Spatial Analysis and the Distribution Map of Cigarette Expenditures and Tuberculosis CNR in Indonesia in 2021-2022

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ABSTRACT

***Background**: Indonesia is in second place with the highest number of Tuberculosis (TB) cases in the world with a death rate reaching 144,000 cases per year. Smoking has become the second biggest risk factor for TB in Indonesia after poor environmental conditions and Indonesia ranks third with the highest number of smokers in the world. **Objective**: to analyze the relationship between cigarette expenditure and TB Case Notification Rate in 2021-2022. **Method**: The study design is an observational quantitative study using secondary data. Mapping was carried out using the QGIS application and spatial analysis was done using the GeoDa application's spatial regression. **Results**: in 2021 the majority of provinces in Indonesia is in the medium category for average per capita weekly cigarette expenditure and is in the low category for CNR TB. In 2022, most provinces in Indonesia were in the high category for average per capita per week cigarette expenditure and in the medium category for TB CNR. Papua Province needs to get more attention from the government because even though the average cigarette expenditure is low, the TB rate is high. DKI Jakarta Province needs to receive more attention because apart from its high TB rate, the average per capita cigarette expenditure is also high. There's a relationship between cigarette expenditure and TB CNR in 2021 but not in 2022. **Conclusion**: There was an increasing trend in cigarette expenditure and TB CNR in Indonesia from 2021 to 2022 and a lack of consistency in the relationship between the two variables from 2021 to 2022.*

***Keyword**: Cigarette, Cigarette Expense, Tuberculosis, SDGs.*

INTRODUCTION

Tuberculosis (TB) is a contagious infectious disease that mainly affects the lungs caused by Mycobacterium tuberculosis and is a disease with high prevalence throughout the world (Sharma et al., 2021). TB often occurs in individuals from low socioeconomic backgrounds, marginalized groups in society, or groups of people whose immune systems are weakened (Natarajan et al., 2020; Olmo-Fontánez & Turner, 2022). Risk factors for TB transmission include age, history of alcohol abuse, homeless status, and transmission through the environment such as exposure to indoor air pollution and cigarette smoking (Li & Wang, 2023; Martins-Melo et al., 2020; Obore et al., 2020; Xu et al., 2020). TB disease is a significant global health problem with an estimated number of people diagnosed with TB in 2021 reaching 10.6 million cases There was an increase of 600,000 cases from the previous year with a total death rate of 1.5 million people per year (Chiang et al., 2021). Indonesia is in second place with the highest number of TB cases in the world with a death rate reaching 144,000 cases per year, the incidence of TB cases in Indonesia reaches 354 per 100,000 population and this situation is a big obstacle to achieving TB elimination target by 2030 (Kementerian Kesehatan RI, 2022).

Smoking has become the second biggest risk factor for TB in Indonesia after poor environmental conditions (Sulistyawati & Ramadhan, 2021). Indonesia is ranked fourth among countries with the highest smoking rates and has the highest number of male smokers globally (Rachmawati et al., 2023). Most smokers in Indonesia are men

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with the highest level of education being elementary school, living in low economic categories, and living in urban areas. 46% started smoking when they were teenagers with an average cigarette expenditure of IDR 56,000.00 per week. In this case, there are comparable implications for the high number of smokers in Indonesian society with spending on purchasing cigarettes every week (Salsabila et al., 2022).

The negative impact of smoking is not only felt by active smokers but also by passive smokers (Diningrum et al., 2023; Rifqi et al., 2022). Apart from being able to cause noncommunicable diseases, second-hand smoke exposure is also associated with latent TB infection and active TB in children and may alter the immune response (Altet et al., 2022). Smoking has a significant effect on TB, increasing susceptibility to TB by increasing the growth of Mycobacterium tuberculosis more rapidly, which is a major obstacle to successful treatment. The proportion of deaths, failure to follow treatment, and discontinuation of treatment tend to be higher in the smoker group (Corleis et al., 2023).

This article aims to analyze and describe the results of mapping to analyze the relationship between cigarette expenditure and TB Case Notification Rate in 2021-2022. Knowing the picture of the distribution of TB cases and smoking habits, it is hoped that this can help the Indonesian government in making decisions about handling TB and smoking cases in Indonesia, which can then improve the quality of life of the community.

Combining these variables provides a comprehensive view of how smoking prevalence and cigarette expenditure might be correlated with TB rates. Most existing studies might focus on either smoking or TB separately, but not both in conjunction. Applying these distributions geographically can uncover regional patterns and hotspots, which is vital for targeted interventions.

The urgency of this research lies in its potential to influence current and future public health strategies significantly, especially in the context of ongoing global health challenges. Its distinctiveness stems from the integrated, geographically detailed, and timely approach to analyzing the relationship between cigarette expenditure and TB Case Notification Rate, filling a gap left by more narrowly focused studies.

