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Research Article

Predictive measure for Ischemic Heart Disease among Workers in Jakarta, Indonesia

Skor Prediktif pada Penyakit Jantung Iskemik pada Pekerja di Jakarta, Indonesia

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ABSTRACT

Ischemic Heart Disease (IHD) is one of the leading causes of morbidity and mortality in many countries, including Indonesia. Therefore, cardiovascular risk-prediction models are required in clinical practice for early detection in high-risk populations, including the worker population. This study intends to develop a predictive risk measure for early detection of IHD incidences among employees in Jakarta, Indonesia. Source of data was the database of 4,100 medical check-up (MCU) results of employees and entrepreneurs in Jakarta and surrounding areas in January to October 2019. Multivariate analysis showed that being aged >40 years (p=0.000; OR=5.329 (95% CI 2.621-10.833)), having a history of dyspnea (p=0.000; OR=5.699 (95% CI 2.524-12.871)), smoking (p=0.048; OR=2.007 (95% CI 1.924-4.359)) and HDL<50 mg/dL (p=0.049; OR=1.811 (95% CI 1.099-3.281)) were all good predictors to detect IHD in the worker population. The combination of these predictors results with a cut-off point of 2.5, showed accuracy (79.2% sensitivity and 66.3% specificity). Workers who have a score >2.5 are at high risk of developing IHD in the future. This scoring system can be used by workers or companies to take early preventive measures.

Keywords: *Ischemic heart disease, predictive risk score, smoking, workers*

ABSTRAK

Penyakit Jantung Iskemik (PJI) merupakan salah satu penyebab utama morbiditas dan mortalitas di banyak negara, termasuk Indonesia. Oleh karena itu, model prediksi risiko kardiovaskular diperlukan dalam praktik klinis untuk mengidentifikasi dan mencegah penyakit pada populasi berisiko tinggi, termasuk populasi pekerja. Penelitian ini bertujuan untuk mengembangkan matriks risiko prediktif untuk deteksi dini kejadian Penyakit Jantung Iskemik pada karyawan di Jakarta, Indonesia. Sumber data yang digunakan adalah database 4.100 hasil *medical check up* (MCU) karyawan di Jakarta dan sekitarnya antara kurang lebih Januari hingga Oktober 2019. Dilakuka analisis pada beberapa faktor risiko untuk mengembangkan sistem penilaian yang dapat digunakan sebagai metode deteksi dini dalam menggambarkan risiko penyakit jantung iskemik pada penduduk yang bekerja di Jakarta, Indonesia. Analisis multivariat menunjukkan usia >40 tahun (p=0.000; OR=5.329 (95% CI 2.621-10.833)), memiliki riwayat dispnea (p=0.000; OR=5.699 (95% CI 2.524-12.871)), merokok (p=0,048; OR=2,007 (95% CI 1,924-4,359)) dan HDL <50 mg/dL (p = 0,049; OR = 1,811 (95% CI 1,099-3,281)) adalah prediktor yang baik untuk deteksi dini PJI pada populasi pekerja. Kombinasi indikator dengan titik potong 2,5, menunjukkan nilai akurasi prediktif sebesar 79,2% (sensitivitas) dan 66,3% (spesifisitas). Pekerja yang memiliki skor >2,5 berisiko tinggi mengalami PJI di masa mendatang. Sistem penilaian ini dapat diterapkan oleh pekerja atau perusahaan untuk mengambil tindakan pencegahan dini.

Kata Kunci: Merokok, penyakit jantung iskemik, pekerja, skor risiko prediktif

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INTRODUCTION

Ischemic heart disease (IHD), a cardiovascular disease (CVD), is responsible for the leading causes of morbidity and mortality in many countries. In Indonesia, CVD is accountable for one-third of all deaths (1). This figure is made more worrying by the fact that heart disease not only affects the elderly but also has been found among younger age groups (2). The younger population plays a crucial role as the productive age group among the working population. Based on data from Statistics Indonesia, as of February 2018, the total number of workers in Indonesia was 133.94 million (3).

This trend in the development of non-communicable diseases has caused changes in the burden of disease in Indonesia. Inpatient claims to the Healthcare and Social Security Agency (BPJS) from January - June 2014 reached 735 thousand cases, absorbing Rp 4.2 trillion in funds (4). This has also occurred in several developed countries. Data from the United States show that one American dies of IHD every 60 seconds, costing the US approximately $200 billion each year. The total cost not only stems from hospitalizations and treatment, but also includes loss of productivity (5).

