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The Effect of Traditional Medicinal Plants in Preventing Non-Communicable Diseases: Insights from Indonesia Health Survey 2023

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Abstract

Background: This study examines the ecological relationship between the use of Traditional Medicinal Plants (TOGA) and the prevalence of diabetes mellitus, hypertension, asthma, and stroke across provinces in Indonesia. It also explores geographical variations and the potential role of TOGA as a population-level intervention for controlling non-communicable diseases (NCDs).

Materials and Methods: An ecological study was performed using aggregate data from the Indonesia Health Survey 2023, encompassing 639,628 individuals across 38 provinces in Indonesia. Provincial TOGA utilization rates were analyzed in relation to the prevalence of diabetes mellitus, hypertension, asthma, and stroke. Scatter plot diagrams were employed to visualize as well as assess the correlation between TOGA use and NCD prevalence.

Results: The study found significant regional variations in TOGA utilization, ranging from 2.3% to 22.8% across provinces. Provinces with higher TOGA utilization generally revealed lower prevalence rates of NCDs, particularly for hypertension and stroke, suggesting a potential protective effect. However, the relationship was weaker for diabetes mellitus and asthma, indicating that other factors may influence these conditions.

Conclusion: The findings suggest a potential association between higher TOGA utilization and lower prevalence of certain NCDs at the ecological level, particularly hypertension and stroke. Nevertheless, owing to the ecological nature of the study, the results provide a general population-level overview and does not establish individual-level causal relationships. Further research using individual-level data is required to confirm these findings and explore the mechanisms underlying TOGA's potential health benefits.

Keywords: Medicinal Plants, TOGA, Non-Communicable Diseases

Introduction

Non-communicable diseases (NCDs) represent a significant public health challenge globally, including in Indonesia. Traditional and complementary medicine plays a key role in managing NCDs, particularly in low- and middle-income countries. Its integration into national health systems supports universal health coverage by enhancing healthcare accessibility and quality for populations affected by NCDs [1].

According to the Indonesia Health Survey 2023, some of the NCDs with a high prevalence in Indonesian society include diabetes mellitus, hypertension, asthma, and stroke. The prevalence of diabetes among individuals aged ≥15 years in Indonesia is 2.2%, which is lower than that of hypertension (8%), stroke (8.3%), and asthma (1.6%), but higher than chronic kidney disease (0.22%) and cancer (1.2%). Although the prevalence rate may seem relatively low, diabetes remains a significant public health concern given its impact on quality of life, economic burden, as well as the risk of complications such as cardiovascular disease and kidney failure. Based on Indonesia's large

population, this prevalence represents a substantial number of individuals affected, underscoring the need for comprehensive prevention and management strategies. The usage of Traditional Medicinal Plants (TOGA) is one such approach which can aid in preventing and managing diabetes mellitus as well as hypertension. Studies and community programs indicate that promoting healthy lifestyles and TOGA use can improve public knowledge and behavior in preventing these chronic diseases.

TOGA has long been an integral part of the traditional medicine system and played an essential role in managing critical illnesses in Indonesia [2]. The use of TOGA not only reflects local wisdom but can also potentially provide cost-effective solutions in NCDs management. Several recent studies have reported the effectiveness of various medicinal plants in overcoming NCDs. For example, Pradipta et. al. [2] reported the potential of several Indonesian medicinal plants in managing cancer, liver problems, cholesterol problems, diabetes, and stroke. Other studies have identified various natural products that are effective for treating type 2 diabetes mellitus [3-5]. It is essential to implement interventions to optimize the use of TOGA, given the high prevalence of NCDs in Indonesia, where a large portion of the population is affected or at risk of NCDs such as hypertension, central obesity, and type 2 diabetes [5].

While research has presented promising results in specific diseases, a comprehensive understanding of the effect of TOGA utilization on the population level prevalence of NCDs in Indonesia is still lacking. Further research that integrates data on TOGA usage with disease prevalence rates is critical to bridge this gap and effectively inform public health strategies.

