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Body Mapping As Risk Factors For Non-Communicable Disease In East Borneo

Muhamad Ar-Ruhul Jadid[1], and Rea Ariyanti[1]✉

[1]Public Health, Faculty of Public Health, Universitas Mulawarman, Samarinda, Indonesia

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Abstrak

Penelitian ini bertujuan untuk memetakan kejadian hipertensi serta faktor risikonya di 10 kabupaten/kota di Provinsi Kalimantan Timur. Penelitian ini adalah penelitian diskriptif untuk melihat gambaran kejadian hipertensi dan faktor risikonya. Data diambil dari Program Penyakit Tidak menular Aplikasi Sehat Indonesia Ku (ASIK). Sampel dalam penelitian ini adalah seluruh kabupaten kota yang ada di Provinsi Kalimantan Timur sejumlah 10 Kabupaten/Kota yang sudah melaksanakan Program sistem informasi PTM ASIK Tahun 2024. Analisis Data dilakukan secara diskriptif dan disajikan dalam bentuk narasi, tabulasi dan pemetaan dengan menggunakan aplikasi QGIS. Hasil analisis menunjukkan prevalensi hipertensi tertinggi berada di Penajam Paser Utara (36,5%) dan Samarinda (36,0%), sementara beban kasus absolut terbesar terdapat di Kutai Kartanegara (84.335 jiwa). Terdapat disparitas risiko yang signifikan, di mana Kabupaten Mahakam Ulu mendominasi hampir seluruh faktor risiko, termasuk aktivitas fisik kurang (70,7%), konsumsi alkohol (25,5%), obesitas (34,5%), dan merokok (22,7%). Kesimpulannya, distribusi hipertensi di Kalimantan Timur cukup merata namun dipicu oleh determinan risiko yang berbeda antarwilayah, sehingga memerlukan strategi intervensi yang bersifat kontekstual dan spesifik daerah.

Abstract

The objective of this study is to map the incidence of hypertension and its risk factors in 10 districts/cities in East Kalimantan Province. This study employs a descriptive approach to investigate the prevalence of hypertension and its associated risk factors. The data were collected from the Indonesian Healthy Application for Non-Communicable Diseases (ASIK) program. The sample in this study consisted of all 10 districts/cities in East Kalimantan Province that have implemented the ASIK NCD information system program in 2024. The analysis was conducted using descriptive methods and presented in the following forms: narrative, tabular, and mapping. These data were analyzed using the QGIS application. The analysis revealed that the highest prevalence of hypertension was observed in Penajam Paser Utara (36.5%) and Samarinda (36.0%), while the largest absolute case burden was identified in Kutai Kartanegara (84,335 individuals). The analysis revealed significant disparities in risk factors, with Mahakam Ulu District exhibiting predominance in nearly all domains, including insufficient physical activity (70.7%), alcohol consumption (25.5%), obesity (34.5%), and smoking (22.7%). In conclusion, the distribution of hypertension in East Kalimantan is fairly even, but it is driven by different risk determinants across regions. This makes it challenging to implement uniform prevention strategies.

Alamat korespondensi:
Jl. Sambaliung, Gn. Kelua, Kec. Samarinda Utara,
Kota Samarinda, Kalimantan Timur 75119

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INTRODUCTION

Non-communicable diseases (NCDs) represent a significant challenge for Indonesia's healthcare system, including in East Kalimantan Province. Hypertension, a noncommunicable disease (NCD), has both increased in prevalence and significantly impacted the quality of life of the community. According to national data, the prevalence of hypertension in Indonesia reaches approximately 34.1% in individuals aged ≥ 18 years. This figure indicates that more than a third of the adult population is at risk of or already suffers from hypertension, which is a leading cause of disease burden in Indonesia (Fikri et al., 2025; Khasanah & Airlangga, 2022).

A similar trend has been observed in East Kalimantan, where there has been an annual increase in the prevalence of hypertension cases. A substantial body of research has demonstrated a strong correlation between low physical activity and smoking with hypertension in the productive age group (Taamu et al., 2025). Furthermore, smoking and obesity have been demonstrated to markedly elevate the risk of developing hypertension, even when accounting for physical activity levels (Khairani et al., 2025). These findings underscore the significance of leveraging a data-driven approach and systematic evaluation to regulate NCD risk factors, ensuring the judicious targeting of interventions. The underutilization of health data in the NCD planning and control process frequently gives rise to interventions that are not targeted with optimal precision.

