

## Prevalence of hypertension: predictive analytics review

Nur Arifah Mohd Nor<sup>1</sup>, Azlinah Mohamed<sup>2</sup>, Sofianita Mutalib<sup>3</sup>

<sup>1,3</sup>Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia

<sup>2</sup>Advanced Analytics Engineering Centre, Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia

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### ABSTRACT

Hypertension is one of the non-communicable disease (NCD) that is classify as a global health risk with many critical health cases. Malaysia raise the same concern of the increasing NCD health problem. This paper aims to study the techniques used in predictive analytics namely healthcare and identify the factors of prevalence on hypertension. This review would give a better understanding of proper techniques and suggest the technique commonly used in predictive analytics especially for medical data and at the same time provide significant factors of prevalence hypertension. A total of 27 papers reviewed, several techniques on predictive analytics in healthcare are neural network, decision tree, naïve bayes, regression and support vector machine. The rise of economic growth and correlated socio-demographic have cause rise in hypertension problem over past years. The factors of hypertension depicted in this review namely gender, age, locality, family history, physically inactive and unhealthy life style not conform to any boundaries thus far. Thus, the choice on the technique and hypertension factors for predictive analytics is significant to come out with the significant predictive model. The predictive model on prevalence of hypertension may predict the severity of adult having hypertension in future work.

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### Corresponding Author:

Nur Arifah Mohd Nor

Faculty of Computer and Mathematical Science

Universiti Teknologi MARA (UiTM)

40450 Shah Alam, Selangor Darul Ehsan, Malaysia

Email: arifahnur04@gmail.com

## 1. INTRODUCTION

In 2019, Ministry of Health in Malaysia aims to reduce the number of smoking, hypertension, obesity and more non-communicable disease (NCD) [1]. NCD is considered as a non contagious disease Heart problem, stroke, cancer, diabetes or hypertension are health problem that can lead to death. According to WHO data in 2018, significantly high number of NCD cause death, and many people reported died at an early age before reaching 70 years old. The risk of NCD rise every year and mainly are those who are smokers, unactive lifestyle, alcoholic and unhealthy diet. Hypertension also one of health risk that can cause mortality [2]. WHO estimate 29.3% of the world's population will be risk of hypertension by the year 2025. Hypertension is a common condition in medical if not treats early can cause risk to critical health problem [3]. Therefore, prediction on severity of hypertension is significant to give awareness toward health problem. Hypertension may be a silent killer to some people if they do not notice the symptoms that often occurs. People need to monitor their blood pressure and aware with the symptoms to avoid severe complication of hypertension. The risk and factor may differ with others based on lifestyle and socio-demographic.

Industry of healthcare generate large amount of data from the patient that can be used for future prediction and prevention. The potential data is important to improve the quality of healthcare field. Moreover, it can reduce the cost and support medical and healthcare process such as decision support and health management [4]. The potential benefits for healthcare field using data analytics are capable for pattern analytic, unstructured data analytics, decision support, prediction and traceability [5]. By looking at the five element of potential benefits, predictive analytics in healthcare can enhance health management and decision making. In addition, significant technique and algorithm is important for the learning process of the data then the best predictive model can be built. Thus, the objective of this review is to identify the factors of prevalence on hypertension in Malaysia and the others countries that can be analysed using the selected predictive analytics that commonly used by previous researchers. Furthermore, a review on the techniques of predictive analytics will be included in the discussion to identify the significant techniques for predictive model in future work.

The review organized in this paper as follows. Section 2 presents the two segmentation of related works which are information about hypertension and the description of predictive analytics including the techniques used in predictive analytics. Section 3 presents the method and materials used for the review. Section 4 provides the discussion on prevalence factors of hypertension and predictive analytics' techniques commonly used to build predictive model in healthcare.

## **2. RELATED WORKS**

### **2.1. Hypertension**

Hypertension is a common medical problem that currently is a burden to global health. Hypertension is one of health risk that can cause mortality [2]. Hypertension is diagnosed when the blood pressure is greater than 130/80mmHg. Normal blood pressure is when the blood pressure is 120/80mmHg below. Generally, blood pressure between 120/70 and 140/90mmHg will lead to the risk of increased blood pressure. The changes in blood pressure may occur depending on our daily activities. There are several conditions that can affect the blood pressure such as patient age, heart condition, emotions, daily activities and medication taken. Hypertension occurs when high volume of blood flows in narrow or complicated arteries. This will cause the heart to pump more and if not treated can cause major health problems [3].

