Meeting the challenges and strategies regarding malaria elimination: qualitative evaluation of perceptions from a local population in Colombia

Angélica Knudson Ospina[1]*, Elkin Leonardo Simanca Castro[2], Yenny Marcela Barreto-Zorza[3], Olga Lucía Ospina Rodríguez[1], María Alejandra Parada Aguilar[4], Daniel Perilla Roa[4], Yoseth Ariza-Araújo[5], Carlos Felipe Castillo[6], Luz Adriana Olaya Másmela[7], Giovanni Apráez Ippolito[1], Anderson Hair Piamba Dorado[6], Ricardo Sánchez Pedraza[8] and Vladimir Corredor Espinel[1]

[1]Departamento de Salud Pública, Facultad de Medicina, Universidad Nacional de Colombia, Bogotá, Colombia, [2]Maestría en Epidemiología Clínica, Facultad de Medicina, Universidad Nacional de Colombia, Bogotá, Colombia, [3]Grupo de Investigación en Salud Pública, Escuela de Medicina y Ciencias de la Salud, Universidad del Rosario, Bogotá, Colombia, [4]Programa de Medicina, Facultad de Medicina, Universidad Nacional de Colombia, Bogotá, Colombia, [5]Departamento de Salud Pública y Medicina Comunitaria, Facultad de Ciencias de la Salud, Universidad ICESI, Cali, Colombia, [6]Programa de Enfermedades Transmitidas por Vectores, Secretaría Departamental de Salud del Cauca, Popayán, Colombia, [7]Programa de Medicina, Facultad de Ciencias de la Salud, Universidad Libre de Cali, Cali, Colombia, [8]Departamento de Psiquiatría, Facultad de Medicina, Universidad Nacional de Colombia, Bogotá, Colombia

"One Health" and "Social Determinants of Health" approaches are crucial for implementation of sustainable strategies for the control and elimination of infectious diseases such as malaria. These approaches highlight the importance of the social component in the design of elimination strategies, as well as the communities' involvement in the implementation of these measures at local levels. Qualitative analysis approaches for malaria research can be useful for assessing population acceptance of intervention measures and for addressing negative perceptions that can threaten the success of control goals by undermining the community's trust in interventions. In this paper, we explore some observations and interpretations from the qualitative content analysis of two open-ended questions about malaria, from a survey conducted between September and November 2016 in Guapi, a high risk transmission area in the Colombian Pacific Region. Using the spatial transmission unit concept for the analysis of the conditions and factors involved in malaria transmission under the "One Health" and "Social Determinants of Health" approaches, we reveal that responders' perceptions reflects both the need and requirement for continuous assistance to solve local problems and also a comprehensive problem-solving effort by the government that includes basic sanitation. From the analyses, we present a graphic model that illustrates how to address the

problem of malaria control and elimination from the perspectives of the community's perceptions in Guapi, highlighting the need for joint efforts of community, academy, and government to achieve the goal of controlling and eliminating malaria in the region.

1 Introduction

Malaria incidence is associated with wide-ranging characteristics and lifestyles that increase transmission risk, including socio-economic conditions, public policies, poverty and working conditions (Castro, 2017). However, the interaction among humans, vectors and parasites in very specific environments give rise to diverse transmission patterns, hindering or challenging control efforts at local and national levels. For example, though that the distribution of malaria cases occurs in hotspots along international borders, the incidence and transmission patterns of *Plasmodium vivax* and *P. falciparum* in three border areas of Brazil, Venezuela and Guyana are influenced not only by geographical factors, but also correlate with human migrations caused by the social crisis in Venezuela. Malaria elimination in this context requires both the targeted distribution of resources at local levels and highly coordinated cross-border surveillance efforts among countries with different political systems, languages, and economic resources (Wangdi et al., 2022).

Until recently, control strategies focused almost exclusively on deploying interventions with little or no consideration regarding the perceptions that communities have about those strategies. This paradigm has been changing recently, not only for malaria, but also for the management of other transmissible diseases. Initiatives such as the "One Health" approach, defined by WHO as "*an approach to designing and implementing programs, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes*", have been crucial for the implementation of sustainable strategies for the control and elimination of malaria and other diseases (Wangdi et al., 2022). In the same way, social determinants of health are also defined by WHO as "*the circumstances in which people are born, grow up, live, work and age, including economic, political, cultural, and health system aspects. These circumstances result from the distribution of money, power, and resources at the global, national, and local levels, which depends on policies adopted*". Thus, these factors determine population behavior and living conditions and so, influence the outcome of health problems (Instituto Nacional de Salud, 2021).

