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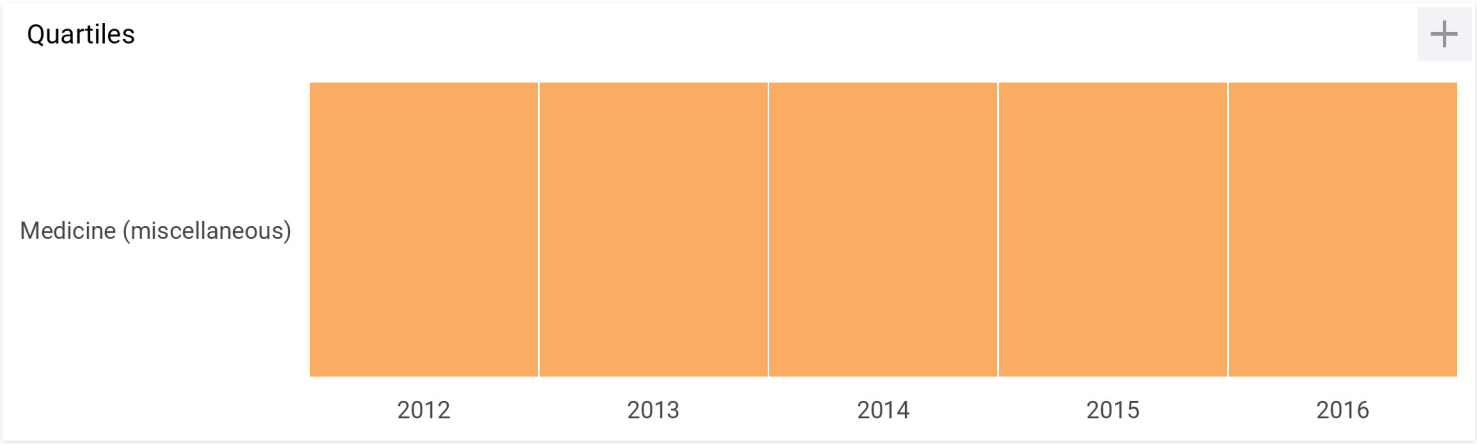

