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The main measures adopted for vector and parasitological control of malaria: A systematic review

As principais medidas adotadas para controle vetorial e parasitológico da malária: Uma revisão sistemática

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ABSTRACT
Malaria is a parasitic disease caused by protozoa of the genus Plasmodium, which for many years have created serious public health problems worldwide, being one of the main causes of morbidity and mortality in children under 5 years of age and pregnant women. One of the most common forms of transmission is through the bite of an infected female mosquito of the genus Anopheles. As it does not have an effective vaccine so far, several interventionist measures are being carried out to combat it through insecticides against insect vectors. To this end, over the years, insecticide-treated bed nets made from pyrethroids or deltamethrin have been developed, which have facilitated the reduction of malaria transmission in many countries that have used it. In addition, there is Causal Chemoprophylaxis (QC), which the World Health Organization (WHO) recommends for use preferably for people classified in the risk group due to the adverse effects that these drugs cause in the victim. This work aims to carry out a survey of the scientific evidence on the main strategies that are adopted for the control of the malaria vector and parasite, in the period between 2012 and 2020. In this logic, we searched for scientific articles whose central approach was related to the intervention actions used to control the malaria vector and parasite. Thus, we searched for scientific articles available exclusively in the database of the journal Scielo, where the articles were filtered, taking strict advantage of those published in the period from 2012 to 2020. The terms and expressions "control", "Malaria", with the Boolean interposition "AND" were used as controlled descriptors. A total of 35 articles were obtained, of which 16 were excluded because they did not address the subject of intervention actions for malaria control. Of the 19 studies selected, 12 specifically reported strategies for vector or parasitic control of malaria, while 7 dealt only with action plans used for malaria epidemiology surveillance. It is recommended that the next research to be carried out research more about the natural products of plant origin considered promising for a possible replacement of such antibiotics.

Keywords: Control, Malaria, Insecticides, Mosquitoes, Surveillance, Epidemiology.

1 INTRODUCTION

Malaria is a parasitic disease caused by protozoa of the genus Plasmodium, which for many years have created serious public health problems worldwide. One of the most common forms of transmission is through the bite of an infected female mosquito of the genus Anopheles or through blood transfusion or also by organ transplantation. The most common species that infect humans are: Plasmodium vivax, P. falciparum and P. ovale sp that mainly attack erythrocytes (RIOS-ORREGO, 2017; ALHO, 2015). Because of this, several countries have adopted different types of strategies to control this disease, such as the use of long-lasting contact insecticides DDT (Dichloro-Diphenyl-Trichloroethane) and GHTsG (Hexachlorane) that were already widely used in the late 1940s, and facilitated the mass destruction of flying mosquitoes in their natural habitats in the Union of Soviet Socialist Republics (USSR) (SHIPITSINA, 1964).

Previously, in present-day South Sudan, great efforts were made for the entomological control of mosquitoes, where "internal residual spraying" and larvicide used to reduce malaria transmission were carried out (CHANDA., 2013). However, the contact insecticide DDT was highly effective in the control of malaria-transmitting mosquitoes, its use contributed greatly to the reduction of the incidence of this disease, but its constant and widespread applications for medical and agricultural purposes induced resistance to DDT in mosquitoes (BAGIROV et al., 1973; BERG, 2009).

A few years after the Second World War, several pilot projects emerged that made important interventions to combat malaria in different African ecological environments, which used techniques based on the elimination of the insects that cause this disease. For this purpose, the following were used: DLD (Dieldrin), HCH (Lindane) and DDT. However, the results were not satisfactory at the expected level of the spraying campaigns (WEBB JR, 2014). Studies conducted by Protopopoff et al. (2013) confirm the report that there are high levels of resistance in *A. gambiae* populations to pyrethroids and DDT. These mosquito species developed phenotypic resistance to these insecticides because they had the presence of the knock-down gene (kdr), an alteration in chromosome 21. However, the resistance of vectors to DDT and pyrethroids is partially attributed to decreased efficacy of the insecticide caused by point mutations in its common target site, the voltage-gated sodium channel (VGSC), supposedly also sharing some metabolic resistance mechanisms.

Da Silva et al.,(2016) observed that the permanence of *Plasmodium falciparum* and the rate of gametocytes in villages decreased greatly after the implementation of Long-Lasting Insecticide-Treated Mosquito Nets (LLINs) in several countries. Proof of this was the success of Insecticide-Treated Bed Nets (ITNs), which after the introduction of lambdacyhalotrin-treated bed nets, facilitated the control of A. darlingi in southern Venezuela, registering a 56% reduction in malaria cases in local indigenous populations, considering that it is essential to use LLINs in accordance with WHO recommendations.

The WHO recommends the use of ITNs and LLINs to reduce episodes of this disease among children under 5 years of age by approximately 50% and all-cause mortality by 17%. The organization recommends the provision of free universal coverage containing ITNs to people at risk for use above 80% in people's homes, in addition to carrying out periodic mass campaigns, places for routine distribution of ITNs (WILLEY et al., 2012).

Malaria control measures in the USSR were conducted simultaneously in several directions: treatment and prophylactic actions, as well as vector control were carried out mainly by malaria stations. P. G. Sergiev also established the country's first antibiotic laboratory at the institute, where a new antibiotic (Gramicidin S) that was very pertinent in the war period was developed in 1942 by Georgy Frantsevich Gause and Maria G. Brazhnikova (GAUSE, BRAZHNIKOVA, 1944).

On the other hand, the plants of the family Annonaceae (order Magnoliales) stand out among the most traditionally used against malaria. The antiprotozoal activity of this plant in the treatment of malaria, American trypanosomiasis and leishmaniasis is directly related to secondary metabolites, acetogenins, steroids and terpenes that are found in the various parts of the body of these plants (Ocampo & Ocampo, 2006).

Since malaria continues to be a disease with a lot of prominence in public health in some endemic countries, especially on the west coast of Africa where our country is located, Guinea-Bissau, which also has many cases of morbidity and mortality due to malaria. In this way, it is possible to understand that this study on the main measures adopted in the control of the malaria vector and parasite - is a work that can serve as a basis for literature at the academic level, especially in the fields of biological sciences, health, basic sanitation, environmental education, etc....; And not only that, but it also brought the possibility of deepening my technical and scientific knowledge on this subject. However, studies of this nature can help in the understanding and awareness of society on how to prevent malaria.

Therefore, this study aimed to carry out a survey of the scientific evidence on the main strategies that are adopted for the control of the malaria vector and parasite, in the period between 2012 and 2020.