It is imperative to comprehend the spatial distribution of hypertension and its risk factors to effectively manage the disease. A health mapping approach can facilitate the identification of areas with high prevalence, the analysis of risk factors geographically, and the determination of priority areas for intervention (Mahendra et al., 2025). A multitude of studies have demonstrated that geographical and socioeconomic disparities exist in the prevalence of hypertension between regions. Consequently, control strategies must be adapted to reflect local characteristics (Oktamianti et al., 2022).

The absence of mapping of hypertension and its risk factors has various impacts on the effectiveness of non-communicable disease control programs in East Kalimantan Province. The absence of a comprehensive spatial framework complicates the identification of regions with elevated disease burdens. Consequently, intervention activities frequently deviate from optimal targeting due to their failure to align with the most pressing priority areas. Moreover, the limitations inherent in spatial analysis result in policies and programs that are general in nature, thereby failing to account for variations in conditions between regions. This can result in the inefficient allocation of resources, including health workers, logistics, and funding, which should be allocated to areas with the most urgent needs. The objective of this study is to identify the risk factors associated with non-communicable

diseases (NCDs) in East Kalimantan Province.

METHOD

The present study is of a descriptive nature, with the objective of examining the prevalence of hypertension and its risk factors. The data were collected from the Indonesian Non-Communicable Disease Application program. The sample in this study consisted of all districts and cities in East Kalimantan Province, totaling 10 districts/cities that had implemented the Indonesian NCD Information System Program in 2024. The data collected were NCD data from East Kalimantan Province, specifically the incidence of hypertension and its risk factors, including obesity, physical activity, alcohol consumption, smoking habits, and exposure to secondhand smoke, as recorded in the Indonesian NCD application at community health centers in 2024. The analysis was conducted in a descriptive manner and presented in the following forms: narrative, tabulation, and mapping. The QGIS application, which is free and open source mapping software, was utilized for this analysis.

RESULT AND DISCUSSION

Table 1. The distribution of hypertension incidence and risk factors in East Kalimantan Province is the subject of this study.

City/District	Hypertension		Obesity		Lack of Physical Activity		Insufficient Fruit and Vegetable Consumption		Excessive Alcohol Consumption		Smoking	
	n	%	n	%	n	%	n	%	n	%	n	%
Samarinda		36	16698	30.0	16051	33.1	1433	29.8	344	0.7	5928	12.3
Balikpapan		31.4	6869	30.9	10395	46.2	1	48.7	423	1.9	1861	8.5
Bontang		26.3	3301	33.7	6046	60.8	1094	74.9	249	2.5	1195	12.2
Penajam Paser Utara		36.5	13586	23.4	10071	19.4	1	18.1	429	0.8	3964	7.5
Paser	20578	33.8	22677	23.5	34945	35.8	7418	43.3	1478	1.5	11034	11.4
Mahakam Ulu	6777	29.5	331	34.5	704	70.7	9555	68.4	267	25.5	237	22.7
Kutai Timur	2589	34.3	9770	26.6	12782	40.6	4219	37.8	704	2.2	4843	16.1
Kutai Kartanegara	20164	29.8	64430	23.0	30183	11.6	1	19.1	1454	0.6	31920	12.6
Kutai Barat	33223	30.7	13863	30.0	12873	27.3	715	55.0	1271	2.7	4901	10.5
Berau	298	30.4	14099	29.1	3440	7.5	1191	7.8	73	0.2	5113	10.6
	12823						4					
	84335						4946					
	14548						6					
	14916						2581					
							4					
							3570					

The results of the analysis in Table 1 indicate that the distribution of hypertension cases in East Kalimantan Province exhibits a relatively high and consistent prevalence across the region. The highest rates of hypertension are observed in Penajam Paser Utara District (36.5%) and Samarinda City (36.0%).

With regard to the absolute case load, Kutai Kartanegara District recorded the highest number of patients, reaching 84,335 people. A salient finding is the low consumption of fruits and vegetables, which peaks in Bontang City (74.9%), as well as the high rate of physical inactivity, which predominates in Mahakam Ulu District (70.7%).