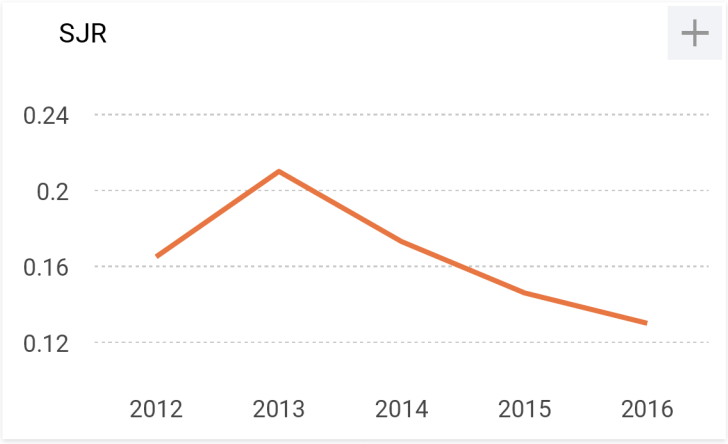

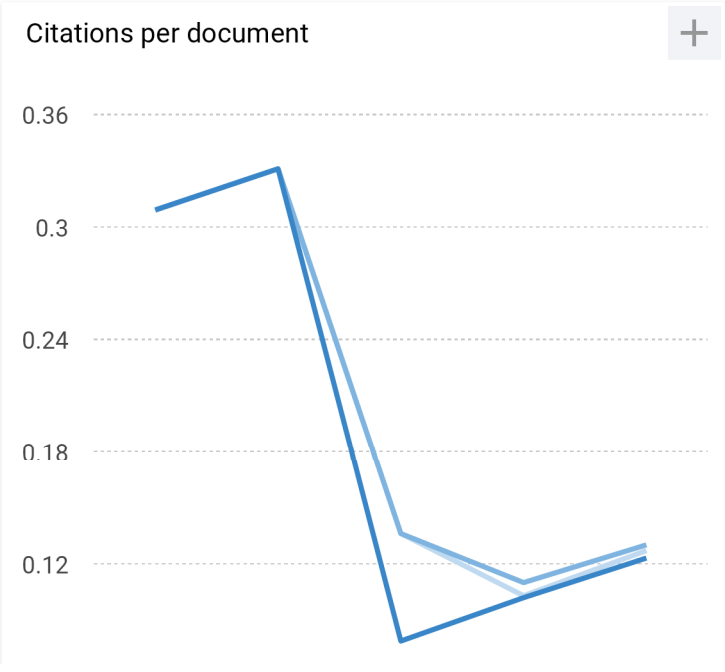

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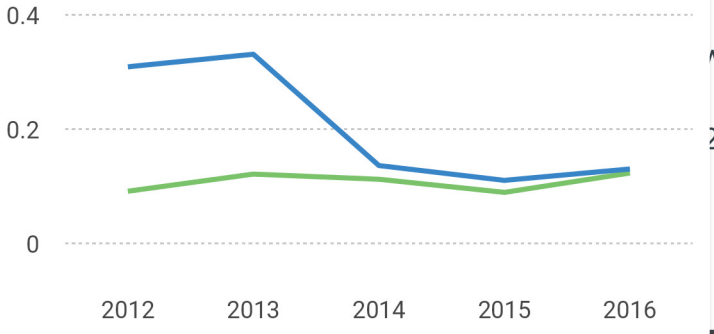

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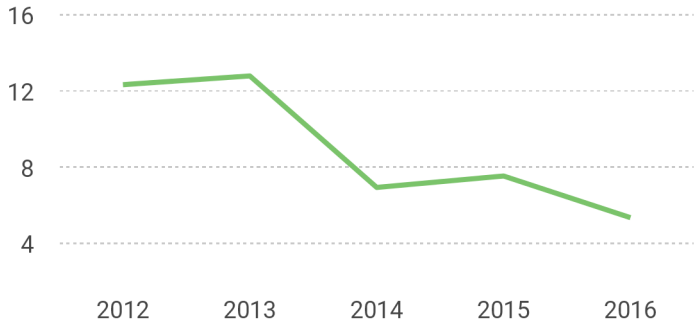

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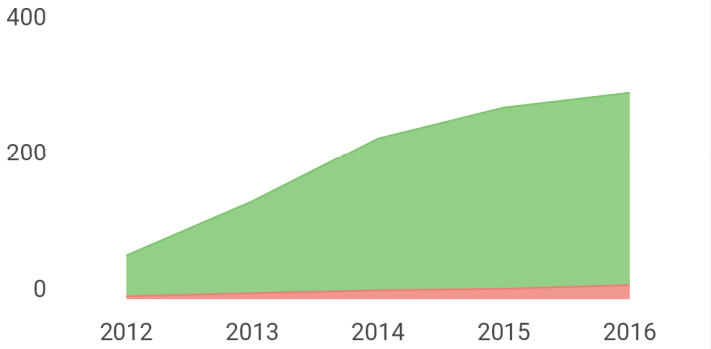

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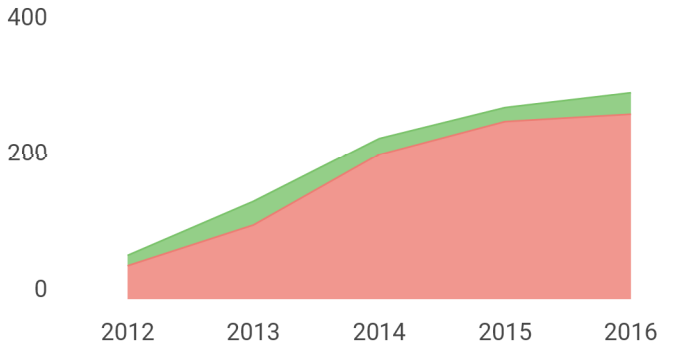

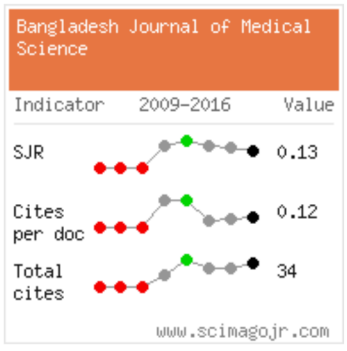

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Original article

Infarction Stroke Risk Prediction Model for Indonesian Population: A Case-Control Study

Jusuf MI[1], Machfoed MH[2], Keman S[3]

Abstract:

