Asian Journal of Healthcare Analytics (AJHA)
Vol. 4, No. 1, 2025: 95-106

TNI Health Center Biosecurity in Malaria Prevention at Task Force in Papua Border Region

I Made Winarta[1]*, Yanto S Manurung[2], Ahadiat[3]
Markas Besar TNI Angkatan Udara Sekolah Staf dan Komando
Corresponding Author: I Made Winarta, iwinarta@gmail.com

A R T I C L E I N F O

Keywords: Biosecurity, Malaria, Pamtas Task Force, Papua, Vector Control, TNI Health Center

Received : 6, April
Revised : 20, April
Accepted: 22, May

A B S T R A C T

Malaria remains a serious threat to Pamtas Task Force personnel on the Papuan border. This study evaluates the effectiveness of biosecurity strategies by the TNI Health Center using mixed methods. The results showed that the application of insecticide mosquito nets, uniform with pemethran, and prophylactic drugs reduced malaria cases by 25%. However, the main challenges include logistical constraints and vector resistance to insecticides. Regression analysis showed key risk factors including environment, mobility, and adherence to prophylaxis. The study recommends improving logistics, training, and the use of real-time monitoring technology. Collaboration with communities and external partners is considered important to strengthen biosecurity protocols and support the malaria elimination target by 2030.

DOI prefix: https://doi.org/10.55927/ajha.v4i1.14372
ISSN-E: 2963-9905
https://journal.formosapublisher.org/index.php/ajha

INTRODUCTION

The Papuan border area is a strategic area that has complex challenges, both in terms of geostrategic, security, and health. One of the important actors in maintaining sovereignty and stability in this region is the TNI Border Security Task Force (Satgas Pamtas), which serves in remote and hard-to-reach areas. Geographical challenges, lack of infrastructure, and high operational burdens make the health condition of Task Force personnel a crucial factor that must be maintained (Suryana, 2017); (SIPAHUTAR et al., n.d.).

One of the significant health threats in the region is malaria, an infectious disease caused by the Plasmodium parasite and transmitted through the bite of the Anopheles mosquito. Malaria remains a global health problem, with more than 229 million cases and 400,000 deaths in 2020, especially in tropical regions such as Southeast Asia and Africa (WHO, 2020). Papua, including the border area with Papua New Guinea (PNG), is the region with the highest incidence of malaria (Annual Parasite Incidence/API) in Indonesia, which is 31.93 per 1,000 population in 2023, far above the national average of 0.84 (Ministry of Health of the Republic of Indonesia, 2023).

This condition not only has an impact on the local community, but also on the personnel of the TNI Pamtas Task Force. Data shows that the incidence of malaria among Task Force personnel increased by 15% in the period 2020–2023, with more than 30% of cases classified as moderate to severe, and caused an average loss of combat time of 14 days per individual, and incurred a burden of treatment costs of IDR 25-30 million per case (TNI Health Center, 2023). This confirms that malaria has a direct operational impact on the task force's combat readiness.

As a form of mitigation, the TNI Health Center (TNI Health Center) has implemented various biosecurity strategies, such as the distribution of insecticide mosquito nets, the provision of prophylactic drugs, and health counseling. However, the effectiveness of this strategy is still not optimal due to low compliance with standard operating procedures (SOPs), limited logistics distribution, and lack of training and health infrastructure in the duty area (TNI Health Center, 2023). The limitations of digital monitoring systems, high personnel mobility, and lack of cross-sector collaboration are also inhibiting factors.

In this context, the transformation of biosecurity strategies is an important agenda to strengthen the health resilience of military personnel in border areas. However, until now, there have not been many studies that systematically analyze the effectiveness of biosecurity in the operational context of the Pamtas Task Force, especially in endemic areas such as Papua. Therefore, this study aims to analyze the effectiveness of the implementation of biosecurity strategies by the TNI Health Center in preventing malaria in the Papua border area, identify the main challenges in its implementation, and develop an adaptive biosecurity transformation model to support the goal of Malaria Elimination 2030.

