

The amazing eradication story and current situation of malaria in Cyprus

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Malaria is still among the diseases that threaten public health maintaining its infectious importance. Cyprus is a small island that is home to two separate communities: Turkish Cypriots and Greek Cypriots. The history of malarial fevers in Cyprus has been long and tragic, and over the centuries, these fevers have cost many lives on the island and have been the major cause of chronic ill-health. As a result of the eradication project, Cyprus went down in history as the first country in the world where malaria was eliminated, and malaria infection has not been observed in Cyprus since 1950. However, due to the flow of foreign students and workers coming to the island in recent years, there is an increase in imported malaria cases. Clearly nowadays, immigration to the island, especially in the regions where malaria is endemic, poses a risk for the emergence of domestic malaria cases. In this article, we aim to emphasize the historical importance of malaria in Cyprus and to discuss the risk factors associated with the recurrence of the disease on the island.

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INTRODUCTION

Malaria remains a public health threat and one of the most important infectious diseases receiving attention from the World Health Organization (WHO). The term 'Malaria', derived from the Italian words 'mala' (bad) and 'aira' (air), is a disease transmitted by an infective female *Anopheles* mosquito and caused by *Plasmodium* spp. It continues to be a global public health problem because it is endemic in many countries and still occurs as imported cases in regions where it has been eradicated^[1,2]. As a result of the campaign against malaria between 2000-2015, the incidence of the disease has decreased by 41%. Due to the fight against malaria, the number of endemic countries decreased from 108 to 91 in these 15-year period. However, according to another statement, it is claimed that there has been no significant decrease in malaria incidence between 2015 and 2017^[3,4]. According to WHO data, 241 million malaria cases were reported in the world in 2020 and it was estimated that 627.000 people died from malaria infections in the same year^[5].

The history of malarial fevers in Cyprus is long and tragic, and over the centuries, the fevers resulted in significant loss of life, chronic ill-health and invalidism. It is on record that "fevers and bad air" were a source of considerable problems in 1394. A letter written a few years before the British occupation of the island in 1878 by Namık Kemal, who was a Turkish poet of national reputation, stated that "the hum of noxious pests sounds like that of the most modern weapons, and the diseases, the mildest of which is fever, are capable

of killing a person much quicker than bullets."^[6] We intend in this editorial to relate the history of Malaria presence in Cyprus and the efforts undertaken for its eradication.

Malaria struggle in the British colonial period

When the era of the British administration began in 1878 in Cyprus, various measures were taken against malaria^[7]. Quinine drugs were distributed amongst senior British dignitaries and British soldiers as well as indigenous people to protect against and eradicate the effects of malaria. Additionally, eucalyptus trees, which are water-absorbing plants, were planted in certain swamp areas^[8].

In 1900, Dr. G.A. Williamson, the Larnaca Health Director reported that 470 of 503 (93.4%) patients he examined in Larnaca had malaria. According to microscopic data, the distribution of *Plasmodium* species was recorded as 48.47% of tertiary malaria, 8.03% of quartan malaria and 43.5% of aestivo-autumnal malaria (later designated as malignant malaria). In 1912, the British High Commissioner of the island, Sir Hamilton Goold-Adams, sent a letter to the British Foreign Office. The letter stated that malaria was very common on the island, and because measures taken by the local government were not sufficient, more effective actions should be done. In response, the British Foreign Office sent Sir Ronald Ross to Cyprus in 1913 to conduct a survey on malaria in the country^[8,9]. He had received the Nobel Medicine Prize in 1902 for

discovering that malaria was transmitted by female *Anopheles* mosquitos.

Sir Ronald Ross and Cyprus adventure

The British scientist Sir Ronald Ross was interested in the prevention of malaria in different countries such as West Africa, the Suez Canal Zone, Greece, Mauritius and Cyprus^[10]. During his investigations on the Cyprus situation, he declared that ‘In Famagusta, there is a spleen-rate of 20 per cent and over, due I think to small leakages more than to anything else, as well as to the wells among the crowded populations’. ‘Therefore, we ought in Cyprus to have a good vigorous mosquito-reducing policy, in addition to the use of quinine. I feel certain that all these methods will be adopted’^[11]. Sir Ronald Ross found that 25% of the children examined on the island had enlarged spleens and reported that this rate was very high. Based on the suggestions of Sir Ronald Ross, in the fight against malaria, swamps were dried, and specially trained teams were created to control the reproduction of the mosquitos. As a result of the work done, the situation in many parts of the island gradually improved as reported by the Health Services of the British Colonial Administration in Cyprus. The number of malaria cases between 1912-1921 showed gradual decrease of infected cases (Figure 1)^[8].