Background: Stroke is the main cause of death and disabilities in Indonesia and the world. Various prediction model for stroke have been developed. This study attempts to develop a model used to predict infarction stroke in Indonesia. ***Objective***: This study aims to develop a model to predict infarction stroke risks. ***Method***: This study is an observational research applying case-control research design. The number of samples used in this study were 310 individuals, consisting of 155 members of case group and 155 members of control groups. The writers used discriminant analysis to conduct statistical analysis on the data. ***Results***: Valid and reliable risk factors of stroke used to develop prediction model for infarction stroke in this study are systolic blood pressure, diastolic blood pressure, triglyceride levels, stroke history, hypertension history, dyslipidemia history, vegetable consumption, sleep duration, snoring, exercises, and emotional stresses. ***Conclusion***: This study comes up with a prediction model for infarction stroke risks. The prediction model is expressed by following formula: Infarction stroke risk = 0.929 x Systolic Blood Pressure + 0.886 Diastolic Blood Pressure + 0.160 x Triglyceride Levels + 0.850 x Hypertension History + 0.332 x Stroke History + 0.084 x Dyslipidemia History + 0.124 x Vegetable Consumption + 0.245 x Emotional Stresses + 0.346 x Snoring Habit – 0.193 x Exercise Habit – 0.190 x Sleep Duration

Keywords: infarction stroke; prediction model; index; risk factors

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Introduction

Stroke has become the main cause of death and disabilities in Indonesia and the world. The proportion of stroke cases is increasing. Recently, stroke mostly occurs at productive age[1]. Productive individuals can be saved from stroke through promotive actions and primary preventions[2]. One of primary preventions is by predicting the risk of stroke based on stroke risk factors. Various prediction models have been developed but these models were applied on populations outside Indonesia and conducted based on limited risk factors as its variables [3,4,5,6,7]. Previous stroke prediction models developed in Indonesia are based on clinical and laboratory indicators[8]. The development of a new stroke prediction model that is able to predict risks of infarction stroke by adding demographic indicators, behavioral indicators, and psycho-spiritual indicators becomes urgent.

Methods

Research Design

This study applied case-control research design. The case group consists of stroke patients at Prof. Dr. Aloei Saboe Hospital, Gorontalo (both infarction stroke and hemorrhagic stroke). The control group of this study consists of healthy patients or patients with non-stroke diagnosis. The case and control groups were matched based on their age and sex. This study was conducted for two years, starting from December 2012 to December 2014.

Research Subject

The samples of this study were all patients diagnosed with stroke at Prof. Dr. dr. Aloei Saboe Hospital, Gorontalo. The samples were chosen

1. Muhammad Isman Jusuf, Faculty of Health and Sports, Gorontalo State University, Gorontalo, Indonesia
2. Mohammad Hasan Machfoed, mFaculty of Medicine, Airlangga University, Surabaya
3. Soedjadjadi Keman, Faculty of Public Health, Airlangga University, Surabaya, Indonesia

Corresponds to: Muhammad Isman Jusuf, Faculty of Health and Sports, Gorontalo State University, Gorontalo, Indonesia

Table 1: Overview of Research Variables

Variables	Groups	%
High Systolic Blood Pressure (≥ 160 mmHg)	Case	58.6
	Control	6.4
High Diastolic Blood Pressure(≥ 100 mmHg)	Case	47.7
	Control	9.5
High Cholesterol level (≥ 240 mg/dl)	Case	25.0
	Control	10.0
HDL level < 40 mg/dl	Case	5.4
	Control	13.0
LDL Level ≥ 160 mg/dl	Case	24.3
	Control	14.2
Triglyceride level ≥ 200 mg/dl	Case	64.8
	Control	3.9
Blood Sugar level ≥ 126 mg/dl	Case	38.0
	Control	20.0
Uric Acid level >6 (female), > 7 (male)	Case	28.0
	Control	25.2
Stroke History	Case	22.5
	Control	0.0
Hypertension History	Case	73.0
	Control	12.3
Cardiovascular Disorder History	Case	10.0
	Control	5.8
Diabetes Mellitus History	Case	18.0
	Control	14.8
Dyslipidemia History	Case	27.0
	Control	31.6
Hyperuricemia History	Case	0.0
	Control	0.0
Excessive Consumption of Salty Food	Case	67.6
	Control	66.4
Excessive Consumption of Fatty Diets	Case	70.3
	Control	82.5
Low Consumption of Fruits	Case	44.2
	Control	43.9
Low Consumption of Vegetables	Case	91.0
	Control	76.7
Exercise Activities < 3 times/week	Case	45.5
	Control	49.0
Sleep Duration < 6 hours/day	Case	34.2
	Control	18.8
Snoring	Case	65.8
	Control	33.6
Smoking (more than 1 pack/day)	Case	10.0
	Control	2.6
Seldom (low) Involvement on Religious Activities	Case	70.3
	Control	47.7
Impatience	Case	46.8
	Control	35.5
High Stress Level	Case	51.4
	Control	29.0