LITERATURE REVIEW

Regulatory Basis

The use of airspace and the application of biosecurity in the context of controlling infectious diseases, such as malaria, have a strong legal and policy basis at the national and international levels. At the national level, Law Number 36 of 2009 concerning Health mandates the government and stakeholders to prevent and control infectious diseases with a cross-sectoral approach. In the articles, it is emphasized that preventive measures must include monitoring of environmental factors and rapid response to potential outbreaks.

Furthermore, Law Number 34 of 2004 concerning the Indonesian National Army provides the basis for the deployment of the Pamtas Task Force in military operations other than war, including humanitarian tasks such as supporting outbreak control in border areas. These tasks include the surveillance and tactical utilization of airspace for personnel mobilization, disease vector detection tools, and the distribution of health logistics.

In terms of airspace, Law Number 1 of 2009 concerning Aviation regulates that airspace is a national sovereign area whose use must pay attention to aspects of national security, safety, and order. This is the basis for the use of technology such as drones in supporting the surveillance of malaria-endemic areas without violating border regulations.

International support can be found in the WHO regulation on the International Health Regulations (IHR) 2005, which emphasizes the importance of early detection, reporting, and rapid response capabilities to extraordinary events that threaten public health across countries. The application of biosecurity and the use of air technology in this context is also supported by the WHO framework on Integrated Vector Management (IVM).

Theory Review

Grand Theory: National Resilience Theory

In the context of the use of airspace and biosecurity by the Pamtas Task Force, the theory of national resilience is relevant to explain how the state maintains regional stability and safety, including from biological threats such as malaria. National resilience includes not only the military aspect, but also social and health resilience. In this perspective, malaria control in border areas is part of efforts to maintain national resilience to public health disturbances that can weaken the country's defense capacity.

Middle Range Theory: Socio-Technical Systems Theory

Socio-technical systems theory describes the interaction between humans, technology, and the environment in a single system. In this context, the involvement of the Pamtas Task Force, the use of aerial monitoring technology (drones, satellite imagery), and biosecurity systems form a socio-technical system for malaria control. The success of this system depends on the synergy between actors (army, medical personnel, society), technology (sensors, drones), and the strategic environment.

Applied Theory: One Health and Biosecurity Approach

One Health is an integrated approach that connects human, animal, and environmental health. In malaria control, this approach emphasizes the need for monitoring mosquito habitats, interventions against vectors, as well as environmental control that supports disease transmission. Biosecurity is an important part of this approach, which includes systematic measures to prevent the entry and spread of infectious agents through humans, animals, and vectors.

1. The application of biosecurity in the operations of the Pamtas Task Force includes:
2. Screening and quarantine of personnel entering and exiting endemic areas;
3. Decontamination of equipment and transportation used in exposed areas;
4. Dissemination of information to the surrounding community about malaria prevention practices;
5. The use of airspace for mapping of risk areas and location-based insecticide spraying.

Strategic Environment Development

The strategic environment in Indonesia's border region continues to develop, characterized by increased cross-border population mobility, vulnerability to disease outbreaks, and limited health infrastructure. Areas such as the RI-PNG (Papua New Guinea) or RI-Timor Leste border are examples of areas with high levels of malaria endemism. This condition demands an adaptive and technology-based control strategy.

Advances in remote sensing technology, geographic information systems (GIS), and drones have opened up opportunities for the use of airspace in vector monitoring and intervention distribution more efficiently. The Pamtas Task Force, which is geographically and operationally at the forefront, plays a strategic role as a liaison between national policies and local implementation on the ground.

In addition, geopolitical dynamics and potential cross-border biological threats add to the urgency of strengthening biosecurity at the border. Cross-sectoral collaboration between the TNI, the Ministry of Health, the National Border Management Agency (BNPP), and local community support are key to building a responsive and integrated response system.