This study primarily focuses on the more prevalent NCDs in Indonesia, which are considered to have a greater likelihood of being influenced by the use of TOGA (traditional medicinal plants) within the short to medium term. The NCDs reported in the Indonesia Health Survey 2023 include diabetes mellitus, hypertension, heart disease, chronic kidney disease (CKD), asthma, stroke, and cancer. We examined four out of seven NCDs, namely diabetes mellitus, hypertension, asthma, and stroke as they have a reasonably high prevalence in the community and are often the target of public health interventions. In addition, TOGA has demonstrated a more direct and measurable effect on the management of these four conditions compared to cancer, heart disease, and chronic kidney disease.

This study aims to analyze the relationship between the use of TOGA and the prevalence of the four main NCDs in Indonesia. In particular, this study will examine geographical variations in the use of TOGA and the prevalence of NCDs, as well as scrutinizes the potential of TOGA as an intervention strategy in controlling NCDs at the population level.

Materials and Methods

This study applied a quantitative approach with an ecological study design, using secondary data sourced from the Indonesia Health Survey 2023. The data consisted of the usage of TOGA and the prevalence of NCDs based on physician diagnoses across all age groups by province, covering a population of 639,628 people, as published by the Health Research and Development Agency, Ministry of Health of the Republic of Indonesia. The dataset is publicly available at: https://badankebijakan.kemkes.go.id.

The unit of analysis in this study was the province, with all 38 provinces in Indonesia included in the analysis. This study explored the relationship between the usage of TOGA and the prevalence of NCDs across Indonesia, focusing on four major conditions: diabetes mellitus, hypertension, asthma, and stroke. The dependent variable is the provincial-level prevalence of NCDs, whereas the independent variable is the extent of TOGA utilization.

To assess the relationship between TOGA utilization and NCD prevalence, this study applied descriptive statistical analysis and scatter plot diagrams. Further, linear regression analysis was employed to quantify the relationship between TOGA utilization (independent variable) and the prevalence of NCDs (dependent variable). This method would provide estimates of the direction and strength of the association, with results expressed as regression coefficients (β), 95% confidence intervals (CI), and p-values to ascertain the statistical significance. All statistical analyses were conducted using IBM SPSS Statistics (version 29), with a significance level (α) set at 0.05.

Further, radar diagrams were generated using Microsoft Excel (Office 365) to present a comprehensive visualization of TOGA utilization and NCD prevalence across Indonesia.

Results

Table 1 reports the distribution of respondents using TOGA based on age, gender, education, occupation, and residence. TOGA use increased with age, peaking in the 65-74 age group (16.7%; 95% CI: 16-17.5) while being lowest in children under one year (3.4%; 95% CI: 3.1-3.7). Women (11.3%; 95% CI: 11-11.5) reported higher TOGA use than men (8.8%; 95% CI: 8.6-9), likely owing to their caregiving roles. People with higher education (13.4%; 95% CI: 12.8-14) and elementary graduates (12%; 95% CI: 11.6-12.4) showed the highest use, reflecting both health literacy and limited access to modern healthcare. Farmers and farm laborers (15.9%; 95% CI: 15.3-16.4) were the most frequent users, while

students reported the lowest (6.7%; 95% CI: 6.4-7). Rural residents (12%; 95% CI: 11.7-12.4) used TOGA more than urban residents (8.4%; 95% CI: 8.2-8.7), likely because of limited medical services in rural areas.