According to [6], adults over the age of 25 have higher risk to be diagnosed with hypertension. There is an increase of hypertension cases from 594 million in 1975 to 1.13 billion in 2015. Malaysians have a high score related to hypertension among the society and reported as dangerous for health. The emergence of hypertension problem over the years has caused mortality in Malaysia to rise parallel with the expansion of development which changes the socio-demographic behaviour [7]. The rising trend in hypertension cases among adults depends on the education level, race, income level, age and demographic.

The complications of the uncontrolled high blood pressure including heart problem, stroke, weakened and narrowed blood vessels in the kidneys. People who have high blood pressure tend to feel headache, difficulty of breathing, fatigue or vision complication. High blood pressure if not treated can cause complication and risk to heart attacks, stroke, kidney failure and blindness. Thus, data on prevalence factors of hypertension are essential in proposing new strategies to combat hypertension problem and prescribe prevention so that they are aware of their health and take necessary action.

### **2.2. Predictive analytics and techniques**

Data analytics is a technique of collecting data and extracting the data into meaningful information that can be used for solving problem and conclusion. Example of the data is web logs, call records, medical record, images, video, text and more. The analysis is significant with data science, business intelligence and business analytic. The process of data analytic is a way to find unseen information that can be extracted from the raw data for human consumption. There are several processes in data analytics, which are to collect data, transform, cleanse, classify and convert the data to meaningful reporting format that can be understood. Predictive analytic is one of the analytics categories commonly used in industry such as medical, business, agriculture and more. The purpose of predictive analytic is to provide and evaluate a model with accurate prediction for future by looking at historical data. Thus, data is the valuable asset to extract information and to come out with solution for future purposes.

Using artificial intelligence (AI) techniques on predictive analytics is another level of evaluating data on data analytics. The objective of extracting the data is to combine data and provide meaningful results, detect pattern and the relationship between parameters. AI techniques that commonly used in data analytics are association rule mining, genetic algorithm, decision tree analysis, neural network and more. Different technique has different approaches of purpose on the data. Significant technique on prediction is important to make the algorithm learned the pattern well during the learning process.

Data science with advanced computing algorithm using AI are in trend technique to optimize, automate and find unseen value by human. Organizations are seeking to take benefits from data analytics and AI emerging trends that can bring more profits in businesses. Enterprises use the trends of data analytics and AI embedded in enterprise advanced application typically used in large organization to manage resources and customer information. There are five common prediction techniques that mostly used to build predictive model namely neural network, decision tree, linear regression, association rule mining and support vector machine (SVM) [8-13]. The description below explains briefly of each technique with the references paper that used the techniques.

a. Neural network

Neural network is suitable to find patterns in data thru analysing its input and output from the training dataset. The paper by [8] compare different learning strategies with various learning weights in order to identify best algorithm with the lowest error on the training dataset. The outcome provides several approaches for predictive model and comparison to produce the best network.

b. Linear regression

Linear regression models connection of two variables in a linear line on the observed data. For instance, linear regression algorithm is used in the healthcare data to predict whether the patient having a heart problem or not based on the recorded information [9]. The authors aim to assist the non-medical staff to use this application to predict heart disease and reduce the time complexity to meet specialist.

c. Association rule mining

Another technique is association rule mining, a technique that data scientist uses to determine specific patterns and associated relations within the data. Association rule mining determine patterns that occurs constantly, correlations, links, or unintentional structures in sets of items or transaction in databases. It is usually applied for market basket analysis. In [10] apply the association rule with learning management system (LMS) data and present the rules and relevant results on its performance and suitability in LMS environment. Besides, [11] used association rules to extract pattern from the dates' of product dataset to support businesses to explore variety aspect related to productivity and process excellence. The results produce insights information on business vital sign, the its strategy related to consumer and marketing views.

d. Decision tree classifier

Decision tree algorithm splits data into subsets based on an attribute value. The process continues for each consequent subset until target found. Furthermore, predictive analytics also can be used in education field to predict university student intake in selecting the student applicants to be offered. The research produce by [12], presents prediction of student intake using decision tree and k-Nearest Neighbour algorithm. The experiment aims to provide the appropriate model to predict student acceptance to the offer given with the best selected attributes in an intelligent way.

e. Support vector machine (SVM)

SVM construct hyperplanes in multidimensional space to provide classification with separate class levels on either side. Predictive analytics also work well for image recognition and useful for prediction. In [13] used images as the data to predict diabetes. The researcher used PDR images and test the model using probabilistic neural network (PNN), Bayesian classifier and SVM techniques.

