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The Application of Geographic Information System for Assessing the Risk Level of Hypertension in Samut Songkhram Province

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ABSTRACT

This study aims to examined factors associated with hypertension patients and to create spatial models to assesses the risk level for hypertension in Samut Songkhram Province, Thailand. We performed a secondary analysis of data to find causes and relationships between seven factors and hypertension patients. Seven experts used impact feedback to analyze the results of GIS and the risk levels of hypertension. Data were analyzed using Pearson's correlation coefficient. Results indicated that seven factors were associated with the occurrence of hypertension: age, occupation, land use, population density, physical activity, smoking, and alcohol consumption. This study also found 87 villages within high risk areas in Muang Samut Songkhram district. While the moderate risk areas included 96 villages in Amphawa District. As for the low-risk areas, there were a total of 101 villages located in Bang Khonthi District. The results confirm that the application of GIS for assessing the risk level of hypertension were accurate and effectively in high risk, moderate risk, and low risk areas. Public health sectors strategize to support health and wellness in patients with hypertension and reflect more opportunity for healthcare providers in the area of health promotion and disease prevention.

Keywords: Geographic Information System (GIS), Hypertension, Application, Thailand

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INTRODUCTION

Hypertension or high blood pressure is a major cause of disability and premature death worldwide.[1] According to the World Health Organization, the number of patients with hypertension is as high as a billion people with two-thirds.[2] In Thailand, hypertension is a major health problem as well —the prevalence of hypertension is higher when comparing the number of patients from 4 million in 2013, to 6 million in 2018.[3] It is likely that the mortality rate of hypertension will increase. [4] Currently, Thailand has established the Thailand Lifestyle Health Strategic Plan 2011 - 2020 with the goals of enabling people to control and prevent disease caused from five major lifestyle factors (e.g. diabetes, hypertension, heart disease, vascular disease, and cancer) and supporting a self-sufficient lifestyle in terms of diet, physical activity, and emotional management. [5,6]

Samut Songkhram is a small province located in the lower central part of Thailand. In fact, Samut Songkram province had the highest number of patients with hypertension as well as the highest morbidity and mortality rate within its health service area.[7] According to Samut Songkhram Provincial Public Health Office [8], 25,294 patients with hypertension per 100,000 population, was 12,883.14, increasing to 28,280 people or equivalent to 14,572.13 people per 100,000 population, which was more common in the age group 60 years and over. Followed by age group 50 - 59 years, the most common areas are in Bang Khonthi district, Amphawa district, and Muang Samut Songkhram district. Samut Songkhram Provincial Public Health Office has been monitoring and controlling patients with

hypertension. However, there is still an increasing number of patients with hypertension. In today's modern world, technology is being used to analyze and evaluate geographic information systems (GIS) in geographic areas. [9] GIS has the strength to be able to model and present maps clearly and with high precision. For public health sectors, GIS is applied at various levels, including spatial pathogen distribution model analysis, disease trends, mapping at risk populations, outbreak forecasting, disease surveillance planning, route planning, support of assistive devices to health workers, and use of disease outreach mapping.[10] Previous studies used GIS for disease analysis, such as health mapping to track patients with hypertension of King Chulachomklao Royal School Hospital [11]. On the other hand, the study of Kumsuk [12] found that the GIS confirmed patients who were infected with Zika virus in Lopburi Province, Thailand. Regarding this study, GIS could be used to assess the risk of hypertension. Therefore, the healthcare sector can be more effective by using GIS to surveil and control hypertension in Samut Songkhram province. The researchers applied GIS by using the factors associated with hypertension as a database and created a model of the risk level of hypertension to monitoring and evaluating patients. In addition, GIS can help to prevent many diseases and can continue to plan the treatment as well as promote the health of patients with hypertension on a continual and better quality of care.

PURPOSE

This study aims to examine factors associated with hypertension patients and to create
spatial model to assesses the risk level for hypertension in Samut Songkhram Province,
Thailand.