Table 1. Frequency Distribution of Respondents

Characteristics		Utilize TOGA		N
		%	CI 95%	
Age Group	< 1	3.4	3.1-3.7	21,921
	1-4	4.9	4.6-5.2	39,959
	5-14	5.9	5.7-6.2	123,743
	15-24	7.8	7.4-8.1	115,103
	25-34	10.5	10.1-10.9	97,548
	35-44	12.2	11.8-12.6	85,567
	45-54	14.8	14.3-15.3	69,225
	55-64	16.3	15.7-16.9	48,042
	65-74	16.7	16-17.5	27,633
	75+	15.1	14-16.3	10,886
Gender	Male	8.8	8.6-9	328,445
	Female	11.3	11-11.5	311,183
Education Level	No/Incomplete Formal Education	9.1	8.6-9.6	55,439
	Did Not Complete Elementary	8.3	7.9-8.7	92,281
	Completed Elementary	12	11.6-12.4	135,961
	Completed Junior High School	10.6	10.2-11	102,768
	Completed Senior High School	10.6	10.2-10.9	150,041
	Completed Higher Education	13.4	12.8-14	41,257
Occupation	Unemployed	12.6	12.2-13	149,975
	Student	6.7	6.4-7	103,148
	Civil Servant/ Military/Police/BUMN	15.1	14.2-16	13,388
	Private Employee	8.7	8.1-9.2	49,579
	Entrepreneur	10.4	9.9-10.9	63,491
	Farmer/Farm Laborer	15.9	15.3-16.4	70,381
	Fisherman	8.8	7.4-10.5	3,946
	Laborer/Driver/Domestic Helper	11	10.2-11.8	34,522
	Others	13.3	12.7-14	28,300
Residence	Urban	8.4	8.2-8.7	361,045
	Rural	12	11.7-12.4	278,583

Fig. 1 highlights significant variation in TOGA utilization across Indonesian provinces, ranging from 2.3% to 22.8%. Aceh had the highest utilization rate (22.8%), followed by Nusa Tenggara Timur (21.7%), while DKI Jakarta (2.3%) and Kepulauan Riau (3.6%) showed the lowest. A regional pattern emerges, with higher utilization in eastern provinces such as Nusa Tenggara Timur, Nusa Tenggara Barat, and Maluku, while urbanized provinces (provinces with high urbanization levels, where most residents live in urban areas with modern infrastructure, intensive economic activities, and broad access to public services) such as DKI Jakarta, Jawa Barat, and Banten exhibited lower rates.