### 3. METHOD AND MATERIALS

This section presents the two different gaps of review which is health domain focusing on hypertension and predictive analytics techniques. The overview gap of research area in this paper is shown in Figure 1. A literature review was conducted to identify recent journal and articles about the predictive analytic opportunities in healthcare. In addition, the review also focuses on the domain which is prevalence factors of hypertension in adult. The keyword terms were used are “predictive analytics”, “prediction”, “big data analytics”, “prevalence of hypertension”, “factors of hypertension”, “risk of hypertension”, “awareness of hypertension” and more. The source of finding the articles were Google Scholar, Science Direct, Springer, IEEE, PLOS ONE and more.



Figure 1. Gap of research area

A total of 15 papers on predictive analytic and 12 papers on the prevalence of hypertension were studied and analysed to gather all the information on the prevalence of hypertension: predictive analytics review. The literature review included articles published within the last 7 years has been reviewed to fulfil the objective of this review paper to analyze. The total number of 27 papers that was published from 2013 until 2019. All the sources of literature review have been analyses to come out with the best review about predictive analytics and the prevalence on hypertension. From the reading, Figure 2 shows the percentage of article collected to be reviewed by year it is published.

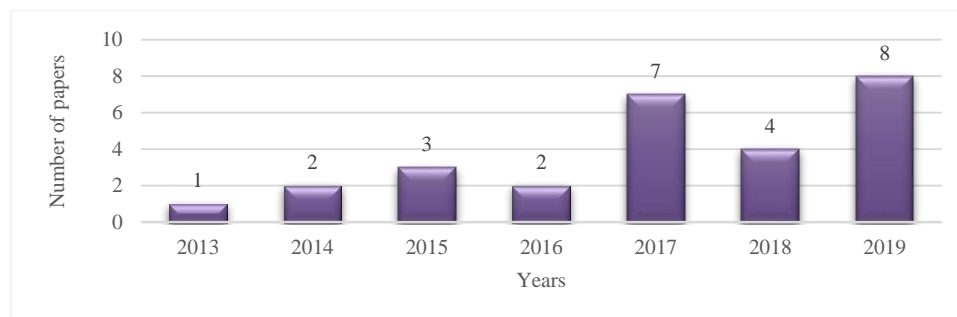


Figure 2. Number of review paper on hypertension and predictive analytics by publishing years

The articles that related on prevalence factors of hypertension were found among several countries such as Indonesia, Thailand, India, China, Spain, Korea, Lebanon and Turkey included Malaysia. These articles were reviewed to compile the common factors of hypertension among the countries. The common and relevance factors can be used as the selected variables to build predictive model on hypertension as shown in Table 1 in Section 4. Next, several articles of predictive analytics that related on the prediction technique that used medical data were identified and compiled. Thus, the choice of the technique to build predictive model is important to provide with the significant predictive model.

#### 4. RESULTS AND DISCUSSION

This section will discuss the significant prevalence factors of hypertension among several countries and the predictive analytics review.

##### 4.1. Prevalence factors of hypertension

The increase in hypertension depends on the gender, age, locality, marital status, income, current smoker, current drinker, physically activity, family history and BMI status. Based on the review, there are 11 factors that have been regularly discussed by researchers for determining the prevalence of hypertension in Malaysia, Indonesia, Thailand, India, China, Spain, Korea, Lebanon, Turkey and India. Figure 3 presents the associated factor of hypertension from the 12 articles meanwhile Table 1 presents the associated factor of hypertension based on 9 countries.

