



MALARIA AND COVID-19 IN NATIVE COMMUNITIES OF AMAZONAS, PERU

MALARIA Y COVID-19 EN COMUNIDADES NATIVAS DE AMAZONAS, PERÚ

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ABSTRACT

Introduction: In recent years, the number of malaria cases in native communities from Condorcanqui, Amazonas has considerably increased. *Plasmodium vivax* malaria is endemic in the region and the re-introduction of *Plasmodium falciparum* was reported in 2019. **Objective:** Here, we compiled and analyzed malaria and COVID-19 data reported by the Dirección Regional de Salud (DIRESA) during the 2020. **Methods:** Additionally, we performed an odds ratio analysis to evaluate significant associations between COVID-19 symptoms and previous malaria infections. In 2020, 1547 malaria (97% were *P. vivax*) and 5968 COVID-19 cases were reported. Furthermore, 96 patients got COVID-19 after getting a malaria infection. **Results:** From these, 87 were symptomatic (90.6%), and mostly adults, ages 30 to 59 (62.3%). Also, we found that malaria previous infections represent a risk for the presence of symptoms such as fever, cough, throat pain, and respiratory difficulty. Nevertheless, there was no significant association between these patients and hospitalization or death. **Conclusions:** Our analysis suggests that previous malaria infections might affect COVID-19 symptomatology, which highlights the importance of a continuing control and surveillance malaria program to avoid potential syndemics with COVID-19.

Keywords: Malaria; COVID-19; Disease; Syndemic. (Source: MeSH NLM).

RESUMEN

Introducción: En los últimos años, el número de casos de malaria en las comunidades nativas de Condorcanqui, Amazonas, ha aumentado considerablemente. La malaria por *Plasmodium vivax* es endémica en la región y en 2019 fue reportada la reintroducción de *P. falciparum*. **Objetivo:** En este estudio, recopilamos y analizamos los datos de malaria y COVID-19 reportados por la Dirección Regional de Salud (DIRESA) durante el 2020. **Métodos:** Además, realizamos un análisis de razón de posibilidades "odds ratio" para evaluar las asociaciones significativas entre los síntomas de la COVID-19 y las infecciones previas de malaria. En el 2020, se reportaron 1547 casos de malaria (97% por *P. vivax*) y 5968 de COVID-19. **Resultados:** Por otro lado, 96 pacientes contrajeron COVID-19 después de contraer una infección de malaria. De éstos, 87 eran sintomáticos (90,6%) y en su mayoría adultos de 30 a 59 años (62,3%). Además, encontramos que las infecciones previas de malaria están asociadas a la presencia de síntomas como fiebre, tos, dolor de garganta y dificultad respiratoria. Sin embargo, no hubo asociación significativa entre estos pacientes y la hospitalización o la muerte. **Conclusiones:** Nuestro análisis sugiere que las infecciones previas por malaria podrían afectar la sintomatología de la COVID-19, lo que destaca la importancia de un programa continuo de control y vigilancia de la malaria para evitar posibles sindemias con la COVID-19.

Palabras claves: Malaria; COVID-19; Enfermedad tropical; Sindemia. (Fuente: DeCS BIREME).

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INTRODUCTION

Malaria is a widespread disease throughout the world and especially in tropical and subtropical regions. In Peru, the cases represent 6% of the total for all of America. In 2021, the majority of cases occurred in Loreto (84.6%), Amazonas (9.8%), Junín (3.4%), and San Martín (0.8%)⁽¹⁾.

In particular, native communities are the most affected. These populations lack basic services (such as electricity or drinking water) and the main means of transportation is by the river. The province of Condorcanqui, on the northeastern side of the Amazon region in Peru, has more than 300 native communities and 42,700 inhabitants, with a majority population of the Awajun and Wampis ethnic groups. Here, malaria is endemic and *P. vivax* is more prevalent than *P.falciparum* infections. Between 2015 and 2018, only four imported cases of *P.falciparum* were reported. In 2020, an outbreak of *P. falciparum*, increased the risk of malaria severity and mortality⁽²⁾. On the other hand, COVID-19 has had the considerable transmission in these populations, with a high cumulative incidence of 63.84/1000 inhabitants and a much lower mortality rate (0.95%) than the national average⁽³⁾.