Period of Mehmet Aziz in Cyprus

In 1948 a ‘Malaria Eradication Project’ was carried out by Mehmet Aziz. As a result the *Anopheles* mosquitos which were the carriers of malaria parasites in Cyprus, were successfully eliminated^[8]. In the campaign programme, the locations were divided two groups: Eradication and Protection. The island was divided into six districts, which were subdivided into 39 sections, 111 zones and 556 blocks (Figure 2)^[6,12]. All sections were treated using the same method. Mehmet Aziz reported that ‘the whole strategy was concentrated against larvae using a 4-5% solution of DDT (dichloro diphenyl trichloroethane) in gas oil (fuel oil) which was found to be more convenient than Paris green on account of its residual effect against ovipositing females or newly emerged imges during the 1946 campaign’. The campaign results were recorded by Mehmet Aziz in various tables. Table (1) is an example of how the data

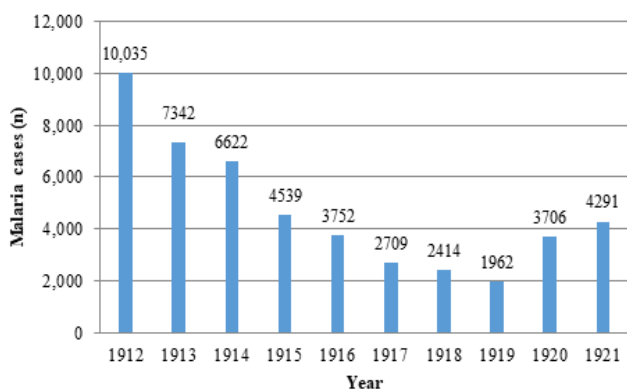


Fig. 1. Distribution of malaria cases in Cyprus between 1912-1921.

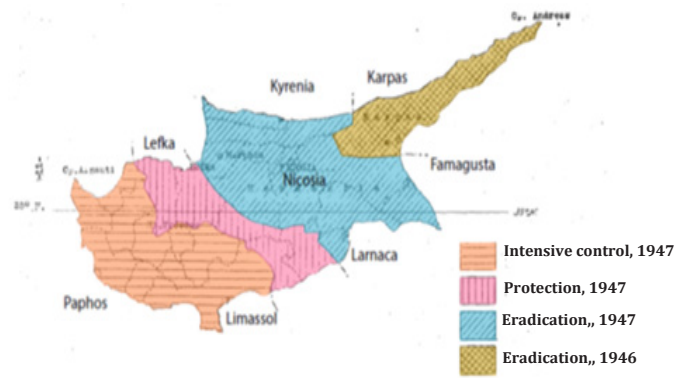


Fig. 2. The division of the island of Cyprus in 1947 within the scope of the antimalarial camping^[12].

was recorded at that time indicating the time lapsed for eradication of adult and larval mosquitos (4-20 and 3-20 weeks respectively) in various regions^[12]. During the period of 1944-1948, the rate of enlarged spleens among school children decreased from 32.4% to 10.6%, and the rate of malaria parasites reduced from 51.9% to 1.3%^[8]. After the successful fight against malaria, which involved 46 tons of DDT and the engagement of 770 Cypriots, the British press gave wide coverage to this important public health event. As a result of this project, Mehmet Aziz successfully made Cyprus the first country to eradicate malaria in the world (Figure 3).

Present time in Northern Cyprus

At the present time, there are no domestic malaria cases in Northern Cyprus and all diagnosed cases are imported. Despite this, three British citizens were diagnosed with malaria when they had a 2-3-week holiday in the Esentepe region of Northern Cyprus in August 2017. One traveler (49-year-old female) visited Esentepe for 2 weeks, returned to the United Kingdom (UK) on August 19, and developed symptoms ten days later on August 29. The other two travelers were 12-year-old children who visited Esentepe for 3 weeks. They developed the symptoms on 29th of August before returning to the UK, on 31st of August. As a result of the analyses performed in UK, the three cases were diagnosed with *Plasmodium vivax*; were treated successfully and recovered^[13,14]. Consequently, investigations were carried out by the responsible inspectors of the Turkish Republic of Northern Cyprus (TRNC) Ministry of Health. A statement was released by the Ministry that there were no vector mosquitos found

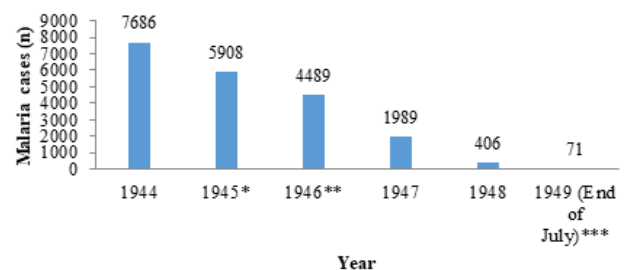


Fig. 3. The number of malaria cases during the campaign period in Cyprus from 1944-1949.

