Predictive Score to Predict Ischemic Heart Disease among Workers in Jakarta

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Abstract: Ischemic Heart Disease (IHD) is one of the leading causes of morbidity and mortality in many countries, such as Indonesia. Therefore cardiovascular risk-prediction models are required in clinical practice to identify and prevent the disease in the high-risk population, including the working population.

Purpose :

This study intends to develop a predictive risk score for early detection of IHD incidence in the workers in Jakarta, Indonesia.

Patients and methods: This study analyzed the database of 4100 medical check-ups (MCU) results of workers in Jakarta and surrounding areas around January to October 2019. We assessed some of the risk factors to develop a scoring system that can be used as tools and early detection methods in describing the risk of IHD in the working population in Jakarta, Indonesia.

Results: Multivariate analysis showed that age>40 years (p = 0.000; OR = 0.190 (95% CI 0.093-0.387)), history of dyspnea (p = 0. 000 ; OR =0.180 (95% CI 0,080-0,407)), HDL< 50 mg/dL (p = 0.027 ; OR = 2.014 (95% CI) 1,085-3,740) and smoking (p= 0.065; OR= 2.081 (95% CI 0,955-4,535)) were found to be good predictors to detect IHD in the working population. These variables then combined to make the prediction score for early detection of IHD, with a cut-off point of -0,5 , sensitivity of 74% and specificity of 77%.

Conclusion: Workers who have a score of> -0.5 are at high risk of developing IHD in the future. This scoring system can be applied directly by workers and the company to take early preventive measures.

Keywords: predictive risk score, ischemic heart disease, workers

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]. And it has become more worrying due to the fact heart disease is not only affecting the elderly but also has been found at a younger age [2]. This younger population is playing as productive age among the working population. Based on the data from the Central Bureau of Statistics in Indonesia, as of February 2018, the number of workers here reached 133.94 million[3]

The trend in the development of non-communicable diseases has caused changes in the burden of disease in Indonesia. Inpatient claims for Health Social Security Administering Bureau in January - June 2014 reached 735 thousand cases by absorbing the funds of Rp 4.2 trillion[4]. This also actually happened in other developed countries. Data from the United States shows that an American dies of IHD every 60 seconds. As a result, this disease costs the US about $ 200 billion each year. The total cost not only stems from hospitalizations and treatments but also includes loss of productivity.[5]

According to Ministerial regulation (02-1980), every company in Indonesia must conduct the Medical Check-Up (MCU) to assess specific job's effects on their healths [6]. These activities are also a manifestation for the running of occupational health and safety (OHS) program for the company's workers. From the results of the MCU, it could be detected earlier, some of the diseases in workers, including IHD, occurs because of several risk factors. Some of them are modifiable risk factors, including smoking, exercise, hypertension, obesity, cholesterol, LDL, and triglyceride levels. In contrast, age, sex, and family history are non-modifiable risk factors [7]. Together with the potential hazards found in many work environments, such as physical, chemical, and psychological hazards, these risk factors might increase the risk of IHD in the working population [8].

Based on Medical Check-Up (MCU) data in one company in Jakarta, using Skor Kardiovaskular, Jakarta described that 38% of employees are at high risk of developing heart disease [9]. In case that IHD is found in many workers, this will undoubtedly be detrimental for many parties, including the government, which have to bear the burden of costs for the treatment of the diseases. But unfortunately, in Indonesia, the availability of data from MCU in various companies that are used for research purposes is still limited, even though this data could be used for research on numerous diseases, including occupational diseases. So far, the OHS's program in Indonesia is still dominated by a safety program to prevent work accidents. In contrast, occupational health and work environment efforts for preventing and controlling occupational diseases have not been widely implemented. Almost all of OHS data is in the form of work accident data, while the data of occupational diseases remained very minimal[10]

Because of a high prevalence of CVD with the increased burden cost, high-risk workers with various hazards in the workplace, and the presence of MCU data, it should be expected that we could construct the relationship between characteristics of employees in Indonesia and the risk of IHD. This

study intends to develop a predictive score from several risk factors that play a tool for detecting IHD among Indonesian workers. Hence, the utilization of MCU's report will be more optimal. The prevention of the diseases should be carried out as early as possible so that worker productivity is maintained and the OHS program will be running well.

Material and methods

Research Subjects

This is a diagnostic study using a cross-sectional research design with consecutive sampling by taking data from 4100 workers from Jakarta and surrounding areas who conducted medical check-ups (MCU) at a leading clinic providing MCU services to the workers from January to October 2019. In this study, respondents with congenital heart disease are currently using specific drug therapies (digoxin, psychotropic drugs). Those who did not attend the MCU due to certain conditions were excluded. Ethics approval was obtained from the Ethics Committee for Research, Medical Faculty, University of Muhammadiyah Prof. Dr. HAMKA, Jakarta, Indonesia.