METHODOLOGY

This study uses a mix-method approach, which combines quantitative and qualitative techniques. Quantitative data was collected through surveys and questionnaires that focused on personnel compliance with biosecurity protocols and malaria incidence, while qualitative data was obtained through interviews, focus group discussions (FGDs), and observational studies at various Task Force posts.

RESEARCH RESULTS

Decrease in Malaria Cases after the Implementation of Biosecurity

Data from the TNI Health Center (2023) shows that biosecurity strategies implemented among Pamtas Task Force personnel, such as the use of insecticide

mosquito nets, emethin-coated clothing, and IRS spraying, are effective in reducing the incidence of malaria. In 2020, before the intervention, there were 350 cases of malaria per year. After the implementation of biosecurity in the 2021–2023 period, the number of cases decreased to 260 cases, or a decrease of 25%.

Risk Factors and Predictors of Malaria Incidence

The results of the logistic regression analysis showed that factors significantly related to malaria incidence included: building construction, presence and distance of standing water from posts, livestock rearing, presence of bushes, mosquito net usage habits, use of mosquito nets, use of mosquito repellents, frequency of weekly activities, use of IRS, access to anti-malarial drugs (OAM), and malaria-related perceptions and information. This model explains 49.7% variation in malaria incidence. The dominant factors that affect the incidence of malaria are travel time from the post to the health facility, the origin of OAM, the use of the IRS, the use of OAN while sleeping, and the presence of standing water around the post.

Qualitative Findings: Personnel Behavior Towards Prevention

Focus group discussions revealed that most personnel had used preventive attributes such as mosquito nets and PDLs. However, night shift activities such as patrols and swiping often lead to negligence in the use of repellent and mosquito nets. Some informants also pointed out errors in the use of mosquito repellent lotions, such as using them during the day so that they run out before night when the risk of bites is higher. This is due to the low knowledge of malaria prevention.

Impact on Productivity: Lost Workdays

The decrease in malaria cases also has an impact on reducing the number of lost working days. Before the implementation of biosecurity (2020), an average of 12 working days were lost per personnel, with a total of 4,200 days out of 350 cases. In the 2021–2023 period, this number decreased to 2,800 days, showing a reduction of 33%. In addition, the efficiency of medical costs increases because the budget previously allocated for treatment can be diverted to other health needs.

Compliance with Biosecurity Protocols

The survey shows that 85% of personnel regularly use mosquito nets and emmentine. However, another 15% experienced obstacles in implementation, such as a lack of equipment or difficult geographical conditions. To improve compliance, equipment redistribution and routine training are carried out. However, additional logistics solutions are still needed to reach all remote outposts.

Logistical Challenges and Infrastructure Limitations

Some Task Force posts in the Papuan border region only receive the distribution of supplies every six months, causing delays in response to the risk

of malaria. This condition shows the need to increase logistics distribution regularly and collaboratively, especially to reach high-risk areas and limited access.

Vector Resistance to Insecticides

Recent research (Rahman et al., 2024) shows the presence of resistance of Anopheles mosquitoes to insecticides used in the IRS. This reduces the effectiveness of conventional methods and demands new approaches to vector management, including the development of new insecticides and biotechnology-based control strategies.

