Original article

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Observing Dengue Fever, Malaria, and Chikungunya Before and During the COVID-19 Pandemic in Indonesia: An Epidemiological and Climate Change Perspective

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ABSTRACT

Introduction. *Dengue Fever, Malaria, and Chikungunya persist as alarming global health threats. This paper aims to examines Dengue Fever, Malaria, and Chikungunya before and during the COVID-19 Pandemic in Indonesia for understanding epidemiological trends and developing evidence-based strategies of climate change impact.*

Materials and methods. *Data were collected since 2017-2022 from various sources, including national health surveys and meteorological agencies in Indonesia. Statistical analyses and correlations were conducted to understand the relationships between disease incidence, temperature, rainfall, and pandemic-related measures*

Results. *In Indonesia, Dengue fever incidence rose significantly from 26.1% in 2017 before the COVID-19 pandemic to 52.1% in 2022, malaria's annual parasite incidence (API) increase by 0.6, from 1.0 per 1,000 population in 2017 to 1.6 in 2022 during the pandemic. Chikungunya cases surged by 23,6 times, increasing from 126 cases in 2017 to 2974 cases in 2022 From 2017 to 2019, temperature and rainfall showed a decreasing trend. However, between 2020 and 2022, both indicators fluctuated, with a notable spike in 2022 where rainfall reached 550 mm and temperatures increased by 1°C compared to previous years. An anomaly occurred in 2019 when both temperature and rainfall decreased, yet Dengue Fever Malaria, and Chikungunya cases increased.*

Limitations. *One limitation of this study is the potential for incomplete or inconsistent data reporting during the COVID-19 pandemic due to total lockdowns in Indonesia, which may affect the accuracy of the observed epidemiological trends.*

Conclusion. *Dengue Fever cases rose, possibly due to increased exposure at home. Malaria displayed a fluctuating trend, initially decreasing due to travel restrictions and possibly reduced testing coverage, then experiencing a rebound post-pandemic. Chikungunya's surge during the pandemic and subsequent fluctuations underlines the need for ongoing disease surveillance. The correlation with environmental factors like temperature and rainfall underscores climate's role in disease prevalence.*

Keywords: *vector-rorne diseases; dengue fever; malaria incidence; chikungunya outbreak climate variability*

Compliance with ethical standards. *This study was conducted in accordance with ethical standards and approved by the relevant institutional review boards, ensuring that all data were handled with confidentiality and integrity.*

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Наблюдение за лихорадками денге, чикунгунья и малярией до и во время пандемии COVID-19 в Индонезии: эпидемиологическая и климатическая перспектива

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РЕЗЮМЕ

Введение. *Лихорадки денге, чикунгунья и малярия продолжают вызывать тревогу в связи с глобальными угрозами для здоровья населения.*

Цель работы *– изучение лихорадок денге, чикунгунья и малярии до и во время пандемии COVID-19 в Индонезии для понимания эпидемиологических тенденций и разработки научно обоснованных стратегий в отношении эффектов изменений климата.*

Материалы и методы. *Данные получали с 2017 по 2022 г. из различных источников, в том числе из национальных опросов обследования здоровья населения и сведений метеорологических агентств Индонезии. Для определения взаимосвязи между частотой заболеваний, температурой, количеством осадков и мерами, связанными с пандемией COVID-19, был проведён корреляционный анализ, использованы статистические методы.*

Результаты. *В Индонезии заболеваемость лихорадкой денге значительно выросла с 26,1% в 2017 г. (до пандемии COVID-19) до 52,1% в 2022 г., ежегодная заболеваемость малярией (ЕЗМ) увеличилась с 1 на 1 тыс. населения в 2017 г. до 1,6 в 2022 г. во время пандемии. Число случаев лихорадки чикунгунья увеличилось в 23,6 раза: 126 случаев в 2017 г. и 2974 случая в 2022 г. В Индонезии с 2017 по 2019 г. отмечена тенденция к снижению температуры и количества осадков. Однако в период с 2020 по 2022 г. оба показателя колебались с заметным подъёмом в 2022 г., когда количество осадков достигло 550 мм, а температура выросла на 1 °С по сравнению с предыдущими годами. Аномалия имела место в 2019 г., когда и температура, и количество осадков снизились, но число случаев лихорадок денге, чикунгунья и малярии возросло.*