Variable

This study's dependent variable is IHD, which is indicated by the results of ECG readings by the cardiologist (SpJP) in the form of possible and suspect myocardial infarction or myocardial ischemic, myocardial infarction, and myocardial ischemic and old myocardial infarction. Demographic parameters such as age, gender, height, weight, and waist circumference were recorded for all the subjects using international standard definitions. The Body mass index(BMI) is a subject's weight in kilograms divided by the square of height in meters. We used WHO Classification 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 of the lipid profile according to the NCEPATP III criteria was determined from the results of the parameters of total cholesterol <200 mg / dL, LDL <100 mg / dL, triglycerides <150 mg / dL, and cut off point for HDL cholesterol level<50 mg/dL and blood sugar< 200 mg/dL were from PERKENI[13],[14] .

History of hypertension, history of chest pain, and dyspnea history came from the answers to the questionnaire to the subjects. Smoking is recognized from the questionnaires about smoking habits from the subjects that are still being carried out until the day of the MCU without considering the length and number of cigarettes per day. The exercise is 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 the demographic, 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 multivariate analysis. Multivariate analysis

was completed to estimate the independent association between predictor variables and the diagnosis of IHD. Multivariate analysis using a logistic regression model. A two-tailed p-value < 0.05 was considered as statistically significant. To determine the Area Under Curve (AUC), then the Receiver Operating Characteristic (ROC) procedure was operated and the optimal cut-point value to assess the probability of IHD. This stage produces the probability value of IHD in the working population. A test of sensitivity and specificity was done to analyze the predictive score's validity. Analyses were performed using IBM SPSS Statistics for Windows, Version 20.0

Results

Most of the research subjects were men (83.5 %) and 66.7% more than 40 years old. Among the 4100 study subjects, there were 48 subjects with IHD (1.7 %). Baseline characteristics and results for ischemic heart disease assessment are shown in Table 1 and Table 2.

Multivariate analysis showed that age>40 years (p = 0.000; OR = 0.190 (95% CI 0.093-0.387)), history of shortness of breath (p = 0. 000 ; OR =0.180 (95% CI 0,080-0,407)), and HDL< 50 mg/dL (p = 0.027 ; OR = 2.014 (95% CI) 1,085-3,740) were found to be good predictors to detect IHD in the working population. In addition, we also included smoking as a predictor because of its significance in the multivariate analysis (p= 0.065; OR= 2.081 (95% CI 0,955-4,535)). These variables are then combined to make the prediction score for early detection of IHD of the working population. Scoring is obtained through statistical calculations using the value of B and SE. The resulting predicting score is shown in table 4. Receiver Operating Characteristic (ROC) procedure produced an AUC value of 0.790 (95% CI 0.728–0.852) (figure 1). By utilizing the sensitivity and specificity value of the AUC curve, we determine the cut-off point. The predictive score with a cut-off point of -0,5 has sensitivity = 74.1%, specificity = 77.1%

Discussion

The prevalence of IHD in this study was 48 people (1.17%). The results of the research are almost in line with the research conducted by the Indonesian Ministry of Health, which mentioned 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 will be required in clinical practice to identify and prevent the disease in a high-risk population, including the working population.

In this study, we developed a score that would estimate the incidence of IHD that has combined from several risk factors. Mostly (77.1%), the workers who experienced IHD were the respondents with age> 40 years, and this category was also statistically significant with IHD. These results are in line with Ros Endah et al., which showed that age>40 years were associated with IHD [16]. In contrast, Fournier et al. and Analysis of INTERHEART data in South Asians have presented that myocardial ischemic (MI) were found in the younger, with an incidence of almost 4% and 11,7% respectively aged below 40 years[17],[18] .

Those differences could be attributed to the population's different age distributions, differences in life expectancy, and lifestyle. The elderly have an aging process correlated with progressive physiological processes, including their effect on the heart and arterial system. However, in younger, the most critical risk factors for myocardial infarction events among young individuals were smoking. Many smoking materials have entered the body from active and passive smokers with a potential effect that causes the IHD [19] .

Yusuf et al. identified smoking as one of the most important risk factors related to the IHD in a younger age. They suggested the association of smoking and IHD in the young people (OR=3.33 (99%CI 2.86-3.87)) has an odds ratio (OR) higher than older individuals (OR=2.44(99% CI 2.86-3.87))[20]. In this study, smoking status was also one of the risk factors to build our predictive score. Based on the 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].

In our predictive score, dyspnea is one of the parameters, and it makes this score different from the previous scores. Mario Santos et al. found that dyspnea is associated with a heightened risk of incident myocardial infarction (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 workers with IHD in this study have HDL levels<50 mg/dL and were associated significantly with the disease. Therefore, this risk factor includes our predictive score and in line with a cardiovascular study in Quebec and research by Salonen et al., which have confirmed that HDL cholesterol was an independent predictor for IHD [23] [24].