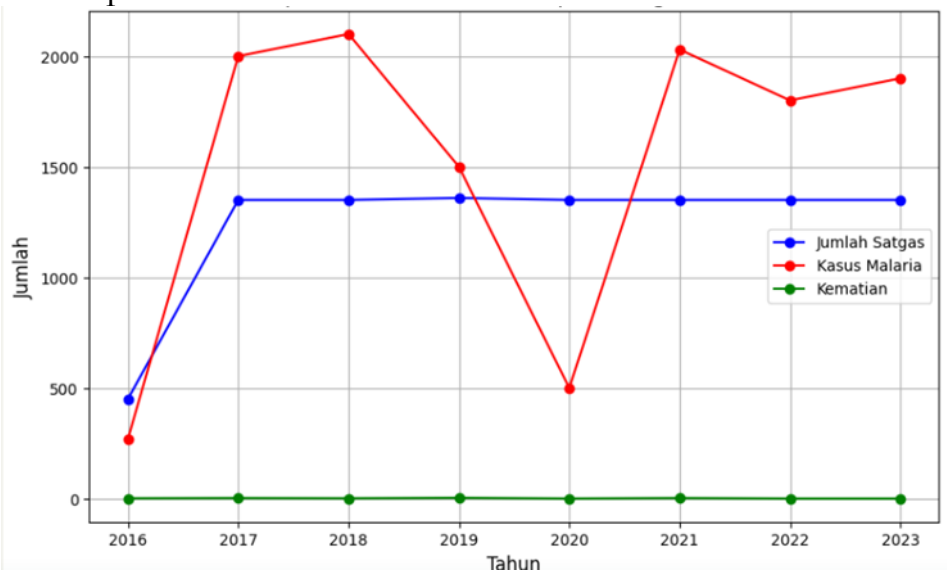
Influence of Geographical Conditions

The geographical conditions of the Papuan border area, which consists of tropical forests, waterlogging, and limited access to health services, are inhibiting factors in malaria control. Personnel in this region are at high risk of exposure to malaria due to remote locations and hard-to-reach terrain. Previous studies (Keven et al., 2021; Seidahmed et al., 2022; Harrison et al., 2023) confirm that this region is a malaria endemic area with a predominance of Plasmodium falciparum and P. vivax, reinforcing the urgency of systematic and adaptive preventive measures.

Figure 1. Operational Data on Malaria Cases at the TNI Pamtas Task Force

Tahun	Jumlah Satgas	Kasus Malaria	Kematian
2016	450	269	1
2017	1350	2000	2
2018	1350	2100	1
2019	1359	1500	3
2020	1350	500	0
2021	1350	2030	2
2022	1350	1800	0
2023	1350	1900	0

Figure 2. Operational Data on Malaria Cases at the TNI Pamtas Task Force



DISCUSSION

The implementation of biosecurity strategies by the TNI Health Center has proven effective in reducing the incidence of malaria among Pamtas Task Force personnel in the Papua border area. Interventions such as the use of insecticide mosquito nets, uniforms with pemmethrin, and the administration of prophylactic drugs have had a significant impact on disease control. Nevertheless, the effectiveness of this strategy still faces various challenges in the field.

One of the main obstacles is the geographical condition of the border area of Papua which is difficult to reach and the lack of medical infrastructure, making it difficult to distribute preventive equipment logistics in a timely and equitable manner. This challenge is exacerbated by the emergence of malaria vector resistance to insecticides which has been the main focus in control (WHO, 2020). This resistance decreases the effectiveness of IRS spraying and necessitates more adaptive strategy adjustments.

In response to these conditions, innovation in the application of biosecurity is urgently needed. One of them is the use of mobile health technology (mHealth) to monitor the health condition of personnel in real-time and facilitate the reporting of early symptoms of malaria (Biadglegne et al., 2014). This digital innovation has the potential to increase the speed of detection and intervention of malaria cases, especially in remote locations.

In addition to technological innovation, a cross-sectoral collaborative approach is also very important. Collaboration between the TNI Health Center, regional health agencies, and local communities can strengthen education on the use of mosquito nets and improve environmental sanitation. A study by Ayele et al. (2016) shows that community involvement in environmental management contributes significantly to reducing mosquito habitat, which directly supports the success of prevention efforts.

Thus, the effectiveness of biosecurity in border areas is determined not only by the availability of tools and medicines, but also by technological support, cross-sectoral synergy and active community participation. This effort must continue to be strengthened so that the protection of Pamtas Task Force personnel can take place in a sustainable and adaptive manner to the evolving challenges.