METHODS

The study design is an observational quantitative study using secondary data obtained from the Indonesian health profile and the Central Bureau of Statistics publication. This study used publicly accessible secondary data that did not require ethics approval. Spatial classification analysis techniques were performed to map TB cases and cigarette expenditure across provinces in Indonesia based on the categories of low cigarette expenditure and low TB cases (LCLT), low cigarette expenditure and medium TB cases (LCMT), low cigarette expenditure and high TB cases, medium cigarette expenditure and low TB cases (MCLT), medium cigarette expenditure and medium TB cases (MCMT), medium cigarette expenditure and high TB cases, high cigarette expenditure and low TB cases (HCLT), high cigarette expenditure and medium TB cases (HCMT), and high cigarette expenditure and high TB cases (HCHT). The spatial analysis was carried out using spatial lag model regression of GeoDa application based on the average expenditure of cigarettes, smoking prevalence, and TB CNR.

The process of data analysis in map creation with QGIS encompasses several essential stages. Initially, geographical data was gathered from diverse origins and brought into the QGIS platform. Subsequently, this data undergoes adjustments and refinements, which may involve configuring projection settings or performing data cleansing tasks. Following this, spatial examination is conducted using the array of analysis tools within QGIS, such as overlay techniques, interpolation methods, or distance measurements. The outcomes of these analyses are then translated into visually informative maps, presenting patterns, trends, or spatial correlations within the geographical data in a clear and accessible manner. QGIS's user-friendly interface and adaptable functionalities enable efficient and precise analysis of geographical data.

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RESULTS AND DISCUSSION

Average Cigarette Expenditure and TB CNR in Indonesia (2021-2022)

Figure 1 shows a comparison of the average expenditure on cigarettes in each Indonesian province in 2021 and 2022. Almost all provinces show an increase in average expenditure on cigarettes from 2021 to 2022 (the average increase is Rp603,41 per capita per week), which is indicated by the height of the graph bars in 2022 compared to 2021. Provinces such as West Java (Rp21.493,35 per capita per week), Central Java (Rp21.822,55 per capita per week), and DI Yogyakarta (Rp21705,65 per capita per week) are the provinces that have the highest average cigarette expenditure in 2021. However, in 2022 there is a change in the highest ranking with West Java (Rp22.207,27 per capita per week), Aceh (Rp22.166,14 per capita per week), and North Sulawesi (Rp22.134,67 per capita per week) being the three highest, indicating cigarette consumption in the region. This increased significantly from the previous year. Meanwhile, there are provinces such as Papua, West Papua, and North Maluku with the lowest average cigarette expenditure in 2021-2022.

The province with the highest average increase in cigarette expenditure in 2021-2022 was DKI Jakarta, with an increase of 4.48%. On the other hand, the province with the lowest increase in average expenditure in both years was East Java, with an increase in expenditure of only 0.98%. Regionally, no very striking pattern differentiates between the western and eastern regions of Indonesia in terms of cigarette expenditure, with each province having a unique trend and not showing a geographically consistent pattern.

The graph in Figure 2 depicts a comparison of the Tuberculosis (TB) Case Notification Rate (CNR) in all provinces in Indonesia between 2021 and 2022. Most provincial areas show an increase in TB CNR from 2021 to 2022. Several provinces with significant increases include South Kalimantan (109%), DI Yogyakarta (103%), and West Java (100%) On the other hand, several provinces showed the lowest increase in TB CNR from 2021 to 2022, namely West Sulawesi (30%), Riau Islands (43%), Riau (47%). The provinces with the highest TB CNR in 2021 are DKI Jakarta (263) and Papua (268). In 2022, the highest position for CNR TB will also be the same in the two provinces, namely DKI Jakarta (501) and Papua (454).

The Distribution Map of Average Cigarette Expenditure and TB CNR in Indonesia (2021-2022)

In 2021, most provinces in Indonesia are colored orange, indicating that the average per capita per week of cigarette expenditure is in the medium category (Figure 3). The results of the spatial analysis of TB CNR in 2021 show that most provinces in Indonesia are in the low category (Figure 4). The analysis results showed LCLT (6%), LCMT (6%), MCLT (47%), MCMT (6%), HCLT (32%), and HCMT (3%). An interesting finding is in the provinces of Papua and West Papua where the average per capita per week of cigarette expenditure is in the low category but the CNR is in the medium category.

The low weekly per capita expenditure on cigarettes in Papua and West Papua can be caused by the economic level in these two provinces which tends to be lower compared to other provinces in Indonesia. Papua has big challenges in terms of economic and social development, even though it has abundant natural resources. Limited economic access and low-income levels make residents prioritize other basic needs over cigarettes. This is supported by (Adam & Purwana, 2022) who explained that there is the income per capita variable partially has a substantial impact on the dependent variable with a negative coefficient which means that low-income groups are more vulnerable to becoming smokers.