based on consecutive sampling method, namely by matching all new patients into inclusion criteria and exclusion criteria until the ideal number of samples reached. The inclusion criteria of this sampling method were willingness of the subjects to participate in this research, the subjects were in compos mentis consciousness state, and the subjects came from Malay Sub-races. Compos mentis condition becomes one of inclusion criteria because this condition enables the writers to collect research data easily through interviews and laboratory examinations. Since all the subjects were Indonesian, they were members of Malay sub-race. Meanwhile, the exclusion criteria of this sampling method were aphasia and loss of consciousness. Aphasia and loss of consciousness were the exclusion criteria of this study because these conditions can make communication with the subject more difficult. Based on these criteria, the number of the subjects participated in this study were 310 respondents divided into two groups: case group and control group, consisting of 155 respondents on each group.

Data Collection

Physical examinations on the subjects consisted of different types of examination. Head CT Scan examination was conducted to obtain stroke diagnosis. This examination were conducted using Siemens Sensation 64 model Multi Slice Head CT Scanner with mAs 300 Slice, 3.0 mm, KV: 120, rotation time 1 second. Blood pressure examination was conducted using mercury sphygmomanometer. The examination was conducted while patient in lie down position; cuff was installed around patient's upper arm, 2.5 cm above cubital fossa; the process was repeated twice. Blood sugar examination were conducted based on hexokinase method and cholesterol level examination were conducted based on colorimetric enzymatic method. These examinations were carried out using Hitachi 912 autoanalyzer. Uric acid examination were conducted based on uricase method using Hitachi 912 autoanalyzer. The writers carried out interviews on the patients by using validated questionnaire to obtain data related to the patients and his/her behaviors, such as age, sex, medical history, smoking habit, dietary habit, exercise habit, and religious activities. The writers used Analog Anxiety Scale (AAS) to obtain data related to emotional stresses experienced by the patients and validated patience level proposed by Prasetyono (2014) to measure patience level of the patients.

Table 2: Lambda (λ) Value of Each Variables (Stepwise Discriminant Analysis)

Indicators	Variables	λ
Clinical/ Laboratory	Systolic Blood Pressure	0.957*
	Diastolic Blood Pressure	0.859*
	Triglyceride Levels	0.625*
	Uric Acid Levels	0.128
	Cholesterol Levels	0.068
	Blood Sugar Levels	0.060
	HDL Levels	0.044
	LDL Levels	0.038
Medical History	Hypertension	0.946*
	Stroke	0.652*
	Dyslipidemia	0.628*
	Cardiovascular Disorders	0.164
	Diabetes Mellitus	0.090
	Hyperuricemia	-
Dietary Habits	Less Vegetables	1*
	Excessive Fats	0.167
	Excessive Salt	0.026
	Less Fruits	0.014
Demographical and Lifestyle	Sleep Duration	0.849*
	Snoring	0.741*
	Exercises	0.425*
	Smoking	-
	Age	-0.042
	Sex	-0.038
Psychological and Spiritual	Emotional stresses	1*
	Impatience	0.738
	Religious Activities	-0.39

Statistical Analysis

The writer conducted statistical analyses on the collected data. The statistical analyses consisted on measuring each variable, discriminant analysis, and analyzing each variable factors composing stroke index.

Results

Based on the obtained data, 152 respondents were male (49%) and 158 respondents were female (51%). Based on age categories, 31% respondents aged 50-59 years old; 29% were aged 60-69 years old; 27% were aged 40-49 years old. Based on their residence, 45.8% of the respondents lived in urban areas while 54.2% lived in rural areas.

The writers conducted further analysis on the 27 variables of stroke risk factors based on Stepwise Discriminant Analysis. The results of this analysis indicated that only 11 of these risk factors with the highest lambda (λ) value representing five main indicators. As presented on Table 2 below:

The writers conducted factor analysis and found 11 variables, including systolic blood pressure, diastolic blood pressure, triglyceride levels, hypertension history, stroke history, dyslipidemia history, low vegetable consumption, emotional stresses, sleep durations, snoring, and low exercise activities.