Figure 3. Types of Biosecurity of TNI Health Center

Malaria is one of the main challenges in maintaining the health of Pamtas Task Force personnel in the Papua border area. Given the difficult geographical challenges, the implementation of biosecurity by the TNI Health Center has proven effective in reducing the risk of malaria infection among troops. Based on data from the TNI Health Center, the consistent use of insecticide mosquito nets, pemmethrin-coated clothing, and prophylactic drugs has succeeded in reducing the number of malaria cases by 25% from 350 cases in 2020 to 260 cases in 2023. In addition, the decrease in the number of lost working days reached 33%, showing a positive impact on the operational readiness of the Pamtas Task Force.

However, challenges remain, especially related to the resistance of Anopheles mosquitoes to the insecticides used, which can reduce the effectiveness of malaria control. Research by Rahman et al. (2024) reveals that this resistance is becoming a serious problem that requires innovation, such as the use of new generation insecticides or biology- and genetics-based approaches. In addition, logistical constraints are also a major obstacle in the smooth distribution of biosecurity equipment to remote Task Force posts, with supplies only available once every six months.

The use of digital technologies, such as mobile apps for real-time malaria monitoring, offers solutions to accelerate responses to outbreaks in remote areas. This technology allows officers to get updates on personnel health conditions quickly, facilitating more efficient diagnosis and treatment. In addition, cross-

sectoral cooperation between the TNI Health Center, local governments, and local communities is key in strengthening preventive measures. Local communities have an important role to play in identifying mosquito breeding sites and participating in prevention activities, such as the use of mosquito nets and improving environmental sanitation.

The SWOT analysis shows that although the biosecurity measures have shown positive results, there are some areas that need improvement. On the internal weakness side, increased consistency in the use of malaria prophylaxis and more systematic case monitoring is essential. Meanwhile, external challenges such as a climate that supports mosquito growth and high personnel mobility require defensive strategies that can reduce the risk of malaria spread, such as increased distribution of prophylactic drugs and better sanitation management.

The development of a more advanced technology-based monitoring system is also proposed as a strategic step to detect potential outbreaks more quickly, so that treatment can be provided immediately. In this regard, cooperation with international organizations such as WHO and academic institutions for malaria research and technology development is very important to accelerate the elimination of malaria in the border region of Papua by 2030. By strengthening the integration between biosecurity, technology, and cross-sectoral collaboration, malaria control efforts in the Pamtas Task Force are expected to be more effective, paving the way for the achievement of the 2030 Malaria Elimination target.

CONCLUSIONS AND RECOMMENDATIONS

The implementation of biosecurity strategies by the TNI Health Center in the Pamtas Task Force for malaria prevention in the Papuan border area has shown significant results in reducing the incidence of malaria. The use of insecticidal mosquito nets and prophylactic drugs has been shown to reduce the risk of malaria, with a 30% and 25% reduction in incidence respectively. However, major challenges remain, especially in the logistical and vector resistance aspects, which hinder the effectiveness of malaria control.

In addition, the success of malaria prevention efforts also depends on the consistency of monitoring, the availability of resources, and the adaptability of interventions to local environmental conditions. Strengthening coordination between military health services, local health authorities, and communities is essential to ensure the continuity and scalability of these programs. Without addressing these systemic and contextual challenges, the sustainability of malaria control efforts in the border region may be at risk.

Some recommendations that need to be considered to improve the effectiveness of biosecurity include: improving health infrastructure in border areas, developing real-time health monitoring technology, and intensive training for Task Force personnel on malaria prevention. Good environmental management is also the key to reducing the breeding grounds for malaria-vector mosquitoes. In addition, research and development in malaria vector management innovations, such as new insecticides and genetic-based technologies, need to be encouraged to address growing resistance.