According to Ministerial Regulation No. 02/1980, each company in Indonesia must conduct medical check-ups (MCUs) to assess the effects of specific jobs on their employees' health (6). This activity is also a manifestation of the implementation of occupational health and safety (OHS) programs in order that the company's employees maintain their productivity. From the results of the MCUs, several diseases are able to be detected early in workers, including IHD, which occurs due to several risk factors. Some of these risk factors are modifiable, for instance smoking, hypertension, elevated total cholesterol, excess body weight, and diabetes (7). Together with the potential hazards found in many work environments, including physical, chemical, and psychological hazards, these risk factors may increase the risk of IHD in the working population (8).

Based on the medical check-up (MCU) data from one company in Jakarta using the Jakarta Cardiovascular Score, 38% of employees were at high risk of developing heart disease (9). Detecting IHD in a large number of workers will undoubtedly be detrimental for many parties, including the government, which must bear the burden of costs for the treatment of diseases. Yet, unfortunately, in Indonesia, the availability of data from MCUs conducted by various companies for research purposes is still limited, even though this data could be used for research on numerous diseases, including occupational diseases. The OHS program in Indonesia is currently still dominated by a safety program to prevent work accidents. In the meantime, occupational health and safety efforts to prevent and control occupational diseases have not been widely implemented. Almost all OHS data is in the form of work accident data, while data on occupational diseases remains extremely minimal (10).

Due to the high prevalence of CVD with its increased cost burden, high-risk workers with various workplace hazards, and the presence of MCU data, it should be possible to outline the relationship between workers' characteristics in Indonesia and the risk of IHD. This study intends to develop a predictive score from several risk factors to act as a tool for detecting IHD among Indonesian workers. This will result in the more optimal utilization of MCU reports. The prevention of diseases should be carried out as early as possible in order to maintain workers' productivity and to ensure that the OHS program is well implemented.

METHOD

Research Subjects

This is a diagnostic study using a cross-sectional research design with consecutive sampling by taking data from 4,100 workers from Jakarta and surrounding areas who conducted medical check-ups (MCU) at a clinic providing MCU services to workers from January to October 2019. The subjects of our research were workers aged >18 years, who were able to read and write, and who were registered for MCUs. Meanwhile, those who did not attend the MCUs due to certain conditions or whose MCU results were incomplete were excluded.

Variables

This study's dependent variable is IHD, which was indicated by the results of ECG readings conducted by a cardiologist (Sp.JP) in the form of possible/suspected myocardial infarction or myocardial ischemia, or old myocardial infarction or myocardial ischemia. Demographic parameters, including age, gender, height, weight, and waist circumference, were recorded for all subjects. Body mass index (BMI) is a subject's weight in kilograms divided by their height in meters squared. We used WHO classifications for body mass index and waist circumference (11). Hypertension was defined as systolic blood pressure (sBP) >140 mmHg and/or diastolic blood pressure (dBP) >90 mmHg and/or reported use of antihypertensive drugs (12). The cut-off point for the lipid profile, according to NCEPATP III criteria, was determined from the results of the parameters of total cholesterol <200 mg/dL, LDL <100 mg/dL, and triglycerides <150 mg/dL, and the cut-off point for HDL cholesterol level <50 mg/dL and blood glucose level >200 mg/dL were taken from PERKENI (the Indonesian Association of Endocrinology) (13,14). History of hypertension, history of chest pain, and dyspnea history came from the answers to a questionnaire provided to the subjects. Smoking was determined from the questionnaire about smoking habits, and included subjects who had continued consuming cigarettes until the day of the MCU without considering length of consumption or number of cigarettes per day. The subjects' exercise levels were defined from the questionnaire answers about routine exercise habits without considering exercise frequency per week.