Despite the possible concurrent infection of COVID-19 and malaria, little is known about the clinical course of coinfected patients. Malaria-induced immunomodulation has been shown to have a protective effect against severe manifestations of respiratory viral infections⁽⁴⁾. A study in Kenya showed that children hospitalized with a diagnosis of Influenza and Malaria were less likely to progress to respiratory distress than those with only influenza⁽⁵⁾.

Furthermore, co-infection was found to suppress the production of pulmonary cytokines and decrease the recruitment of immune cells to the lung⁽⁶⁾. The impact of malaria on clinical outcomes of COVID-19 has remained unaddressed by longitudinal studies.

In this article, we present a preliminary analysis of the epidemiology of malaria in the native communities of Condorcanqui, Amazonas, Peru, and assess the impact

of the COVID-19 pandemic during the year 2020. This is the first study to describe the behavior of COVID -19 in an endemic area for malaria. Finally, we suggest a syndemic approach and additional studies to learn more about the effect of malaria and other tropical infections and their relationship with respiratory infections such as COVID-19.

METHODS

Study design type and area

The Regional Directorate of Health - Amazonas (DIRESA- Amazonas), in collaboration with the Condorcanqui Health Network and the Institute of Tropical Diseases of the Toribio Rodríguez National University of Mendoza, has carried out an analysis of the data on Malaria infections that have been reported in the native communities of Rio Santiago, Condorcanqui province, Amazonas region during 2020. Additionally, the analysis of COVID-19 cases in the province of Condorcanqui, confirmed serologically and notified during the year 2020, was carried out.

Data consists of open demographic information, clinical characteristics, and contact history. This investigation was carried out as part of the epidemiological surveillance approved by DIRESA-Amazonas.

Study site

The Province of Condorcanqui is located in the northern jungle of the Amazon Region of Peru and is part of the Marañón Basin. This province is limited by the Republic of Ecuador to the Northwest; the region of Loreto to the East, and the provinces of Bagua, Utcubamba, and Bongará to the South. Condorcanqui has three districts: Nieva, El Cenepa, and Río Santiago, and has an area of 17,892 km², with an estimated population of 42,470 inhabitants⁽⁷⁾. The rugged relief of this region has an extensive river network made up of the Marañón River



and its tributaries Cenepa, Nieva, and Santiago, as well as a large number of streams of different flows and sizes. Condorcanqui has a humid tropical climate with temperatures that can reach 35 °C, average annual rainfall around 4,800 mm, and relative humidity above 90%. The rainy season occurs from October to December but could last until May⁽⁸⁾.

Malaria and COVID-19 Database

In this study, we compiled and analyzed malaria and COVID-19 data reported by DIRESA-Amazonas during the year 2020. In addition, we performed an odds ratio analysis with a 95 % confidence interval to assess significant associations between COVID-19 symptoms and prior malaria infection. Statistical analyzes were performed using the IBM SPSS Statistics program (version 21.0), and graphs were made using GraphPad Prism (version eight). The heat map was performed using QGIS version 3.10.8 to assess the spatial distribution of malaria and COVID-19 cases in Condorcanqui.

RESULTS

The descriptive analysis based on the information collected from the DIRESA-Amazonas open databases shows that during 2020 in the native communities located along the Santiago River, the transmission of the SARS-CoV-2 virus occurred in a population affected by malaria. Thus, 1,547 cases of malaria (97% due to *P. vivax*) and 5,968 cases of COVID-19 were reported in Condorcanqui (Figure 1, 2A).

Although they are official data, the restrictions caused by the state of emergency and the limited access to the communities could have caused the data to be underestimated. Santa María de Nieva is the capital of the province of Condorcanqui. In this city alone, 1,792 cases of COVID-19 were reported, with the rest of the cases being distributed among the other districts of the province. However, the communities of the Río Santiago district were affected by both Malaria and COVID-19 diseases (Figure 1).