The Global Technical Strategy for the Elimination of Malaria aimed to reduce malaria incidence and mortality by 40% for the year 2020 through early diagnosis and treatment (artemisinin-based combination therapy), vector control (long-lasting insecticidal nets, indoor residual spraying), investigation and response (World Health Organization, 2021). Within this framework, the Integrated Management Strategy for the Promotion, Prevention and Control of Vector-borne Diseases (EGI-ETV) was implemented in Colombia from 2012 to 2021 as a model for managing the operational response required to achieve the reduction of malaria mortality and morbidity by 80% and 50%, respectively, and to eliminate peri-urban transmission in identified foci, most of them in the Pacific region (Ministerio de Salud y Protección Social, 2013; Ministerio de Salud y Protección social, 2017; Organización Panamericana de la Salud et al., 2020). However, as in the rest of the country, malaria cases in the Colombian Pacific Region have increased since 2016, registering multiple outbreaks in which *P. falciparum* infection is the most frequent (Feged-Rivadeneira et al., 2018; Knudson et al., 2020).

In Colombia, heterogeneity and focalization are the most common epidemiological characteristics of malaria transmission, but the delimitation of units where control measures can be implemented in a cost-effective way has been challenging, mainly because of the lack of knowledge about factors that locally define malaria burden. Nonetheless, identifying spatial transmission units is key for implementing or improving control programs in ecologically and socially complex endemic areas. Spatial analysis and modelling tools are useful for this purpose, helping to define ecological associations between malaria risk, environment and biological aspects of vectors and parasites, to quantify temporal and spatial diffusion and predict patterns of disease spread.

On the other hand, research about malaria in Colombia has been focused on clinical, biological and epidemiological procedures, with little attention paid to qualitative research. However, qualitative approaches are important because they not only allow population perceptions to be identified in a specific context but also allow successes and setbacks during the control policies to be recognized. Moreover, qualitative research help to understand whether management plans are adequate, opportune and adapted to the target community. In general, qualitative focused investigations about malaria elimination in Colombia have shown similar results regarding structural determiners, effects on individuals and families and ways to understand malaria transmission (Cardona-Arias et al., 2020). Nevertheless,

community perceptions about health policies, the systematic deployment of solutions originated from the community core and how to motivate the communities to participate in public health interventions remain poorly understood. Exploring this neglected topic could improve population engagement in malaria control and elimination initiatives (Cardona-Arias et al., 2020).

Through a qualitative analysis approach (content analysis) (Bengtsson, 2016), we describe and interpret findings of a study aimed to analyze the perception of the community towards malaria control and elimination strategies in Guapi, a municipality of the Colombian Pacific region. To perform the content analysis, we used the EGI-ETV as a political framework and the concept of spatial transmission unit (explained in detail in the next section) within the framework of the principles of the "One Health" approach and "Social Determinants of Health". We chose to use content instead of discursive analysis, because the former is a more flexible and immediate approach to obtain categories and subcategories, and whose results are more suitable for identifying key points in the implementation of public policies for the current malaria scenario in this region. From the community perspective and according to our standpoint, the results from this kind of studies should be considered during the development of health policies and interventions at local or regional levels.

2 Malaria in the Colombian Pacific Region: the Guapi spatial transmission unit

Like all the Pacific Coast of Colombia, Guapi (2°34′11″ N, 77° 53′10″ W) is a lowland area, with a maximum altitude of 5 meters above sea level, a tropical rainforest climate according to Köppen classification, with an average temperature of 29 °C, rainfall between 4000 and 6000 mm^3 and relative humidity between 80% and 95%. According to the latest census in Colombia, Guapi had 24,037 inhabitants in 2018 (Departamento Administrativo Nacional de Estadística DANE, 2018a; Departamento Administrativo Nacional de Estadística DANE, 2018b); approximately 45% of the population inhabit rural areas, 97% are from Afro-Colombian origin and the main economic occupations are related to fishing, agriculture, and mining activities (Knudson-Ospina et al., 2019).

Guapi lacks potable water supply, regular garbage collection and separation services; because of that, the Guapi River is the recipient of large amounts of solid waste. Approximately 67.5% of the population had unsatisfied basic needs and the illiteracy rate is around 14.9%. Infant mortality triples the national rate, vaccination coverage is the lowest in the department, and health care is also deficient (Departamento Administrativo Nacional de Estadística DANE, 2020).