Statistical Analysis

Statistical comparisons were performed using the Chi-square test to compare demographics, clinical factors, and the workers' medical history, which are independently associated with ischemic heart disease. Any variables with $p<0.25$ were then included in the multivariate analysis. Multivariate analysis using a logistic regression model was completed to estimate the independent association between predictor variables and the diagnosis of IHD. A two-tailed p-value <0.05 was considered to be statistically significant. To determine the Area Under the Curve (AUC),

the Receiver Operating Characteristic (ROC) procedure was then applied and the optimal cut-point value defined to assess the probability of IHD. This stage produced the probability value of IHD in the working population. A sensitivity and specificity test was conducted to analyze the predictive score's validity. Analyses were performed using IBM SPSS Statistics for Windows, Version 27.0.

RESULTS

The baseline characteristics and results for the ischemic heart disease assessment are shown in Table 1.The majority of the research subjects were men (83.5%) and 66.7% were over 40 years old. Of the 4,100 research subjects, 48 had IHD (1.17%).

Table 1. Characteristics of the study participants

Variables	Frequency N = 4100	Percentage (%)
Demography		
Gender		
Female	673	16.5
Male	3427	83.5
Age		
≤ 40 years	1365	33.3
> 40 years	2735	66.7
BMI		
≤ 25	2115	51.6
> 25	1985	48.4
Waist Circumference		
≤ 80 cm	1034	25.2
> 80 cm	3066	74.8
Lab Results		
Total Cholesterol		
≤ 200 mg/dL	2487	60.6
> 200 mg/dL	1613	39.4
Triglycerides		
≤ 150mg/dL	2974	72.5
> 150 mg/dL	1126	27.5
HDL		
≥ 50 mg/dL	1462	35.6
< 50 mg/dL	2638	64.4
LDL		
≤ 100 mg/dL	713	17.4
> 100 mg/dL	3387	82.6
Blood Glucose Level		
≤ 200mg/dL	4019	98.0
> 200 mg/dL	81	2.0
Medical History		
Hypertension		
≤ 140/90 mmHg	3687	89.9
> 140/90 mmHg	413	10.1
Hypertension History		
No	4038	98.5
Yes	62	1.5
Chest pain History		
No	4027	98.2
Yes	73	1.8
Dyspnea History		
No	3909	95.3
Yes	191	4.7
Habitual History		
Smoking		
No	2782	67.8
Yes	1318	32.2
Exercise		
Regular	2282	55.6
Non-regular	1818	44.4

Note: Table 2 show that there is a significance difference between age, BMI, waist circumference, blood glucose level, dyspnea history and smoking with Ischemic Heart Disease.

Table 2. Brief assessment results of the participants with Ischemic Heart Disease (IHD)

Variables	Ischemic Heart Disease				Total		*P value*
	No		Yes				
	N	%	N	%	N	%	
Demography							
Gender							
Female	663	98.5	10	1.5	673	100.0	0.406
Male	3389	98.9	38	1.1	3427	100.0	
							Age
≤ 40 years	2724	99.6	11	0.4	2735	100.0	0.000
> 40 years	1328	97.3	37	2.7	1365	100.0	
							BMI
< 25	2099	99.2	16	0.8	2115	100.0	0.011
> 25	1953	99.2	32	1.6	1985	100.0	
Waist Circumference							
< 80 cm	1028	99.4	6	0.6	1034	100.0	0.041
> 80 cm	3024	98.6	42	1.4	3066	100.0	
Lab Results							
Total Cholesterol							
< 200 mg dL	2461	99.0	26	1.0	2487	100.0	0.354
> 200 mg dL	1591	98.6	22	1.4	1613	100.0	
Triglycerides							
≤ 150mg/dL	2942	98.9	32	1.1	2974	100.0	0.359
> 150 mg/dL	1110	98.6	16	1.4	1126	100.0	
HDL							
≥ 50 mg/dL	1439	98.4	23	1.6	1462	100.0	0.075
< 50 mg/dL	2613	99.1	25	0.9	2638	100.0	
LDL							
≤ 100 mg/dL	704	98.7	9	1.3	713	100.0	0.803
> 100 mg/dL	3348	98.8	39	1.2	3387	100.0	
Blood Glucose Level							
≤ 200mg/dL	3974	98.9	45	1.1	4019	100.0	0.032
> 200 mg/dL	78	96.3	3	3.7	81	100.0	
Medical History							
Hypertension							
≤ 140/90 mmHg	3647	98.9	40	1.1	3687	100.0	0.127
> 140/90 mmHg	405	98.1	8	1.9	413	100.0	
Hypertension History							
No	3992	98.9	46	1.1	4038	100.0	0.130
Yes	60	96.8	2	3.2	62	100.0	
Chest Pain History							
No	3980	98.8	47	1.2	4027	100.0	0.873
Yes	72	98.6	1	1.4	73	100.0	
Dyspnea History							
No	3874	99.1	35	0.9	3909	100.0	0.000
Yes	178	93.2	13	6.8	191	100.0	
Habitual History							
Smoking							
No	2742	98.6	40	1.4	2782	100.0	0.021
Yes	1310	99.4	8	0.6	1318	100.0	
Exercise							
Regular	2258	98.9	24	1.1	2282	100.0	0.427
Non Regular	1794	98.7	24	1.3	1818	100.0	
Total	4052	98.8	48	1.2	4100	100.0	