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Оригинальная статья

Ограничения исследования. *Одним из ограничений этого исследования является вероятность предоставления неполных или непоследовательных данных во время пандемии COVID-19 из-за тотальных локдаунов в Индонезии, что может повлиять на точность наблюдаемых эпидемиологических тенденций.*

Заключение. *Количество случаев лихорадки денге возросло, возможно, из-за условий локдауна. Продемонстрирована тенденция к колебаниям частоты случаев малярии. Снижение вначале связано, возможно, с ограничением передвижения и уменьшением охвата тестированием во время пандемии, в то время как после наблюдался подъём. Подъём заболеваемости лихорадкой чикунгунья во время пандемии и последующие колебания подчёркивают необходимость постоянного наблюдения за этой инфекцией. Корреляция с факторами окружающей среды, такими как температура и количество осадков, указывает на роль климата в распространённости лихорадки чикунгунья.*

Ключевые слова: *трансмиссивные болезни; лихорадка денге; малярия; лихорадка чикунгунья; вспышка; колебания климата*

Соблюдение этических стандартов. *Это исследование было проведено в соответствии с этическими стандартами и одобрено соответствующими институциональными наблюдательными советами, что гарантирует конфиденциальность и целостность обработки всех данных.*

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Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов в связи с публикацией данной статьи.
Финансирование. Исследование не имело спонсорской поддержки.

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Introduction

Dengue Fever, Malaria, and Chikungunya persist as alarming global health threats, with alarming statistics to underscore their peril. Dengue Fever, with an estimated 100 million cases annually, continues to spread across the globe, with a mortality rate of approximately 2.5% [1]. Malaria, causing over 400,000 deaths each year, predominantly in sub-Saharan Africa, still affects millions, with children under the age of five accounting for 67% of these fatalities [2]. Chikungunya, while less fatal, exhibits a high attack rate in susceptible populations during outbreaks, affecting up to 60% of exposed individuals [3].

In Indonesia, a tropical country with a high prevalence of vector-borne diseases, the dangers posed by Dengue Fever, Malaria, and Chikungunya are particularly pronounced. Dengue Fever remains a significant public health concern, with thousands of cases reported annually [4]. The country experiences a continuous battle against Malaria, with several regions, especially in eastern Indonesia, being endemic for the disease, resulting in an annual toll of over 8,000 deaths [5]. Chikungunya, though less deadly, is a recurring problem, with sporadic outbreaks affecting various parts of the archipelago [6]. These diseases thrive in the warm and humid climate, making accurate data updates and surveillance crucial to understanding their local impact and implementing effective prevention measures. As tropical regions like Indonesia are more susceptible to vector-borne diseases due to favorable environmental conditions, monitoring their prevalence through rates and percentages is vital for safeguarding public health [7].

Before the COVID-19 pandemic, Dengue Fever, Malaria, and Chikungunya posed persistent health challenges in many regions, including tropical areas like Indonesia. Dengue was a leading cause of hospitalization and mortality, with an annual average of over 120,000 cases reported in the country. Malaria continued to affect millions, particularly in remote areas, with approximately 500 deaths annually. Chikungunya outbreaks were sporadic but a cause for concern, impacting local populations periodically [8].

During the COVID-19 pandemic, the situation regarding these vector-borne diseases evolved in complex ways. Public health resources were diverted to address the pandemic, leading to disruptions in disease surveillance and control programs, while lockdowns and social distancing measures temporarily reduced transmission in some areas. However, strained healthcare systems made managing patients with these diseases more challenging. Moreover, the pandemic's economic impact exacerbated vulnerabilities, potentially increasing disease transmission in the long term [9]. Therefore, accurate data updates and comprehensive strategies were critical during this period to mitigate the combined impact of COVID-19 and existing vector-borne diseases. The lack of comprehensive data on the prevalence and impact of diseases like Dengue Fever, Malaria, and Chikungunya in Indonesia before and during the pandemic underscored the need for ongoing research and surveillance efforts.

