatian malaria

The Charter of the Town of Korula from 1265 is the first written record in Croatia that attests to the control of malaria. The public healthcare system that was designed to cure malaria was founded in 1874 by the Law on Healthcare System of Croatia and Slavonia. There was no medical expertise or awareness of malaria, but drainage was done to bring "good air" to the city [69, 70]. Giuseppe Arduino, a physician, informed the Austrian authorities in 1798 that Istria had malaria. A planned hygienic solution of draining wetlands was approved by a government delegate named Vincenzo Benini [71].

The drainage of marshes in the vicinity of Pula and on the archipelagos started in 1864, and since 1902, a programme for the treatment of malaria patients with quinine has been implemented [72]. The Hospital for Malaria was established in Trogir in 1922. Under the direction of Dr. Otmar Trausmiller, a project was launched in 1923 on the island of Krk to remove malaria by sanitising water surfaces and administering quinine to patients. By transplanting the fish *Gambusia holbrooki* to Istria as well as the coast, bio control of mosquito has been established since 1924 in addition to chemical treatment [73]. A law requiring village sanitation was adopted in 1930, and as a result, safe wells and water infrastructure were built, helping to reduce the risk of malaria. Regular larvicidal treatment of standing water and toxic green (copper acetoarsenite) fogging of mosquitoes were implemented. Since malaria is spread by mosquitoes that reside near water and is common near wetlands, streams, ravines, and other such areas, it has historically been a problem in Croatia [74]. In the region of Croatia, the Croatian Littoral, Istria, and river flows, it was pervasive. It was common on some islands, including Krk, Rab, and Pag, in the Croatian Littoral, but largely avoided the mainland. Due to the severity and regularity of epidemics, the parasitologist from Germany Schaudin and the Italian malarialologist Grassi arrived in Dalmatia. The quininization processes started to be used, and in 1908 24 doctors and 423 tablet distributors were sent to the villages to distribute tablets that were to be taken on a regular basis to eliminate malaria [75].

When visiting Dalmatia, ethnographer Albert Fortis (1741–1803) recorded impressions and data about the malaria outbreak that plagued the basin of the Neretva River. Fortis wanted to travel there, but the crew members were reluctant. This was likely because they were reluctant to visit a location where the Neretva plague had recently broken out [76]. Malaria was the Neretva scourge, and it is thought that this is why the Neretva was given the moniker "Neretva—damned by God" [77, 78]. Fortis claims that there were so many mosquitoes in the Neretva region's wetland area that individuals had to sleep in stifling canopy tents as a form of self-defense. Additionally, according to Fortis, the number of mosquitoes that they damaged him. During his visit, Fortis saw a priest who claimed to have received a mosquito bite for a bump on his head and who thought that fever that the Neretva Valley's residents contracted was similarly a result of their exposure to insect bites [76]. Dugaki detailed some of the outbreaks in Croatia in a document. Thus, it was noticed that Nin had a limited population in 1348 as a result of the unclean air and high population mortality. In 1646, this illness was reported in Novigrad, and 1717 was a critical year for the Istrian city of Dvigrad, which has been completely evacuated as a result of malaria. The Zadar Provincial Hospital was reportedly packed with malaria patients during the turn of the twentieth century, or more specifically in 1902. About 180,000 persons in Dalmatia suffered from this ailment at the start of the 20th century, demonstrating the severity of its prevalence.

Similar effects were seen in Slavonia, where malaria was widespread in the 18th century due to the region's profusion of wetlands. Such areas were highly harmful to settlers as they were more vulnerable to the disease than the native population [78, 79]. William von Taube (1728-1778) remarked that malaria primarily affected German immigrants and it may be considered "German Graveyard" in his characterization of the illness [80]. According to Skenderovi, malaria number of fatalities among German settlers in the Danube regions where they had settled in the 18th century was also high, with Banat and Baka having the greatest rates of malaria infection. Slavonia did not have a good reputation in the 18th century. Even Taube admitted that the Habsburg Dynasty didn't really respect Slavonia and that aristocrats were reluctant to settle there. Taube listed a few reasons for this avoidance, including the polluted air and the extensive adjacent wetlands that were home to a large number of insects. Malaria had already claimed a large number of lives, so there needed to be a means to stop it from spreading further. As the Austrian Monarchy as well as other European countries realised that marsh drying was a practical solution, swamp draining began in the 18th century, resulting in cultivated fields [81]. As malaria epidemics continued to occur, the Journal Article from 1877 includes one more important mention of the disease. Doctor A. Holzer, who had long served as a spa doctor, made reference to his findings from Lipik & Daruvar in it. Holzer sends a warning against the agonising illness that

spa visitors are known to suffer from most frequently in the months of August and July. The fact that no one seemed to be in excellent health was something that Holzer, a doctor, felt hard to ignore. The fact that other Croatian areas were not actually an exception was also made obvious. Holzer highlighted the example of Virovitica County, where illness was also prevalent. He wanted to halt the onset and spread of the disease. The concept was to use charcoal, since it has the capacity to absorb gases and so stop vapour in rising from the ground.