Multivariate analysis showed that age >40 years (p=0.000; OR=5.329 (95% CI 2.621-10.833)), a history of dyspnea (p=0.000; OR=5.699 (95% CI 2.524-12.871)), smoking (p=0.048; OR=2.007 (95% CI 1.924-4.359)) and HDL <50 mg/dL (p=0.049; OR=1.811 (95% CI 1.099-3.281)) were all good predictors to detect IHD in the working population (Table 3).

Table 3. Multivariate logistic regression analysis

Variable	OR	P value	CI Interval
Age >40 years	5.329	0.000*)	2.621-10.833
HDL <50 mg/dL	1.811	0.049*)	1.099-3.281
Blood Glucose Level > 200 mg/dL	0.458	0.262	0.117-1.794
Dyspnea history	5.699	0.000*)	2.524-12.871

Table 3. Multivariate logistic regression analysis (Cont.)

Variable	OR	P value	CI Interval
Hypertension history	1.338	0.732	0.253-7.070
Smoking	2.007	0.048*)	1.924-4.359
BMI >25	0.631	0.199	0.312-1.274
Waist circumference > 80cm	0.905	0.847	0.329-2.491
Hypertension	2.056	0.133	0.804-5.260

Note: *) statistically significant

These variables were then combined to produce a predictive score for early detection of IHD among the working population. The scoring was obtained through statistical calculations using the values of B and SE. The resulting predictive score is shown in Table 4. Receiver Operating Characteristics (ROC) produced an AUC value of 0.726 (95% CI 0.655-0.797) (Figure 1). By utilizing the sensitivity and specificity values of the AUC curve, we determined the cut-off point. The predictive scores have a cut-off point of 2.5 with 79.2% sensitivity and 66.3% specificity.

Table 4. Predictive scoring

Variable	B	S.E	B/SE	B/SE/ 2.145	Scoring
Age	1.673	0.362	4.621	2.628	3
HDL < 50 mg/dL	0.594	0.303	1.980	1.126	1
Smoking	0.696	0.396	1.758	1	1
Dyspnea History	1.740	0.416	4.183	2.379	2

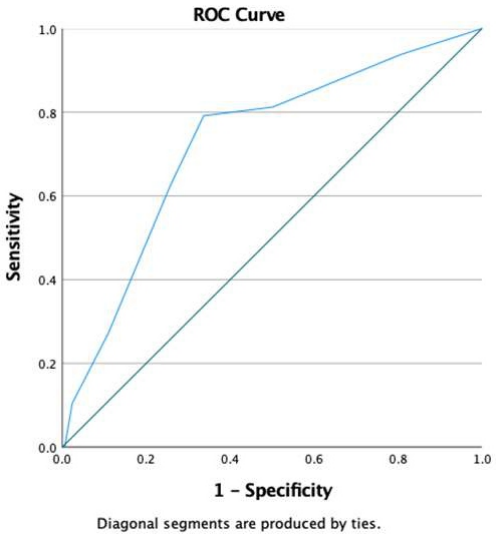

Figure 1. Area Under Curve (AUC) of the predictive score for Ischemic Heart Disease (IHD)

DISCUSSION

The prevalence of IHD in this study was 48 subjects (1.17%). The results of the research are similar to a study conducted by the Indonesian Ministry of Health, which found that the national prevalence of coronary heart disease, based on doctor's diagnosis or symptoms, was 1.5% (15). Therefore, a cardiovascular risk-prediction model is required in clinical practice to identify and prevent the disease in high-risk populations, including the working population.