This research aim to observing Dengue Fever, Malaria, and Chikungunya before and during the COVID-19 Pandemic in Indonesia for understanding epidemiological trends, developing evidence-based strategies of climate change impact, and strengthening public health interventions in Indonesia and similar tropical regions facing these challenges.

Materials and methods

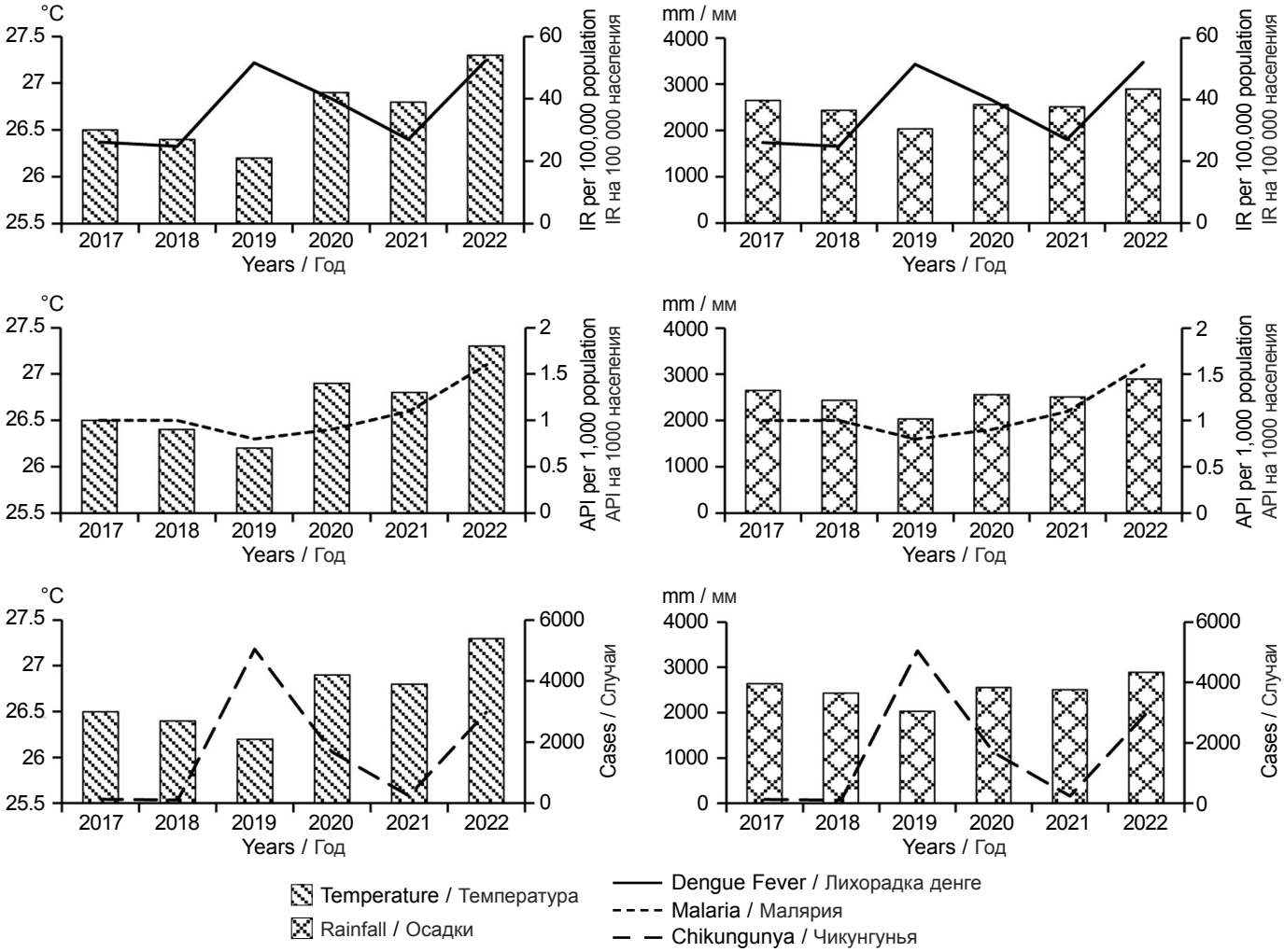
This retrospective longitudinal study, conducted from 2017 to 2022, encompasses all provinces and cities within Indonesia as its study area. The survey exclusively focuses on all citizen residing in Indonesia, with foreigners who do not possess Indonesian identification being excluded from the research.