The TB CNR for Papua and West Papua Provinces are in the medium category (Figure 4), which can be caused by several contributing factors. One of them is limited access to health services in Papua and West Papua which is one of the main factors (Efraim Mudumi et al., 2021). The existing health infrastructure is faced with geographical challenges that make the distribution of medical personnel uneven, thus hampering the distribution of adequate health services. Low public knowledge about TB also plays a role in the spread of this disease. Limited access to information risks causing individuals not to immediately intervene for the TB symptoms they are

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suffering from (Depo & Pademme, 2022). Increasing public knowledge and behavior regarding TB leads to increased early detection and prevention behavior (Ayu Rahmadani et al., 2023).

Table 1. The symbol of every province in Indonesia is based on the number on the Indonesian map (figure 3-6)

Number/ Symbol	Province
1	Aceh
2	Bali
3	Banten
4	Bengkulu
5	DIY Yogyakarta
6	DKI Jakarta
7	Gorontalo
8	Jambi
9	West Java
10	Central Java
11	East Java
12	West Borneo
13	South Borneo
14	Central Borneo
15	East Borneo
16	North Borneo (before 2019, North Borneo is part of East Borneo)
17	Bangka Belitung Islands
18	Riau Islands
19	Lampung
20	Maluku
21	North Maluku
22	West Nusa Tenggara
23	East Nusa Tenggara
24	Papua
25	West Papua
26	Riau
27	West Sulawesi
28	South Sulawesi
29	Central Sulawesi
30	Southeast Sulawesi
31	North Sulawesi
32	West Sumatera
33	South Sumatera
34	North Sumatera

In 2022, most provinces in Indonesia is red, indicating that the average per capita per week of cigarette expenditure is in the high category (Figure 5). These results show that there is an increasing trend in cigarette expenditure in almost all provinces in Indonesia. Even West Papua, which was previously in the low category, has increased its status to medium. Only Papua province remains in the low category.

An increase in cigarette spending can occur due to several factors. Exposure to cigarette advertising and promotions is still very high in Indonesia (Septiono et al., 2022). Many adults and teenagers report frequently seeing cigarette advertisements on television, radio, and in stores. In addition, cigarette advertising in Indonesia focuses on controlling emotions, increasing masculinity, and upholding traditional values while embracing modernity and globalization (MANAN et al., 2023; Turisno et al., 2021). This encourages an increase in cigarette consumption in Indonesia. Ease of access to cigarette products, both in terms of affordable prices and availability in various places, also contributes to high cigarette expenditure.

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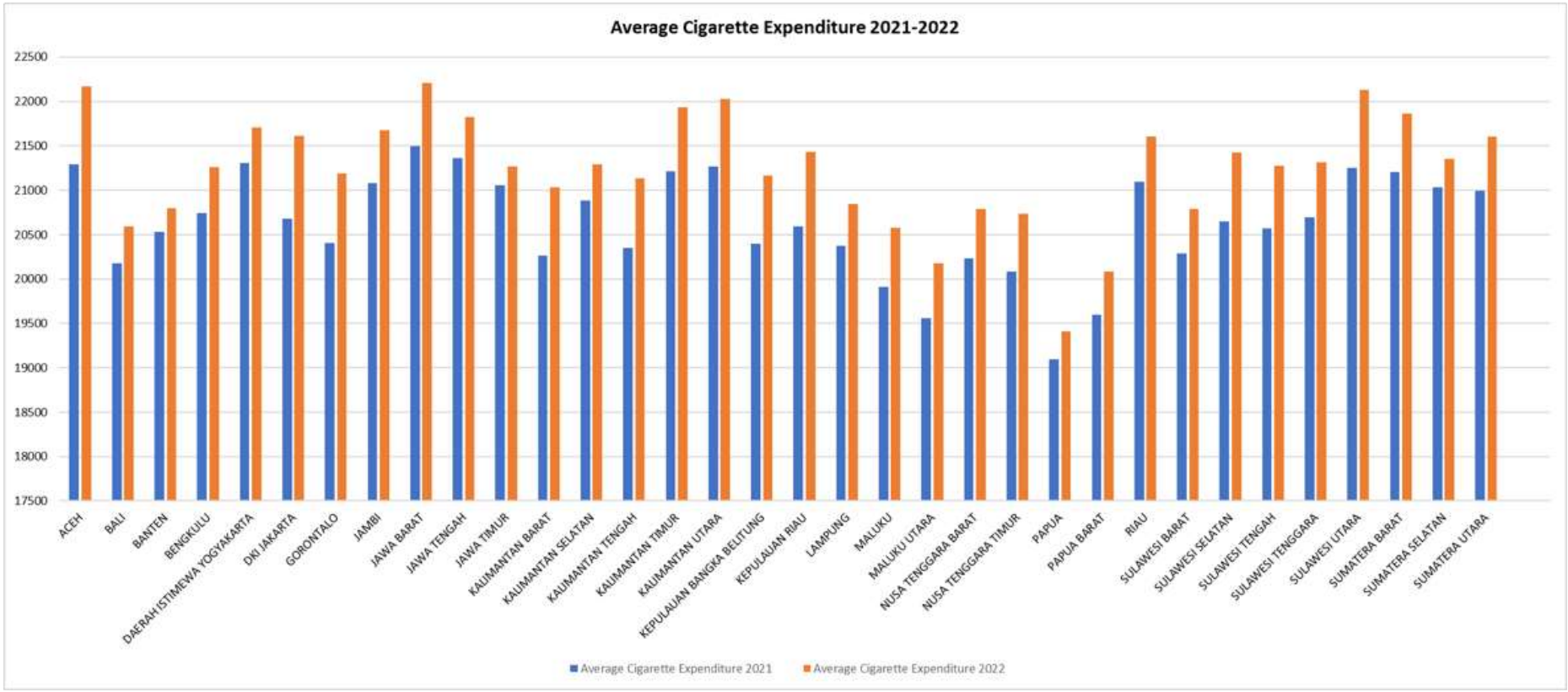