Moreover, risk factor analysis reveals distinctive characteristics in several domains, particularly in Mahakam Ulu District, which exhibits the most intricate risk profile. The region exhibits a prevalence of obesity (34.5%), excessive alcohol consumption (25.5%), and smoking (22.7%) that significantly exceeds the respective averages for other districts and cities in East Kalimantan. Concurrently, urban centers such as Balikpapan and Samarinda exhibit persistent concerns regarding obesity, with prevalence rates reaching approximately 30%.

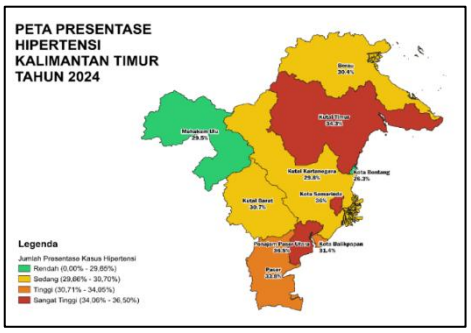

Figure 1. The following map illustrates the distribution of hypertension incidence in East Kalimantan Province in 2024.

The distribution map of hypertension cases indicates a concentration of chronic cardiovascular disease risk in several areas of East Kalimantan Province. The highest category (34.06%–36.50%) is predominantly comprised of three regions: North Penajam Paser Regency (36.5%), Samarinda City (36.0%), and East Kutai Regency (34.3%). Conversely, regions such as Mahakam Ulu Regency (29.5%) and Bontang City (26.3%) are classified as low-risk (0.00%–29.65%).

The mapping results indicate a discrepancy between areas with high prevalence of hypertension and areas with high risk factors. Penajam Paser Utara Regency, Samarinda City, and Kutai Timur Regency have the highest prevalence of hypertension; however, most risk factor indicators such as active smoking, obesity, excessive salt consumption, alcohol consumption, and low physical activity are in the low to moderate category. This condition suggests that the prevalence of hypertension in these regions is potentially influenced by a variety of factors, including demographic characteristics, urbanization, family history, occupational stress, and the accessibility and effectiveness of health services that facilitate enhanced case detection.

These findings are consistent with the conclusions of a study by Lee et al., (2022), which posits that urban areas with adequate access to health facilities tend to have higher prevalence rates due to more intensive screening activities. As an urban area, the city of Samarinda has a more extensive network of health facilities and screening programs, which may lead to more accurate prevalence estimates. This suggests that the observed increase in hypertension may not be solely attributed to heightened exposure to risk factors, but rather, it

may reflect enhanced detection capabilities within the healthcare system.

In contrast to this pattern, Mahakam Ulu Regency and Bontang City exhibit the opposite phenomenon. The classification of these two regions as having low prevalence of hypertension is based on ASIK data. However, mapping reveals that most risk factors, including low physical activity, alcohol consumption, active smoking, excessive salt consumption, and obesity, are in the high to very high category. The phenomenon under scrutiny can be explained by two theoretical possibilities. Firstly, the low prevalence of hypertension could be attributed to limited access to health services, signifying that a significant number of cases remain undetected. According to Suntornlohanakul et al., (2022), regions with geographical barriers, such as Mahakam Ulu, have the potential for underreporting due to limited screening services and distance to health facilities. Secondly, the elevated risk factors observed in these regions are indicative of the potential future burden, as the likelihood of developing hypertension may rise in conjunction with the accumulation of behavioral and metabolic risk factors (Hou & Yang, 2024).

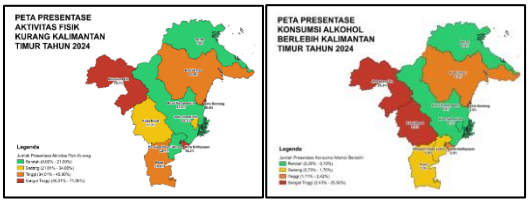

Figure 2. The following map illustrates the distribution of risk factors for non-communicable diseases, namely physical activity and alcohol consumption, in East Kalimantan Province in 2024.