Guapi is one of the Pacific Region municipalities considered to be at medium and high-risk of malaria transmission and the frequency of *P. falciparum* infection is higher than 95%, although, in accordance with the Annual Parasite Index (API), Colombia is classified as a low and unstable malaria transmission zone (Feged-Rivadeneira et al., 2018; Knudson et al., 2020; Sistema Nacional de

Vigilancia en Salud Pública (SIVIGILA), 2023). Malaria in Guapi shows peri-urban, endemic, and epidemic outbreaks as epidemiological patterns which are almost exclusively caused by *P. falciparum*. Between 2007 and 2021, annual parasite indices for *P. falciparum* infection fluctuated between 1.8 and 105; four out of the 21 neighborhoods that make up the urban area of Guapi report cases of peri-urban malaria, with Santa Monica being the neighborhood that historically reports the most cases (Feged-Rivadeneira et al., 2018; Knudson et al., 2020).

As a region of malaria transmission, Guapi has been target of several strategies and interventions, including the National Malaria Eradication Program in the 20th century and, in recent years, the elimination campaigns focused on urban and peri-urban malaria (Organización Panamericana de la Salud et al., 2020). The success of these attempts has been moderate, partially because of their lack of sustainability as a consequence of program's financial constraints, socio-political instability (related to human migration caused by illegal culture dynamics and the internal armed conflict), and the resurgence of illegal extraction mining activities. In this context, and considering the national policies for malaria elimination, the optimization of political and administrative resources and recognition and integration of the community role should be acknowledged to achieve the malaria elimination objective.

To understand the dynamics of malaria transmission in Guapi from an epidemiological point of view we have previously defined a *spatial malaria transmission unit* as the area contributing >= 95% of the malaria cases that are diagnosed at the catchment site i.e. the site where microscopic diagnosis and treatment are provided (Knudson et al., 2020). Using a combination of epidemiological (malaria incidence in human settlements within the spatial unit) and genetic data from parasites circulating in the area (molecular markers for parasite populations, drug resistance and gene targets for Rapid Diagnostic Tests) we were able to characterize the spatial unit in terms of the spatiotemporal heterogeneity of transmission and the connectivity of human populations resulting from human movements and migration (Knudson et al., 2020). This study determined that *P. falciparum* transmission was heterogeneous in time and space, highly influenced by local human movements and, to a lesser extent, by external migrations (Knudson et al., 2020).

3 Data collection

We conducted a qualitative study using content analysis (inductive and interpretative methodology) (Bengtsson, 2016). The study was carried out between September and November 2016 in Guapi through semi-structured interviews associated with the malaria survey of knowledge, attitudes and practices (KAP) and within the framework of the project "Tools, training and networks aimed at reducing the burden of malaria in the Colombian Pacific Coast" (Knudson et al., 2020). The study is classified as minimal risk and informed consent was obtained from all participants (WMA - World Medical Association (WMA) and WMA Declaration of Helsinki, 2013; Ministerio de Salud y Protección Social, 1993) and it was approved by the Faculty of Medicine ethics committee of the Universidad Nacional de Colombia (Evaluation Report 127-14).

The KAP survey was applied only in the Santa Monica neighborhood, and it encompassed socio-demographic description, knowledge, attitudes and practices regarding malaria and a section for community participation. The two questions that were open-ended are the focus of this qualitative analysis. The interviews were conducted in participants' homes and while recording the information, the research group reviewed striking aspects of the responses to deepen the subsequent analysis. All of the houses (229 households in which 1134 people live) were surveyed and one person of legal age (>18 years old) and residing in the neighborhood for at least the previous year, was in charge of answering the questions. Their responses were recorded on physical forms and reviewed; the household was revisited and asked to expand or complete the information if necessary.

Each interview lasted about one hour and was carried out by four female community health workers. Information bias was considered, especially with popular expressions that required further explanation by the participants, who sometimes associated the topic with other social and health problems whether it was related to malaria or not (Guber, 2004). To reduce this bias, the community health workers were four women from the South Pacific region of Colombia, who were between 30-50 year-old, with technical training in nursing, that were instructed by researchers regarding malaria topics and data collection. These women were recognized as health workers in their community, generating an opportunity to promote an empathetic relationship in order to conduct interviews with specific explanations of questions about popular expressions as needed. A pilot test was carried out to ensure the correct use of the data collection tools, and the data recording was supervised by a third person from the research group that did not belong to the community.

4 Qualitative analysis, "One Health" and "Social Determinants of Health" approaches

The two open-ended questions that are the basis of the qualitative component analysis were:

1. Do you believe that malaria cases in Guapi could increase due to (explain)
2. Which strategy would you propose to eliminate malaria in Guapi?