Table 1. Time lapsed for eradication of adult and larval mosquitos in various regions assessed in terms of imago or larvae^[12].

Zoon	Negative for adults			Negative for larva		
	From	To	No. of weeks	From	To	No. of weeks
Rikokarpaso	18.8	16.11	13	15.9	16.11	9
Yialousa	18.8	16.11	13	15.9	16.11	9
Leonarisso	15.9	16.11	9	25.8	16.11	12
Ayios Theodoros	14.7	16.11	18	28.7	16.11	16
Komi-Kebir	30.6	16.11	20	30.6	16.11	20
Trikomo	6.10	16.11	6	6.10	16.11	6
Ardhana	8.9	16.11	10	8.9	16.11	10
Lefkoniko*	13.10	16.11	5	13.10	16.11	5
Akanthou*	20.10	16.11	4	13.10	16.11	5
Chatos*	6.10	16.11	6	27.10	16.11	3

*Protection Zone

and no new cases of malaria were encountered^[15]. In 2020, Güler *et al.*^[16] reported that a total of 13 imported cases were diagnosed at a university hospital in Northern Cyprus during the period from 2016 to 2109. While two of these cases were Turkish citizens, the remaining eleven were Nigerian. Moreover, one of the Turkish citizens was working in Africa and had come to Cyprus for a holiday. *Plasmodium vivax* malaria was detected in the other Turkish citizen and it was accepted as a recurrence because the patient had a history of malaria^[16]. According to the TRNC Ministry of Health, 26 imported malaria cases were reported in Northern Cyprus between 2016 and 2019 (Figure 4)^[17], versus 13 cases recorded by Near East University (NEU) in Northern Nicosia, Cyprus (Figure 4)^[16,17].

Although there are no domestic malaria cases on our island, there has been an increase in imported cases originating from abroad in parallel with the increasing number of foreign students in recent years^[16]. It is known that *Anopheles* mosquitos, the vector of malaria, have not been seen on the island since 1950^[8]. However, in a study conducted in the Southern Cyprus region in 2009, another *Anopheles* species (*Anopheles sacharovi*) that can carry and transmit *Plasmodium* parasites have been shown to exist^[18]. In addition, according to the CDC, mosquito vectors for malaria, *Anopheles claviger*, *Anopheles algerienses*, *Anopheles sacharovi*, and *Anopheles superpictus*, are present in Cyprus^[14].

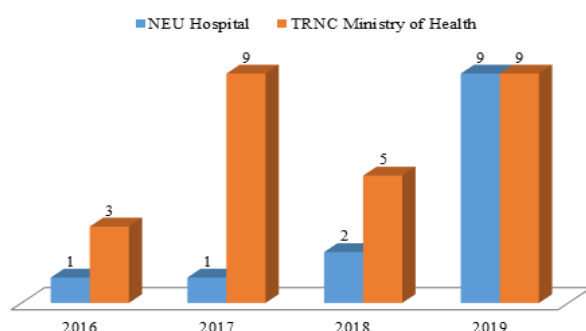


Fig. 4. Distribution of malaria cases over four years (2016-2019) according to the data of NEU Hospital and TRNC Ministry of Health^[16,17]. **NEU:** Near East University; **TRNC:** Turkish Republic of Northern Cyprus

CONCLUDING REMARKS

Cyprus receives immigration from many countries, especially African countries where malaria is endemic. Most of the incoming people are studying at universities in the country or they are working in different occupations. The higher education sector in TRNC has grown over the years, and especially since 2011, where the number of students has increased rapidly. It is also noteworthy that patients bring malaria drugs from their own countries. Due to these changes in the North Cyprus population, the Ministry of Health changed their policies on malaria control by increasing the number of malaria drugs. Therefore, malaria patients coming to our island from endemic regions, for any reason, are a major risk factor in the reappearance of the eradicated malaria infection on the island.

In terms of public health, it is essential that the fight against mosquitos should not be interrupted, and all imported malaria cases must be treated without delay. Another critical point is that malaria infection should be kept in mind by clinicians for all patients with malaria symptoms and who had history of travel to a malaria endemic region.

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The anti-schistosomal activity of magnetite and zero-valent iron nanoparticles on *Schistosoma mansoni*: An *in vivo* study

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