The distribution map illustrates notable disparities in risk associated with insufficient physical activity in East Kalimantan Province. The Mahakam Ulu Regency demonstrated the highest percentage of insufficient physical activity, with 70.7% of the population falling into this category. This figure exceeds the upper limit of the very high category, which is defined as 45.01%–71.00%. In addition to Mahakam Ulu, Bontang City (60.8%) and Balikpapan City (46.2%) also fall into the same category, indicating that sedentary lifestyles have become a public health challenge in both rural and urban areas. This pattern indicates that the decline in physical activity is influenced by a combination of urbanization and socio-economic changes, including increased technology use, changes in work patterns, and shifts in lifestyle. This condition underscores the necessity of implementing behavior-based health promotion interventions, including the Healthy Living Community Movement campaign, which emphasizes the importance of regular physical activity. This study aligns with prior research indicating that low physical activity is significantly associated with the development of hypertension in the

productive age group (Taamu et al., 2025).

Conversely, several other regions exhibited low risk categories (8.00%–21.00%), including Berau Regency (7.5%), Kutai Kartanegara Regency (11.6%), and Penajam Paser Utara Regency (19.4%). The low proportion of physical inactivity in these regions is likely influenced by the geographical characteristics and types of livelihoods that still require high levels of physical activity, such as agriculture, fishing, and field work. The findings indicate that environmental and socioeconomic factors exert a substantial influence on the physical activity patterns exhibited by communities in East Kalimantan.

The distribution map indicates that excessive alcohol consumption is a risk variable that manifests a highly concentrated spatial pattern in several areas of East Kalimantan Province. The Mahakam Ulu Regency has the highest prevalence rate of 25.5%, which is considered to be in the very high category (2.43%–25.50%). This figure is regarded as extreme due to its almost tenfold increase compared to other regions classified as very high, including West Kutai Regency (2.7%) and Bontang City (2.5%). This spatial pattern suggests that cultural, social, and accessibility factors related to alcoholic beverages may have a significant influence on alcohol consumption behavior in rural areas such as Mahakam Ulu. This condition also demonstrates that risky behavior is not invariably geographically uniform; rather, it can be concentrated in specific communities that exhibit particular social and cultural characteristics.

Conversely, regions such as Berau Regency (0.2%), Kutai Kartanegara Regency (0.6%), and Samarinda City (0.7%) exhibited remarkably low prevalence, categorizing within the low category (0.20%–0.72%). This spatial disparity underscores the necessity for a contextual intervention approach, one which takes into account socio-cultural aspects and local regulations in controlling excessive alcohol consumption in the interior of East Kalimantan.

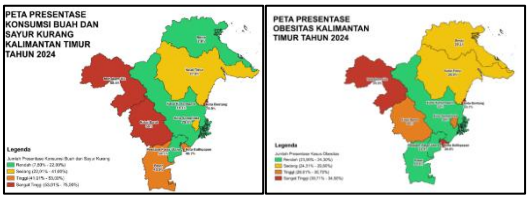

Figure 3. The following map illustrates the distribution of risk factors for non-communicable diseases in East Kalimantan Province in 2024. The risk factors in question include fruit and vegetable consumption and obesity.

The distribution map indicates that the percentage of fruit and vegetable consumption is not distributed uniformly in East Kalimantan Province, with the highest concentrations observed in specific urban and rural areas. The highest category (53.01%–75.00%) was identified in Bontang City (74.9%), Mahakam Ulu Regency (66.4%), and West Kutai Regency (55%). The fact that Bontang City ranks highest (74.9%) indicates that issues of access to nutritious food, imbalanced consumption behaviors, and socioeconomic factors play a role in the formation of risky dietary patterns, even in urban areas with relatively good food availability.

High-risk categories (41.01%–53.00%) were identified in Balikpapan City (48.7%) and Paser Regency (43.3%), suggesting that dietary imbalance is a cross-regional issue affecting both densely populated and semi-rural regions. In contrast, Berau Regency exhibited the lowest risk (7.8%), categorizing within the low risk range (7.80%–22.00%). This spatial pattern reveals substantial disparities in consumption behavior across regions, underscoring the necessity for nutrition interventions and educational initiatives focused on healthy eating that are adapted to the socioeconomic and geographic context of each region.