Figure 1. Average expenditure on cigarettes in 2021-2022 in Indonesia

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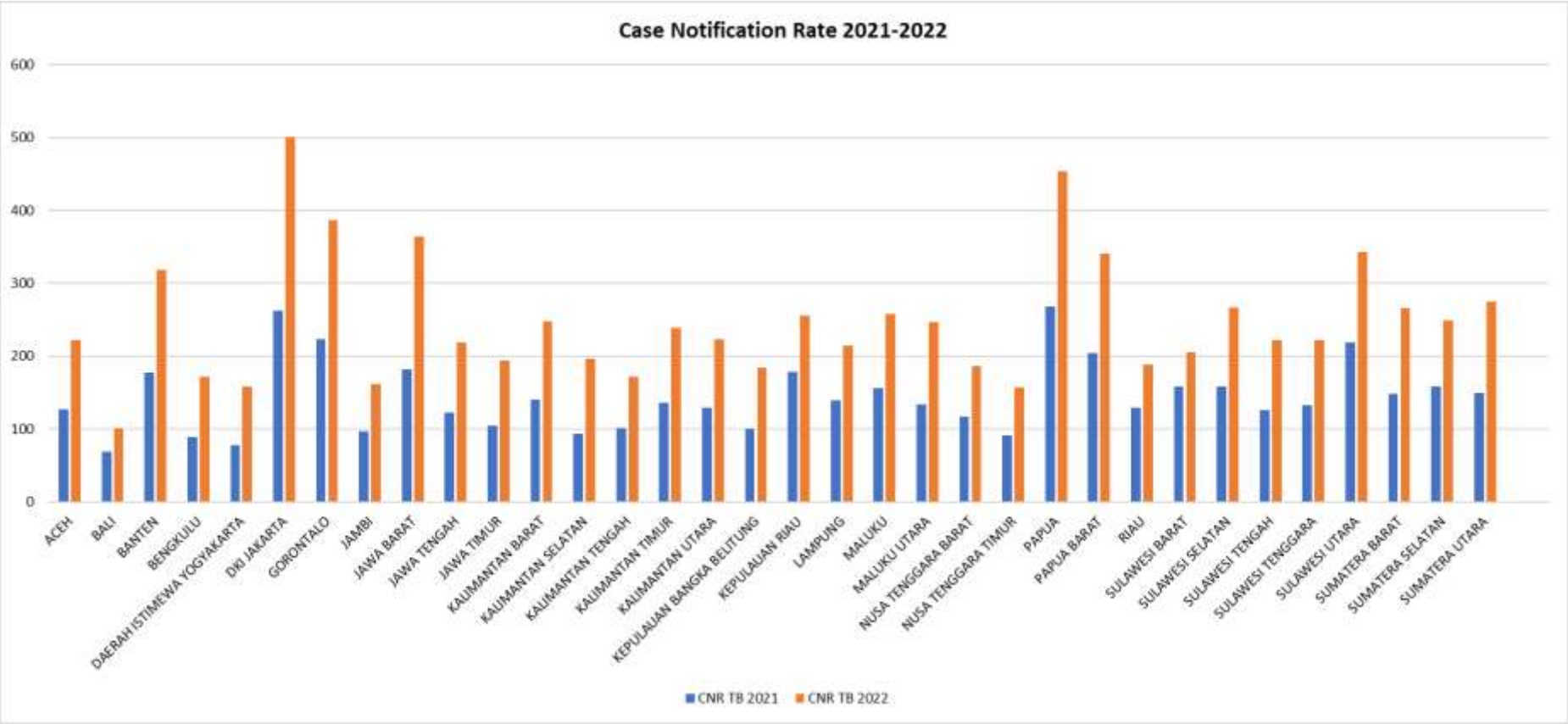