Dengue Fever. Data on Dengue Fever was sourced from the Indonesian national health survey conducted between 2017 and 2022. This survey encompassed a total of 273,8 million people each year, spanning all regions across Indonesia [10, 11]. The specific ICD-10 code A-90 was employed to categorize cases of Dengue Fever in population [12]. The data on Dengue Fever in this study represent the incidence rate (IR) per 100,000 population.

Malaria. Information regarding Malaria was extracted from the Indonesian national health survey conducted from 2017 to 2022. This extensive survey covered the entire Indonesian population, totalling 273.8 million individuals each year and spanning all geographical regions of the country. To classify Malaria cases within the population, the specific ICD-10 code B-54 was utilized [13]. The malaria data in this study consists of figures for annual parasite incidence (API) per 1,000 population.

Chikungunya. Data pertaining to Chikungunya was gathered from the comprehensive Indonesian national health survey conducted between 2017 and 2022. This expansive survey encompassed the entirety of Indonesia's population, comprising 273.8 million individuals annually and spanning all geographic regions across the nation. The specific ICD-10 code A-92.0 was applied for the categorization of Chikungunya cases within this population [14]. In this study, the Chikungunya data represents the annual number of Chikungunya cases in Indonesia.

Temperature Data. Temperature data presents an annual average temperature record spanning the entire country of Indonesia. This information is acquired from the Indonesian Meteorology, Climatology, and Geophysics Agency's annual reports, which compile data from 185 observation stations positioned across Indonesia. The temperature is quantified in degrees Celsius (°C) [15].



Temperature, rainfall and Dengue Fever, Malaria and Chikungunya.
IR – incidence rate; API – annual parasite incidence.

Температура, количество осадков и заболеваемость лихорадками денге, чикунгунья и малярией.
IR – заболеваемость; API – ежегодная заболеваемость паразитарными болезнями.

Rainfall Data. Rainfall data signifies the annual average precipitation levels observed throughout Indonesia. This dataset is sourced from the Indonesian Meteorology, Climatology, and Geophysics Agency's yearly reports, consolidating information collected from 185 observation stations strategically located across the nation. Precipitation is quantified in millimeters (mm) [16].

Data Validity. The information regarding Dengue Fever, Malaria, and Chikungunya is collected through diagnoses made by certified and Ministry of Health-registered doctors in the Republic of Indonesia. All diagnostic equipment used undergoes annual calibration by the Indonesian government to ensure accuracy.

Ethical Clearance. This research project has received ethical clearance from the Health Research Ethics Committee in Indonesia with ethical approval number is No.2245/UN25.8/KEPK/DL/2023. All research participants provided their informed consent, expressed both in written and verbal forms, signifying their comprehension of the research's objectives, processes, and possible consequences.

Statistical analysis. The analysis conducted utilizes a descriptive methodology with the purpose of assessing the prevalence, ratios, percentages, and mortality rates related to Dengue Fever, Malaria, and Chikungunya. The data will be graphically represented to facilitate a clearer understanding of the findings. To measure alterations in incidence rates across time, the annual percent change has been computed.

