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Effectiveness of Malaria Eradication Programs in Endemic Areas: A Case Study in Papua province

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***Abstract*:** *This study aims to evaluate the effectiveness of malaria eradication programs in Papua, Indonesia, with a focus on implementation in endemic areas. Through a qualitative approach and case study method, the study involved in-depth interviews with health workers, communities, and policy makers in several districts in Papua. The results showed that although programs such as the distribution of insecticide-treated mosquito nets and spraying of insecticides have had a positive impact in the reduction of malaria cases, significant challenges remain, especially regarding the accessibility of remote areas and limited resources. Communities and health workers expect an increase in malaria education, training for field workers, and increased budgets and equipment to support the success of the program throughout Papua. This study provides recommendations to improve coordination between sectors and the implementation of programs that are more targeted and based on local needs.*

Keywords : *Malaria Eradication Program, Papua, Program Evaluation, Endemic Malaria*

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INTRODUCTION

Malaria remains one of the significant global public health problems, especially in tropical regions. According to World Health Organization (WHO) data, malaria causes more than 200 million cases of infection each year and more than 400,000 deaths, mostly in sub-Saharan Africa, Southeast Asia and Latin America. Efforts to eradicate malaria internationally continue through antimalarial drug delivery programs, distribution of insecticide-treated mosquito nets, insecticide spraying in high-risk areas, and vaccination. Despite significant progress in reducing the incidence of malaria, the disease remains a major challenge for many countries, especially those with limited access to adequate health services and infrastructure. Indonesia is one of the malaria endemic countries in Southeast Asia, with a high prevalence in some areas. Papua, in particular, has the highest prevalence of malaria in Indonesia. The region faces major challenges in malaria eradication, ranging from remote geographical conditions, limited accessibility, to dependence on effective treatment methods. Although Indonesia has made various efforts to control malaria, including the use of insecticide-treated mosquito nets, insecticide spraying, and the distribution of

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antimalarial drugs, this problem is still a major challenge that requires special attention and more intensive treatment, especially in provinces such as Papua.

Papua is one of the malaria endemic areas in Indonesia, with geographical and environmental conditions that strongly support the spread of this disease. The humid tropical climate, the presence of many swamps and dense forests, as well as stable temperatures make it an ideal place for the Anopheles mosquito to breed, the main vector of the spread of malaria. Remote and hard-to-reach areas make the distribution of malaria eradication programs more challenging. Based on data from the Papua Health Office, the prevalence of malaria in the province is still high, with the incidence of cases increasing in the rainy season. Despite efforts to tackle malaria, Papua still faces a significant death toll from the disease. Malaria in Papua has a far-reaching impact on people's quality of life. Public health is compromised by high rates of infection, which leads to reduced productivity and often leads to long-term disability in infected individuals. This impact also worsens access to education, as children who contract malaria are often absent from school. Economically, malaria burdens individuals and families in the form of medical expenses, as well as reducing income due to absence from work. At the local government level, the economic burden is increasing due to spending on malaria eradication programs and medical care costs. These conditions exacerbate socio-economic inequality in Papua, which requires greater attention for more effective interventions.

At the national level, the Indonesian government has launched various programs to eradicate malaria, one of which is the Malaria free movement which aims to significantly reduce the incidence of malaria. The government targets malaria-Free Indonesia by 2030, with various initiatives and concrete steps that continue to be pursued. Support from international organizations, such as WHO, UNICEF, and the Global Fund, is essential in this eradication program. Through funding, training, and technology transfer, these organizations assist the government of Indonesia in implementing effective health policies, as well as ensuring malaria eradication programs are running well in endemic areas, including Papua. In Papua, malaria eradication programs are implemented with an approach adapted to local conditions. Some of the main programs implemented are the distribution of insecticide-treated mosquito nets to protect the community from Anopheles mosquito bites, spraying insecticides in mosquito breeding areas, and educating the public about the importance of malaria prevention. However, the implementation of the program in Papua faces various challenges, such as accessibility constraints to remote areas that are difficult to reach, as well as differences in local culture and habits that can affect community acceptance of the program. In addition, limited resources, both in terms of trained medical personnel and protective equipment, complicate efforts to combat malaria more effectively.