Figure 2. Tuberculosis Case Notification Rate in Indonesia in 2021-2022

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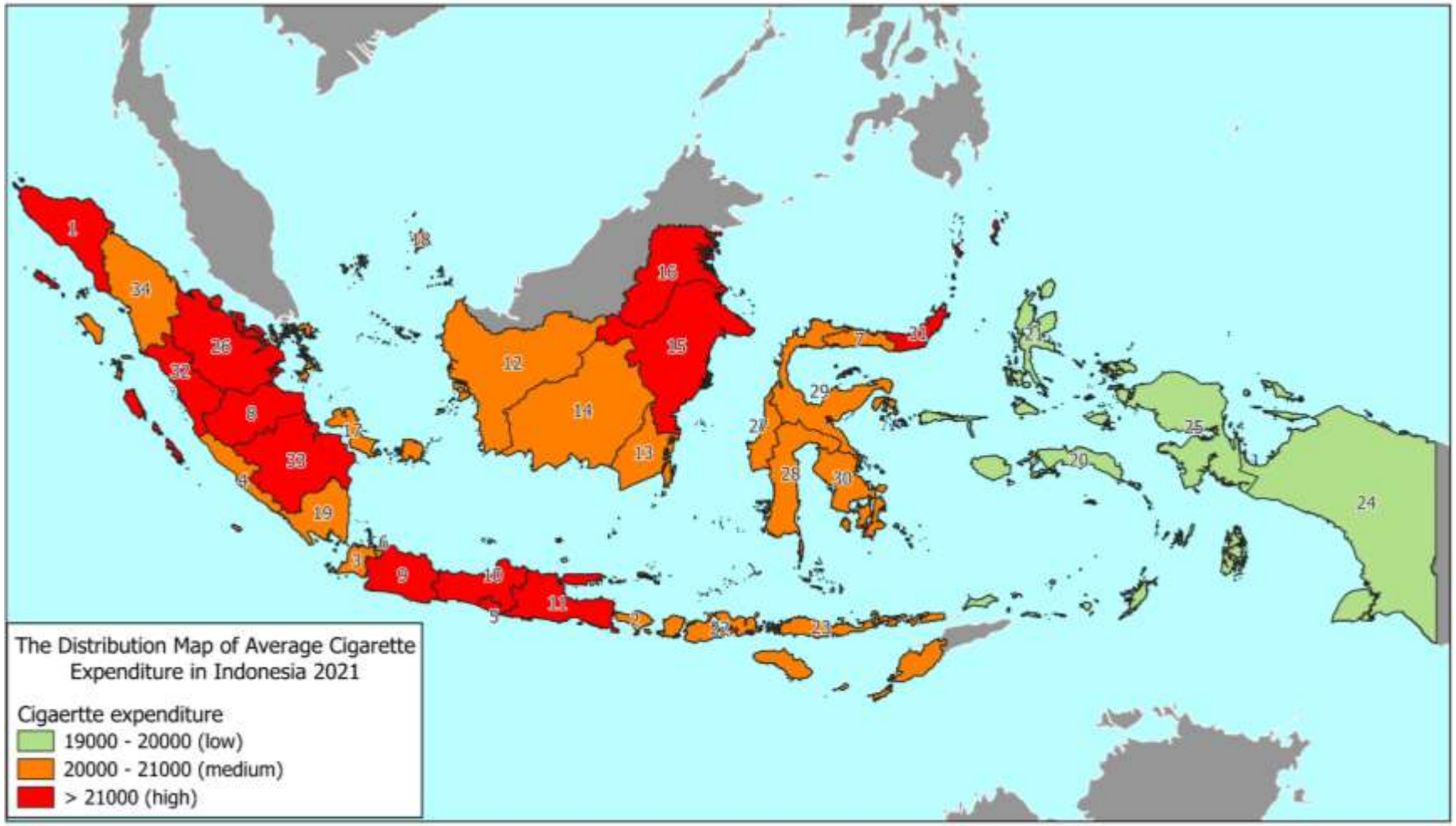