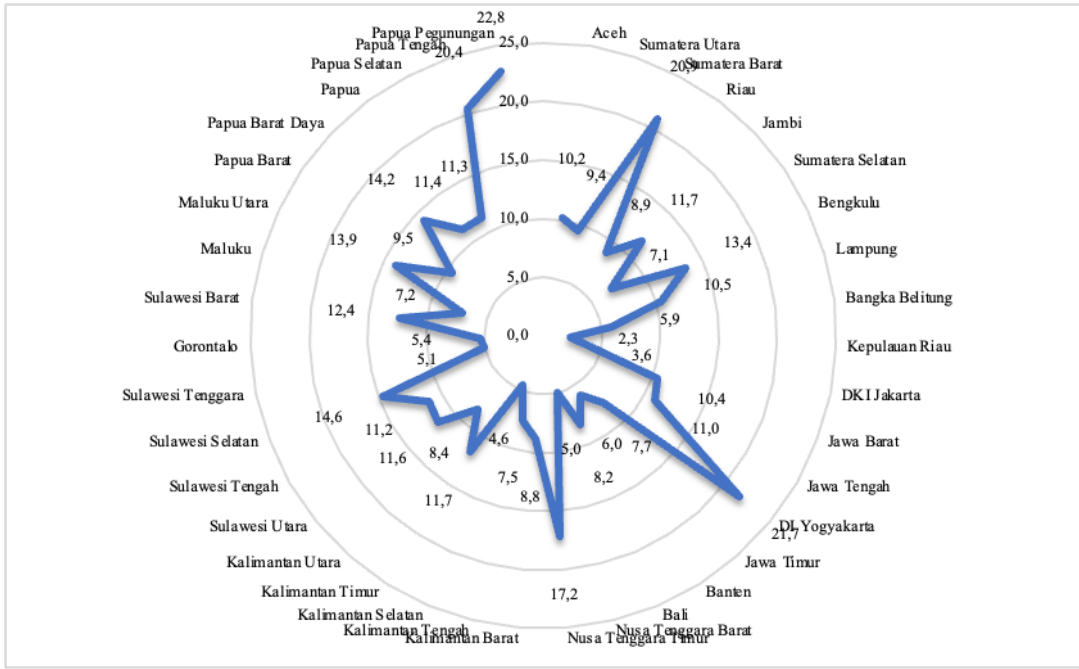

Fig. 1. Proportion of TOGA utilization in various provinces in Indonesia 2023

Fig. 2 depicts the prevalence of four major NCDs across 38 provinces in Indonesia. Hypertension consistently recorded the highest prevalence, particularly in Sulawesi Utara (13.1%), DI Yogyakarta (12.3%), and Bangka Belitung (11.1%), while asthma remained the least common, with the highest levels in Aceh (4.3%) and Sulawesi Barat (3.2%). In contrast, the lowest prevalence of all NCDs was observed in Papua and Papua Pegunungan, indicating significant regional disparities.

DM was most prevalent in urbanized areas, with the highest rates found in DI Yogyakarta (9.0%), DKI Jakarta (8.0%), and Kalimantan Timur (7.9%). This pattern suggests a link between urbanization, lifestyle factors, and increased disease incidence. Meanwhile, stroke prevalence mirrored hypertension trends, with Sulawesi Utara (8.3%), DI Yogyakarta (8.0%), and Kalimantan Barat (7.9%) showing the highest rates, highlighting potential shared risk factors.

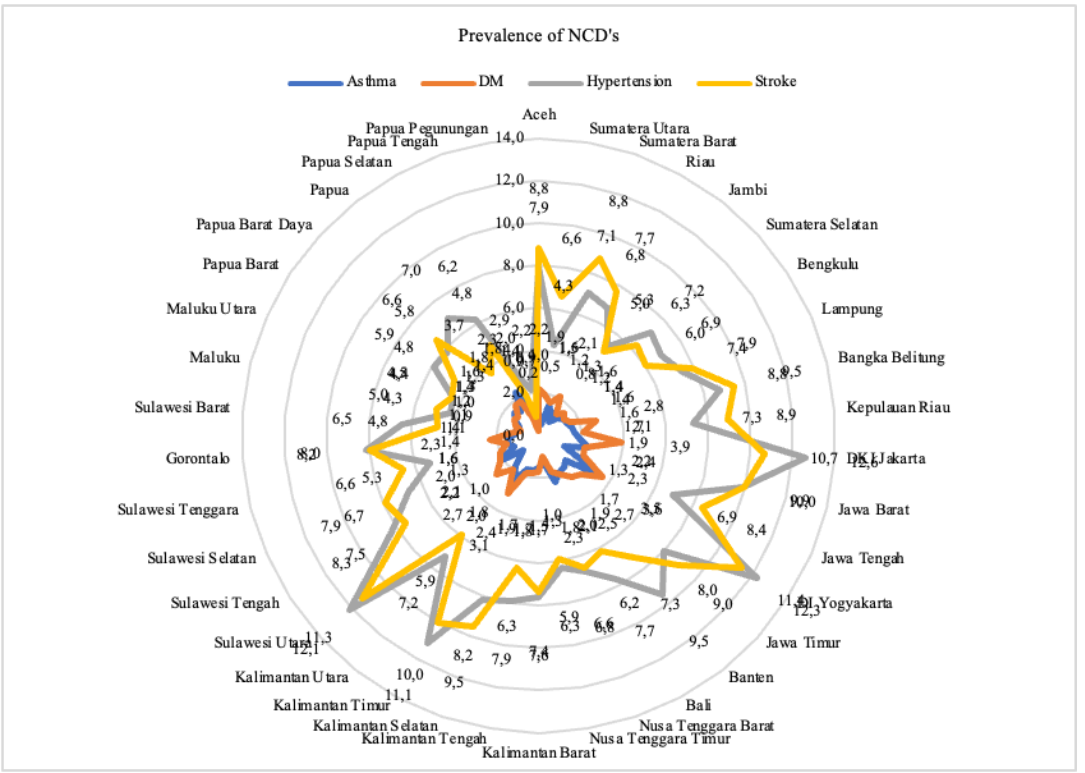

Fig. 2. Prevalence of four types of NCDs in various provinces in Indonesia 2023

Fig. 3 illustrates the relationship between TOGA utilization and the prevalence of various NCDs in Indonesia. A negative trend was observed, indicating that higher TOGA utilization would correlate with a lower disease prevalence. The relationship was strongest for hypertension (y = 8.59 - 0.12x) and stroke (y = 8.62 - 0.15x), while being weaker for D.M. (y = 2.45 - 0.05x) and asthma (y = 1.59 – 3.97E-3x). Nevertheless, significant data variation across provinces suggests the influence of other factors beyond TOGA utilization.