The utility of the cardiovascular prediction model has already been proven in evaluating risk in cardiology due to multifactorial etiology. There has been a regression formula to assess both the coronary events and the mortality in patients. Probably the most frequently used and the oldest model is the Framingham Risk Score (FRS) system. Age, gender, systolic blood pressure, dyslipidemia (total cholesterol and HDL) levels, smoking status, diabetes mellitus (DM) existence, and treatment for hypertension were used as the predictors. In a population-based study from Southern Europe, the FRS has a sensitivity 51,6% and specificity 85,6 % for women, and the sensitivity 79,1% and sensitivity 65,9% for men [25] [26]. Indonesia itself has been developed a cardiovascular risk-prediction model, namely as Skor Kardiovaskular Jakarta (SKJ). This model modified the FRS and used gender, age, blood pressure, smoking, diabetes, body mass index, and weekly physical activities with sensitivity 77,9% and specificity 90.0% [27]. Meanwhile, our study proposes a new predictive combination of 4 parameters consisting of age, smoking, HDL cholesterol level, and dyspnea history with sensitivity 74.1% and sensitivity 77.1%.

This is the first study to be carried out on Indonesia'sking population to The best of our knowledge. From the scoring system above, there were the same several equation parameters used in this study, which were age, HDL levels, and smoking status. The history of dyspnea in our score makes this study distinguish and unique. Our model has lower sensitivity and specificity than SKJ, but our sensitivity is almost the same and even higher for FRS for women compared to FRS in men. Moreover,

our model is easier to use, with fewer variables, so it takes a shorter time. This will undoubtedly help company doctors with a large number of workers. However, our study had several limitations. First, our study population was restricted to the working population and dominated by men. Second, because this is a cross-sectional study with secondary data, so it may result in bias. Therefore, such validation on a different database from a diverse population with a larger sample is still required for this formula.

Conclusions

This study proposes a new predictive score with a combination of 4 parameters, including age, smoking, HDL cholesterol level, and history of dyspnea. Workers who have a score of> -0.5 are at high risk of developing IHD in the future. This method is the early detection before the subjects are referred for a complete examination to establish a diagnosis of IHD. This scoring system can be applied directly by workers and the company to take early preventive measures. In the meantime, a large enough multi-center study is still needed so that this predictive score could be applied universally.

Acknowledgment

There is no conflict of interest.

References

1. WorldHealthOrganization. NCDs Country Profiles 2018 WHO. Published online 2018:224. https://www.who.int/nmh/publications/ncd-profiles-2018/en/
2. Gulati R, Behfar A, Narula J, et al. Acute Myocardial Infarction in Young Individuals. *Mayo Clin Proc*. 2020;95(1):136-156. doi:10.1016/j.mayocp.2019.05.001
3. Midayati N. Keadaan Ketenagakerjaan Indonesia Februari 2018. *Ber Resmi Stat*. 2018;(42):1-16. doi:No. 74/11/35/Th.XVI, 5 November 2018
4. Wati H, Thabrany H. Perbandingan Klaim Penyakit Katastropik Peserta Jaminan Kesehatan Nasional di Provinsi DKI Jakarta dan Nusa Tenggara Timur Tahun 2014. *J Ekon Kesehat Indones*. 2017;1(2):18-27. doi:10.7454/eki.v1i2.1771
5. Jayaraj JC. Epidemiology of Myocardial Infarction. In: Davatyan K, ed. IntechOpen; 2019:Ch. 2. doi:10.5772/intechopen.74768
6. Menteri Tenaga Kerja dan Transmigrasi RI. PERATURAN MENTERI TENAGA KERJA DAN TRANSMIGRASI No. Per.02/MEN/1980 TENTANG PEMERIKSAAN KESEHATAN TENAGA KERJA DALAM PENYELENGGARAAN KESELAMATAN KERJA. *Menteri Tenaga Kerja dan Transm RI*. 1980;(02):1-6.
7. Hussain MA, Mamun A Al, Peters SAE, Woodward M, Huxley RR. The burden of cardiovascular disease attributable to major modifiable risk factors in Indonesia. *J Epidemiol*. 2016;26(10):515-521. doi:10.2188/jea.JE20150178
8. Bortkiewicz A, Gadzicka E, Siedlecka J, et al. Work-related risk factors of myocardial infarction.