Figures 3. Distribution Map Average Cigarette Expenditure in Indonesia 2021

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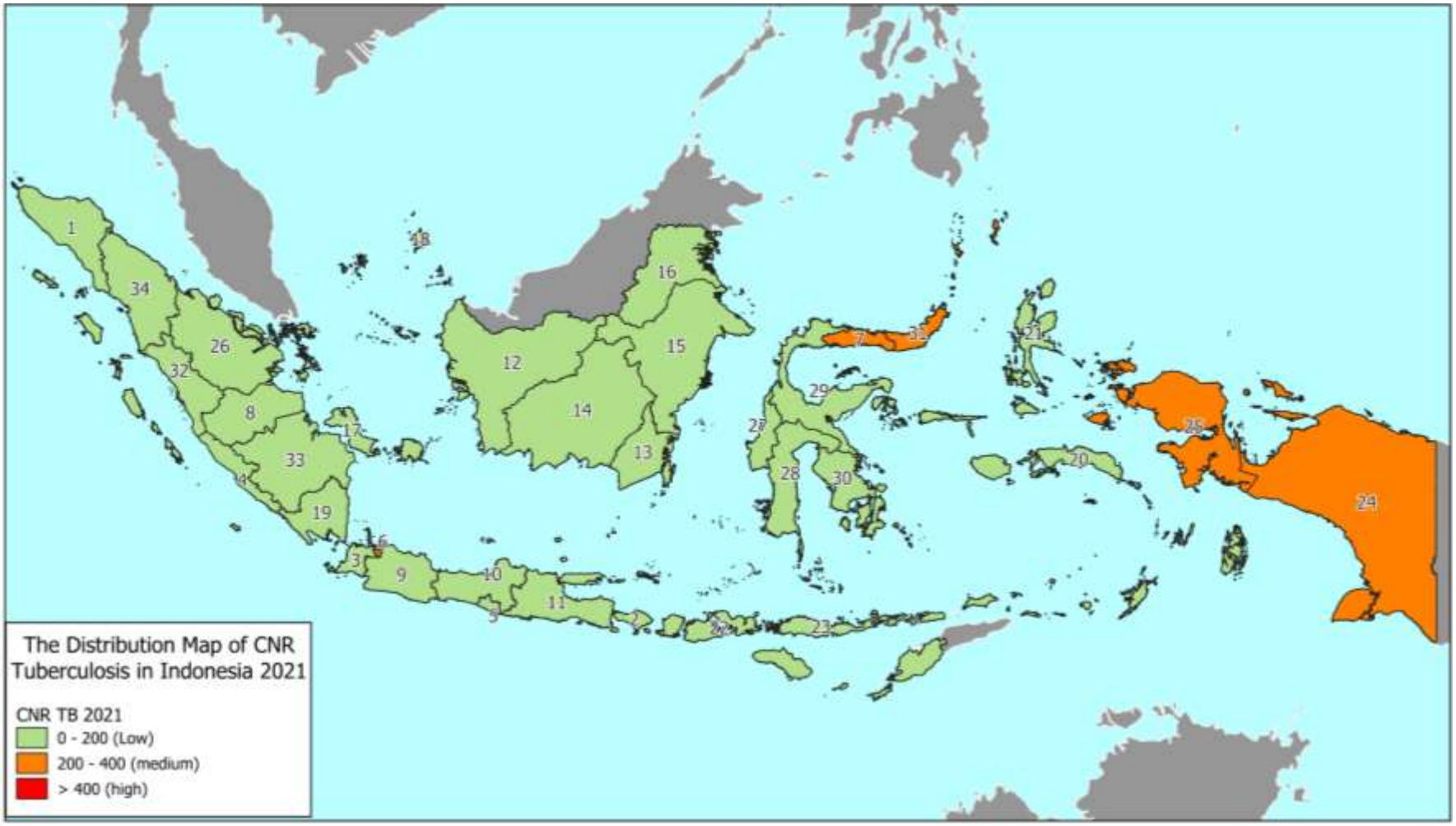