2 METHODOLOGY

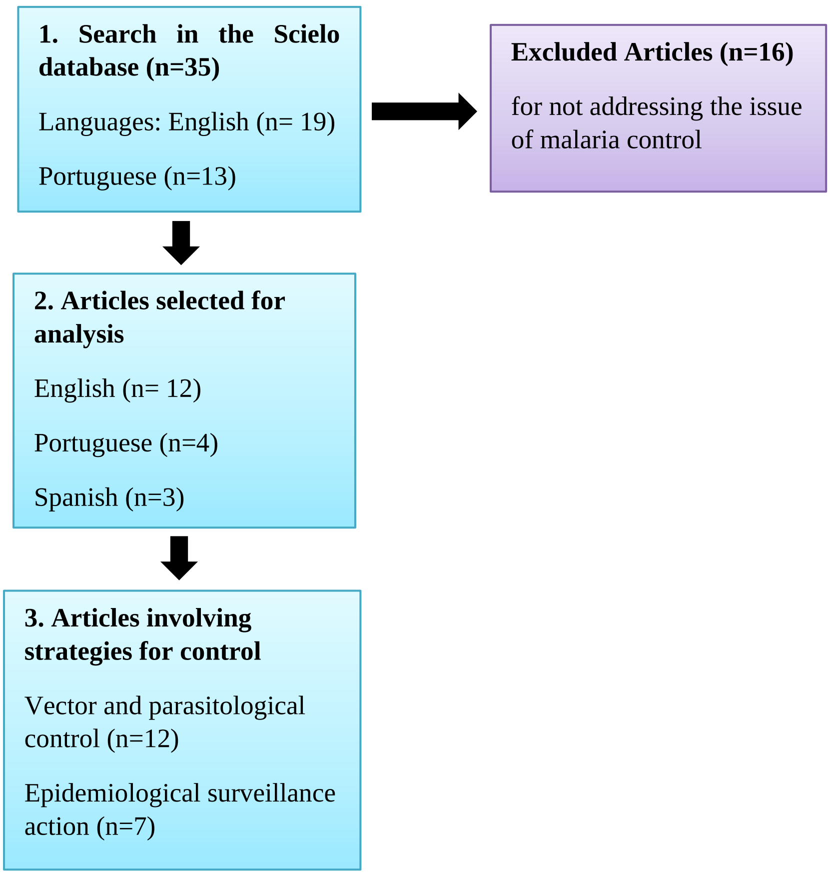
A survey of scientific articles was carried out, whose central approach was related to the intervention actions used for the control of the malaria vector and parasite worldwide. Thus, we searched for scientific articles available exclusively in the Scielo databases, where the articles were filtered, taking strict advantage of those published in the period from 2012 to 2020.

The terms and expressions "control", "Malaria", with the Boolean interposition "AND" were used as controlled descriptors. The selection of samples was based on the following inclusion criteria: articles available online in full, in the languages Portuguese, English and Spanish, which present an approach related to the controlled descriptors mentioned above. Google Translate online and the website www.onlinedoctranslator.com was used to translate the texts into foreign languages.

3 RESULTS AND DISCUSSION

From the consultation, 35 articles were obtained exclusively from the Scielo database (19 articles from English, 3 from Spanish and 13 from Portuguese), submitted to analysis, 16 of which were excluded (7 from English and 9 from Portuguese) in this screening stage because they did not present content on the actions of interventions that involve the elimination of the vector or control of the parasite that causes malaria. Of the 19 articles selected after screening, 12 specifically addressed control strategies while 7 dealt with action plans used for malaria epidemiology surveillance.

Figure 1. Represents the flowchart of the search and selection of articles



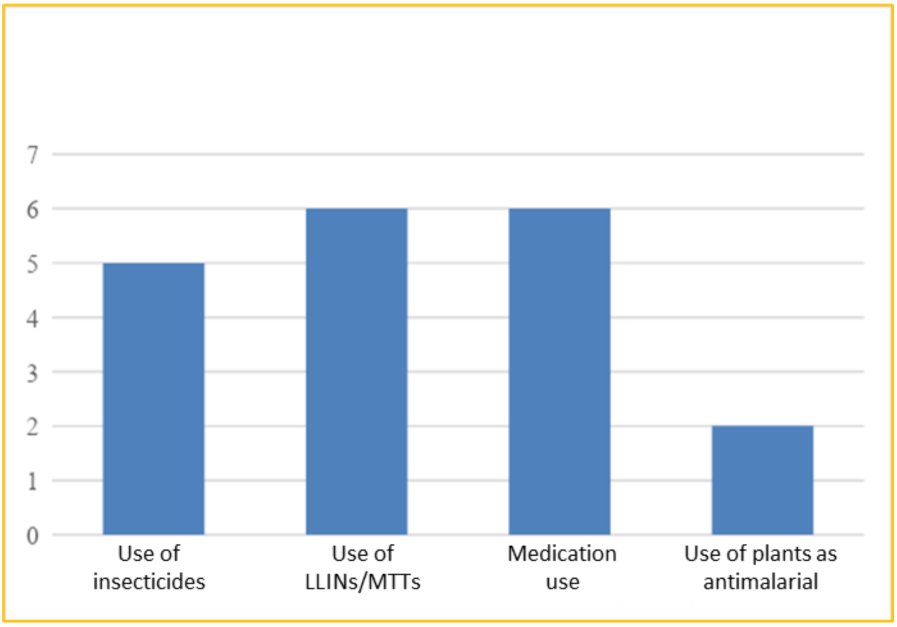


Figure 2. Number of Strategies most discussed in the analyzed articles

The investigative study by Da Silva et al. (2016) pointed out that many countries obtained satisfactory results with the implementation of Long-Term Insecticide Nets (LLINs) because their use allowed a great decrease in vector density within households. On the other hand, it was found that, in the study carried out by Protpopoff et al. (2013), the populations of mosquitoes of the species *A. gambiae and A. Darlingi* developed phenotypic resistance to insecticides known as DDT and pyrethroid, which is practically used to treat LLINs. According to these authors, this fact happens because the supposed insect vector of malaria is able to develop the knock-down gene (kdr), which is a mutation or alteration in chromosome 21.

Thus, this evidence may make sense to facilitate the understanding of the result of the evaluation of the efficacy of mosquito nets treated with long-lasting insecticides in Brazil, where 9 municipalities with and nine without installation of LLINs in the State of Rondônia were evaluated, that the result of the statistical examination of the Annual Parasite Index (API) and its annual variation, indicated that the use of such mosquito nets did not greatly reduce the API in municipalities that used mosquito nets as well as in those that did not benefit from these nets (VIEIRA et al., 2014).

(Chanda et al., 2013; Willey et al., 2012; Arroz.,2017), reported a common point that has to do with the WHO's recommendation to distribute ITNs and LLINs to groups considered vulnerable to malaria disease, especially children under 5 years of age and pregnant women. It is known that the WHO is an organization with the mission of promoting health worldwide, so it has the prerogatives to establish the recommendations that will be beneficial for global health.

The established pattern of prioritizing the distribution of insecticide-treated bed nets must be related to the fact that younger children and pregnant women tend to produce a low amount of immunity. In addition to the two vector control measures described above (use of mosquito nets and insecticides), another way to reduce malaria transmission reported in the articles is through the use of drugs such as Gramicidin S, which was considered relevant during the Second World War in the USSR (GAUSE, BRAZHNIKOVA, 1944). Pyrimethamine, Chloroquine and Primaquine were useful in the intervention carried out by antimalarial activists in sub-Saharan Africa in the 1950s and 1960s during the malaria eradication pilot project (WEBB JR, 2020).

In the following session, we present the first experiences of the USSR in the vector and parasite control of malaria in the Soviet Union, in order to present the pioneering experiences in the fight against malaria.

3.1 EARLY ANTIMALARIAL EXPERIMENTS

In the late 19th to early 20th centuries, malaria was among the most widespread diseases in the former USSR. At that time, official statistical records in 1902 indicate about 3.2 million patients who underwent diagnoses. A committee was set up among a group of Russian doctors to study and propose malaria control measures in the country. The team chaired by Soviet scientist Martsinovsky Evgeny Ivanovich, along with his companions, began to work hard to find ways to combat the malaria epidemic, holding lectures and publishing educational posters. Not only that, but this group created the first station in 1912 for malaria control in the Transcaucasian region of Batumi (present-day Georgia); where the first educational courses on the control of the disease (malaria) were promoted and many doctors participated in the training that was important for future control of the epidemic. Activities continued until they were interrupted when some conflicts began, such as the First World War in 1914, the Russian Revolution in 1917 and the Civil War in 1918-1920, which consequently caused a major collapse in the health system (SOPRUNOV; GOLD, 1986).

Despite the economic and political instability that the country was facing, a decision was made by the young Soviet government to create the Tropical Institute in Moscow in the same year of 1920. Their main job was to know how intensely malaria was spreading throughout the country and thus use this information for analysis of epidemiological situations, in order to develop a systematic strategy for malaria control and reduce its occurrence (RASHINA, 1954).