In Figure 1, we summarized the content analysis strategy from the answers to the open-ended questions. With this approach, an overall (pooled) analysis of the answers was carried out, so we did not explore each question separately. The categories corresponded to the seven components of the Integrated Management Strategy for the Promotion, Prevention and Control of Vector-borne Diseases (EGI-ETV), namely program management, epidemiological intelligence, knowledge management, health promotion, primary prevention of transmission, comprehensive patient care, and contingency management and care (Ministerio de Salud y

Protección social, 2017). On the other hand, the content analysis was developed through four stages: decontextualization, recontextualization, categorization, and compilation (Figure 1). Data validation was carried out including researchers that worked with the respondents, others who did not work directly with them and community health workers in order to achieve data saturation through data triangulation and unifying categorization criteria (Sampieri, 2021).

The concepts of "One Health" approach and "Social Determinants of Health" were also used for the analysis. In "One Health", the role of the environment was taken into account to explain the malaria dynamics from the perception of the participants (World Health Organization, 2022). On the other hand, the structural and intermediate factors of the "Social Determinants of Health" were taken into account to explain the conditions, infrastructure, and lifestyles described by the participants (Instituto Nacional de Salud, 2021) (Figure 1).

5 Community perspectives about malaria control and elimination in Guapi

From the analysis of the answers to the two-opened question regarding perceptions about malaria transmission in Guapi, we were able to define seven subcategories that belong to three of the seven components of the EGI-ETV, as shown in Figure 1.

The general perception of the inhabitants of the urban area of Guapi, reflects a series of requirements and needs that demand prompt and effective attention. Specifically, participants believe malaria dynamics in their neighborhood are determined by environmental, administrative, socio-cultural, demographic, educational, basic health, and living factors. The participants' requisitions spanned concerns, associated or not with malaria transmission, about health promotion, community education, collaborative work with academic institutions and the government, solid waste disposal and the absence of potable water and sewage systems, vector control, weather and natural phenomena, individual protective measures, and comprehensive patient care including case search, diagnosis and patient treatment.

In particular, the community identified waste disposal and lack of drinking water supply as the most urgent problems to be solved in Guapi. The inhabitants manifested concerns about solid waste disposal practices such as littering, rubbish accumulation and/or burning, obstruction of drainage systems by dumping residues into rivers and streams, and waste burial to build roads and trails. Besides, the lack of an adequate drinking water supply compels the people to find it from other sources (rain, rivers or artesian wells) and store it in semi-permanent containers or uncovered tanks. According to them, these conditions and the typical climatic and natural phenomena of the region favor the emergence of breeding sites for vectors, not only for malaria, but also for other diseases that require immediate attention. Among the strategies that the community considered important for vector control were vegetation clearing, draining of stagnant water, wells and ponds,
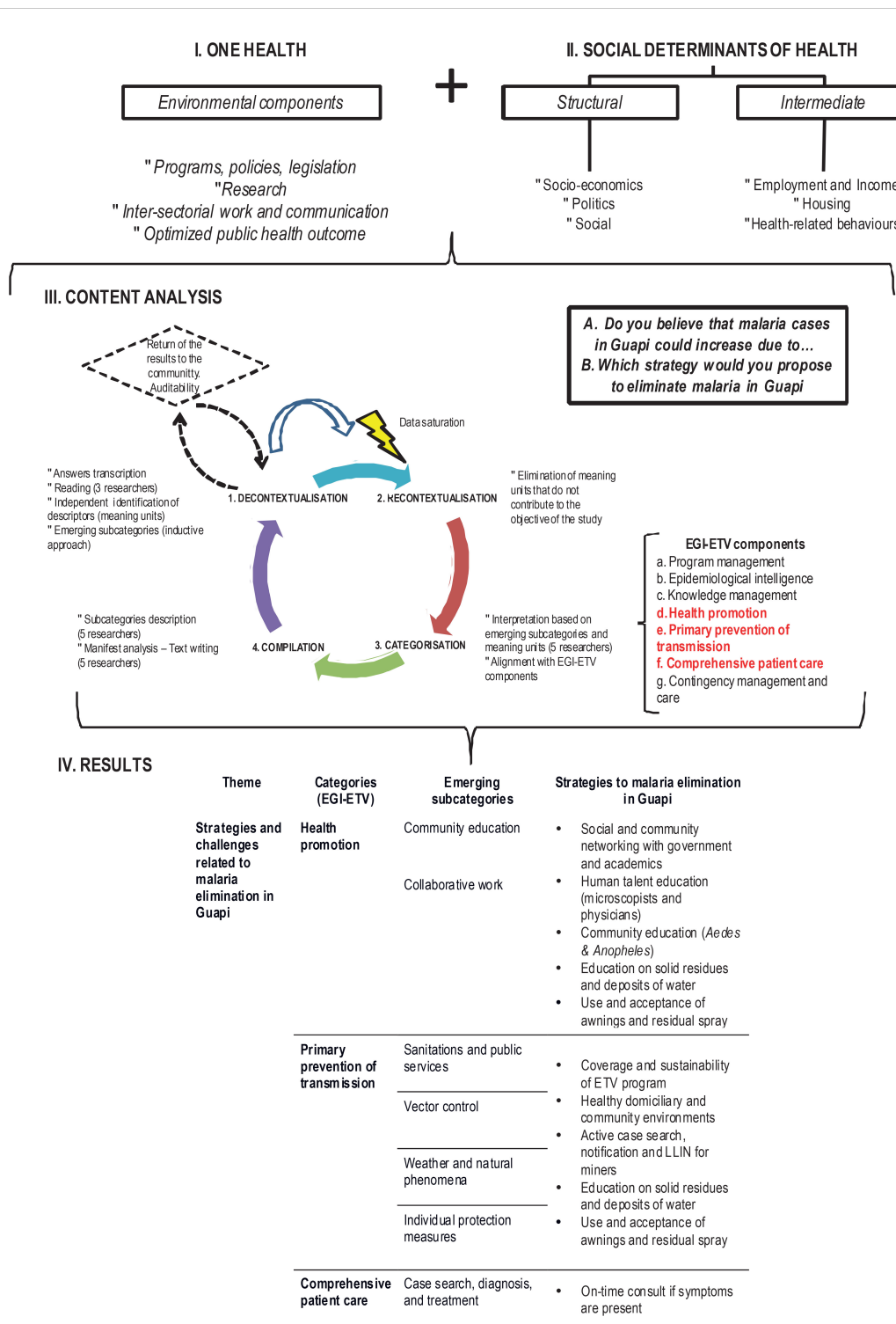
FIGURE 1