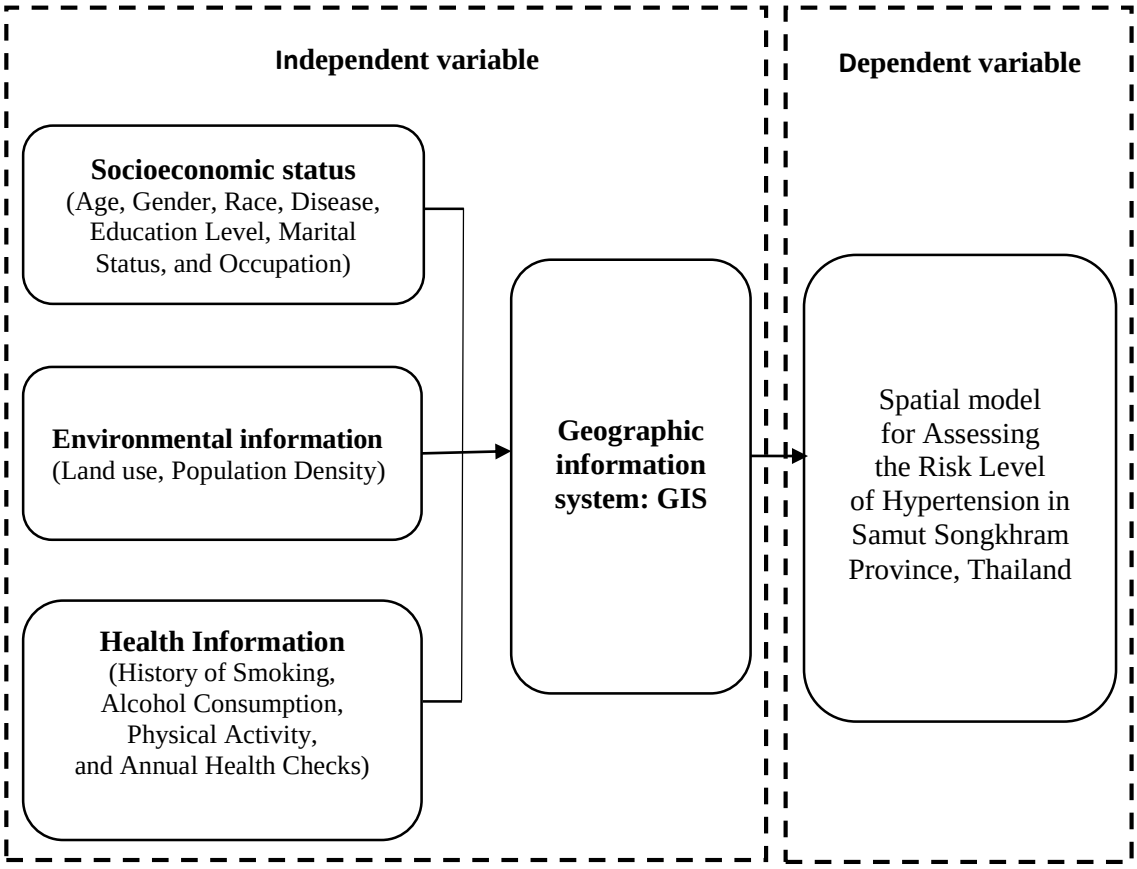

Figure 1. Conceptual framework

METHODS

This study examined the secondary data to determine the causes and factors associated with the occurrence of hypertension. A total of 14 factors consisted of (1) demographic data (age, gender, race, family disease, educational level, status, and occupation); (2) environmental data (land use and population density); and (3) health history data (smoking, alcohol consumption, physical activity, and annual health checks). The researchers used these data to create the GIS and assess the risk of hypertension in elderly people in Samut Songkhram Province. The researchers used the medical records of 19,829 patients with hypertension in Samut Songkhram Province in 2019. The researchers used a computer notebook and quantum geographic information system (QGIS) program used to import the data on the map. A software package for data analysis and a printer were then used to create a spatial model for assessing the risk of hypertension in Samut Songkhram Province. Next, researchers used by using Pearson's Correlations Coefficient to analyze the data.

RESULTS

Factors associated with the occurrence of hypertension

The aims of this study were to examine the factors related to hypertension and to study

factors associated with the occurrence of hypertension in Samut Songkhram Province. The study reported the significance of factors that associated with the occurrence of hypertension. Based on literature review and relevant research, this study included fourteen factors (i.e., number of patients, age, gender, race, comorbidities, education level, marital status, occupation, land use, population density, smoking, alcohol consumption, physical activity, and annual health checks).