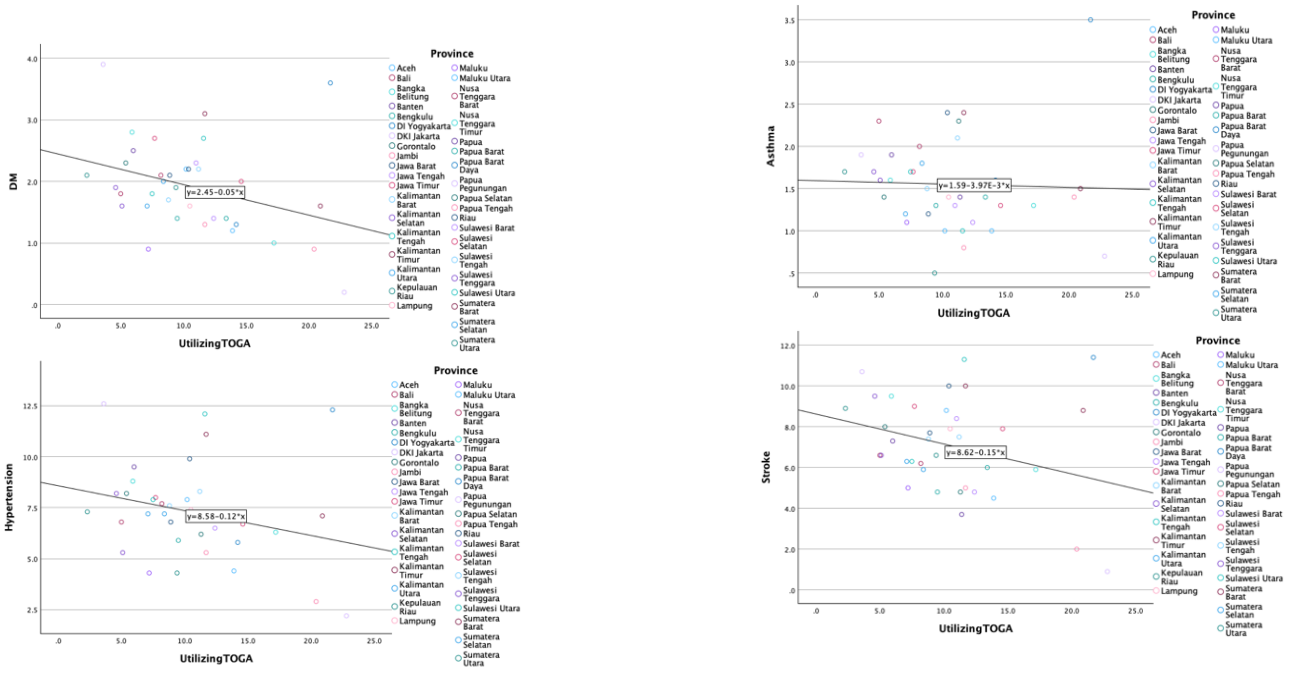

Fig. 3. Scatter plot of TOGA utilization with prevalence of DM, asthma, hypertension, and stroke by province in Indonesia 2023

Discussion

The Utilization of TOGA as Culture in Indonesia: The results of this study found a significant variation in the utilization of TOGA in various provinces in Indonesia. An interesting regional pattern can be observed where provinces in eastern Indonesia tended to have higher levels of TOGA utilization compared to provinces in Jawa and Sumatra. In addition, more urban areas such as DKI Jakarta, Jawa Barat, and Banten revealed a relatively low utilization rate compared to rural areas.