The next step taken by the writers is measuring factor score. The formula used to find out stroke predictor index (A) is 0.929 (Systolic Blood Pressure) + 0.886 (Diastolic Blood Pressure) + 0.160 (Triglyceride levels) + 0.850 (Hypertension History) + 0.332 (Stroke History) + 0.084 (Dyslipidemia History) + 0.124 (Vegetable Consumption) + 0.245 (Emotional stresses) + 0.346 (Snoring) – 0.193 (Exercise Activities) – 0.190 (Sleep Durations).

After measuring the score of score risk factors based on the formula above, the writers classify the score of stroke predictor index into three categories, namely:

1. Low Risk, if the score of Stroke Predictor Index is lower than X-SD
2. Moderate Risk, if the score of Stroke Predictor Index is ranged between X-SD and X+SD
3. High Risk, if the score of Stroke Predictor Index is higher than X+ SD

Mean value (X) of infarction stroke predictor model is 0.613 and its Standard Deviation (SD) is 0.762. Therefore, Low Risk category is defined when the index score is lower than 0.877; Moderate Risk is defined when the index score is ranged between 0.877 and 2.103; and High Risk is when the index score is higher than 2.103.

Discussion

This study conducted on 24 variables of stroke risk factors reveals 11 risk factors with the highest scores. The 11 variables represent five main indicators of stroke prediction model. Systolic Blood Pressure, Diastolic Blood Pressure, and Triglyceride Levels represent Clinical/Laboratory Indicators. Stroke History and Hypertension History represent Medical History Indicators. Vegetables Consumption represents Dietary Habit Indicators. Sleep Duration, Snoring, and Exercises represent Demographical and Lifestyle Indicators and Emotional Stresses represents Psychological and Spiritual Indicators

The highest scores of stroke risk factors are found on systolic blood pressure, diastolic blood pressure, and hypertension history, as indicated by the scores of these factors 0.929, 0.886, and 0.850 respectively. Previous stroke prediction model in

Indonesia also acknowledged these variables as the composite indicators[8]. A study in Chinese population acknowledged systolic blood pressure (indicated by score of 3) and diastolic blood pressure (indicated by score of 2)[4]. EUROSTROKE model included hypertension history and diastolic blood pressure (as indicated by score of 3 and 0.2 respectively)[6], while INTERSTROKE model only included hypertension history[3]. These findings of previous studies indicate that patient systolic blood pressure, diastolic blood pressure, and hypertension history may affect the occurrence of infarction stroke. Hypertension is the main risk factors of all types of stroke either it is infarction stroke or hemorrhagic stroke[6] . The increasing of systolic blood pressure by 10 mmHg improves the risk of stroke by 1.2 and increasing of diastolic blood pressure by 1 mmHg improves the risk of stroke by 1.3. Meanwhile, hypertension history improves the risk of stroke by 2.37 [3].

Another variable composing stroke predictor model in this study is stroke history (as indicated by factor score 0.332). EUROSTROKE model finds that stroke history contributes stroke prediction by the score of 19 [6]. In Chinese population study, includes stroke history within family as one of the risks of stroke[4]. This finding is consistent with previous study that 19.9% of patients in the 28 hospitals in Indonesia have ever experienced stroke attack before[9].Stroke attack might reoccur with higher risk of death for the patients who experienced stroke attack before[10].

Snoring also contributes as stroke risk factor with risk factor score +0.346. This finding is coherent with previous studies. In proving anamnesis that snoring is one of infarction stroke risks. The study conducted by Palomaki on 177 stroke patients proves that snoring is one of infarction stroke risk factors. The study found that ratio of snoring and infarction stroke odd ratio was 2.13. Through McNemar test, he found strong correlation between snoring and infarction stroke on patients with sleep apnea anamnesis, daytime sleepiness, and obesity[11]. Snoring also correlates with vascular disorders, such as arterial hypertension and coronary diseases. Snoring mostly correlates with obstructive sleep apnea syndrome[11]. Breathing stoppage increases Carbon dioxide (CO_2) levels on blood. Chemoreceptors on blood vessel responds this condition and triggers the patient's awakening to breathe. Normal breathing may improve oxygen levels in blood and the patient may sleep[12]. However, continuous sleep apnea may drastically reduce oxygen level on brain and triggers infarction stroke[11]. Diagnosis on snoring may be conducted by an instrument named polysomnogram[12]. However, due to lack of facilities, polysomnogram examination cannot be conducted.