Based on the articles found about prevalence of hypertension in 9 countries, gender, age, BMI status, locality and smoker are the top factors of hypertension as shown in Table 1. Out of 12 articles from 9 countries, the gender, age and BMI status are the famous variables that have been discussed. Meanwhile drinker, education type, income, family history and marital status are also mentioned as factors of hypertension. However, these factors are not popular discussed in others countries, but it can affect the rate of awareness among people.

The geographical factors (locality) are likely to affect the awareness of hypertension. People who stayed in urban area are more aware than people in the rural area. The fact that it is an urban area has good prevention and control programs to access by communities. Accessibility to healthcare services in Malaysia has been emphasized as the key focus area of the Malaysian government. It is the concern of inequity of unbalanced doctor population ratio in urban and rural area. Urban areas have more doctors and better resources as compared to rural areas. Hence, availability to apt health check-up in the rural area could be inadequate.

According to [14], people who are not being physically active and practicing unhealthy lifestyle have the tendency to develop hypertension. Besides that, smoking and drinking alcohol too much are also considered to be unhealthy lifestyle that immediately rise your blood pressure and increase heart disease risk. Regular physical exercise such as walking, jogging or cycling is one of the steps to make the blood vessels work well and manage body weight. Overweight or obese would cause the body to process more blood to supply oxygen and nutrients to the body and it will pressure on the body's artery walls.

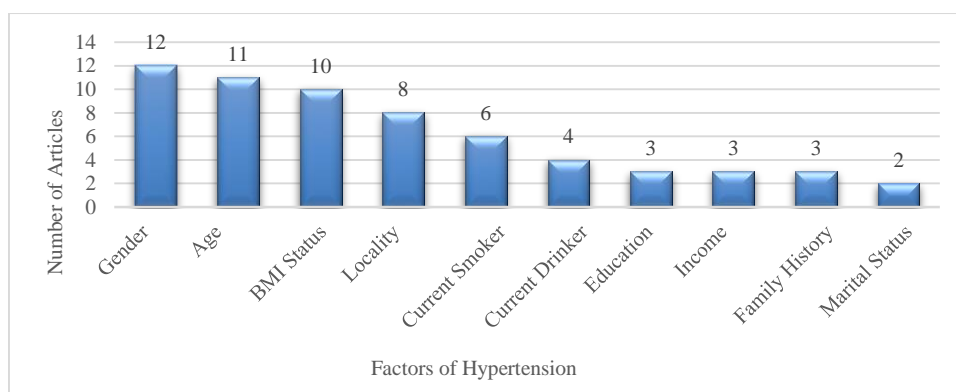


Figure 3. Factors on prevalence of hypertension

Table 1. Analysis of factors associated with hypertension in adult based on others countries.

Factor	Country								
	Malaysia	Indonesia	Thailand	China	Spain	Korea	Lebanon	Turkey	India
Gender	√	√	√	√	√	√	√	√	√
Age	√	√		√	√	√	√	√	√
BMI Status	√	√		√		√	√	√	√
Locality	√		√	√	√			√	√
Smoker		√		√			√	√	√
Drinker				√			√		√
Education		√		√	√				
Marital Status		√					√		
Physical Activity			√			√			
Family History	√	√							
Income Level	√						√		
Reference	[3, 6, 15]	[16]	[17]	[18-19]	[20]	[21]	[22]	[23]	[24-25]

The income and education level have correlation factors that could risk to hypertension. People with good education and high-income level could access better medical care and take awareness on their health problem. They can use many sources such as internet or books to read, understand and act on the health information. However, low income status would expose to restricted access of health care and unawareness of risks in hypertension.

#### 4.2. Predictive analytics review

Data mining, statistics modelling, deep learning and artificial intelligence are the example of techniques on the predictive analytics. There are several industry and sectors included healthcare use predictive analytics in different ways to extract the valuable information in order to determine pattern and predict future outcomes and trends. Based on the analysis of the reviewed papers, there are various techniques that have been compiled in the work of other authors on predictive analytics. We came out with

most common prediction techniques used by the researcher to build predictive model in healthcare as shown at Table 2.