According to Sokolov (1959), between 1922 and 1934 nine Tropical Institutes were added to the domain of the Soviet Union for the control of malaria and other parasitic diseases, created in Kharkov (Ukraine), Yerevan (Armenia), Tbilisi (Georgia), Bukhara (Uzbekistan), Makhachkala (Dagestan), Baku (Azerbaijan), Dushanbe (Tajikistan), Rostov-on-Don (Russian Federation) and Ashgabat (Turkmenistan), and all these institutions operated under the leadership of the Martsinovsky Institute. As a result, the best researchers from the Moscow Institute were sent to these newly founded institutes to take up and create qualifications in the field of tropical medicine. About 2,500 malaria stations were also established throughout the USSR.

On Martsinovsky's initiative, the Russian Journal of Tropical Medicine was founded in 1923, which helped a lot in joining scientific forces in the country in 1932. The title of the journal was changed to Medical Parasitology and Diseases (SOKOLOV, 1959) and continues to publish regularly until 2020, studies by medical parasitologists from all over Russia (where information related to congresses and conferences is issued, as well as decisions on the main trends in medical parasitology (STRELKOVA, BARANOVA, KUHLS, 2020).

The Union of Soviet Socialist Republics (USSR) achieved a good result in the fight against malaria because it had the intervention of the government through centralized and concerted health policy. Investing a lot in actions to combat malaria, which helped reduce the disease, thus preventing the occurrence of later cases. With this government effort, patients had access to intensive care in a wide network of hospitals, polyclinics, antimalarial clinics, febrile medical units, and health facilities. Not only that, but it also consists of early diagnosis, reliable notification, detailed registration and follow-up of previous patients by visits to schools, factories or farms.

Comprehensive studies in Biology, Ecology and Systematics of Mosquitoes along with assessment of their epidemiological significance were carried out in different geographical zones of the USSR (BEKLEMISHEV, 1944 apud STRELKOVA, BARANOVA, KUHLS, 2020).

According to Webb Jr, (2014), in the years after the Second World War between 1950 and 1960, several pilot projects emerged that made fundamental interventions to combat malaria in different African ecological environments, which used techniques based on the elimination of the insects that transmit this disease. For this, DDT (synthetic chemical), DLD (Dieldrin), HCH (Lindane) were used. However, the results were not satisfactory at the expected level of the spraying campaigns. The fight against malaria in West Africa has seen the application of synthetic chemicals, such as larvicides, in order to annihilate mosquito larvae and pupae. Until now, the strategy adopted was visibly aimed at attacking and eliminating insect vectors capable of transmitting malaria to humans.

However, a few decades ago South Sudan, well before the partition with Sudan that culminated in its independence in 2011, being a malaria-endemic country, has also made many efforts for the entomological control of mosquitoes, however, it was possible to carry out "internal residual spraying" and larvicide used to reduce the transmission of the disease (CHANDA., 2013).

In addition to the experience of the USSR and the African continent (West Africa and South Sudan) in the process of building techniques and methods to combat malaria, there are other similar experiences that participated in malaria control, for example, that of Brazil. The first campaign to fight malaria in Brazil took place in 1905. After its opening, several programs were implemented, among them: the studies of some authors presented these experiences, for example, below are records of programs created:

Barata, 1995; Silva; Paiva, 2015; Brazil, 2017; Loyola; Silva, Tauil, 2002, provided a historical assessment of the malaria programs that were implemented over the years: from 1938 to 1939 it was implemented an antimalarial program with partial support from the Rockefeller Foundation. In 1947 the large-scale DDT Fumigation Program was created. In 1965 was the adoption of the WHO Global Malaria Eradication Program (CEM). In 1989, the Amazon Basin Malaria Control Program (PCMAM) was launched. The year 2000 was the launch of the PIACM - Plan for the Intensification of Malaria Control Activities. In 2003, the National Program for the Prevention and Control of Malaria (NMPCP) was launched. In 2015 was the creation of the Malaria Elimination Plan. Finally, it was the launch of the campaign to prevent and encourage the treatment of malaria that took place in 2017 (KAMIMURA; BURANI; SAUER, 2018).

Loiola (2002) values the contributions of these programs to the success of malaria eradication in the Amazon region, but he does not agree with the ways in which they were implemented and their efficiency, pointing out that very few municipalities fulfilled the purpose of the work plan of these programs. In 1999, 631,000 cases were registered in the Legal Amazon (AL), by 2001 they had reduced to 384,000, which corresponds to 39%, a percentage that has decreased considerably and that had not been reached since 1960.

This decrease in transmission is due to the fact that there were several changes in the implementation of the PIACM in 2000. They admit that this achievement is the result of an ongoing effort by the government over the years (KAMIMURA; BURANI; SAUER, 2018). Another record of the reduction in the incidence of malarial cases verified in Brazil recently, between 2000 and 2014, was 76.8% (FERREIRA; CASTRO, 2016).

In an investigative study carried out to discover an additional cause that resulted in the great decrease in malaria cases in the states of the Brazilian Legal Amazon (LA), based on IBGE data from 2010, about 23 million people live in LA, corresponding to 12% of the total population (KAMIMURA; BURANI; SAUER, 2018). When compiling records of malaria cases in 2000, in which 613,300 cases were found in this region, which reduced to 265,400 cases in 2011, it was a 57% drop, which practically continued to decrease until 2014 to 144,000 cases (BRASIL, 2013; FERREIRA; CASTRO, 2016). The reduction continued and a drop in occurrences of up to 129 thousand was recorded in 2016 (BRASIL, 2017).

The authors Kamimura; Burani and Sauer (2018) started from the assumption that to reduce mosquito bites in humans could also be replaced by cattle as a food host for Anopheles. A hypothesis that, according to these authors, can only be valid in cases where there is a sufficiently close coexistence between the community staff and the cattle herd or other types of animals.

Rouband (1920) describes the way cattle provided protection against malaria in some places in Normandy. All common domestic animals, with the exception of birds, are the preferred hosts of mosquitoes, and man was chosen only in the absence of these animals, pointing out that the disappearance of malaria in Denmark between 1830 and 1900 may be closely related to Anopheles' preference for animals.

Maiori (2012) points out that the great decrease in malaria transmission in Italy is due to the presence of livestock. In a study conducted by Missori, Hackett and Erich Martini in 1933, they found that in Italian areas with low malaria endemicity, the dominant anopheline mosquitoes were the ones that preferentially bite cattle, which probably prevented them from participating in the transmission of the disease in humans. This theory was further confirmed by observing the intestinal contents of engorged mosquitoes collected from animal shelters and human dwellings.

The study by Barata (1995) on the epidemiological panorama of malaria in Brazil confirms this hypothesis by pointing out that pasture areas have a lower incidence of the disease in humans. The Legal Amazon, which is considered endemic to this disease, has as its main cause of epidemic outbreaks the issue of deforestation, the anopheles darlingi mosquito, is the prevalent vector in the region. The feeding habits of these mosquitoes were initially studied by Deane et al (1949), in Belém, Pará, and repeated by Oliveira et al. (1989), and by Ferreira et al. (1992).

3.1.1 Brazil's adherence to the WHO Global Malaria Eradication Programme

At the 14th Pan American Sanitary Conference, held in 1954 in the city of Santiago, Chile, it was recommended that WHO member countries change their control programs in eradication campaigns (CUETO, 2004). A year later, at the Eighth World Health Assembly held in Mexico City, a resolution was passed that indicated that member countries should seek the eradication of malaria before vector species acquired resistance to insecticides. The two meetings reinforce this debate about the increase in the resistance of vectors to DDT, when it was used for a long period, the argument of resistance generated the need to eradicate the disease (PACKARD, 1998).