These findings are in accordance with several recent studies. The research was conducted in various rural areas, such as Sandu Regency in China [6], Tehsil Mastuj in Pakistan [7] , as well as the northern districts of Jammu and Kashmir in India [8], highlighting the extensive knowledge and utilization of traditional medicinal plants by rural communities. In addition, research from regions such as Southern Romania [9], Nepal [10], Peru [11], and Mexico [12] revealed that rural areas often show higher levels of utilization of traditional medicinal plants. In Southern Romania, despite urbanization, the rural background is linked to a preference for harvesting crops for medicinal use [9]. Similarly, in Nepal, people in rural areas heavily rely on plant-based medicines for their primary healthcare needs [10]. In Peru, those with lower economic resources and limited access to modern services have higher knowledge of medicinal plants, emphasizing the importance of rural livelihoods in maintaining this traditional practice [11]. Furthermore, in Mexico, communities with less urbanization demonstrated greater knowledge and use of wild medicinal plants, highlighting the influence of urbanization on the introduction and use of local flora for medicinal purposes [12]. These studies corroborate our findings that rural areas tend to have higher levels of TOGA utilization.

In contrast, urban areas present a decline in the use of native medicinal plants owing to limited land and knowledge [13,14]. Interest remains, but urbanization impacts utilization in the family environment [12]. This aligns with our findings, indicating low TOGA utilization in urban areas such as DKI Jakarta.

The use of TOGA as a culture in Indonesia presents a complex and geographically varied pattern. Although this practice is still strong in some areas, particularly those more rural and traditional, there are challenges in maintaining and promoting the use of TOGA in urban areas.

Prevalence of NCDs in Indonesia: The prevalence of NCDs in Indonesia reveals significant variations among regions. Hypertension has the highest prevalence in most provinces, followed by diabetes mellitus and stroke showing similar patterns, while asthma generally has the lowest prevalence. This geographical variation reflects the influence of social, cultural, and environmental factors on public health across different regions.

Research by Cini et al. indicates that adolescents in Indonesia are at high risk of NCDs, influenced by lifestyle changes and urbanization [15]. Another study by Fritz added that environmental factors, such as temperature also affect the distribution of NCDs, especially hypertension as well as other cardiovascular diseases [16]. In addition, research by Asrullah et al. found that changes in menarche age in Indonesia are linked to elevated body mass index (BMI) and the prevalence of NCDs [17].

Overall, the distribution of NCDs in Indonesia is affected by various geographical, social, and cultural factors, suggesting the need for public health strategies tailored to local contexts to lower the burden of NCDs across Indonesia.

Utilization of TOGA and Reduction of Prevalence of Asthma: Key results of the study indicated a fragile negative relationship between the use of TOGA and the prevalence of asthma in Indonesia. A slightly downward trend line reveals that increased TOGA utilization is correlated with a decline in asthma incidence, but the correlation is very weak. The wide distribution of data suggests that other factors may have a more significant influence on the prevalence of asthma. These findings imply that although TOGA may have potential in asthma management, its impacts at the population level are limited.

The findings of this study concord with and differ from recent studies that have explored the effectiveness of medicinal plants in asthma management. Bezerra et al., in a systematic review, reported that several traditional medicinal plants, such as Fabaceae, Lamiaceae, and Asteraceae, in Brazil presented promising effects in mitigating asthma symptoms. They identified 188 species and revealed hope in preclinical as well as clinical studies [18].

Further, Gandhi et al. performed a systematic review of the use of medicinal plant extracts in treating asthma through the modulation of interleukin expression. According to their findings, plant extract therapy, including Ginkgo biloba, can control asthma symptoms by regulating the secretion of different inflammatory and anti-inflammatory cytokines that lower inflammation in the respiratory tract [19]. However, they also emphasized that the quality of the evidence for most studies was still low to moderate, suggesting the need for further research.

In the context of Indonesia and Southeast Asian countries such as Thailand, Nishidono et al. researched the potential of Indonesia's medicinal plants in asthma management. They identified the Plai plant known as cassumunar ginger. This plant has been traditionally used in Southeast Asia to treat asthma since it has a broad spectrum of bioactivities, including anti-

inflammatory, antioxidant, antimicrobial, and anti-asthmatic properties [20]. However, most of the evidence is still limited to in vitro and in vivo studies, with few clinical trials being conducted.