The points and levels of each factor were evaluated from seven experts, which 2.5 or more points (moderate to greatest) were identified met the inclusion and exclusion criteria. Results showed that factors at high level consisted of: disease, population density, number of patients, education level, occupation, land use, smoking, age, marital status, alcohol consumption, and physical activity, weight scores were 4.71, 4.57, 4.43, 4.43, 4.43, 4.43, 4.29, 4.14, 4.14, 4.00, and 4.00, respectively. Meanwhile, factors that were shown at a moderate level included gender, annual health check, and race (3.86, 3.86, and 3.14, respectively).

For factors associated with hypertension patients, this study used Pearson's Correlations Coefficient with a significance level of .05. The results showed that seven factors associated with the occurrence of hypertension consisted of age, occupation, land use (living area), population density, physical activity, smoking, and alcohol consumption.

Table 1. Factors related to hypertension and factors associated with the occurrence of hypertension in Samut Songkhram Province

Factors	Pearson's Correlations	*p*-value	Interpretation
Age			
15-24	1.000**	.001	Positive relationship
25-34	.997*	.048	Positive relationship
35-44	.999*	.030	Positive relationship
45-54	1.000**	.010	Positive relationship
> 65	.999*	.023	Positive relationship
Occupation			
Government service /state enterprise	1.000**	.016	Positive relationship
General employment	.998*	.038	Positive relationship
Students	.999*	.035	Positive relationship
Land use (living area)	.997*	.046	Positive relationship
Population density	.998*	.041	Positive relationship
Physical activity	-.999*	.032	Negative relationship
Smoking	.997*	.050	Positive relationship
Alcohol consumption	.997*	.046	Positive relationship

*p-value < .05, ** p-value < .01

The spatial model for assessing the risk level of hypertension

The spatial model for assessing the risk level of hypertension in Samut Songkhram Province included (1) assessment of the risk of hypertension at the district level, and (2) the assessment of the risk of hypertension at the village level.

The assessment of the risk of hypertension at the district level. Based on spatial modeling for assessing the risk of hypertension by applying GIS and data overlay methods from different factors. Results showed that seven factors included age, occupation, land use (living area), population density, physical activity, smoking, and alcohol consumption directly correlated with hypertension patients as in Figure 2. The objective of the study was to assessment the risk level of hypertension patients in three districts of Samut Songkhram Province included Muang Samut Songkhram District, Bang Khonthi District, and Amphawa District. The risk level was assessed at four levels: 1) high risk areas, 2) moderate risk areas, 3) low risk areas, and 4) lowest risk areas. This study found that the high-risk area was Muang Samut Songkhram district (40.57%), which has a total area of 169,057 square kilometers. While the area with moderate risk was Amphawa district (40.84%), which has a total area of 170,164 square kilometers. In addition, the lowest risk areas were Bang Khonthi District (18.59%), which has a total area of 77,486 square kilometers of all provincial areas.

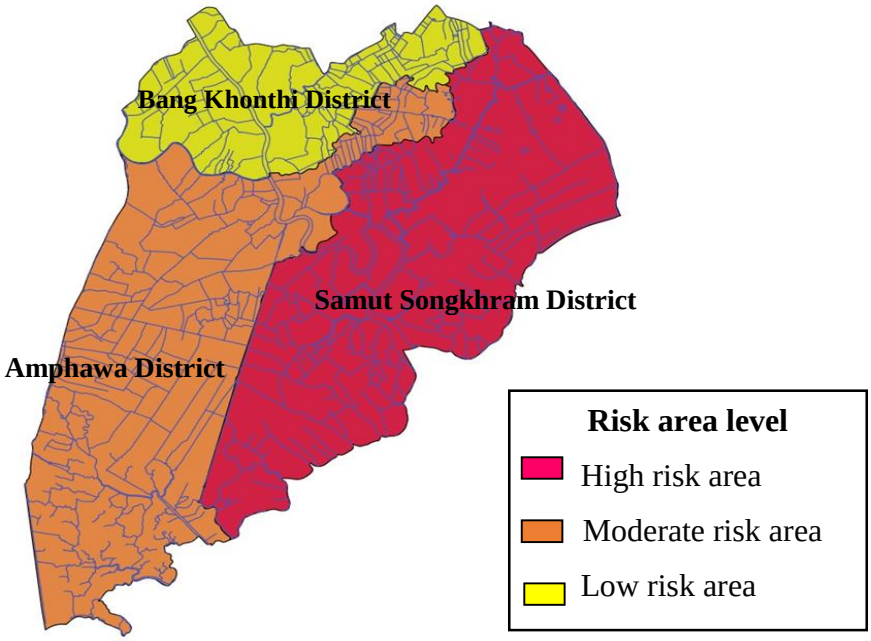

Figure 2. Spatial model for hypertension patients in Samut Songkhram Province

For the assessment of the risk of hypertension patients at the village level. This study
found the assessment was four risk levels consisted of: (1) high risk area, (2) moderate risk area, (3) low risk area, and (4) least risk area. The researchers found that the high-risk areas were 87 villages in the area of Muang Samut Songkhram district. While the moderate risk areas were 96
villages in Amphawa District. As for the low-risk areas, there were a total of 101 villages located in Bang Khonthi District, Thailand.