Evaluation of the effectiveness of malaria eradication program is very important to determine the extent to which the program has been run to reduce the incidence of malaria. The evaluation process allows the identification of the strengths and weaknesses of the program being implemented, as well as the obstacles encountered in the field, such as geographical, cultural, or resource constraints. By conducting an evaluation, it can be seen whether the strategies implemented are effective, or if there are aspects that need to be improved so that the program objectives are achieved more optimally. In addition, the evaluation also provides an opportunity

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to ensure that the use of budget and resources is carried out efficiently. The focus on Papua as an evaluation site is very important, given the characteristics of this area which is different from other malaria endemic areas in Indonesia. Papua has unique geographical conditions, such as remote and hard-to-reach areas, and cultural diversity that influence community responses to malaria eradication programs. Therefore, evaluation based on local conditions is needed to obtain a more accurate picture of the effectiveness of the program there. Thus, a careful evaluation can provide deeper insights for improvements and adjustments to the program to better suit the needs of the Papuan people.

Malaria remains a significant health challenge in Indonesia, particularly in Papua province, which accounts for 79% of the country's cases (Lusiyana, 2020). Despite efforts to eliminate malaria by 2030, progress has been stagnant, necessitating cross-sector cooperation and innovative approaches (Lusiyana, 2020). In Mappi District, South Papua, malaria transmission remains high, with an average Annual Parasite Index of 46.9 per 1000 (Lasut & Herawati, 2024). New strategies, such as pre-erythrocytic vaccines and transmission-blocking treatments, show promise in reducing malaria spread (Handari et al., 2022). However, malaria distribution is markedly disproportionate across the region, with high spatial heterogeneity observed at district and health-unit levels (Fadilah et al., 2022). This heterogeneity emphasizes the need for spatially targeted interventions and periodic risk assessment using routine surveillance data to guide resource allocation and track progress towards elimination (Fadilah et al., 2022).

This study aims to provide evidence-based input regarding the effectiveness of malaria eradication programs in Papua. Given the high prevalence of malaria in the region, it is important to evaluate whether the programs that have been implemented can achieve their goals in reducing the incidence of malaria. This study also aims to identify the obstacles encountered in the implementation of the program, as well as supporting factors that can strengthen its success. Thus, the results of this study are expected to provide relevant and practical recommendations for policy makers and health program implementers, to improve and adjust malaria eradication strategies to be more effective in tackling this health problem in Papua.

METODOLOGI

This study uses a qualitative approach with a case study method, which allows researchers to explore in depth how the implementation of malaria eradication programs in Papua. This approach was chosen because of the complex nature of malaria eradication programs that involve various factors such as government policies, geographical conditions, and local community behavior. The focus of the study is to understand the experiences, challenges, and perceptions experienced by various parties involved, both health workers, local communities, and policy makers. The qualitative approach was chosen because it provides an opportunity to explore in depth the views and subjective experiences of informants involved in malaria eradication programs. With in-depth interviews and direct observation, the researcher can identify obstacles encountered in the implementation of the program that cannot be expressed through quantitative approaches.

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This research was conducted in several districts or cities in Papua known as malaria endemic areas. Papua is one of the regions with a high prevalence of malaria in Indonesia, which makes it a relevant location to study the effectiveness of malaria eradication programs. The selection of this location is based on the high incidence of malaria that still occurs despite various programs have been implemented. In addition, geographical conditions that are difficult to access are also an important factor in choosing this research area, because logistical challenges in the distribution of malaria tools and drugs are obstacles that need to be considered. This study involved various parties directly involved in the malaria eradication program, namely health workers, local communities, and policy makers. Health workers involved in the implementation of the program, including the distribution of mosquito nets, insecticide spraying, and community education, will provide important insights into operational challenges on the ground. Local communities, who are targeted by malaria eradication programs, will give their views on the effectiveness of the program and the obstacles they face in following malaria prevention procedures. Policy makers at the local level, such as local health offices, have an important role in planning and monitoring programs, and can provide perspective on the policies implemented. The informant selection technique uses purposive sampling, which is the selection of informants based on certain criteria, such as their experience in malaria eradication programs or direct involvement in field activities.