Content analysis: theme, categories, subcategories, and strategies emerging from data analysis in the framework of the "One Health" and "Social Determinants of Health" approaches. For the analysis, the categories corresponded to the seven components of the EGI-ETV. The content analysis was developed in four stages: during the decontextualization stage, the survey responses were transcribed and read by three researchers who independently identified and highlighted the *meaning units* (descriptors) (Bengtsson, 2016). The same researchers inductively identified emerging subcategories that were subsequently regrouped throughout the analysis according to the objective of the study. Methodological rigor considered the credibility of the work by returning the results to the community to explore how well the descriptors fit into the messages the community wanted to transmit. Each of the meaning units were coded and are included in the results. In the recontextualization stage, the three researchers eliminated the meaning units that did not contribute to the objective of the study. The third step or categorization stage included five researchers (three of the above and two more), who interpreted the information based on the emerging subcategories and their meaning units, and aligned them with the EGI-ETV components (categories). The fourth stage of the quantitative analysis was the compilation where the five researchers described each category, maintaining a neutral and objective perspective in the writing; through a "manifest analysis", the information from the respondents was used to write the text, considering the objective of the study.

elimination of temporary water containers (e.g. plastic bottles), and cleaning and coverage of water tanks. In the same way, people also mentioned the necessity of municipal government support for having an organized and frequent intra- and peridomiciliar insecticide application program and the supply of long-lasting insecticide-impregnated mosquito nets, in spite of some degree of rejection to use them because of the lack of motivation or fear of developing allergic reactions. From their answers, we concluded that even though people from Santa Monica neighborhood did not differentiate clearly which strategies are focused specifically on malaria control, they perceive them as a main axis for preventing malaria transmission at individual level.

6 Community participation: a model for malaria control and elimination in Guapi designed from the community perspectives

In general, the community perceptions align well with three of the seven components of the official policies, as shown in Figure 1. However, because of the poor Guapi socio-economics infrastructure,

people are more concerned about clean water supply and waste disposal than in the specific contribution of these interventions to solve the problem of malaria control and elimination. Based on our analysis, the strategies that emerged from the interpretation of the respondent's answers for malaria management in Santa Monica, Guapi that are classified into the structural determinants are: 1. Coverage and sustainability of the Vector Transmitted Diseases program (ETV by its Spanish first initials); 2. Social and community networking with government and academics; 3. Healthy domiciliary and community environments. As intermediate determinants, the intervention strategies that are inferred from the community answers are: 4. Human talent education (microscopists and physicians); 5. On-time consultation if symptoms are present; 6. Active case search, notification and long-lasting insecticide-treated nets (LLINs) for miners; 7. Education on solid residues and deposits of water; 8. Use and acceptance of awnings and residual spray; 9. Community education (*Aedes & Anopheles*). It was established that the malaria elimination strategies emerging from the participants' responses and analyzed in the light of the theoretical approaches of "One Health" and "Social Determinants of Health" are related to the categories corresponding to EGI-ETV components.