Figures 4. Distribution Map CNR TB in Indonesia 2021

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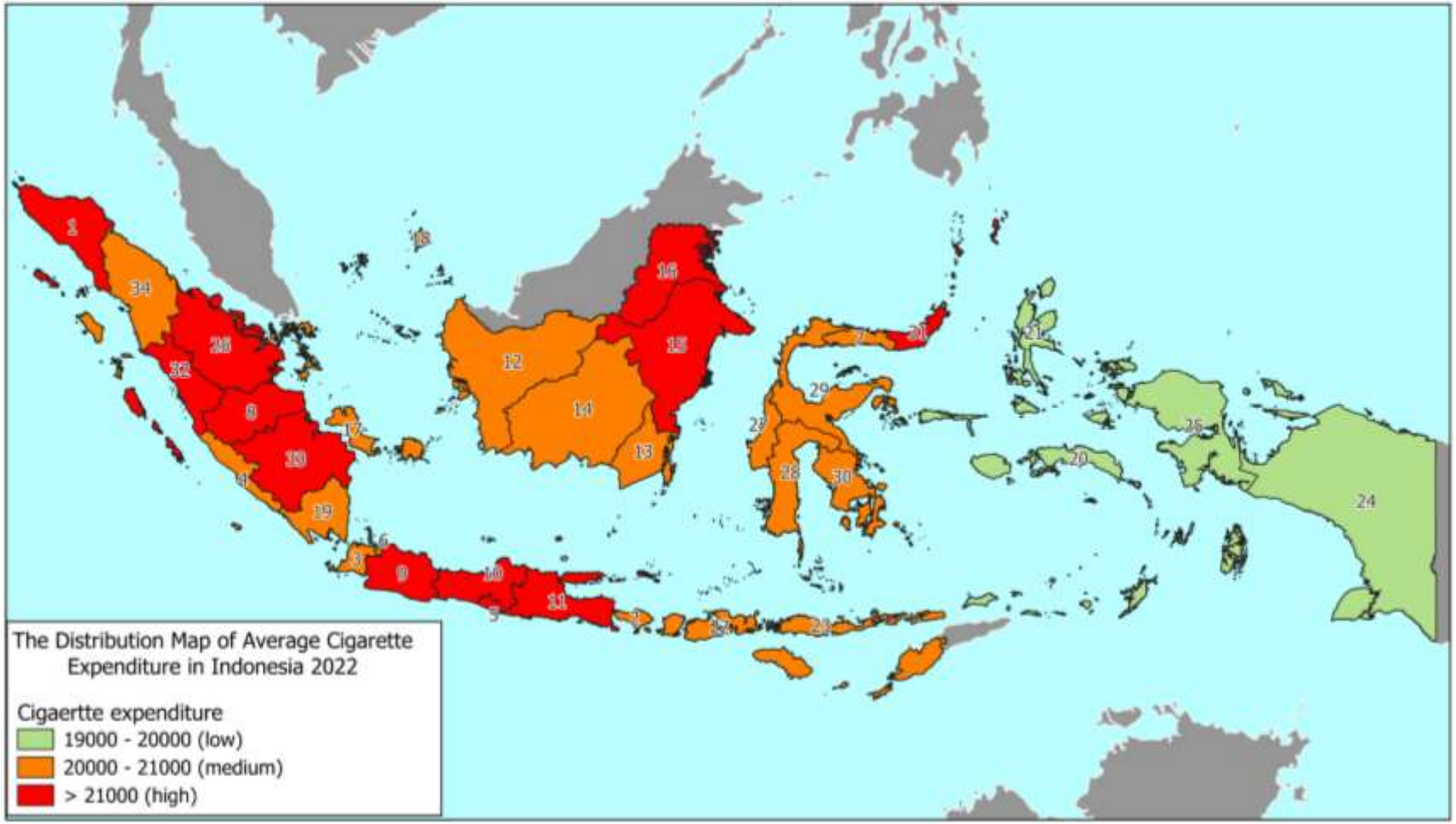

Figures 5. Distribution Map Average Cigarette Expenditure in Indonesia 2022

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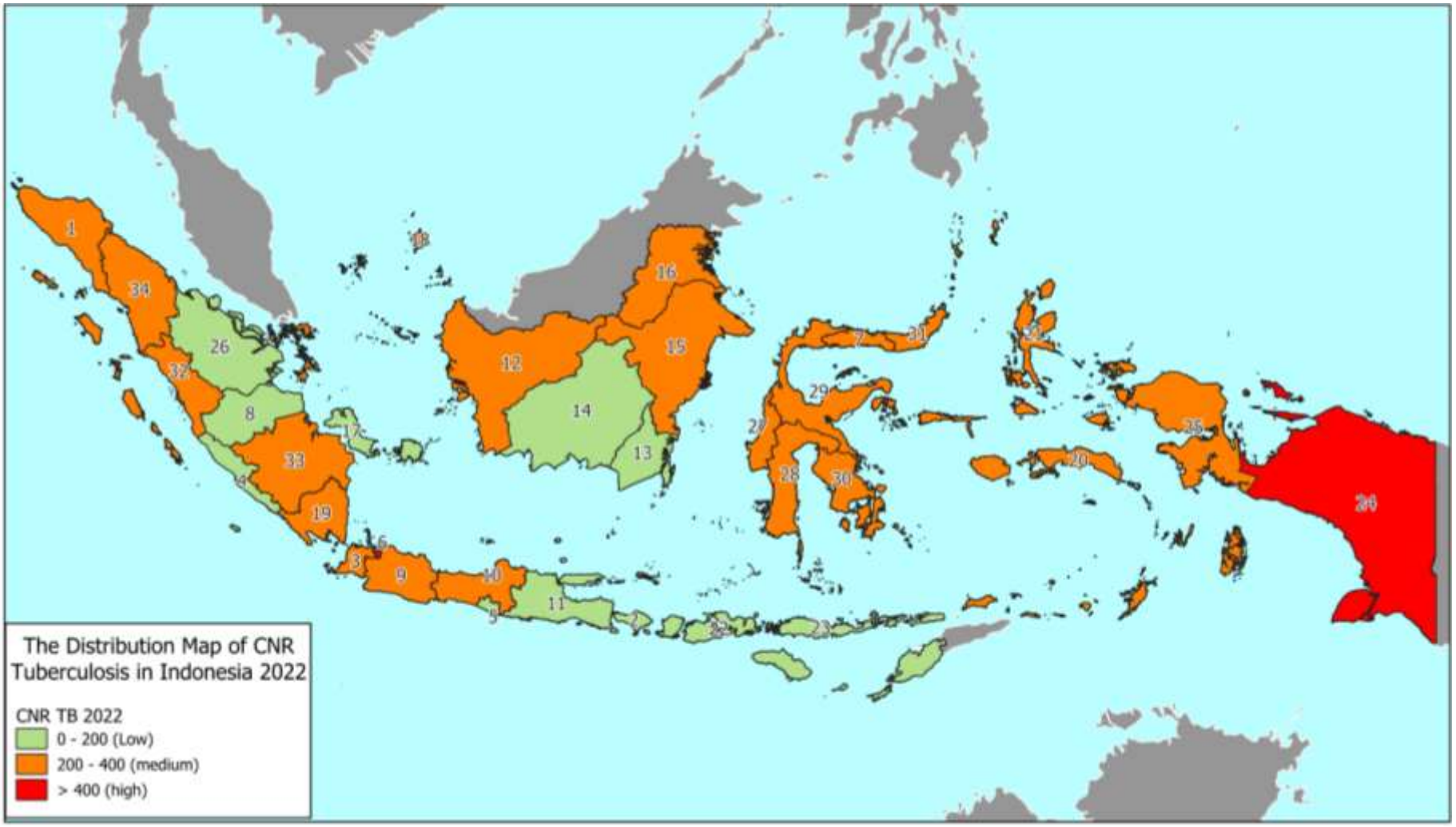