Data collection techniques were conducted with in-depth interviews aimed at digging deeper information from health workers, policy makers, and the public. The questions raised revolve around the implementation of the program, the challenges faced, as well as community views on the effectiveness of the program. In addition to interviews, observations were also carried out to directly observe the implementation of programs, such as the distribution of mosquito nets, spraying insecticides, and health education to the community. Observation also includes recording environmental conditions and community participation in these activities. Secondary Data were also collected through documentation studies that included program reports, malaria statistics, and local policies relevant to malaria eradication in the study area. Once the data is collected, the analysis steps are carried out by transcribing all interviews and observation results to ensure that no information is missed. The coding process involves coding relevant data to identify key emerging themes, such as implementation barriers, community support, or program effectiveness. The Data that has been encoded is then grouped in major themes and analyzed to find patterns that describe the informant's experiences and views. To ensure the reliability of the findings, data triangulation is used, which involves utilizing various data sources, such as interviews, observations, and documentation, to verify the findings and increase the validity of the study.

The study faces several limitations, such as limited accessibility to some remote areas in Papua. Geographical factors and inadequate infrastructure often hinder data mobilization and interaction with local communities. In addition, the existence of local language and cultural differences can also affect the understanding and interpretation of the interview results. Before conducting interviews or observations, participants will be explained about the purpose of the study and given the opportunity to give voluntary consent (informed consent). This process aims to ensure that participants understand their rights and are willing to participate in the research. All information obtained from the participant will be kept confidential. Participants ' identities will be

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masked to protect their privacy and ensure that the data collected is used only for research purposes.

RESULTS

Public understanding and perception of malaria eradication programs generally shows a high level of awareness of the importance of efforts to reduce the spread of this disease. Most respondents stated that they understood the dangers of malaria and the importance of prevention, such as the use of insecticide-treated mosquito nets and appropriate treatment. However, despite this, there are still some people who do not fully understand the ways of effective prevention. This is especially noticeable in groups that are poorly educated about the correct preventive measures. Community views on the effectiveness of programs are often influenced by their personal experiences or their families who have contracted malaria despite participating in eradication programs. Some respondents expressed disappointment that despite their participation in the program, malaria rates in their area remained high, casting doubt on the success of the program.

The results of the interviews showed that most of the respondents understood the importance of malaria eradication programs and realized that the disease could have a serious impact on public health. One respondent revealed, " *I know that malaria is dangerous and contagious, so I always use mosquito nets and make sure children also take malaria medication if necessary*." However, there are still respondents who express a lack of understanding of the appropriate ways of prevention. Another respondent said: "*I know that mosquito nets are important, but I don't know if I should change them every so often or if there is another way*." Although public awareness is quite high, their views on the effectiveness of malaria eradication programs are often influenced by personal experience. Some respondents reported that even though they had joined the program, some of their family members had contracted malaria. One mother interviewed stated: "*I've been on all the programs, but my son still got malaria last year. I do not know why, maybe because there are still mosquitoes around the House*." This shows that there are doubts among the public about the success of the program, even though they are aware of the importance of prevention. However, there are also those who feel that the program is quite effective, although they admit that much still needs to be improved, especially in terms of the distribution of mosquito nets and more intensive socialization.

The main challenge faced in the implementation of malaria eradication programs on the ground, according to health workers and policy makers, is accessibility to remote areas that are difficult to reach. Some areas of Papua, particularly in isolated mountainous or coastal areas, have limited infrastructure, making the mobilization of health workers and distribution of medical materials very difficult. One of the health workers revealed, "*there are many places that can only be reached on foot or by boat, so the delivery of mosquito nets and medicines is often late.*" Logistical problems are also a significant obstacle, especially related to the distribution of insecticide-treated mosquito nets and drugs that must be timely so that they can be used optimally by the community. This is exacerbated by the limited human resources that can handle the distribution of these essential goods on the ground, so some regions are forced to wait longer for

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assistance. These constraints not only hinder the effectiveness of the program, but also threaten the achievement of malaria eradication targets in Papua.