After the compilation stage, a graphic model (Figure 2) was developed for describing the strategy to address the problem of
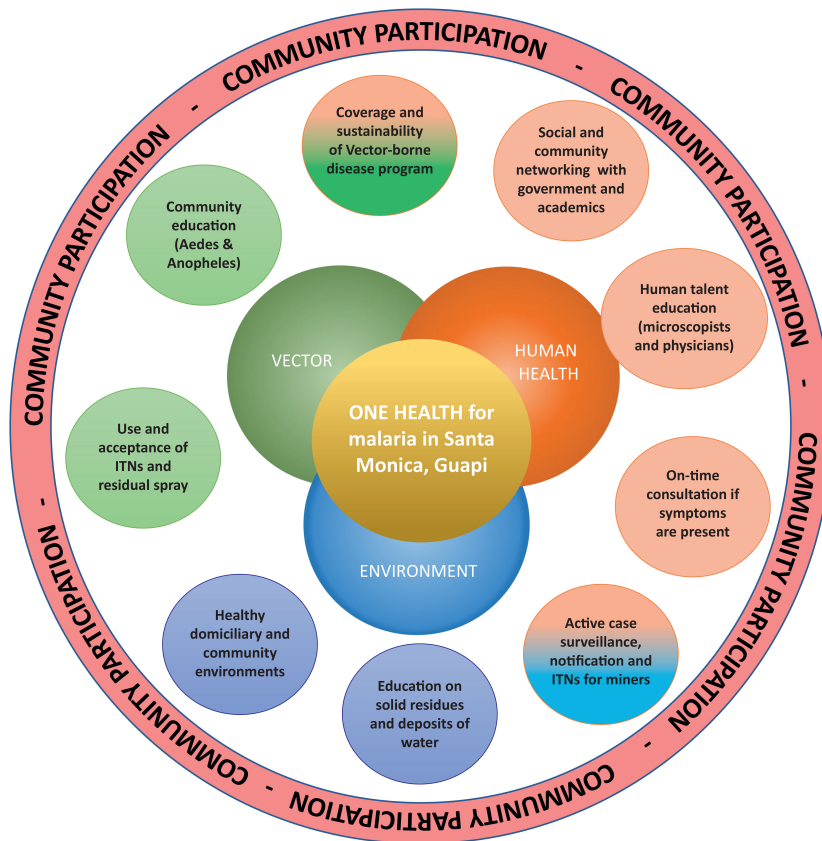

FIGURE 2
Graphic model for addressing malaria control and elimination in the Guapi spatial transmission unit. The central circles correspond to the role of the environment, a constitutive element of the "One Health" approach, and the small circles on the periphery are considered as strategies for malaria management by respondents; these elements are classified as structural and intermediate determinants of the "Social Determinants of Health" approach, and all of them are influenced by community participation (thick red line).

malaria control and elimination based on the perception of the community in Santa Monica, Guapi. To establish a specific malaria control and elimination program for the operational spatial transmission unit previously identified, it is necessary to characterize the obstacles to its implementation through the recognition of categories identified, in the first place, by the community that inhabits the region. The obstacles can be of different kinds and include biological components of malaria, functioning of the health system, and social and cultural aspects of the inhabitants of the regions. For example, *P. falciparum* cases from the Colombian Pacific Region, where this species is more prevalent and, in some places, exceeds 95% prevalence, contribute significantly to the malaria burden in The Americas Region. In terms of the biology of the parasite, *P. falciparum* infection is eliminable by treatment without relapse risks; nevertheless, this is possible only under the premise of timely access to diagnosis and proper treatment; meaning that the persistence of *P. falciparum* infection could indirectly reflect the absence of a competent health system unable to ensure adequate treatments. In this scenario, we assume that the malaria control and elimination goal in Guapi is achievable and would contribute to improving the regional and national health situation.