Int J Occup Med Environ Health. 2010;23(3):255-265. doi:10.2478/v10001-010-0030-7

9. Yusvita F, Nandra NS. Gambaran Tingkat Risiko Penyakit Jantung Dan Pembuluh Darah Pada Pekerja Di Pt . X. *J Forum Ilm*. 2018;15(2):267-275.
10. International Labour Organization. Profil K3 Nasional Indonesia 2018. *J Chem Inf Model*. 2018;53(9):287.
11. Han TS, Lean ME. A clinical perspective of obesity, metabolic syndrome and cardiovascular disease. *JRSM Cardiovasc Dis*. 2016;5(0):204800401663337. doi:10.1177/2048004016633371
12. Chobanian A V., Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 2003;42(6):1206-1252. doi:10.1161/01.HYP.0000107251.49515.c2
13. Inada A, Weir GC, Bonner-Weir S. Induced ICER Iγ down-regulates cyclin a expression and cell proliferation in insulin-producing β cells. *Biochem Biophys Res Commun*. 2005;329(3):925-929. doi:10.1016/j.bbrc.2005.02.046
14. Soelistijo S, Novida H, Rudijanto A, et al. *Konsesus Pengelolaan Dan Pencegahan Diabetes Melitus Tipe2 Di Indonesia 2015*.; 2015. https://www.google.com/url?sa=t&source=web&rct=j&url=https://pbperkeni.or.id/wp-content/uploads/2019/01/4.-Konsensus-Pengelolaan-dan-Pencegahan-Diabetes-melitus-tipe-2-di-Indonesia-PERKENI-2015.pdf&ved=2ahUKEwjy8KOs8cfoAhXCb30KHQb1Ck0QFjADegQIBhAB&usg=AOv
15. Ghani L, Susilawati MD, Novriani H. Faktor Risiko Dominan Penyakit Jantung Koroner di Indonesia. *Bul Penelit Kesehat*. 2016;44(3):153-164. doi:10.22435/bpk.v44i3.5436.153-164
16. Patriyani REH, Purwanto DF. Faktor Dominan Risiko Terjadinya Penyakit Jantung Koroner (PJK). *J Keperawatan Glob*. 2016;1(1):23-30. doi:10.37341/jkg.v1i1.12
17. Shah N, Kelly AM, Cox N, Wong C, Soon K. Myocardial Infarction in the “Young”: Risk Factors, Presentation, Management and Prognosis. *Hear Lung Circ*. 2016;25(10):955-960. doi:10.1016/j.hlc.2016.04.015
18. Dalal J, Hiremath MS, Das MK, Desai DM, Chopra VK, Biswas A Das. Vascular disease in young Indians (20-40 years): Role of ischemic heart disease. *J Clin Diagnostic Res*. 2016;10(9):OE08-OE12. doi:10.7860/JCDR/2016/20206.8517
19. Hbejan K. Smoking effect on ischemic heart disease in young patients. *Hear Views*. 2011;12(1):1. doi:10.4103/1995-705x.81547
20. Yusuf S, Hawken S, Ounpuu S. Erratum: Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study (Lancet (2004) 364 (937-952)). *Lancet*. 2004;364(9450):2020. doi:10.1016/S0140-6736(04)17513-2
21. WHO. Heart disease and stroke are the commonest ways by which tobacco kills people. *Who*. 2018;1(1):1-2. http://www.searo.who.int/tobacco/data/ino_rtc_reports,
22. Santos M, Kitzman DW, Matsushita K, Loehr L, Sueta CA, Shah AM. Prognostic importance of dyspnea for cardiovascular outcomes and mortality in persons without prevalent cardiopulmonary disease: The atherosclerosis risk in communities study. *PLoS One*. 2016;11(10). doi:10.1371/journal.pone.0165111

23. Després J-P, Lemieux I, Dagenais G-R, Cantin B, Lamarche B. HDL-cholesterol as a marker of coronary heart disease risk: the Québec cardiovascular study. *Atherosclerosis*. 2000;153(2):263-272. doi:10.1016/S0021-9150(00)00603-1
24. Ramirez A, Hu PP. Low high-density lipoprotein and risk of myocardial infarction. *Clin Med Insights Cardiol*. 2015;9:113-117. doi:10.4137/CMC.S26624
25. Artigao-rodenas LM, Carbayo-herencia JA, Divisón-garrote JA, Gil- VF. Framingham Risk Score for Prediction of Cardiovascular Diseases : A Population-Based Study from Southern Europe. 2013;8(9):1-10. doi:10.1371/journal.pone.0073529
26. Günaydın ZY, Karagöz A, Bektaş O, et al. Comparison of the Framingham risk and SCORE models in predicting the presence and severity of coronary artery disease considering SYNTAX score. *Anatol J Cardiol*. 2016;16(6):412-418. doi:10.5152/AnatolJCardiol.2015.6317
27. Kusmana D. The influence of smoking cessation, regular physical exercise and/or physical activity on survival: A 13 years cohort study of the Indonesian population in Jakarta. *Med J Indones*. 2002;11(4):230-242. doi:10.13181/mji.v11i4.78