Health worker 1: "*in some remote areas, access is very difficult. We can only get to the boat or have to walk for hours. Thus, the distribution of insecticide-treated mosquito nets and drugs is often too late to reach the public. This makes the program can not be implemented on schedule."*

Health worker 2: "*one of the big challenges is logistics. Many areas cannot be reached by vehicles due to damaged road conditions or even no roads at all. When we successfully deliver mosquito nets, sometimes there are delays in the delivery of medicines, so people have to wait longer."*

Policy makers: "*another challenge is the limited number of health workers who can distribute in the field. We have tried to send volunteers, but not all regions are willing to accept outside help. This constraint indeed hinders the success of the program and the achievement of malaria elimination targets."*

Community: "*I know the importance of mosquito nets and medicines, but sometimes we have to wait a long time before they arrive. Some places are difficult to reach, so I understand that sometimes the process takes a little longer."*

Health workers revealed that they have a very important role in malaria eradication programs, ranging from counseling the community about the importance of malaria prevention, to the distribution of insecticide-treated nets, medicines, and the implementation of insecticide spraying. They are also directly involved in conducting examinations and treatment for people infected with malaria. Despite this, they often feel that the lack of facilities and resources is a major obstacle in carrying out their tasks. Some officials revealed that limited stocks of medicines and mosquito nets, as well as a lack of health workers in remote areas, made the program unworkable. In addition, poor infrastructure conditions also slow down the distribution of resources to hard-to-reach areas, reducing the effectiveness of program implementation on the ground.

Health worker 1 (doctor at the Puskesmas): "*I am involved in almost all aspects of the malaria eradication program, from providing counseling to the community about the importance of using insecticide-treated mosquito nets to providing treatment to patients with malaria. We also conduct regular examinations to detect malaria. However, we often face a shortage of mosquito nets and medicines, so their distribution is uneven. Sometimes we also have to walk far to some villages because of inadequate infrastructure."*

Health worker 2 (nurse at Posyandu): *"we often conduct counseling on malaria prevention, but sometimes it is difficult to reach all communities due to distance and limited transportation. We also have limitations in providing mosquito nets and medicine, which are often only enough for a small part of the population. In addition, the number of remote villages makes it difficult for us to provide assistance in a timely manner."*

Health worker 3 (field worker): *"the biggest challenge I face is access to remote areas. Some areas can only be reached on foot or using small boats, and that affects the distribution of protective equipment and medicines. We are not always able to reach everyone on time, especially during the rainy season, which makes the roads even more difficult to pass."*

Health Officer 4 (policy maker at Dinas Kesehatan): *"as policy makers, we are trying to make sure this program works well, but we are also aware that the lack of facilities and resources is a*

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major obstacle. To increase the effectiveness of the program, we are constantly looking for ways to improve the distribution of mosquito nets and medicine and support health workers on the ground with more training and equipment."

Health worker 1 (doctor at the Puskesmas): *"the insecticide spraying Program and the distribution of insecticide-treated mosquito nets have had a positive impact, especially in villages that are within easy reach. However, the effectiveness of this program is less than the maximum in more remote areas. Even so, we continue to strive to improve distribution and service to areas that are difficult to reach."*

Health worker 2 (nurse at Posyandu): *"I see a significant reduction in malaria cases in areas that receive the program on a regular basis. However, there are still many areas that have high prevalence rates due to limited access. In these areas, even though we have distributed mosquito nets and carried out treatment, they still have difficulty accessing health services quickly."*

Health worker 3 (Field Worker): *"this Program is very helpful for people in areas that can be reached, but for areas where access is difficult, we feel this program is not very effective. Malaria cases in these areas are still very high despite various efforts, such as insecticide spraying and the distribution of mosquito nets."*