Neural network, decision tree, naïve bayes and regression classifier are the most common technique used in diagnosing. These techniques have the highest accuracy that commonly used by the researcher. Basically, the technique used on prediction disease such as on heart disease, diabetes and liver prediction using the factors of the disease. The prediction made gives impact on the disease and improve the the cost of care before and after. Table 2 shows neural network, decision tree, naïve bayes and regression are with high average accuracy. The average accuracy for each technique is calculate by the total accuracy divide by the number of researchers using the technique.

Neural network shows the better average prediction accuracy because of the learning weight and parameter setting during the execution of the algorithm on the data. The frequent technique used by researcher on predictive analytic for healthcare is decision tree. The accuracy result on prediction rest upon the correct selected factors that were essemble throughout the prediction procedure.

Table 2. Common technique used in predictive analytic on healthcare domain

AI Techniques	Topic Prediction	Average Accuracy	References
Neural Network	Type of Disease, Heart Disease	95.46%	[26-27]
Decision Tree	Heart Disease, Diabetes, Liver Disease	84.75%	[9, 27-31]
Naïve Bayes	Heart Disease	87.50%	[9, 27, 31-33]
SVM	Heart Disease	85.19%	[32, 34]
Logistic Regression	Diabetes	90.50%	[9, 28, 32, 35]

However, the structure of the data also affects the performance of the algorithm. The finding also found that, there are researchers who explored hybrid predictive analytic techniques. The amalgamation of data mining techniques helps to increase performance of the predictive model. Moreover, researcher also tries to use different parameter setting on their modelling to increase accuracy of the prediction. Thus, the combination of the techniques may improve the prediction model and come out with better accuracy.

## 5. CONCLUSION

The review paper focus on the predictive analytic techniques and the prevalence on hypertension among adult as well as the factors based on several countries and the awareness of hypertension. In brief, the rate of the awareness is different by the factors associated among the people. Based on the review, we can prevent a major health issue and complications that contribute to the disease if we identify early the factors that affected the health issues. We identify 11 factors of hypertension that are significant and relevance to be used as attribute to build the predictive model. The factors are gender, age, BMI status, locality, smoker status, drinker status, education, marital status, physical activity, family history and income level. These factors are most discussed in 9 countries which are Malaysia, Indonesia, Thailand, China, Spain, Korea, Lebanon, Turkey and India. Moreover, the choice of significant technique is important beside the data to come out with significant predictive model. Neural network, decision tree, regression and naïve bayes are the suggested techniques in shaping good prediction model. In addition, discussion about the awareness between the factors were also presented in the discussion in order to come out with significant variables that can be use in the dataset to improve the performance modelling. The important challenges in predictive analytics is to build precise and computationally efficient model for Medical application. In conclusion, the review objective to understand the correlation among the related factors and review on the predictive analytic techniques in the healthcare can be enhanced for future work.

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## BIOGRAPHIES OF AUTHORS



Nur Arifah Mohd Nor received her bachelor's degree of Intelligent System in 2018 from Universiti Teknologi MARA (UiTM). Currently, she is a master's degree student of Information System (Intelligent Systems) at the Center of Information System Studies, Universiti Teknologi Mara (UiTM) Shah Alam, Selangor, Malaysia.



Azlinah Mohamed is a Professor in the Information Systems Center of Studies at the Universiti of Teknologi MARA of Malaysia. She holds a M.Sc. (Artificial Intelligence) from Bristol University and PhD (Decision Support Systems) from National University of Malaysia. Prior to this she was a tutor in University of Bristol and a Research Fellow in National University of Malaysia. Her current research interests are in the areas of Big Data, Soft Computing, Artificial Intelligence, and Web-based Decision Support Systems using intelligent agents in electronic government applications. She has published well over 140 peer-refereed journals, conference publications and book chapters internationally and locally. Besides that, she has also contributed as an examiner and reviewer to many conferences, journals and universities academic activities. In addition, she had also held administration post pertaining to academic development at the university level as Head of Academic Development, Special Officer on Academic Affairs and Development to the Vice Chancellor and Dean of the Fakulti Sains Komputer dan Matematik for 7 years.



Sofianita Mutalib is a senior lecturer of Information System in Universiti Teknologi MARA. She received a master's degree in Information Technology from the National University of Malaysia in 1998. She teaches courses related to Intelligent Systems such as intelligent system development, decision support systems and data mining. Her primary research interests involve intelligent systems, data mining as well as machine learning.