The main proposal that emerged through this was the guidance for WHO member countries to transform their malaria control programs to that of eradication as soon as possible (RACHOU, 1956).

The WHO's decision to launch the malaria eradication campaign was based on many assumptions, which has to do with the prolonged and inconsistent use of DDT that could trigger mosquito resistance to this insecticide. However, physician Marcolino Gomes Candau, who held the position of second director-general of the WHO in 1953, suggested that as resistance may take many years to appear, then an effort to eradicate malaria in a short time is necessary, before the appearance of resistance (WHO, 1955).

In 1955, the WHO Committee of Experts on Malaria established the difference between "control" and "eradication." According to the committee, in Control actions, the main focus is to reduce transmission to a tolerable degree, while eradication is practically the extermination of the disease (BRASIL, 1967).

The first step in the Brazilian government's commitment to the global eradication campaign was in 1958, through the creation of the Working Group for the Eradication and Control of Malaria (GTEM), established by Decree-Law 43.174, of February 4, 1958, when a working group responsible for the planning and execution of the eradication of the disease in Brazil was founded. The GTEM was created within the National Department of Rural Endemic Diseases (DNERu), established in the first months of the government of Juscelino Kubitschek linked to the National Health Services in 1941, the DNERu had as its priority the diseases that affect the inhabitants of rural areas (SILVA; PAIVA, 2015).

Brazil did not quickly integrate into the global plan to eradicate malaria because it already had a history of fighting this disease in the country, so there was political and scientific resistance to the plan. On the contrary, this tradition of malaria control is based on a successful case of eradication of the vector *Anopheles gambiae*. The WHO Committee of Experts on Malaria in 1955 had as its main intention the extinction of the disease, while the control programs were interested only in reducing transmission.

Juscelino KubitscheK (JK), stressed that the experience associated with malaria control policy provided three basic lessons as a model for future health policies in Brazil. The first lesson indicates that sufficient technical and financial resources must be made available in order to undertake effective health actions. The second lesson points out that these resources should be managed and directed by capable professionals who are outside the political environment. The third lesson indicates that the capacity of Brazilian professionals in the field of public health must be exemplary, thus overcoming obstacles of all kinds (SILVA; PAIVA, 2015). The Malaria Eradication Campaign (CEM) was not completely successful in Brazil; however, malaria transmission was interrupted in the Northeast, Southeast, Midwest and South regions (LOIOLA, SILVA, TAUIL, 2002).

According to Zapata et al., (2014), the global policy of malaria eradication in the mid-twentieth century failed, in some parts, because of intervention models implemented, by default that practically do not correspond to the variability of the locations, however it is necessary that the implementation of the dynamics models be appropriate to the local contexts.

3.2 INNOVATIONS ADOPTED IN THE FIGHT AGAINST MALARIA

3.2.1 Use of LLINs and ITNs

The Roll Back Malaria Foundation (RBM), through the WHO Office project in 1998, launched by investing considerable funds in the distribution of materials, especially insecticide-treated bed nets. It is known that ITNs, treated by immersion in a synthetic pyrethroid insecticide, result in twice the protection compared to untreated nets" (PACKARD, 2007).

Da Silva et al. (2016) conducted a study that aimed to demonstrate the genus of mosquito Anopheles spp, which involves the main vector species of malaria, and the types of insecticides that are applied, their effects and varieties of resistance mechanisms that these species present. However, he observed that the permanence of *Plasmodium falciparum* and the rate of gametocytes in villages decreased greatly after the implementation of LLINs in several countries. And they warn that it is essential to use LLINs in accordance with WHO recommendations. According to these authors, the two interventions, respectively, Internal Residual Spraying (IRS) and Insecticide-Treated Bed Nets (ITNs), decreased the densities of indoor vectors. Proof of this was the success of ITNs, which, after the introduction of lambdacyhalotrin-treated mosquito nets, facilitated the control of *A. darlingi* in southern Venezuela, recording a 56% reduction in malaria cases in local indigenous populations (DA SILVA et al. 2016).

Vieira et al. (2014), in their review study, evaluated the efficacy of using mosquito nets treated with long-lasting insecticides (LLIN), pointing out that in 2012, nine municipalities with installation of LLINs and 9 without implementation were evaluated. However, the statistical result indicated that there was no major difference in the reduction in malaria incidence in the two municipalities of Rondônia. The results of the statistical examination of the Annual Parasite Index

(API) and its annual variation revealed that the use of LLINs in the municipalities of Rondônia did not significantly reduce the API, both in those who used mosquito nets and also for those who did not have mosquito nets impregnated.

According to Chanda et al. (2013), in a study carried out in 2004, case management and programmatic control of malaria vectors in South Sudan were relaunched through a public-private partnership, thus distributing long-lasting insecticide-treated bed nets (LLINs) to individuals considered especially vulnerable to malaria, such as: children under 5 years of age, pregnant women, internally displaced persons, and nomadic herders. The large-scale deployment of LLINs was only done after the signing of a peace agreement in this country in 2005, even with the free distribution of mosquito nets, the success of the intervention was still strongly hampered by social and geographical barriers.

Between 2006 and 2009, the percentage of households with at least one mosquito net impregnated rose from 12% to 53%, and by the year 2012, approximately 8.0 million LLINs were distributed throughout the country (South Sudan). Regarding use, LLIN use rates increased among children under 5 years of age, from 5 to 25% and for pregnant women it was from 5 to 36%. Meanwhile, the number of malaria cases recorded that same year grew from 71,948 in 2008 to 1,198,357 in 2012. According to the authors, this disappointing increase in the number of cases verified was due to the use of LLIN, which was suboptimal, and the intervention was not considered very effective (CHANDA et al. 2013).

Willey et al. (2012) conducted a systematic review study in order to synthesize research published between 2000 and 2010 on distribution strategies of insecticide-treated bed nets (ITNs) and long-lasting insecticide-treated bed nets (LLINs) in areas where *Plasmodium falciparum and P. vivax* are endemic, according to these authors, the WHO, through the Malaria Roll Back Partnership, established the goals for 2015, with the objective of reducing global cases of malaria from the levels that were in the year 2000 to 75%, in addition to having an interest in also reducing deaths from malaria to almost zero, through universal coverage, and efficient prevention and treatment interventions. The WHO recommends the use of ITNs and LLINs to reduce episodes of this disease among children under 5 years of age by approximately 50% and all-cause mortality by 17%.

The organization recommends the provision of free universal coverage containing ITNs to people at risk for use above 80% in people's homes, in addition to carrying out periodic mass campaigns, places for routine distribution of ITNs.

However, they obtained 32 articles describing 20 studies conducted in 12 African nations (Burkina Faso, Eritrea, Ghana, Kenya, Madagascar, Malawi, Niger, Nigeria, Togo, Uganda, United Republic of Tanzania, and Zambia) and one partially autonomous region (Zanzibar). 6 studies were implemented at the national level, 2 at the regional level, 12 at the district level (three take place in a single district). 14 studies provided ITNs only to children under 5 years of age and pregnant women (WILLEY et al. 2012).

3.2.1.1 Antimalarial drugs applied in the elimination of plasmodium

Malaria control measures in the USSR were conducted simultaneously in several directions: treatment and prophylactic actions, as well as vector control were carried out mainly by malaria stations. P. G. Sergiev also established the country's first antibiotic laboratory at the institute, where a new antibiotic (Gramicidin S) that was very pertinent in the war period was developed in 1942 by Georgy Frantsevich Gause and Maria G. Brazhnikova (GAUSE, BRAZHNIKOVA, 1944).