Health Officer 4 (policy maker at the Department of Health): *"in general, these programs are effective in reducing malaria in affordable areas, but we recognize that more remote areas require a different approach. We are looking at ways to improve programs in these areas, such as by improving access and distributing more resources."*

The results of the interviews showed that although malaria eradication policies already exist and are quite clear, the main challenge faced is in the implementation of these policies on the ground. Policy maker 1 (Dinas Kesehatan) stated, *" We have policies that are already quite good, but what is difficult is to make sure they are well implemented throughout the region. Some regions are experiencing difficulties in implementing the program in accordance with the expected standards."* Meanwhile, policy maker 2 (Local Government) added,*"coordination between the health sector, local government, and the community is very important. Without strong support from all parties, the implementation of the program in the field is often hampered."*This shows that although policies and regulations already exist, the biggest challenge lies in the alignment and coordination between relevant parties in the implementation of malaria eradication programs in various regions.

Based on interviews conducted, the community and health workers expressed hope for improvements in malaria eradication programs. **Community 1 States**, "*we want more information about the correct ways to prevent malaria, such as how to use mosquito nets and recognize early symptoms of the disease."* So did the **Health Worker 1**, who said, "*further training for us will be very helpful. We need a deeper understanding of more effective approaches to communicating with people, so that they better understand the importance of prevention*". In addition, **Health Worker 2** added, "*the need for increased budgets and adequate equipment is also very urgent. Without it, we find it difficult to conduct a comprehensive program, especially in hard-to-reach areas."* This hope shows that improved education, training, and better resources are needed to improve the effectiveness of malaria eradication programs in the future.

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DISCUSSION

This study shows that malaria eradication program in Papua has produced significant findings. Based on the results of interviews, observations, and documentation, this program managed to reduce the incidence of malaria in some areas, although not evenly throughout the region. In areas with better access and strong cooperation between governments, international agencies, and communities, there is a clear decline in malaria cases. Meanwhile, in more remote regions, the decline in the incidence of malaria is more limited. Community participation in this program, especially in the use of insecticide-treated mosquito nets and insecticide spraying, showed positive results, despite the challenges in mobilizing communities in areas far from the central government.

Comparison with previous studies

The results of this study are consistent with several previous studies showing that malaria eradication programs are more effective when they involve active community participation. Previous studies in Indonesia and similar countries have also highlighted that community awareness and engagement are critical to the success of the program. However, as noted in previous studies, local geographical and cultural barriers pose major challenges in program implementation. In Papua, geographic challenges such as remoteness and limited infrastructure affect the distribution of resources and medical personnel. This is in line with existing findings that in hard-to-reach areas, program effectiveness is often limited.

Factors affecting the effectiveness of the Program

A major contributing factor in the success of malaria eradication programs in Papua is cooperation between governments, communities, and international institutions. In this context, community participation plays a key role. For example, the use of insecticide-treated mosquito nets and regular spraying of insecticides can reduce the prevalence of malaria. In addition, ongoing health education on the importance of malaria prevention also strengthens the effectiveness of the program. However, there are some obstacles encountered, especially geographical problems that make it difficult to distribute the program to remote areas. Some local customs and inadequate understanding of malaria prevention methods are also factors that slow down the implementation of the program in some regions. In addition, the lack of trained medical personnel in the field is also an obstacle in ensuring the success of the program at the community level.

Practical implications for Malaria eradication programs

Based on these findings, there are several recommendations that can improve the effectiveness of malaria eradication programs in the future. First, the program needs to be adapted to Papua's geographical conditions, such as strengthening the distribution of tools and medicines to remote areas by using technologies such as digital-based applications for monitoring and reporting. In addition, it is important to improve training for local health workers so that they can be more effective in running programs at the community level. Programs should also strengthen health education to raise public awareness of the importance of malaria prevention, especially in hard-to-reach areas. Government policy is also very important in supporting the implementation of this program, especially in terms of allocating adequate budgets and improving coordination between Central, Local, and international agencies.