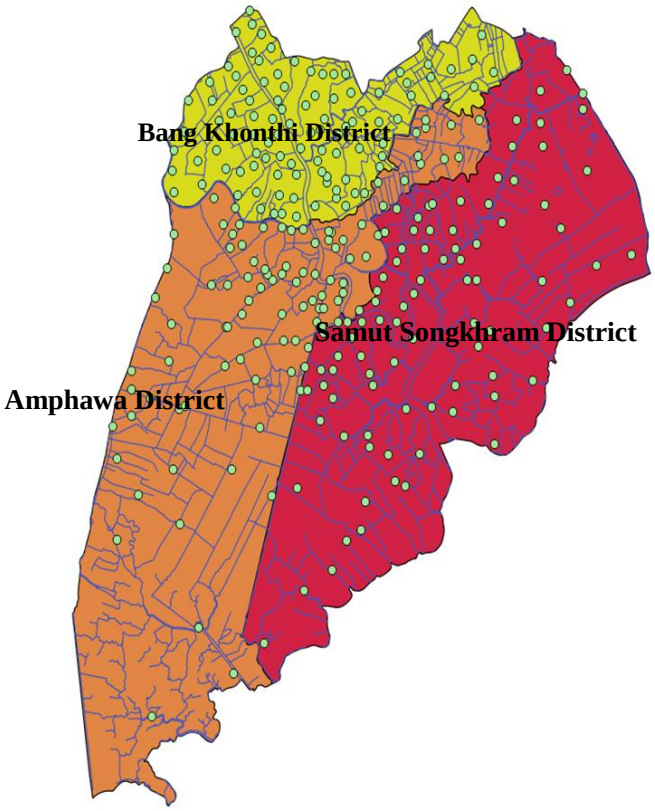

Figure 3. Distribution of villages in Samut Songkhram Province

DISCUSSION

Factors associated with the occurrence of hypertension

This study examined the factors associated with hypertension in Samut Songkhram Province. The researchers reviewed concepts, theories, and research

related to factors associated with the occurrence of hypertension, and relevant factors. Pearson's Correlations Coefficient revealed that age, occupation, land use (residential area), population density, physical activity, smoking, and alcohol consumption.

The findings that the age was associated with hypertension patients, statistically significant at the .05 level. Studies show that older patients with hypertension showed better self-management behavior such as food consumption and psychical activity than younger patients. While the older patients experienced problems with both their own health and the experiences of others, they were able to adjust themselves by managing themselves well to their disease conditions along with their daily life than the younger patients. Thus, the older patients have better self-management behaviors on food consumption and psychical activity. These results were consisted of Chulwattaka [13] who examined the relationship of knowledge and self-care behavior of hypertensive patients in Sakon Nakhon Province, found that age was related to the self-care behavior level in patients with hypertension.

The results showed that occupation was associated with health behavior in patients with hypertension. Studies show that the non-domestic workers and those working in the government service or state enterprises had physical activity at moderate level than those with occupational career. Most of the reasons for patients who were not exercising because they lack time and tiredness from routine work. [14] This finding reinforced previous reports that occupation is a factor that directly correlated with health behavior in patients with hypertension.[15] In addition, These results also consisted of Sukprungprom [16] who identified the factors related to health promoting behaviors of hypertension patients in Thailand, found that occupation was associated with health promotion behavior of hypertensive patients at significant level (p<.05).

The findings showed that physical activity was associated with the occurrence of hypertension. To explained that patients who physical activity regularly or often, they had low levels of systolic blood pressure. [17,18] On the contrary, patients with low physical activity had high levels of systolic blood pressure. [19,20] The finding that length of stay was associated occurrence of hypertension is consistent with other studies. [17,21,22] Furthermore, these results supported of Parker, Schmitz, Jacobs Jr, Dengel, Schreiner [23] who found that individuals with low physical activity were low risk with the occurrence of hypertension.