Antimalarial activists have adopted the use of antimalarial drugs such as pyrimethamine, chloroquine, and primaquine on the human body to eliminate malaria infections. In this way, chloroquine, which practically proved to be a drug of great potential, was combined with primaquine, to replace pyrimethamine that was suffering resistance from the malaria parasite, so the combination of the two drugs results in a drug, capable of eliminating malaria gametocytes and preventing its spread through mosquito bites. That is, with the use of these drugs, it became unfeasible for a mosquito to transmit infections from one person to another through the bite of anopheline mosquitoes (WEBB JR, 2014).

Another available drug recommended by the WHO is precisely atovaquone and proguanil, which are combined in the treatment process, act in the elimination of contaminated liver cells, in this case trophozoites, but it is not efficient against sporozoites and does not solve hypnozoites (Rios-Orrego; Blair-Trujillo ; Pabón Vidal, 2017).

Plants of the family Annonaceae (order Magnoliales), stand out among the most traditionally used against malaria. The antiprotozoal activity of this plant in the treatment of malaria, American trypanosomiasis and leishmaniasis is directly related to secondary metabolites, acetogenins, steroids and terpenes that are found in the various parts of the body of these plants (Ocampo & Ocampo, 2006). Eleven antimalarial species of the genera Xylopia and Annona make them more abundant in the family Annonaceae (FISCHER et al., 2004; GARAVITO et al., 2006).

In the study by Frausin et al. (2014), they found in the scientific literature 63 species of Annonaceae that belonged to 27 genera as a therapeutic source to combat malaria. Although some species are not useful for the treatment of the disease, they were used to treat symptoms in countries in the Amazon region (northern South America); Africa, Central America, India and Malaysia. Several plants of the Annonaceae family have already been well studied and have provided active substances against malaria. For example, the ethanolic extracts of Polyalthia debilis, according to Deharo & Ginsburg (2011), and Xylopia aromatica, according to Mesquita et al. (2007), who stated that these extracts of these species have been proven and are active against Plasmodium falciparum by medium inhibition concentration ($IC50< 1.5$ µg/ml).

There are still a large number of species traditionally used in the treatment of malaria of the Annonaceae family that have not yet been studied, stressing that intensification in the area of chemistry of natural products with antimalarial activity can bring potentially effective compounds to make new drugs (FRAUSIN et al.2014). Artemisinin combination therapy was effective in the treatment of confirmed cases, as evidenced by the 40,000 positive cases of malaria that were effectively treated during the coverage of the Malaria Control Program (PCM) in Pakistan (MALIK et al., 2013).

Bustamante, who was the coordinator of the Working Group for the Eradication and Control of Malaria (GTEM), presented the main drugs used in malaria control actions developed after World War II, according to his position, quinine dominated for almost three centuries, being prophylactic drugs such as chloroquinin (Aralen, Resoquine, Nivaquine B), Amodiaquine (Camoquim), Proguanil (Paludrin), pyrimethamine (Duraprin) and Primaquine were the most efficient (SILVA; PAIVA, 2015).

3.3 PLASMODIUM DRUG RESISTANCE

A factor that is very evident in the analyzed studies is what has to do with resistance. This resistance, by chance, did not only happen with insecticides, it was also verified with pyrimethamine that after a year that antimalarial activists use it through Mass Drug Administration (MDA), the solution adopted was precisely to combine chloroquine and primaquine, which practically results in a potentially effective drug for the elimination of malaria gametocytes (WEBB JR, 2014).

There is a need to develop natural products derived from plants, since the main parasites responsible for causing malaria infections in humans, in this case Plasmodium *falciparum and Plasmodium vivax*, are becoming resistant to two drugs considered beneficial, namely, quinoline antimalarials and artemisinin (FRAUSIN et al. 2014).

According to the testimony of one of the interviewees (health professional), he points out that one of the main causes that cause the inappropriate use of antimalarials in Pakistan is precisely resistance to antimalarials, especially chloroquine and some antimalarial drugs that were being prescribed very frequently, even without foresight or an effective methodology, as well as lack of analysis facilities and poor management of medicines (MALIK et al., 2013).

3.3.1 Government and community engagement in malaria control: barriers and achievements

With regard to government interventions in the creation of malaria control policies, 7 articles were found that reported aspects of the participation or involvement of governments in the creation of policies and programs to reduce the disease, an example of this is the intervention made by the Soviet government in initially expanding 9 tropical institutes that were scattered in different parts of the Soviet territory for the purpose of research, training of researchers and health professionals in order to combat malaria, the creation of stations or posts for this disease.

These actions greatly contributed to the success of control in the countries mentioned in the 7 articles analyzed. Although the control plans were considered beneficial, the implementers had to face enormous difficulties during the creation of these programs, as an example of Brazil in which there was the creation of many programs, until when the PIACM (Plan for the Intensification of Malaria Control Activities) launched in the year 2000 was implemented.

According to Kamimura, Burani, and Sauer (2018), its implementation has allowed the reduction of malaria transmission in the country. On the other hand, among some of the interventions for the distribution of LLINs/ITNs, 4 studies revealed that there was distribution, among which 3 addressed the issue of special priority to the risk group and 1 had been distributed only to test the effectiveness of mosquito nets in the people of the municipality who used them, comparing them with those who were not implanted such nets. However, in 8 articles they reported the challenging factors found.

Zapata points out influences that malaria control policies suffer during the intervention, which he describes as factors related to socio-ecological dynamics such as deforestation, health reforms, poverty, conflict, climate change, lack of communication, geographical barriers (distance from the public health system) (ZAPATA et al., 2014; RINCÓN-VÁSQUEZ et al., 2020).

Another type of barriers frequently verified is related to adherence to the use of diagnostic tests, however 4 studies addressed this subject, and among them the importance of diagnostic tests during use for the purpose of discovering malaria was highlighted, but only 1 that dealt with a research on the introduction of tests to assess adherence of the population to the test in the way that found that only a small portion that sought to perform tests in the places where they were introduced.

5 articles agreed with the idea that before carrying out an intervention to combat malaria, it should be adapted to the context of the place where such intervention actions will be applied, taking into account the factors influencing the dynamics of the control program or policy, as recommended by the Medical Research Council, which reveals that evaluations of complex interventions should include information on the context for the implementation of interventionist actions (WILLEY et al., 2012)

The PCM professionals interviewed stressed in their testimonies that the Government of Pakistan and the Global Fund are their main collaborators in the implementation of the program, in which they are able to provide diagnostic kits and mosquito nets to vulnerable groups, pregnant women and children under the age of five. They also offer training to doctors and microscopists in order to make diagnoses properly, the drugs are made available free of charge in the facilities found in 19 districts and different priority provinces where the PCM operates in the country. In addition, they design an ideal information system, which provides daily data through e-mails from all such facilities and on top of that the system is regularly updated (MALIK et al., 2013).

3.3.2 Barriers and challenges to the implementation of malaria control strategies

The challenges at the level of cultural, sociolinguistic, as well as administrative multiplicity often bring negative consequences that lead patients to self-medicate, a fact that the researchers of this study consider as very risky practices taking into account that the use of medications, contraindicated before the thick drop test, (which is a type of diagnosis used to detect the parasite), It can cause problems related to alterations in the results and compromising the diagnoses. However, in this type of case, health professionals recommend that the test be repeated for more than two days (at least 3 tests) to confirm the result of the gross drop test (RINCÓN-VASQUEZ; MORALES-SUÁREZ-VARELA ; TOBÓN-CASTAÑO, 2020).

According to Cohen et al. (2015), in their research it was about 60% (55/92) of Ugandan drugstores that decided to buy the rapid diagnostic test kits, on the other hand it was less than 20% (390/2261) of febrile patients who visited a pharmacy. Despite not knowing the main characteristics of poor adherence to rapid tests, the authors point out as possible solutions for acceptance the combination of efforts for behavioral change, greater reduction in the prices of kits and also creating incentives for pharmacies to carry out tests and provide appropriate treatments to patients who test positive.