Results

From 2017 to 2022, the study observed notable variations in the incidence of vector-borne diseases in Indonesia, alongside changes in climate. Dengue Fever incidence displayed a fluctuating trend, initially at 26.1% in 2017, it decreased to 24.8% in 2018, surged to 51.5% in 2019, then dropped to 40.01% in 2020 during the COVID-19 pandemic, followed by a decrease to 27% in 2021 and a rise to 52.1% in 2022. Malaria cases exhibited a similar pattern, with the annual parasite incidence (API) remaining stable at 1.0 in 2017 and 2018, then decreasing to 0.8 in 2019, slightly increasing to 0.9 in 2020, and further rising to 1.6 by 2022. Chikungunya cases dramatically increased from 126 in 2017 to a peak of 5042 in 2019, followed by a decrease to 1689 in 2020, then to 241 in 2021, and rising again to 2974 in 2022.

Climate data indicated variable patterns in temperature and rainfall. Temperature slightly decreased from 26.5°C in 2017 to 26.2°C in 2019, then increased to 27.3°C by 2022. Rainfall decreased from 2647 mm in 2017 to 2032 mm in 2019, then increased to 2898 mm by 2022 (Figure).

The year 2019 was an anomaly, with decreasing temperature and rainfall, but a simultaneous increase in Dengue Fever, Malaria, and Chikungunya cases. These findings underscore the intricate and dynamic interplay between climatic factors and the transmission of vector-borne diseases.

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Discussion

The trend in Dengue Fever cases in Indonesia during the pandemic years, especially the notable increases in 2019 and again in 2022, compared to the average incidence rate from 2017 to 2019, highlights significant public health concerns. Despite the implementation of lockdowns and stay-at-home measures to curb COVID-19, Dengue Fever's persistence and resurgence suggest a complex interaction of factors at play. This trend may be attributed to several elements, including behavioural changes due to prolonged lockdowns, which could have inadvertently increased exposure to Dengue-transmitting mosquitoes in residential areas. Additionally, the focus of healthcare resources on managing COVID-19 might have led to reduced attention and resources for Dengue surveillance and control efforts, potentially exacerbating the situation. The resurgence in 2022, following the relaxation of COVID-19 measures, further indicates that as public life resumes, the risk of Dengue transmission increases, underscoring the need for vigilant and sustained vector control strategies even as the COVID-19 pandemic recedes [17].

The fluctuating trend in the Annual Parasite Incidence (API) of malaria in Indonesia during the period from 2017 to 2022 reveals a complex epidemiological picture. Notably, there was a slight decrease in malaria cases during the pandemic year of 2020, compared to the average from 2017 to 2019. This decline might be partially attributed to the unintended consequences of COVID-19 control measures. The implementation of lockdowns and travel restrictions, designed to curb the spread of COVID-19, likely limited people's mobility and access to malaria-endemic areas, thereby reducing exposure to malaria-transmitting mosquitoes. However, this trend was not sustained, as evidenced by a subsequent increase in malaria cases in 2021 and a more significant rise in 2022. This increases post 2020 suggests that as restrictions eased and normal activities resumed, the factors contributing to malaria transmission regained prominence. This dynamic indicates the need for continued vigilance and effective malaria control strategies, even as the focus on COVID-19 management evolves [18].

The trend in Chikungunya cases from 2017 to 2022 in Indonesia underscores the evolving nature of vector-borne diseases alongside global health crises. The initial 23.6-fold surge in Chikungunya cases between 2017 to 2020 highlights the complexity of managing infectious diseases during periods of significant disruption, such as the COVID-19 pandemic. This increase suggests that while significant resources were allocated to COVID-19, other diseases like Chikungunya also thrived, potentially due to factors like climate change, urbanization, and global travel patterns. After 2020, the number of Chikungunya cases fluctuated, decreasing in 2021 before rising again in 2022. This oscillation in case numbers post-2020 indicates the continuing impact of various socio-environmental factors on the spread of Chikungunya. It emphasizes the need for continuous surveillance and adaptable public health strategies that can effectively respond to the changing patterns of vector-borne diseases, reflecting the interconnected nature of these health threats [19].