7 Using the concept of spatial transmission unit for malaria control and elimination in Guapi

The characterization of the spatial transmission unit in Guapi that we achieved in a previous study (Knudson et al., 2020) is a key first step towards converting it into a malaria control unit. Integrating intrinsic or biotic information (parasite, mosquito, and human biological information) and extrinsic or abiotic information (i.e. information regarding control and prevention measures, as well as social, demographic, behavioral, economic, political and environmental information) allow us to evaluate the roadblocks for implementing a malaria elimination program and unequivocally calculate costs of malaria elimination in a clearly delineated area.

The analysis of our current study allows a more precise characterization of the malaria control unit in Guapi, where the following strategies for control and elimination can be suggested: community education on the distinction between vector-borne diseases, specifically those related to *Aedes* and *Anopheles*; management of solid waste and water tanks; the use and acceptance of LLINs and indoor residual spraying; timely medical consultation after recognition of symptoms of malaria; use of protective measures when performing high-risk activities such as mining and fishing as well as conduct active, passive and reactive surveillance for malaria cases. In addition to education, there is a need to promote healthy environments in homes and communities. In parallel, ongoing training and re-training in malaria diagnosis and patient care should be provided to microscopists and healthcare personnel.

Other studies carried out in Colombia using qualitative analysis allow malaria to be approached as a problem from the perspective of the social determinants of health, grouped as structural determinants (the origin of malaria, its relation to life and work conditions, and the importance of home and family) and individual determinants (traditional knowledge about paludism, the importance of knowledge secularization about malaria and the perception of different communities about the risk of infection and death from malaria) (Cardona-Arias et al., 2019; Cardona-Arias et al., 2020; Cardona-Arias, 2022). Here, our work aimed to use qualitative analysis to understand the perceptions of the residents about: malaria risk areas, their own problems, the solutions proposed by themselves and how those solutions are related to the strategies proposed in the official programs from health institutions.

It is necessary to strengthen the local malaria program, ensuring the coverage and sustainability of activities, using social and community networks, and integrating government entities and academic institutions into the program. On the other hand, a special approach is required in mining areas, where uncontrolled movement of people occurs; the approach should include active surveillance, timely notification, and education on LLINs use. All the above processes should be mediated by community participation through the social groups formed, thus becoming information multipliers. In this context, the transferability of our findings involves the southern subregion of the Colombian Pacific, which includes municipalities with similar ethnographic origins (Afro-Colombian), socioeconomics and environmental characteristics. For populations from other regions, different backgrounds, or as a part of control programs for the management of diseases other than malaria, it could be useful to conduct similar surveys, not only to appraise the penetration and impact of health and government policies on the community, but also to include the communities own proposed solutions on the design and/ or improvement of the new strategies, and eventually, to figure it out why those policies are successful or not in a specific locality.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Faculty of Medicine ethics committee of the Universidad Nacional de Colombia (Evaluation Report 127-14). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AKO, VCE, NAI, RSP, LOM and CC contributed to conception and design of the study. AKO and ELSC organized the database. ESC performed the statistical analysis. AKO, ESC, YBZ, MPA and DPR

performed qualitative analysis. AKO, ESC, YBZ and OOR wrote the first draft of the manuscript. OOR, MPA, DPR, YAA and APD wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open* 2, 8–14. doi: 10.1016/j.npls.2016.01.001

Cardona-Arias, J. A. (2022). Systematic review of mixed studies on malaria in pregnancy: individual, cultural and socioeconomic determinants of its treatment and prevention. *Trop. Med. Infect. Dis.* 7, 423. doi: 10.3390/tropicalmed7120423

Cardona-Arias, J. A., Salas-Zapata, W. A., and Carmona-Fonseca, J. (2019). Determinación y determinantes sociales de la malaria: revisión sistemática, 1980-2018 [Social determination and determinants of malaria: a systematic review, 1980-2018. Determinação social e determinantes sociais da malária: revisão sistemática, 1980-2018]. *Rev. Panam Salud Publica* 43, e39. doi: 10.26633/RPSP.2019.39

Cardona-Arias, J. A., Salas-Zapata, W., and Carmona-Fonseca, J. (2020). Systematic review of qualitative studies about malaria in Colombia. *Heliyon* 6, e03964. doi: 10.1016/j.heliyon.2020.e03964

Castro, M. C. (2017). Malaria transmission and prospects for malaria eradication: the role of the environment. *Cold Spring Harb. Perspect. Med.* 7, a025601. doi: 10.1101/cshperspect.a025601

Departamento Administrativo Nacional de Estadística DANE. (2018a). *Censo Nacional de Población y Vivienda CNPV-2018* (Bogotá, Colombia). Available at: https://www.dane.gov.co/files/censo2018/informacion-tecnica/cnpv-2018-presentacion-3ra-entrega.pdf.