Another challenge has to do with the remarkable low adherence to Artemisinin combination therapies, with only 40.9% of infected patients purchasing a number that these authors consider very low, since in the survey carried out in drugstores, 84.2% (96/114) drugstores in this study reported having these combined therapies sufficiently available in stock until the exact moment of the end of their research.

Meanwhile, they concluded that rapid diagnostic tests should be introduced not only in the public sector, but also in the private sector, especially in places where malaria is endemic, but this could improve case management and avoid loss of antimalarial drugs for nonmalarial diseases (COHEN et al. 2015).

According to Chanda et al. (2013), when the First and Second Sudanese Civil Wars began, which occurred respectively from 1955 to 1972 and from 1983 to 2005, they consequently caused great damage to infrastructure and public health services. Throughout these periods there was no vector control intervention, even with this free distribution of the mosquito nets, the success of the intervention was still strongly hampered by social and geographical barriers. As such, the South Sudanese Ministry of Health produced a health policy document in 2006 that highlights the need for malaria control. They also developed a strategic plan to cover malaria control between 2007 and 2013. In the plan's guidelines, priority was given to the distribution of LLINs, initially with a target of 60%, which was later increased to 80% household coverage.

Even in 2007, the Global Fund to fight AIDS, tuberculosis and malaria has financed the reinforcement of the distribution of LLIN in the country in order to reduce the incidence of the disease by at least 50% by 2010, thus opting for an increase in the level of supervision, precision and quality of the work that was applied by community volunteers who were trained in activities adapted to the needs of the target communities. Which were important in improving the knowledge of the beneficiaries about taking good advantage in the use and maintenance of the LLIN. According to the above-mentioned authors, between 2006 and 2009, the percentage of households with at least one impregnated mosquito net rose from 12% to 53%.

On the other hand, they found many visited family members sleeping in the open, without donated mosquito nets, while others used the nets for fishing or for making fences, and there were also reports of illegal sales of LLINs in local markets. However, the media were used to raise awareness among the population about behavioral changes, highlighting the correct way to hang them and the need to use mosquito nets every night, regardless of the season, unfortunately these communications have been few.

According to these researchers, illegal sales were discouraged by labeling each mosquito net with a statement "not for sale" and its removal inside each package at the time of distribution at the direction of local leaders and authorities. Although the Roll Back Malaria Partnership supports the idea of universal use of bed nets, the authors consider that the expansion of LLIN distributions in related settings needs to be carefully adapted to the context of the site (CHANDA et al., 2013).

While in the testimonies of the patients investigated in the study by Rincon-vasquez and company, the challenges were geographical factors in relation to individuals who live far from the hospital, low literacy of users, and difficulties in communication, since the Spanish language is predominantly the most used in hospitals, administrative barriers in the hospital itself are also predictable, with delays in care (RINCÓN-VASQUEZ; Morales-SUÁREZ-VARELA; TOBÓN-CASTAÑO, 2020).

Based on the identification of some factors that may be obstacles in the process of implementing policies and strategies to combat malaria, some authors have given basic recommendations to consider. In general, depending on the social and cultural reality of each society, preventive and inclusive measures are taken. In the following section, we present these recommendations.

3.3.3 Authors' suggestions for encouraging research that may be useful for malaria control strategies

Second Rice. (2017), an action at the SDH level that the Brazilian National SDH Commission defines as social, economic, cultural, ethnic/racial, psychological, and behavioral factors that interfere with the occurrence of health problems along with their risk factors in the population, can contribute with great benefits in malaria control. And the author also points out that Communication for Social and Behavior Change (CMSC) is defined as an interactive, researched and planned process that aims to change social conditions and individual behaviors, because he considers that with several approaches it can facilitate the effort to successfully control the disease, because the exclusive use of the health unit channel cannot account for everything, especially in countries where access to hospitals is available it is limited including the distance factor as in the case of Mozambique, where most people from rural communities tend to have little involvement with modern medicine, resorting more to traditional medicine. Therefore, the author suggests diversified approaches, such as community radio, pamphlets, lectures, plays. However, all these CMSC approaches must be a process of community mobilization and empowerment.

A community network involving a health committee, volunteer community leaders of religious denominations, traditional medicine practitioners trained in malaria prevention in different CMSC approaches can be an asset in aiding health workers and the main interventions of insecticide/spraying networks associated with case management in the CMSC of the communities. Teachers can be a bridge in promoting behavioral changes through their classes to students, so that they can disseminate information in their communities and families (ARROZ, 2017).

On the other hand, in the study by Rincón-Vasquez, Morales-Suárez-Varela & Tobón-Castaño (2020) carried out in the Colombian Amazon region, municipality of El Bagre Antioquia, in 2016, through the application of questionnaires to patients with febrile malaria syndrome, administrative care staff of the ESE Hospital Nuestra Señora del Carmen. These authors emphasized the need to provide training not only clinically, but also at the communication level to facilitate dialogue between patients and health professionals. They also emphasize the role of means of communication such as municipal radios that are able to facilitate approximation with the community. However, these authors point out that in spaces of social interaction, communication through language becomes very important since it is through it that individuals translate everything that happens around them. Community leaders with knowledge of health care can play a key role (RINCÓN-VASQUEZ; Morales-SUÁREZ-VARELA ; Tobón-CASTAÑO, 2020).

On the other hand, Frausin et al. (2014), in their research, reinforces, pointing out as a solution to reduce the adverse effects caused by the use of Causal Chemoprophylaxis (QC), the increase in research in the field of chemistry of natural products, especially plants of the Annonaceae family, which still contains a considerable amount not studied, and are pointed out as promising for a possible legal substitute for QC such as Primaquine, Atovaquone and Proguanil, although they help in interrupting the infectious cycles of the malaria parasite, are capable of causing a number of serious consequences of adverse effects to consumers.

Da Silva et al. (2016) suggest alternative research for biological control, using other organisms as a possible regulator of the malaria vector population in critical outbreaks. Products of plant origin and fungi are currently under constant study, since they have many antagonistic activities against Anopheles mosquitoes, through crude extracts of fungi and plants. They also report that a study of this nature opens the possibility of further investigations into the efficacy of the larvicidal properties of extracts of natural products that should be encouraged to discover new products with larvicidal activities, supporting the idea that they are less harmful to the environment.

According to Willey et al. (2012), the Medical Research Council recommends that evaluations of complex interventions include information from the context to implement the interventions. Therefore, the reviewers of the study in question highlight that the preference among the options of ITN distribution strategies depends on contextual factors such as the epidemiological characteristics of malaria, the peculiarity of health systems, and contextual constraints.

3.4 EPIDEMIOLOGICAL SURVEILLANCE AND ITS ANTIMALARIAL CONTRIBUTIONS

Duval and Silva (2019) would easily enter this debate now, who discovered that an automated pharmacological surveillance system can make a good contribution to the identification of AEs, of drugs that malaria victims can present through a Tweet AE Miner tool capable of collecting them through the API (application programming interface) of the social network Twitter. The success of such a tool was proven in this same study by compiling the reported AE data found in the tweets with those from the reports of the American Food and Drug Administration (FDA), where they detected that the social network was able to provide more signs of Adverse Events than the FDA data, however they concluded that Twitter is a potential tool that can greatly facilitate pharmacovigilance in the findings of AE reports, in order to properly diagnose and treat the victims of this disease.

Malik et al. (2013), in their research on the correct use of antimalarial drugs, reinforce the testimonies of one of the health professionals interviewed, say that inappropriate use of antimicrobials was seen in Pakistan due to the lack of trained personnel, as well as the inappropriate application of diagnostics, resistance of some antimalarials, especially chloroquine, which was being prescribed more frequently even without an effective methodology.