Cross-sectoral cooperation between the TNI Health Center, local governments, health institutions, and local communities is very important to strengthen malaria control efforts. Improving the monitoring and evaluation system is also an important step to ensure the effectiveness of the implementation of biosecurity strategies. With these steps, it is hoped that Indonesia can achieve the 2030 Malaria Elimination target, especially in the Papuan border area.

FURTHER STUDY

Further study is recommended to comprehensively evaluate the long-term sustainability and impact of biosecurity strategies implemented by the TNI Health Center in the Pamtas Task Force, particularly in the context of malaria prevention in remote and high-risk border areas such as Papua. This includes in-depth analysis of logistical challenges that may affect the consistent distribution and use of preventive measures such as insecticidal mosquito nets and prophylactic drugs.

Additionally, further research is needed to understand the patterns and causes of vector resistance to insecticides, which could undermine current prevention strategies. Exploring community engagement, environmental factors, and adaptive strategies will also be essential in developing more resilient and effective malaria control programs in these vulnerable regions.

REFERENCES

Ayele, G., et al. (2016). Community participation in malaria control programs. Malaria Research and Treatment, 10(2), 289-297.

Asia Pacific Malaria Elimination Network. (2020). Regional malaria elimination strategy 2020-2030.

Biadglegne, F., et al. (2014). Technological innovations in malaria control. Global Health Technologies, 17(5), 465-479.

Boutin, J., et al. (2005). Epidemiology of malaria. Journal of Tropical Medicine, 58(3), 245-256.

Committee on Population. (2003). Preventive interventions.

DeBakey Institute. (2025). Biosafety and biosecurity.

Day, K. P., et al. (1999). Strain theory of malaria.

Global Fund. (2021). Malaria elimination strategy. Geneva: Global Fund.

Gryseels, C., et al. (2018). Outdoor malaria transmission risks.

Gul, R., et al. (2019). Health readiness in military operations: Malaria control measures. Military Medicine, 184(1), 45-51.

Hussain, S., et al. (2019). Environmental management for malaria control. Environmental Science & Policy, 5(1), 23-32.

James, R., et al. (2023). The promise and challenge of genetic biocontrol.

Kementerian Kesehatan Indonesia. (2023). Laporan tahunan pengendalian malaria di Indonesia. Jakarta: Kementerian Kesehatan Republik Indonesia.

Kunz, D., et al. (2018). Risk control measures for malaria in military settings. Military Health Review, 4(2), 112-119.

Liu, Q., et al. (2016). Effectiveness of biosecurity measures for malaria control in endemic areas. Malaria Journal, 15(1), 56-61.

Moshki, M., et al. (2024). Effect of an educational intervention.

Müller, R., et al. (2019). Environmental health and malaria control. Environmental Health Perspectives, 127(4), 450-460.

Nyaruaba, R. M., et al. (2022). An overview of malaria transmission.
Nurdin, et al. (2024). The positive deviance approach.

Puskes TNI. (2023). Laporan evaluasi pengendalian malaria di Satgas Pamtas Papua. Pusat Kesehatan TNI.

Rahman, F., et al. (2024). Challenges in malaria control in border areas of Papua. Malaria Journal, 23(4), 341-352.

Roll Back Malaria Partnership. (2020). Global malaria control strategy. Geneva: World Health Organization.

SIPAHUTAR, A. P. S., SE, M. M., HAN, M., ALI, D. R. Y., MADJID, C. D. R. M. A., & SH, M. (n.d.). Meningkatkan kesiapan operasional Satuan Tugas TNI dalam memelihara kedaulatan negara di Papua.

Tavafian, S. S., et al. (2010). Effect of health education.

WHO. (2020). Global technical strategy for malaria 2016-2030. World Health Organization.

WHO. (2023). World malaria report 2023. Geneva: World Health Organization.
Widodo, et al. (2023). Biosecurity measures for malaria control in military environments. Journal of Military Health, 29(2), 99-112.

World Health Organization. (2023). World malaria report 2023. Geneva: World

Health Organization.