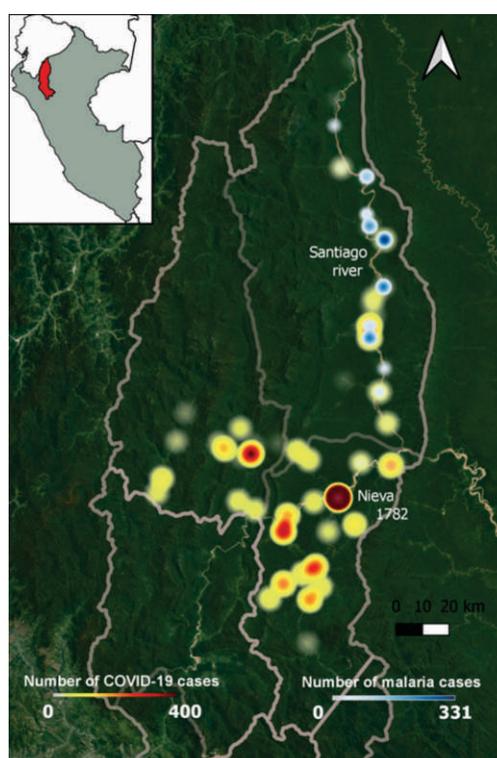
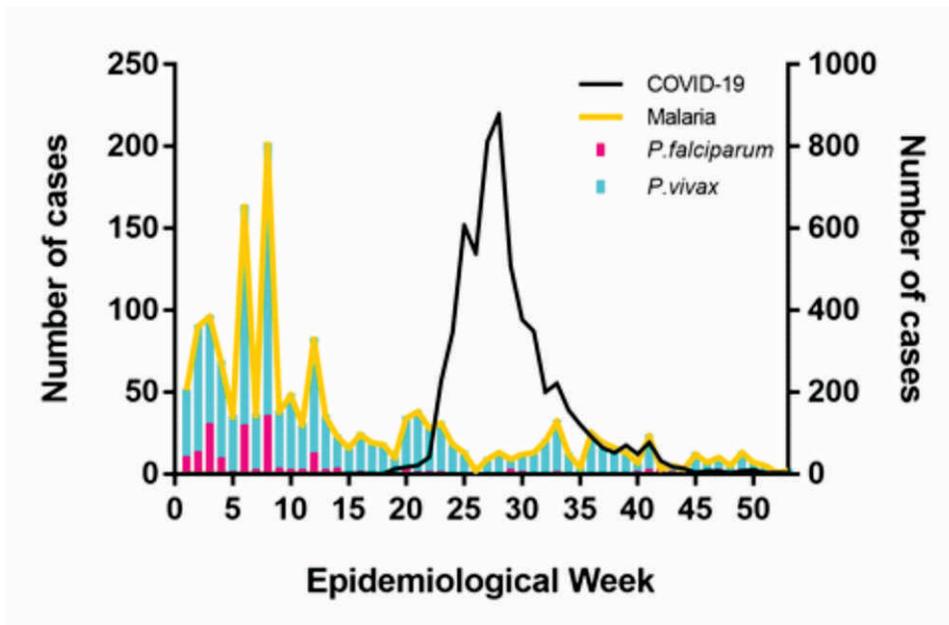


Figure 1. COVID-19 and malaria in 54 localities in the province of Condorcanqui and its capital Nieva during 2020.

Nieva reported the highest number of COVID-19 cases with a total of 1,782 in 2020. COVID-19 cases on a red scale and malaria cases on a blue scale.

In 2020, the largest report of malaria cases occurred in the first ten weeks and coincides with the active search for outbreak investigation where the re-emergence of *P.falciparum* after 13 years. While the peak of COVID-19 cases was reported between weeks 25 and 30.

The decrease in the reporting of malaria cases during a state of emergency shows how malaria surveillance was affected (Figure 2A). As for the age group most affected by malaria, it was children under 11 years of age (48.4%) and for cases of COVID-19, it mostly affected adults between 30 and 59 years of age (62.3%) (Figure 2B).