However, this fact presented by Malik and company may be closely related to the study by Cohen et al. (2015), who emphasized that the WHO recommends parasitological confirmation of malaria before the use of any antimalarial drug, stating that the most appropriate way to control febrile diseases caused by *Plasmodium* It should be through the use of rapid diagnostic tests and then continue to know with the appropriate measures. This fact demonstrates that epidemiological surveillance is an indispensable area in the process of fighting malaria, since the correct use of this diagnostic tool can avoid issues of drug resistance, as well as limit adverse effects.

In this logic, one can hypothetically refer to the research by Nascimento et al. (2020), in which microscopists obtained a higher percentage in the length of their activities in the Malaria Control Program (PCM), while other categories of professionals categorically evaluated nurses and endemic agents with a lower percentage of work. However, what can be noticed here in this result may be so, due to the fact that microscopists are responsible for acting at different levels, performing the preparation and reading of the thick droplet.

Nascimento et al. (2020), conducted a survey in 2017 with professionals from the 3 categories, nurses, microscopists and endemic agents, who make up the Malaria Control Program (PCM) team in the Amazonian municipality of Cruzeiro do Sul, located in the State of Acre, to evaluate the length of treatment activities and cure verification in six Family Health Units (USF), whose research results in 9 activities were, 72% for the microscopists evaluated and 12% for nurses and endemic control agents regarding the length of work of the treatment and verification of cure. However, with this result, the authors came to the conclusion that the PCM presented a performance below the recommended, since it cannot meet the standard mainly established, which consequently may be associated with the permanence of malaria cases in the municipality.

Zuñiga-Sosa et al. (2019), carried out a study of survey and collection of blood samples to perform serological tests in search of antibodies and antigens of Plasmodium vivax. and the *phenotype of the Duffy system made with real-time PCR testing in order to discover the DNA* of Plasmodium vivax and Plasmodium falciparum in a group of people in Ecuador, whose study aimed to discover the presence of the fy(ab-) phenotype and its relationship with *Plasmodium vivax*. Analysis of the results showed 4 phenotypic combinations of the Duffy erythrocyte system, in the inhabitants examined, the most frequent was the phenotype fy(ab-) which has 39.8%, followed by fy(a+b-) with 35.2%. And the last two are phenotypes fy(a-b+) with 17% and fy(a+b+) with 7.6%.

In the survey there are 78 participants who said they had been diagnosed with malaria only once in their lives, of which 34 had a fy(ab-) phenotype thus the result related to the presence of IgG antimalarials. On the other hand, 262 residents said they had not suffered malaria, 111 of them were carriers of the most frequent phenotype fy(ab-), and only 43 samples were selected from the 111 submitted to the IgG antimalarial EIA test, supposedly indicative of immunity against Plasmodium Spp. It was shown that the parasite *P. vivax* was related to risk of asymptomatic malaria, thus, individuals carrying the Fy(ab-) phenotype from endemic areas developed natural immunity, which was considered by the researchers as an innate protective effect against malaria directly related or linked to the structure of the erythrocyte membrane, thus, with a possible absence of a negative Duffy phenotype, because it does not have a chemokine receptor it is able to prevent the union of merozoite to the surface of the erythrocyte membrane, so infection does not occur malarial. Therefore, the results showed that there is a very high affinity from a statistical point of view between the Duffy phenotype and malaria (*Plasmodium vivax*), with a probability of ($P< 0.05$), Zuñiga-Sosa et al. (2019).

Cohen et al. (2015) conducted an evaluative research in eastern Uganda, in order to know the impact of rapid diagnostic tests (CareStar Malaria HRP-PF test), which they introduced into the analysis process and purchases of antimalarials in pharmacies in that area, for this it was possible to encourage drugstore salespeople to buy tests available at an affordable price. According to these authors, the WHO recommends the use of anti-malaria drugs, and parasitological confirmation of the disease is also necessary. According to them, the appropriate way to control febrile illness caused by *Plasmodium* in endemic areas is through the use of diagnostic tests, because when there is a shortage, the consumer runs the risk of using drugs for other diseases that have symptoms similar to malaria.

Thus, the authors consider that a poor diagnosis of malaria not only leads to the waste of health resources, but also increases the risk of resistance to antimalarials, since the lack and delay in the treatment of malaria substantially causes infant mortality. However, this study allowed the authors to show an increase from 10 to 20% in the number of fever cases that seek care in pharmacies using the rapid diagnostic kit.

4 FINAL THOUGHTS

The main malaria control measures that have been widely reported in the scientific studies analyzed are biological control strategies using insecticides to annihilate the larvae of Anopheles mosquitoes – the main insect vector that transmits malaria – and the use of insecticide-impregnated mosquito nets (LLINs or ITNs). Another way to combat this disease is also with Causal Chemoprophylaxis (QC), used to eliminate malaria gametocytes on the human body, but it has already been discovered that they can cause adverse effects to consumers, so before ingesting the drugs an appropriate test is recommended to detect the parasite. so as not to run the risk of consuming a drug to treat diseases that have symptoms like malaria. However, in order to promote the correct use of antimalarial drugs, it is essential not only to have a diagnostic test, but also to have a professional trained for this type of work, capable of interacting and communicating with patients. For this to work in the best way, malaria control programs or policies must consider several factors, such as socio-ecological, geographical, conflict, and others mentioned throughout this work. Regarding adverse effects caused by antimicrobials, it is recommended that the next research on the same subject investigate more about the natural products of plant origin considered promising for a possible replacement of such antibiotics.

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REFERENCES

ALHO, Regina Claudia Reboucas Mendes et al. Malária transfusional nas américas: revisão sistemática.2015.

ARROZ, Jorge Alexandre Harrison. Comunicação para a mudança social e de comportamento na luta contra a malária em Moçambique. Revista de Saúde Pública, v.51,2017.

BAGIROV, Ghazi A. Et al. Resistence of imago and larve of Anopheles masculipennis sacharovi to DDT in Azerbaijan. In: Lysenko, Andrey Ya. (Ed.). Modern problems of malaria prevention in the USSR. Baku: Research Institute of Medical Parasitology and Tropical Medicine named after S.M. Kirov Press. P. 157-162.[in Russian]. 1973.

BARATA, Rita de Cássia B. Malária no Brasil: panorama epidemiológico na última década. Cadernos de Saúde Pública, Rio de Janeiro, v. 11, p. 128-136, 1995.

BERG, Henk van den. Global status of DDT and its alternatives for use in vector control to prevent disease. Environmental Health Perspectives, v.117, n.11, p.1656-1663.2009.

BRASIL. Ministério da Saúde, Secretaria de Vigilância em Saúde. Portal da Saúde, 2017. Available in: http//Brasil.gov.br.

BRASIL. Ministério da Saúde. Relatório do Plano Nacional de Erradicação da Malária: operações para quinquênio 1967-1971. 1967.

CHANDA, Emanuel et al. Scale-up of a programme for malaria vector control using long-lasting insecticide-treated nets: lessons from South Sudan. Bulletin of the World Health Organization, v.92, p.290-296, 2013.

COHEN, Jessica et al. Introducing rapid diagnostic tests for malaria to drug shops in Uganda: a cluster-randomized controlled trial. Bulletin of the World Health Organization, v. 93, p. 142-151, 2015.

CUETO, MARCOS. El valor de la salud: historia de la Organización Panamericana de la Salud. 2004.

DA SILVA, Guilherme Liberato et al. O impacto do manejo de inseticidas relacionado com a expressão de resistência em populações de Anopheles spp. Ciência & Saúde Coletiva, v. 21, n. 7, p. 2179-2189, 2016.