Figures 6. Distribution Map CNR TB in Indonesia 2022

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The results of the spatial analysis also show that there is an increasing trend in TB CNR in all provinces in Indonesia, where previously the majority were in the low category, and now the majority is in the medium category in 2022 (Figure 6). The provinces of DKI Jakarta and Papua are even in the high category so they need to receive more attention. The high CNR of TB in DKI Jakarta and Papua Provinces can occur due to several factors such as literacy levels, and access to better sanitation are associated with a decrease in the incidence of tuberculosis in Jakarta (Falefi et al., 2023). Papua Province has a high social vulnerability to TB, this is caused by several factors such as place of residence, exposure to cigarette smoke, economy, social demographics, and welfare (Lestari et al., 2022) The results of the spatial analysis showed that 6 provinces were classified as showing LCHT (3%), MCLT (9%), MCMT (18%), HCLC (23%), HCMT (44%), and HCHT (3%). These results were dominated by high cigarette expenditure and medium TB cases at 44%. In line with previous research which explains that smoking is associated with an increased risk of TB (Kim et al., 2022). Similar research also shows that smoking is related to pulmonary TB (Feng et al., 2023)

The Relationship of Average Cigarette Expenditure and TB CNR in Indonesia (2021-2022)

Spatial regression results using the spatial lag model show that in 2021 there is a relationship between average cigarette expenditure per capita per week in Indonesia and CNR TB (p-value 0,00306). However, in 2022, the results show that there is no relationship between average cigarette expenditure per capita per week and CNR TB (p-value 0,11928).

Table 2. The Relationship of Average Cigarette Expenditure and TB CNR in Indonesia 2021-2022

Year	Dependent Variable	Independent Variabel	P-value
2021	TB CNR	Cigarette Expenditure	0.00306
2022	TB CNR	Cigarette Expenditure	0.11928

The lack of a consistent relationship between cigarette expenditure and TB CNR from 2021 to 2022 suggests that the dynamics influencing both variables are complex and subject to various external factors. These can include changes in public health policies, economic conditions, healthcare access, data quality, and natural variability in behavior and disease patterns. Further investigation into these factors, possibly through more detailed data analysis or supplementary qualitative research, could provide deeper insights into the observed temporal changes.

CONCLUSION

Mapping results of the distribution of TB cases and cigarette expenditure in Indonesia in 2021-2022 shows an increasing trend in cases. Namely, in 2021 the majority of provinces in Indonesia is in the medium category for average per capita weekly cigarette expenditure and is in the low category for TB CNR. In 2022, the majority of provinces in Indonesia are in the high category for average per capita per week cigarette expenditure and in the medium category for CNR TB. Papua Province needs to get more attention from the government because even though the average cigarette expenditure is low, the TB rate is high. DKI Jakarta Province needs to receive more attention because apart from its high TB rate, the average per capita cigarette expenditure is also high. The analysis of the relationship between average cigarette expenditure and TB CNR shows a lack of consistency from 2021 to 2022.

The study may suffer from data quality issues, including incomplete or inaccurate data on cigarette expenditure and TB cases. There may be other confounding factors not accounted for in the study, such as environmental factors, genetic predispositions, and varying healthcare practices. A two-year study period might be insufficient to capture longer-term trends and relationships. While the study provides valuable insights into the relationship between cigarette expenditure and TB CNR, it is essential to address the identified limitations through more comprehensive data collection, extended study periods, and the inclusion of additional variables and advanced analytical methods. These steps will help in developing more effective public health

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strategies and policies to combat TB and reduce smoking rates.

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