The correlation among the variables of Dengue fever, Chikungunya, malaria, temperature, and rainfall from 2017 to 2022 in Indonesia presents a complex interplay of environmental and epidemiological factors. While establishing a definitive causal relationship requires extensive research, several hypotheses emerge from the observed data. The period witnessed fluctuations in both temperature and rainfall, with a notable increase in temperature and rainfall in 2022 compared to previous years. These changes may have created more favourable breeding conditions for mosquitoes, potentially exacerbating the transmission of Dengue and Chikungunya. The tendency of mosquitoes to thrive in warm, humid environments aligns with the increase in cases of these diseases, especially the significant rise in Dengue fever cases in 2022 and the fluctuating but overall high number of Chikungunya cases, peaking in 2019 and then rising again in 2022. Furthermore, the varied impact of COVID-19 lockdowns and stay-at-home measures across these years might have influenced human exposure to mosquito-prone environments differently, thereby affecting the spread of these diseases [20]. This period underscores the need for ongoing vigilance and adaptive strategies in public health to manage the dynamic nature of vector-borne disease transmission in the context of changing environmental conditions and societal responses [21].

Moreover, the trajectory of malaria cases from 2017 to 2022 suggests a nuanced interaction with environmental conditions and public health responses. While Anopheles mosquitoes, which transmit malaria, have distinct breeding preferences compared to Aedes mosquitoes (responsible for Dengue and Chikungunya), the changing patterns in temperature and rainfall during this period appear to have influenced malaria transmission variably. The initial decrease in malaria cases during the pandemic years, particularly in 2020 with an API of 0.9, might be attributed to altered environmental conditions and reduced human movement due to COVID-19 restrictions. However, the subsequent increase in malaria cases to 1.6 in 2022 indicates that other factors, such as the gradual easing of travel restrictions and potential shifts in mosquito breeding patterns, might have contributed to a resurgence [22]. The diversion of healthcare resources towards COVID-19 management, possibly reduced testing coverage during this period could also have impacted the surveillance and control of malaria, alongside Dengue and Chikungunya. These trends underscore the complexity of managing vector-borne diseases, highlighting the need for adaptive public health strategies that can respond to changing environmental and social landscapes [23].

The anomaly observed in 2019, where a decline in temperature and rainfall coincided with an increase in Dengue Fever, Malaria, and Chikungunya cases, remains a perplexing epidemiological puzzle. This trend continued with fluctuations in disease incidence in the following years, despite varying environmental conditions. These observations suggest that vector-borne diseases are influenced by a complex interplay of factors beyond just immediate environmental conditions. Potential explanations include lag effects in disease transmission from prior environmental states, evolution in mosquito behavior and species, and changes in human movement patterns, especially during and after the COVID-19 pandemic [24]. The readiness and effectiveness of health systems in surveillance and response also play a crucial role in the timely detection and management of these diseases. This period, marked by both predictable and unexpected trends, highlights the need for a comprehensive approach to understanding disease dynamics that integrates environmental, epidemiological, and socio-behavioral factors for effective prevention and control strategies [25].

Conclusion

In summary, the dynamics of vector-borne diseases in Indonesia during the COVID-19 pandemic years highlight a complex interplay of factors. Despite lockdowns, Dengue Fever cases rose, possibly due to increased exposure at home. Malaria displayed a fluctuating trend, initially decreasing due to travel restrictions and possibly reduced testing coverage, then experiencing a rebound post-pandemic. Chikungunya's surge during the pandemic and subsequent fluctuations underlineы the need for ongoing disease surveillance. The correlation with environmental factors like temperature and rainfall underscores climate's role in disease prevalence. The 2019 anomaly, where disease cases increased despite unfavourable climatic conditions, emphasizes the complexity of these diseases. Future research should explore specific driving factors, considering socio-economic, mosquito behaviour, and healthcare resilience, to inform more targeted disease control strategies in a changing health landscape.

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