Departamento Administrativo Nacional de Estadística DANE. (2018b). *Population series 1985 - 2020* (Bogotá, Colombia: DANE and the Ministry of Social Protection of Colombia). Available at: https://www.dane.gov.co/index.php/en/statistics-by-topic-1/population-and-demography/population-series-1985-2020.

Departamento Administrativo Nacional de Estadística DANE. (2020). *Desafíos para la reducción de la pobreza* (Bogotá, Colombia). Available at: https://www.dane.gov.co/files/investigaciones/planes-desarrollo-territorial/200313-Info-Dane-Cauca.pdf.

Feged-Rivadeneira, A., Ángel, A., González-Casabianca, F., and Rivera, C. (2018). Malaria intensity in Colombia by regions and populations. *PloS One* 13, e0203673. doi: 10.1371/journal.pone.0203673

Guber, R. (2004). *El Salvaje Metropolitano - Reconstrucción del conocimiento social en el trabajo de campo (1 ed.)*. Available online at: http://www.derechoshumanos.unlp.edu.ar/assets/files/documentos/el-salvaje-metropolitano.pdf.

Instituto Nacional de Salud. (2021). *Observatorio Nacional de Salud. Observatorio Nacional de Salud*. Available online at: https://www.ins.gov.co/Direcciones/ONS/grupos.

Knudson, A., González-Casabianca, F., Feged-Rivadeneira, A., Pedreros, M. F., Aponte, S., Olaya, A., et al. (2020). Spatio-temporal dynamics of Plasmodium falciparum transmission within a spatial unit on the Colombian Pacific Coast. *Sci. Rep.* 10, 3756. doi: 10.1038/s41598-020-60676-1

Knudson-Ospina, A., Barreto-Zorza, Y. M., Castillo, C. F., Mosquera, L. Y., Apráez-Ippolito, G., Olaya-Másmela, L. A., et al. (2019). Estrategias para la eliminación de malaria: una perspectiva afro-Colombiana. *Rev. Salud Pública* 21, 9–16. doi: 10.15446/rsap.v21n1.76210

Ministerio de Salud y Protección Social. (1993). "Resolución 8430 de 1993," in *República de Colombia, 1993*. (Colombia: Ministry of Social Protection of Colombia) Available at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/DE/DIJ/RESOLUCION-8430-DE-1993.PDF.

Ministerio de Salud y Protección Social. (2013). *Plan decenal de salud pública 2012-2021: La salud en Colombia la construyes tú* (Bogotá, Colombia). Available at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ED/PSP/PDSP.pdf.

Ministerio de Salud y Protección social. (2017). *Lineamiento táctico y operativo de la estrategia de gestión integrada para las enfermedades transmitidas por vectores (EGI-ETV) a nivel territorial* (Bogotá, Colombia). Available at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/PP/PAI/Lineamiento-Tatico-operativo-egi-Etv.pdf.

Organización Panamericana de la Salud, Subdirección de Enfermedades Transmisibles and Equipo Funcional Nacional de Malaria. (2020). *Plan estratégico nacional de malaria 2019- 2022*. Available online at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/PP/PAI/plan-estrategico-malaria.pdf.

Sampieri, R. H. (2021). *Metodología de la Investigación (2.a ed.)* (Sampieri = Ciudad de México: Mcgraw-Hill Interamericana).

Sistema Nacional de Vigilancia en Salud Pública (SIVIGILA). (2023). Available online at: https://portalsivigila.ins.gov.co/Paginas/Buscador.aspx.

Wangdi, K., Wetzler, E., Cox, H., Marchesini, P., Villegas, L., and Canavati, S. (2022). Spatial patterns and climate drivers of malaria in three border areas of Brazil, Venezuela and Guyana, 2016-2018. *(2022). Sci. Rep.* 12, 10995. doi: 10.1038/s41598-022-14012-4

WMA - World Medical Association (WMA) and WMA Declaration of Helsinki. (2013) *Ethical principles for medical research involving human subjects*. Available online at: https://www.wma.net/es/policies-post/declaracion-de-helsinki-de-la-amm-principios-eticos-para-las-investigaciones-medicas-en-seres-humanos/.

World Health Organization. (2021). *Global technical strategy for malaria 2016–2030, 2021 update* (Geneva. Licence: CC BY-NC-SA 3.0 IGO). Available at: https://www.who.int/publications/i/item/9789240031357.

World Health Organization. (2022). *A health perspective on the role of the environment in One Health* (Copenhagen: WHO Regional Office for Europe). Available at: https://apps.who.int/iris/handle/10665/354574.