In this study, we developed a scoring system that can estimate the incidences of IHD, combining several risk factors. The majority (77.1%) of workers who experienced IHD were aged >40 years, with this category being statistically significant with IHD. These results are in line with a study by Ros Endah *et al.,* which showed that an age >40 years was associated with IHD (16). In contrast, Fournier et al. and an analysis of INTERHEART data in South Asians showed that myocardial ischemia (MI) was found in younger populations, with incidences of almost 4% and 11,7% respectively in the age group <40 years (17,18).

These differences may be attributed to the populations' different age distributions, differences in life expectancy, and lifestyles. The elderly have an aging process that correlates with progressive physiological processes, including their effect on the heart and arterial system. Meanwhile, in younger people, smoking was the most critical risk factor for myocardial infarction. Many materials enter the bodies of active and passive smokers, with the potential effect of causing IHD (19).

This fact was identified by Yusuf et al., who suggested that there is an association between smoking and IHD in young people (OR=3.33 (99%CI 2.86-3.87)) which has an odds ratio (OR) higher than older individuals (OR=2.44 (99% CI 2.86-3.87) (20). For this study, smoking status was also one of the risk factors used to build our predictive score. According to a WHO report, in 2018, there were 61.4 million current tobacco users in Indonesia and 147,510 deaths due to CVD caused by smoking (21).

Dyspnea history is one of the parameters of our predictive score, differentiating this score from previous ones. Mario Santos et al. found that dyspnea is associated with a heightened risk of MI and heart failure. Mild dyspnea was significantly related with MI (adjusted Hazard Ratio =1.34; 95% CI=1.20-1.50)), along with moderate-to-severe dyspnea with HR=1.93, 95% CI=1.41–2.56 (22). More than half (52%) of all workers with IHD in this study recorded HDL levels <50 mg/dL, which were associated significantly with the disease. Therefore, this risk factor was included in our predictive score, in line with a cardiovascular study conducted in Quebec and research by Salonen *et al.,* which have confirmed that HDL cholesterol is an independent predictor for IHD (23,24).

The utility of the cardiovascular prediction model has already been proven in evaluating cardiological risk due to multifactorial etiology. Regression formulas have been produced to assess both coronary events and mortality in patients. Probably the most frequently used and oldest model is the Framingham Risk Score (FRS) system. Age, gender, systolic blood pressure, dyslipidemia (total cholesterol and HDL) levels, smoking status, presence of diabetes mellitus (DM), and treatment for hypertension are used as the predictors of this model. In a population-based study from Southern Europe, the FRS had 51.6% sensitivity and 85.6% specificity for women, and 79.1% sensitivity and 65.9% specificity for men (25,26). Indonesia itself has developed a cardiovascular risk-prediction model, called the Jakarta Cardiovascular Score (SKJ). This model is a modification of the FRS using gender, age, blood pressure, smoking status, diabetes, body mass index, and weekly physical activity as its parameters with 77.9% sensitivity and 90.0% specificity (27). Meanwhile, our study proposes a new predictive combination of 4

parameters consisting of age, smoking status, HDL cholesterol level, and dyspnea history, which has 79.2% sensitivity and 66.3% specificity.

To the best of our knowledge, this is the first study to be performed on Indonesia's working population. Several of the equation parameters from the above scoring system were used in this study: age, HDL levels, and smoking status. The history of dyspnea in our score distinguishes this study and makes it unique. Our model has higher sensitivity in women than the SKJ and FRS, but same in men. On the other hand, it has lower specificity in women compared to SKJ and FRS. However, our model is easier to use, with fewer variables, making it more time-efficient. This will undoubtedly help doctors in companies with large numbers of workers. However, we are aware of the limitations of our study in that the study's population was restricted to the working population and dominated by men. Therefore, validation using a different database consisting of a diverse population with a larger sample size is still required for this formula.

This study proposes a new predictive score with a combination of 4 parameters: age, smoking status, HDL cholesterol levels, and dyspnea history. Workers who have a score >2.5 are at high risk of developing IHD in the future. This method is a form of early detection before subjects are referred for a complete examination to establish a diagnosis of IHD. This scoring system can be applied directly by workers or companies to take early preventive measures. In the meantime, a larger multi-center study is required in order that this predictive score can be applied universally.

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