A. Number of cases per epidemiological week in 2020. en 2020.

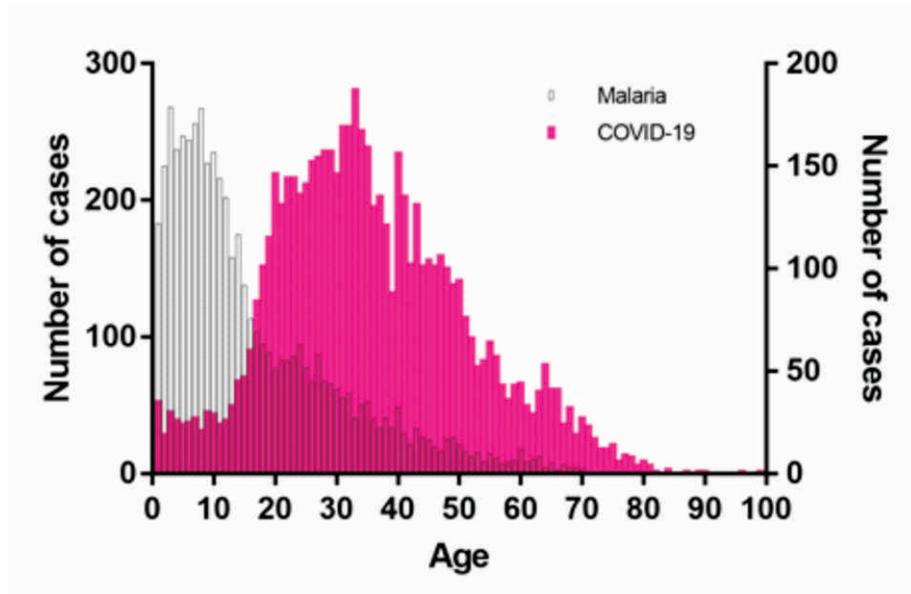


Figure 2A. COVID-19 and malaria in Condorcanqui.

B. Age distribution of confirmed cases of COVID-19 and malaria

In order to measure the association between previous malaria infection and COVID-19 symptoms, an odds ratio analysis was applied. It was found that having previously suffered from malaria is significantly associated with the presence of COVID-19 symptoms such as fever, cough, sore throat, and shortness of breath.

However, regarding hospitalization or death from COVID-19, no significant association was found for these patients. Likewise, no significance is observed with symptoms such as chest pain or abnormal sounds in the lungs (Figure 3).

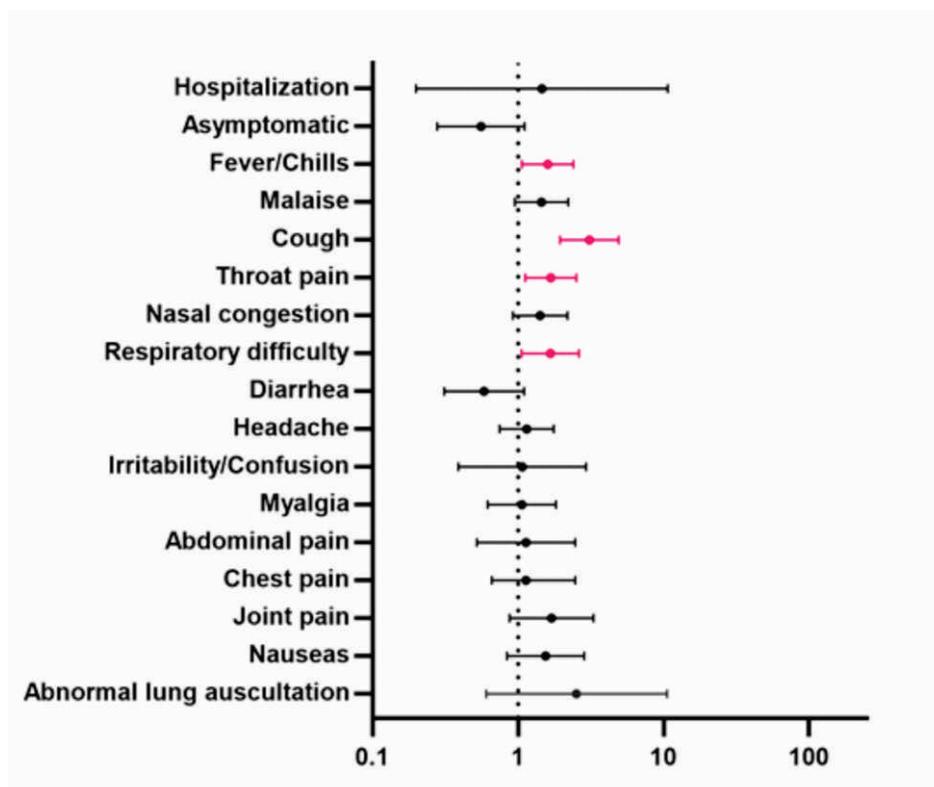


Figure 3. Odds ratio analysis

Risk of symptoms in cases of COVID-19 with a previous infection with malaria. Significant factors are in pink.