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Research Limitations

This research has some limitations, such as limited time and access to some areas in Papua that are difficult to reach. Because the approach used is qualitative, the results of this study only provide an overview of the situation in certain regions, and cannot be generalized to the entire territory of Papua or Indonesia. In addition, the study did not involve quantitative data that could reinforce existing findings. These limitations need to be recognized, and therefore, further research with a more comprehensive approach, including quantitative data collection, is needed to reinforce the findings.

Overall, the malaria eradication program in Papua has shown positive results despite significant challenges, particularly related to access to remote areas and limited resources. Despite this, the program has great potential to reduce malaria incidence if supported by more active community participation, better training for health workers, and the use of technology to improve distribution and monitoring. Ongoing evaluation of this program is critical to ensure its long-term effectiveness in reducing the malaria burden in Papua.

CONCLUSIONS

Malaria eradication programs in Papua show a certain degree of success in reducing the incidence of malaria although there are still significant challenges that affect their implementation. Based on the results of the study, most of the areas covered by the program showed a significant decrease in malaria cases, but in some hard-to-reach areas, the decrease was not optimal. Factors affecting the effectiveness of the program include active community participation, training for trained health workers, and adequate distribution of resources. Communities that are more educated and directly involved in malaria eradication efforts tend to be more committed to the prevention and control of this disease. Resources that include insecticide-treated mosquito nets and medications also greatly influence the success of the program, especially in areas with high prevalence rates. The success of malaria eradication programs is strongly influenced by various supporting factors that can accelerate the achievement of goals. Cooperation between governments, international institutions, and local communities is the main pillar that supports the effectiveness of the program. The community-based approach, which involves local residents in every step of eradication, is proven to increase the level of participation and public awareness of the importance of malaria prevention. In addition, intensive and continuous education on prevention methods, such as the use of insecticide-treated nets, insecticide spraying, and early treatment, is also the key to success. However, on the other hand, there are various obstacles that affect the success of this program. Geographical constraints such as remote areas and difficult for health workers to reach, as well as limited infrastructure conditions, slow down the distribution of necessary tools and medicines. Cultural challenges and local customs also influence the adoption of the program, where some communities are still reluctant to use mosquito nets or follow recommended treatment procedures. Resource constraints, such as a lack of trained personnel and limited health facilities, are also factors that slow the implementation of the program. To improve the effectiveness of malaria eradication programs in Papua, several steps need to be considered. First, it is important to adapt the program to the existing geographical conditions. Given Papua

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consists of many remote areas, the distribution and monitoring of the program must be optimized by utilizing technology. The use of digital-based applications for reporting and monitoring can simplify the distribution process and ensure that assistance gets to areas in need. In addition, increasing community participation is very important. Communities should be more actively involved in planning and implementing programs. More intensive education and active involvement in eradication efforts will increase awareness and adherence to malaria prevention measures. Training for local health workers also needs to be improved, so that they can be more effective in delivering services and leading health campaigns at the community level. Government policies are very instrumental in the success of malaria eradication. Local and national governments need to strengthen policies that support this program, including allocating adequate budgets for program implementation and developing policies that facilitate access to hard-to-reach areas. The government also needs to improve coordination between various government agencies, international agencies, and civil society organizations to ensure more efficient and effective distribution of malaria eradication programs. This study has limitations, especially because the approach used is qualitative with a focus on one region, namely Papua. Therefore, the findings of this study cannot be generalized to all regions of Indonesia. In addition, the study did not collect quantitative data that could provide a clearer picture of the direct impact of malaria eradication programs. Therefore, further research combining quantitative and qualitative approaches is needed to measure the impact of the program more objectively and thoroughly. Further research may also examine the role of technology in improving program distribution and monitoring. Overall, ongoing evaluation of malaria eradication programs in Papua is critical to ensuring their sustainability. The results of this study indicate that despite the challenges faced, malaria eradication programs have the potential to reduce the incidence of malaria, provided that they are supported by high community participation, adequate training for health workers, and optimal distribution of resources. With a more integrated and participatory approach, the program can be more effective in the long term and have a positive impact on public health in Papua.

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