Utilization of TOGA and Reduction of Prevalence of Diabetes Mellitus: Key results of the study presented a negative association between TOGA utilization and the prevalence of DM in Indonesia, though this association appeared weak. These findings imply that TOGA may have the potential to manage or prevent DM at the population level, although the effect could be stronger. Other factors such as diet, physical activity, obesity, and genetics may play a more dominant role in the prevalence of DM. However, these results do not rule out the possibility that TOGA can be beneficial in DM management at an individual level.

This study's findings on the relationship between TOGA utilization and the prevalence of DM in Indonesia align with several recent studies, albeit with different degrees of effectiveness. While this study found a weak negative correlation, previous studies tended to report more positive impacts of medicinal plants on DM management.

For example, Salleh et al., in their review of medicinal plants applied for the treatment of diabetes in human clinical trials in the ASEAN region, reported that some plants presented significant antidiabetic effects, especially in lowering blood glucose levels and enhancing insulin sensitivity [21]. Meanwhile, Hamdan et al. conducted a comprehensive review of the effects of Nigella sativa on type 2 DM. They found this plant has promising potential in lessening blood glucose levels and improving insulin function [22].

More specifically, Widjaja et al., in their study on the potential of Poguntano extract for diabetes management, observed that this extract presented significant hypoglycemic effects in their meta-analysis [23]. In addition, Sukardiman and Ervina conducted a systematic review of the use of Swietenia mahagoni as a type 2 antidiabetic phytomedicin, also showing potential in the management of blood glucose levels through various biochemical mechanisms [24].

Utilization of TOGA and Reduction of Prevalence of Hypertension: The main findings of the study indicated that there was a strong negative relationship between the use of TOGA and the prevalence of hypertension in Indonesia. The descending trend line indicates that the rise in TOGA utilization is correlated with a fall in hypertension rates. This correlation appears to be stronger compared to the association between TOGA and other non-communicable diseases studied. These findings imply that TOGA may have significant potential in the management or prevention of hypertension at the population level.

This study's results concord with several recent studies showing the effectiveness of medicinal plants in hypertension management. A systematic review highlights the significant antihypertensive effects of medicinal plants commonly used in Southeast Asia, such as garlic (Allium sativum) and noni [25, 26]. Garlic, known for its cardiovascular benefits, has been shown to lower blood pressure in hypertensive patients, with meta-analyses revealing reductions in systolic and diastolic blood pressure compared to placebo [27]. In addition, traditional Chinese medicine (TCM) has presented anti-hypertensive effects comparable to those of pharmaceutical drugs, emphasizing the potential of herbal treatment in managing hypertension [24]. These findings underscore the significance of exploring natural remedies such as garlic and noni in the treatment and prevention of hypertension, offering a promising alternative to conventional pharmaceutical interventions, particularly in areas where access to expensive medicines is limited [28].

In Indonesia, Arozal et al. reviewed several Indonesian medicinal plants used to manage metabolic syndromes, including hypertension [29]. The study found that these plants, such as Moringa oleifera and Curcuma longa, have a strong molecular basis in managing metabolic disorders. The mechanisms identified include regulation of inflammatory pathways, enhancement of insulin sensitivity, and modulation of enzyme activity in glucose metabolism.

Utilization of TOGA and Reduction of Prevalence of Stroke: The study's key results revealed a strong negative relationship between the use of TOGA and the prevalence of stroke in Indonesia. The downward trend line demonstrates that the increase in TOGA utilization is correlated with a reduction in the incidence of stroke. This correlation is significant, though there is still considerable variation between provinces. These findings imply that TOGA may have potential in stroke prevention or management at the population level, though other factors may be involved in its effects.