Smoking was associated with the incidence of hypertension. Researchers have shown that smoking is one of the major causes of serious disease and premature death, especially if the patient continues to be smoking, which can lead to increased physical harm, lead to death, and other complications .[24] In fact, when cigarette smoke is absorbed into the body, the adrenal glands secrete epinephrine to stimulate the nervous system, increasing heart rate, the arteries contract, increasing blood pressure by 5-10 mmHg. [25] Early initiation of smoking as a factor for increased risk of increased blood pressure is supported in previous studies. [26]

Alcohol consumption is another factor that was associated with hypertension. Alcohol consumption induces lipid oxidation, increasing the fat content of the body's cells to increasing blood pressure. These results consisted of Ikehara, Iso [27] who found that moderate and heavy alcohol consumption was associated with cardiovascular diseases (p <0.05). In addition, patients who drink more than 30 milliliter of alcohol per day, which is 12 times more likely to increasing metabolic syndrome than those who drink a lower drinking. [28] Therefore, patients with hypertension who drink a lot of alcohol can have increased blood pressure which can lead to hypertension. [29]

The findings that the education level was not associated with the occurrence of hypertension did not support the hypothesis. The findings agree with that of Keawwandee, Siriswang, Katunyu [30] who found that the education level did not correlated with self-care behavior.

The spatial model for assessing the risk level of hypertension

The results of the assessment of the risk of hypertension at district level found that the high-risk area was Muang Samut Songkhram District, which has a total area of 169.057 square kilometers (40.57%) of the total provincial area. This very vulnerable area is a densely populated, urban area. These results supported of Kochasarn [31] who found that patients with non-communicable diseases were distributed as a group. Patients with chronic non-communicable diseases were grouped in the most prosperous community centers, partly due to changing dietary habits and lifestyles. Providing knowledge on the causes of chronic NCDs is of great importance to help foster control of the number of occurrences of hypertension and help healthcare workers reach out to patients in many areas precisely. [32] In addition, the use of distribution maps in hypertensive patients led to further analysis of the relationship of the number of patients with the region. [33] The results found that the assessment of the risk of hypertension in each district was also consistent with the number of patients with hypertension that reported in 2017. The fact shows that this spatial model can be a practical tool for planning hypertension control in the area and it is easily understood, suitable for local residents, including tourists.

This study found that the villages at high risk level had the lowest number of villages out of four levels, 87 villages, which were in Muang Samut Songkhram district. The highest number of villages at low risk level, 101 villages, which were in the Bang Khonthi district. Although most villages were at low risk area, healthcare sectors should be aware of the number of patients in this area. Therefore, all residents of all villages, whether in an area at risk or not, should be treated and prevented by hypertension as an effective process for better prevention.

In terms of using GIS in spatial modeling in assessing disease risk levels. Currently, the application of GIS has advanced to cover a wide variety of healthcare with main components in epidemiology and the public health service system. In the epidemiology focuses on health outcomes, disease patterns or trends. While the health care system focuses on benefits, access, distribution, resource allocation, care inequality and strategics planning. [34] For chronic diseases, GIS is used as a surveillance tool in planning for disease control. [35] In the past, GIS was used to assess areas of hypertension in all areas of Thailand. [36] This study confirmed that GIS is one of the tools used in the planning of hypertension control in Samut Songkhram province with high efficiency. These results consisted of Lunyera, Kirenga, Stanifer, Kasozi, van der Molen, Katagira, Kamya, Kalyesubula [37] who found that GIS has potential as a community assessment tool for hypertension in Uganda. In addition, the GIS has a simple display, can provide local residents and tourists, easily understand and know the local risk of hypertension, leading to self-care and protect themself effectively

CONCLUSION AND IMPLICATIONS FOR PRACTICE

Important findings regarding this group in patients with hypertension included seven variables of interest, age, occupation, land use (residential area), population density, physical activity, smoking, and alcohol consumption. These data can help shape local public health policy, in terms of focusing services for groups of people who are at risk and patients with non-communicable diseases within communities. The results also confirm that the application of GIS for assessing the risk level of hypertension are accurate and effectively in high risk, moderate risk, and low risk areas. Healthcare sectors can develop strategies to support health and wellness in patients with hypertension and reflect more opportunity for healthcare providers in the area of health promotion and disease prevention.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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