The distribution map indicates that obesity cases in East Kalimantan Province demonstrate a spatial pattern influenced by high-risk inland areas and densely populated urban areas. The highest prevalence was recorded in Mahakam Ulu Regency (34.5%), followed by Bontang City (33.7%) and Balikpapan City (30.9%). The classification of these three regions as "very high" (30.71%–34.50%) signifies a correlation between low levels of physical activity, as depicted on the map of low physical activity, and unhealthy eating patterns. It is noteworthy that regions with the highest prevalence of hypertension, such as Penajam Paser Utara Regency (23.4%) and Paser Regency (23.5%), are in the low category (23.00%–24.30%) for obesity. This suggests that the prevalence of hypertension in these regions is potentially more influenced by non-obesity risk factors, including excessive salt consumption, smoking, and psychosocial stress. This spatial pattern lends credence to the multifactorial nature of the relationship between obesity and hypertension, which is further compounded by regional variations, necessitating bespoke intervention strategies tailored to the demographics and environmental characteristics of the local population.

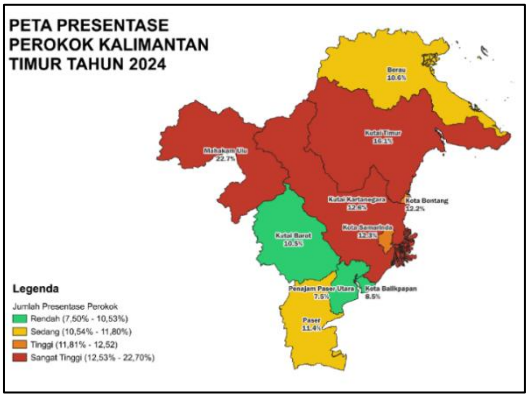

Figure 4. The following map illustrates the distribution of risk factors for non-communicable diseases, specifically the prevalence of smoking in East Kalimantan Province in 2024.

The distribution map indicates that active smoking constitutes a pervasive risk factor in East Kalimantan Province, with the majority of districts/cities falling within the high to very high risk category. The Mahakam Ulu District has the highest prevalence of smokers, with 22.7% of the population reporting current smoking. It is noteworthy that several other regions are similarly designated as very high risk (12.53%–22.70%), including East Kutai District (16.1%), Kutai Kartanegara District (12.6%), Samarinda City (12.3%), and Bontang City (12.2%). This spatial pattern suggests the necessity for prioritizing tobacco control efforts in inland areas and those with high population density, particularly in Mahakam Ulu Regency. Conversely,

Penajam Paser Utara Regency (7.5%) and Balikpapan City (8.5%) exhibited the lowest prevalence, falling within the low-risk category (7.50%–10.53%).

These findings are consistent with and reinforce the results of various previous studies. Research conducted by Dilla et al., (2024) demonstrates a substantial relationship between smoking habits and the prevalence of hypertension. Research conducted by Erman et al., (2021) also demonstrates analogous results, indicating that smokers are more prone to developing hypertension compared to non-smokers. This assertion is further substantiated by the findings of Rahmatika (2021), which indicate that smoking constitutes a significant risk factor for elevated blood pressure.

Hypothetically, the association between smoking and hypertension can be elucidated by multiple pathophysiological mechanisms. One of the primary mechanisms involves the impact of nicotine, the predominant psychoactive agent in tobacco. Nicotine, a highly efficacious sympathomimetic agent, has been demonstrated to elicit a stimulatory effect on the sympathetic nervous system (Rahmatika, 2021). This stimulation triggers the release of catecholamines, such as adrenaline and noradrenaline, into the bloodstream. These hormones induce a transient increase in heart rate and constriction (narrowing) of the arteries. Consequently, the heart must exert greater force to circulate blood through the constricted vessels, resulting in a precipitous surge in blood pressure immediately following the act of smoking (Umbas et al., 2019).

CONCLUSION

The distribution of hypertension cases in East Kalimantan Province is characterized by a high prevalence across the region, yet a spatial mismatch is evident between areas with the highest hypertension rates and areas with the highest concentration of behavioral risk factors. Urban areas, such as Samarinda, demonstrate a high prevalence of hypertension, which is likely influenced by enhanced early detection and screening capacity. Conversely, rural areas, including Mahakam Ulu, exhibit an alarming "future burden" with the most extreme risk factors (obesity, physical inactivity, alcohol consumption, and smoking), which are among the most significant in the province. Consequently, the implementation of NCD control strategies in East Kalimantan must be adapted to the specific characteristics of each region. Urban areas must prioritize the strengthening of case management, while rural areas must focus on active behavior-based health promotion (Germas) and nutrition education to mitigate the future accumulation of metabolic risk factors.

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