In the relationship between recurrent malaria infections and COVID-19 symptoms, no statistical significance was found either. Finally, four people were diagnosed with malaria and COVID-19 in a period of fewer than 30 days. They did not present severe symptoms of COVID-19 and recovered without requiring hospitalization.

DISCUSSION

By 2022, in America, Peru ranks fifth in a number of confirmed infections by Sars-COV-2 with 3,581,524 cases, while Peru ranks second in a number of deaths with 213,205⁽¹¹⁾.

The north-eastern region of the country is home to around 210,000 natives of different ethnic groups. These communities often live in isolation and in conditions that make them vulnerable to various tropical communicable diseases and currently to COVID-19⁽¹²⁾. During the pandemic, worldwide, the focus of attention was on COVID-19, so efforts to cut community transmission caused the neglect of other diseases such as malaria, accentuating the problem in endemic countries, such as in many countries of Africa^(13,14) and in Peru⁽¹⁵⁾.



After Iquitos, Amazonas is the second region with the most cases of malaria, mainly concentrated in the district of Río Santiago, province of Condorcanqui. This behavior has been evidenced since 2010 due to the transmission of *P. vivax* infections *P. falciparum* in the region⁽²⁾. Although it is possible that the restrictive measures due to the pandemic affect the real impact on malaria transmission, an underestimation of the situation cannot be ruled out, due to the reduction of control measures and a consequent resurgence of malaria or expansion to other bordering areas such as Amazon.

As reported for Iquitos, where there is a notable reduction in the number of cases after the intervention by the Ministry of Health's "Malaria Cero" program⁽¹⁵⁾. Malaria circulation could increase susceptibility to COVID-19 disease and affect morbidity and mortality rates.

However, there are reports of the importance of the balance of the immune response against infections, and the possibility that the preparation with *Plasmodium* may have favorable effects.

It has recently been reported that the immune response that appears during malaria infection could protect against Sars CoV-2 infection, and decrease the risk of severe COVID-19^(16,17,18). Likewise, co-infection with *Plasmodium* spp could suppress the production of pulmonary cytokines and decrease the recruitment of inflammatory cellular components to the lungs^(4,5).

In the analysis carried out in the province of Condorcanqui in Amazonas, Peru, we found that in the communities of the Río Santiago district, where the majority of malaria cases occur in the region, they have also reported cases of COVID-19.

Interestingly, reported Malaria cases primarily affect children under 11 years of age, while COVID-19 cases affect adults. This is due to the fact that children with COVID-19 produce a rapid and effective immune response to the virus, with the majority of cases being asymptomatic.

This could be due to the low immune status of children against malaria, while more is known about the immunological susceptibility of adults and older adults against COVID-19. Among the patients who reported a previous malaria infection, no cases of death were reported and no significant association was found with hospitalization or with severe symptoms of the disease.

However, there is an association between malaria infection and recurrent symptoms of COVID-19 (fever, chills, cough, sore throat, and shortness of breath), suggesting that patients from these native communities who have had at least a case of malaria, when sick with COVID-19 they may report symptoms compatible with mild or moderate COVID-19, without evidence of severe COVID-19 or death. In this sense, DIRESA reported for Río Santiago during 2020, 839 cases of COVID-19 and 8 deaths (lethality of 0.95%)⁽¹⁹⁾.

Although one of the limitations of the study is the inability to associate co-infection with malaria in the 8 deaths, the low case fatality reported and our analysis suggest further research on the clinical context of patients with malaria or other infections and how they influence the pathology of COVID-19. Some researchers have proposed the term "syndemic" (syndemic) to describe the occurrence of two or more concurrent epidemics in a detrimental interaction⁽⁴⁾. For this reason and due to the importance that malaria represents for low- and middle-income countries, more studies are required to determine the implication of these co-infections, especially in endemic populations, either to determine the types and quality of antibodies, investigate the regulation of cytokines or behavior of T lymphocytes, or about the knowledge of traditional medicine that these communities safeguard.

Finally, our preliminary analysis reveals that recurrent *Plasmodium* spp are frequent in the Condorcanqui communities along the Santiago River and that a controlled study is necessary to determine if these can be considered recrudescences or relapses instead of reinfections. Furthermore, our analysis suggests that





previous malaria infections could affect COVID-19 symptomatology, highlighting the importance of an

ongoing monitoring and surveillance program for malaria to avoid potential syndemics with the COVID-19.

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