DEANE, L. M.; VERNIN, C. S.; DAMASCENO, R. G. Avaliação das preferências alimentares das fêmeas de Anopheles darlingi e Anopheles aquasalis em Belém, Pará, por meio de provas de precipitina. Revista do Serviço Especial de Saúde Pública, v.2, n. 3, p. 793-808, 1949.

DUVAL, Felipe Vieira; SILVA, Fabrício Alves Barbosa da. O uso do Twitter como minerador de eventos adversos de medicamentos de combate à malária: o caso da doxiciclina: Cadernos de Saúde Pública, v.35, 2019.

FERREIRA, Marcelo U.; CASTRO, Marcia C. Challenges for malaria elimination in Brazil. Malaria journal, v. 15, n. 1-18, 2016.

FISCHER, Dominique Corinne Hermine et al. In vitro Screening for antiplasmodial activity of isoquinoline alkaloids from Brazilian plant species. Acta tropica, v. 92, n. 3, p.261-266, 2004.

FRAUSIN, Gina et al. Plants of the Annonaceae traditionally used as antimalarials: a review. Revista brasileira de Fruticultura, v.36, p.315-337, 2014.

GARAVITO, G. et al. Antimalarial activity of some Colombian medicinal plants. Journal of Ethnopharmacology, v. 107, n. 3, p. 460, 2006.

GAUSE, GEORGY F.; BRAZHNIKOVA, Maria G. Gramicidin S and its use in the treatment of infected wounds. Nature, v. 154, n. 3918, p. 703-703, 1944.

KAMIMURA, Arlindo, BURANI, Geraldo; SAUER, Ildo. Environment as a Complex System: the Malaria Decrease in the Legal Amazonia (LA) Case. Interações (Campo Grande), v.19, p.569-584, 2018.

LITSIOS, Socrates. The World Health Organization 's changing goals and expectations concerning malaria, 1948-2019. História, Ciências, Saúde-Manguinhos, v.27, p. 145-164, 2020.

LOIOLA, Carlos Catão Prates; SILVA, CJ Mangabeira da; TAUIL, Pedro Luiz. Controle da malária no Brasil: 1965 a 2001. Revista Panamericana de Salud Pública, v. 11, n. 4, p 235-244, 2002.

LOURENÇO-DE-OLIVEIRA, Ricardo et al. Anopheline species, some of their habits and relation to malaria in endemic areas of Rondônia State, Amazon region of Brazil. Memórias do Instituto Oswaldo Cruz, v. 84, 501-514, 1989.

MAJORI, Giancarlo et al. Short history of malaria and its eradication in Italy. Mediterranean journal of hematology and infectious diseases, v. 4, n.1, p. e 2012016-e 201216, 2012.

Malik, Madeeha et al. A qualitative study exploring perspectives towards rational use of medicines in Pakistan’s Malaria Control Program (MCP). Brazilian Journal of Pharmaceutical Sciences, v. 49, p. 321-328, 2013.

MG, RASHINA EI Martsinovsky, organizer of control of malaria in USSR. Meditsinskaia Parazitologiia i Parazitarnye Bolezni, v.23, n. 4, p. 362-368, 1954.

Ministério da Saúde, Secretaria de Vigilância em Saúde. Boletim Epidemiológico, Brasília, v. 44, n.1, 2013.

NASCIMENTO, Talita Lima do et al. Avaliação das atividades de monitoramento do tratamento e verificação de cura da malária. Revista da Escola de Enfermagem da USP, v.54, 2020.

OCAMPO, Diana Marcela; OCAMPO, Rogelio. Bioactividad de la família Annonaceae. Revista Universidad de Caldas, v. 26, n.1/2, p. 135-155, 2006.

OLIVEIRA-FERREIRA, Joseli de et al. Feeding preference of Anopheles darlingi in malaria endemic areas of Rondonia state, northwestern Brazil. Memórias do Instituto Oswaldo Cruz, v. 87, n. 4, p. 601–602, 1992.

PACKARD, Randall. The marking of a tropical disease: a short history of malaria. Baltimore: John Hopkins University Pres. 2007.

PROTOPOPOFF, Natacha et al. High level of resistance in the mosquito Anopheles gambiae to pyrethroid insecticides and reduced susceptibility to bendiocarb in north-western Tanzania. Malaria journal, v.12, n. 1, p. 1-8, 2013.

RACHOU, Rene G. Atual estratégia da luta contra a malária. Departamento Nacional de Endemias Rurais, 1956.

RINCÓN-VÁSQUEZ, Diana; MORALES-SUÁREZ-VARELA, María M., TOBÓN-CASTAÑO, Alberto. Barriers to the care of febrile patients in a malaria endemic área. El Bagre (Antioquia, Colombia) 2016. Hacia la Promoción de la Salud, v.25, n.1, p.90-108, 2020.

RIOS ORREGO, Alexandra; BLAIR TRUJILLO, Silvia; PABÓN, Adriana Lucía. Avances en la búsqueda y desarrollo de quimioprofilácticos causales para malaria.2017.

ROUBAUD, E. Les conditions de nutrition des anófeles in france: Anopheles maculipennis et le rôle du bétail dans le prophylaxie du paludisme. Annales del 'l'institut Pasteur, n.34, pág. 181-228, 1920.

SHIPITSINA, Nina K. Transmission season and zones of malaria in the Soviet Union. In: Moshkovsky, Shabsay D. (Ed.). Problems of medical Parasitology and prevention of infectious diseases. Moskow: Ministry of Health of the USSR Press. P.258-276.[in Russian]. 1964.

SILVA, Renato da; PAIVA, Carlos Henrique Assunção. O governo JK e o Grupo de Trabalho de Controle e Erradicação da Malária no Brasil: encontros e desencontros nas agendas brasileira e internacional de saúde, 1958-1961. História, Ciências, Saúde-Manguinhos, Rio de Janeiro, v. 22, n.1, jan-mar.2015, p. 95-114.

SOKOLOV, Evgeni I. The contribution of E.I Martsinovskii in the prevention of infectious diseases in the USSR. Sovetskaia meditsina, v.23, p, 141-146, 1959.

SOPRUNOV, Fyodor F.; GOLD, Evegeny Y.P.G. Sergiev. Moscow: Medicine Press. [in Russian]. 1986.

STRELKOVA, Margarita V.; BARANOVA, Alla M. KUHLS, Katrin. History of the EI Martsinovsky Institute of Medical Parasitology and Tropical Medicine: research on malaria and leishmaniasis. Histórias, Ciências, Saúde-Manguinhos, v.27, n.4, p.1097-1124, 2020.

VIEIRA, Gabriel de Deus et al. Insecticide-treated bed nets in Rondônia, Brazil: evaluation of their impact on malaria control. Revista do Instituto de Medicina Tropical de São Paulo, v.56, p.493-497, 2014.

WEBB JR, James. Historical epidemiology and global health history. História, Ciências, Saúde-Manguinhos, v.27, p.13-28, 2020.

WHO. World Health Organization. Eigth World Health Assembly, Mexico 10-27 May 1955. Official Records of the WHO, n. 63.

WILLEY, Barbara A. et al. Strategies for delivering insecticide-treated nets at scale for malaria control: a systematic review. Bulletin of the World Health Organization, v.90, p.672-684, 2012.

ZAPATA, Walter Salas et al. Análisis de sostenibilidad de la política de control de malaria del municipio de El Bagre, Colombia. Revista Gerencia Y Políticas de Salud v. 13, n. 27, p.7, 2014.

ZUÑIGA-SOSA, Evelyn Alexandra et al. Tipificación del antígeno Duffy como método indireto para identificar indivíduos assintomáticos de malaria. Acta bioquímica clínica latino-americana, v.53, p.71-77, 2019.