This study's findings align with several recent studies indicating the potential of medicinal plants in stroke prevention and management. Zhu et al. reviewed various therapeutic targets for neuroprotection and neurorestoration in ischemic stroke, primarily related to applying natural compounds from medicinal plants [30]. They found that these compounds work through various mechanisms, including reduction of oxidative stress, inhibition of apoptosis, and modulation of inflammatory pathways, all contributing to nerve cell protection and recovery post-stroke.

The research of Zhang et al. further identified advances in using medicinal plants and their active metabolites to treat ischemic reperfusion injuries in stroke [31]. The study highlighted a new therapeutic strategy based on crosstalk regulation between mitochondria (the process of clearing damaged mitochondria) and ferroptosis (a type of cell death that depends on iron). This approach

indicates how compounds from medicinal plants can mitigate nerve damage by regulating complex cellular processes that occur during and after ischemic stroke.

In Indonesia, research carried out by Machin et al. assessed the effects of Camellia sinensis (green tea) and its active compound, epigallocatechin gallate (EGCG) [32]. They found that the administration of a green tea extract rich in EGCG can reduce neuronal cell necroptosis. In the context of this study, EGCG helps minimize brain tissue damage resulting from ischemia, potentially promoting the recovery of post-stroke neurological function.

This study had several limitations which should be considered when interpreting the findings. First, while it identified geographic variations in NCD prevalence, it cannot confirm that TOGA use would directly reduce NCDs. Establishing causality requires further controlled studies, including in vitro and in vivo experiments. Further, the use of aggregate data from 38 provinces may overlook individual factors such as smoking, diet, and physical activity. Future longitudinal studies or randomized controlled trials are required to explore these relationships more thoroughly. Finally, as an ecological study, it is subject to the ecological fallacy. Group-level findings cannot be directly applied to individuals, which may result in inaccurate conclusions.

In spite of these limitations, this study is significant in mapping the regional burden of NCDs across Indonesia. The results establish a strong basis for policymakers to design region-specific health interventions and encourage further investigation into the effectiveness of TOGA as a complementary therapeutic approach.

Further, this study emphasizes the importance of adopting a multidisciplinary perspective to comprehensively understand the risk factors associated with NCDs. Such an approach guides the development of evidence-based public health policies which are both effective and contextually relevant.

This study can expectedly offer new insights into the role of TOGA within the framework of public health in Indonesia, particularly in the management of NCDs. The results can potentially inform policies on integrating traditional medicinal plants into healthcare practices, providing valuable opportunities to manage NCDs effectively and safely. This is in line with the World Health Organization’s emphasis on leveraging traditional medicine to address modern healthcare needs in developing countries [33-35].

Conclusion

Overall, the use of TOGA varies significantly across Indonesia, with higher usage in rural and eastern areas. A clear negative correlation was found between TOGA usage and the prevalence of non-communicable diseases, especially hypertension and stroke, suggesting the potential of TOGA in managing these conditions. However, the connection with diabetes and asthma was less pronounced. These findings underscore the importance of integrating traditional knowledge with modern healthcare to effectively address NCDs. Further research is imperative to examine TOGA's mechanisms, drug interactions, and long-term effects. While TOGA presents potential as a complementary approach, its incorporation into national health strategies should be supported by robust scientific evidence, and public education on its safe usage is crucial.

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Conflict of interest

None declared.

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Ethical Considerations

This study uses secondary data from the "Indonesia Health Survey 2023" published by the Health Research and Development Agency, Ministry of Health of the Republic of Indonesia (https://layanandata.kemkes.go.id/katalog-data). It also involved the analysis of publicly available provincial-level aggregate data without individual identification. However, all research activities are carried out by the ethical principles of research integrity and data protection.

Code of Ethics

The research has been approved by the Head of the Data and Information Technology Center, Ministry of Health of the Republic of Indonesia, with the approval number: FRM/SMKI-PUSDATIN/70/0059/2025.

Authors' Contributions

Yudi Adnan: Led the manuscript drafting; Dewi Setiawati: Contributed to literature review and revisions; M. Fais Satrianegara: Assisted with data processing and analysis and Emmi Bujawati provided supervision and final approval. All authors contributed to the study's conception, design, data analysis, and interpretation. Reviewed and approved the final manuscript.

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