Sleep duration is also one of stroke risk factors as indicated by risk factor score -0.190. A previous found that prevalence of stroke is higher on individuals who sleep for less than 6 hours/day or more than 9 hours/day compared to individuals who sleep for 7-8 hours/day[13]. Obstructive Sleep Apnea (OSA) also increases mortality of stroke[14]. OSA also correlates with worse functional impairment and affects the length of rehabilitation period [15]. OSA is found on 44-72% of post-stroke patients. OSA can cause functional damage through intermittent nocturnal hypoxia, reduced cerebral perfusion, and fragmented sleep[16]. Although the data showed there is no significant changes of sleep duration, previous researches indicated that changes on sleeping pattern may affect the occurrence of stroke. However, the writers could not analyze the effects of sleeping pattern change due to lack of polysomnogram facility used to conduct the analysis.

Emotional stresses are also one of stroke risk factors (as indicated by score of this factor as much as +0.245). The group exposed to emotional stresses has the highest because the stresses may affect cerebral hemodynamic functions[17]. A study conducted by Hacinski found that emotional stress might improve the risk of stroke by 1.5 – 2 times[18]. Empirical findings has proven the effect of psychological factors (including psychological stresses) on cardiovascular disorders. The results of INTERHEART study, a semi-quantitative research on subjective perception of psychological stresses involving participants from 52 countries, indicated strong correlation among the aspects of stress, including financial stress, and life-related stress[19].

Previous prospective and case-control studies reported that severe self-perceived psychological stress, life-related stresses, and failures in overcoming stresses individually correlated with stroke risk[20]. Through sub-group analysis, several studies showed significant correlation between self-perceived psychological stresses with fatal stroke[21]. A study conducted by Iso in Japan proves that severe self-perceived psychological stress correlates with stroke mortality[22].

This study reveals that Triglyceride levels is one of risk factors of stroke (as indicated by the score +0.160). A longitudinal study conducted for 7.2

years by Berger found that 68.1% patients with triglyceride level higher than 200 mg/dl are most likely experiencing stroke[23]. Different studies show that the increasing of triglyceride levels by 90 mg/dl improves the risk of stroke by 70% for female patients and by 30% for male patients[24]. Every increasing triglyceride levels by 1 mmol/L independently correlates with increasing stroke cases by 14-37%. Triglyceride metabolism abnormalities trigger atherogenesis by increasing CAMs expression on vascular system[25].

Dyslipidemia history is one of the risk factors of stroke (indicated by score + 0.084). A meta-analysis of 45 cohort observational prospective involving 45000 individuals found that there was no correlation between total cholesterol levels and infarction stroke[26]. Data of previous studies indicating the effect of hypercholesterolemia on stroke were not consistent. Surprisingly, there are consistent findings indicating correlation between low total cholesterol level and high incidents of intra-cerebral hemorrhagic stroke and sub-arachnoid hemorrhagic stroke on oriental populations. Related to these findings, some experts opine that low total cholesterol serum may weaken intra-cerebral arterial endothelium that causes bleeding during hypertension[27].

Low vegetable consumption and low exercise activity also contribute as two of stroke risk factors (as indicated by risk factor scores + 0.124 and – 0.193 respectively). This finding confirms the result of previous study conducted by Prawirohardjo on 52 subjects, which consists of 24 cases and 28 controls. The study found that low ischemic stroke repetition might be related with high consumption of vegetables (more than 10 portions/week), indicated by OR 0.16895% and CI 10.04-0.714 and habit of aerobic exercises (for 30 minutes/session repeated 3 times a week), indicated by OR 0.21695% and CI 0.065-0.713 [28].

Conclusion

This study comes up with a prediction model for infarction stroke risks. The prediction model is expressed by following formula: Infarction stroke risk = 0.929 x Systolic Blood Pressure + 0.886 Diastolic Blood Pressure + 0.160 x Triglyceride Levels + 0.850 x Hypertension History + 0.332 x Stroke History + 0.084 x Dyslipidemia History + 0.124 x Vegetable Consumption + 0.245 x Emotional Stresses + 0.346 x Snoring Habit – 0.193 x Exercise Habit – 0.190 x Sleep Duration

Recommendation

The model to predict infarction stroke risks should be socialized to medics and paramedics. The model serves as screening instrument to predict the risks of stroke in the community. The result of screening will help mapping stroke risks of the community. Individuals categorized into low risk and moderate risks shall receive promotive treatments while for individuals categorized as high risk shall receive primary preventive treatments.

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