A key player in the fight against malaria was Dr. Andrija Tampar (1888–1958). Tampar established a variety of malaria stations, hygiene clinics, and public healthcare homes in addition to the Division of Malaria. Dr. Tampar has devoted his life to raising public knowledge of healthy behaviours and preventing the spread of infectious diseases. In 1927, a number of films and health talks about malaria were shown in Osijek, among which was entitled "Malaria in Trogir" [82]. With the end of the Second World War, Dr. Branko Richter developed a plan to combat malaria. These measures are now routinely used in countries wherever malaria is a problem, claims Dr. Andrija Tampar [83]. In Croatia and throughout Yugoslavia, DDT has been used to eradicate malaria since 1947 [83]. Malaria is the parasite disease that causes the most fatalities overall, making it one of the most contagious illnesses. By 1975, there was no malaria throughout Europe. Following that year, cases of malaria in Europe are associated with travel and immigration from endemic countries. Even while there is a low likelihood that plasmodium will spread across Europe, particularly in the west and northwestern, it is nevertheless crucial to raise public awareness of health issues and take precautions to prevent the illness from getting to the continent's least vulnerable areas [84]. Imported malaria has occasionally occurred in Croatia since 1964. The imported malaria is evident given Croatia's emphasis on maritime concerns, tourism, and business trips. In particular, sailors from both local and foreign countries as well as tourists, particularly from Africa and Southeast Asia, are to blame for spreading malaria into Croatia [85-87]. 423 imported cases of malaria have indeed been found since the disease's eradication, according to reports from the Croatian National Health Institute [86-90].

4. Global Trends in Malaria

The WHO's 2017 assessment of plasmodium malaria shows how difficult it is to achieve the two main goals of a global, professional approach to malaria. One of these is a reduction in morbidity and mortality of at least 40% by 2020. Whilst evidence suggests a slowing and perhaps an increase in incidence in 2015 and 2017, the rate of malaria has dramatically dropped since 2010. There have been 219 million incidences of malaria during 2017, up above 190 million cases in 2015 and 239 million people at risk in 2010. As the initial and most crucial step in eliminating malaria globally, decrease the number of cases in the countries with the largest burdens of the disease (many in Africa). There have been 435,000 malaria-related deaths globally in 2017, down to minimum threshold in 2016 and 607,000 in 2010, as a result of the drop in disease-related fatalities [91]. As a result, malaria incidence in India decreased by 24% in 2017 as compared to 2016. More nations worldwide reported fewer than 10,000 cases of malaria, up from 37 in 2010 through 44 in 2016, and afterwards 46 in 2017. In addition, the number of nations with fewer than 100 countries increased from 15 in 2010, to 26 in 2017. [92, 93].

5. Conclusions

A global campaign to end malaria was started in the 1950s, but it ultimately failed because of logistical challenges, pesticide-resistant insects, drug-resistant *Plasmodium parasite*s, and other problems. Additionally, the initial eradication efforts did not cover most of Africa, which is where malaria is most common. Despite the reality that the vast majority of cases of malaria may be treated successfully with current anti-malarial drugs, *P. falciparum* fatalities and morbidity are on the rise. The developing parasite resistance to drugs and the rising vector resistance to insecticides are the two main causes of this issue, which has become one of the most significant issues in the management of malaria in recent years. It has been established that all antimalarial drugs are resistant. As a result, research is currently being conducted to create and test new antiretroviral therapy as well as a potential vaccine, mainly due to the unanticipated mass movement of individuals (birds, parasite-transmitting disease insects) from areas with a severe and diversified infestation. The eradication of malaria in several countries has provided evidence that current technology might be sufficient. The rising number of ACT failures raises the possibility that the present approaches to eradicating malaria are insufficient. As a result, it will be important to update and adapt the principles, techniques of management positioning, and methods of treating malaria in order to manage and prevent the disease's spread successfully.

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