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Analysis of the Risk Factors Associated with Coronary Heart Disease for Cement Factory Workers

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Abstract

Cardiovascular disease is the leading cause of death globally each year. The study was conducted to determine the risk factors for coronary heart disease (CHD) based on the results of a treadmill test data. This cross-sectional study included 173 employees from medical check-up (MCU). The results showed that the risk of acquiring CHD had statistically significant associations with age, hypertension, total cholesterol, Low Density lipoprotein (LDL), diabetes mellitus, smoking, body mass index (BMI), shift, and stress based on a treadmill test, but CHD risk was not found to have an association with High Density Lipprotein (HDL). After conduncting logistic regression, seven risk factors of CHD were found: age, hypertension, total cholesterol, diabetes mellitus, smoking, BMI, and stress.

Keywords: Risk Factors, Coronary Heart Disease, Treadmill test

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1. INTRODUCTION

Heart disease still becomes the greatest cause of death and disability in the United States and many developed and developing countries [1]. Type of heart disease is the leading cause of death in the world is coronary heart disease. Coronary heart disease (CHD) is a disorder caused by the narrowing or inhibition of the arteries, which supply blood to the cardiac muscle. CHD begins with atherosclerosis, which is triggered by the presence of various risk factors. Atherosclerosis is a systemic disease and therefore rarely occurs in only one blood vessel. Atherosclerotic plaques often occur in areas with maximum turbulence regarding branching or high pressure and in areas that have experienced trauma; this plaque results in the desquamation of platelet to endothelial adhesion [8].

The American Heart Association (AHA) in 2007 estimated that the prevalence of CHD in the United States was about 13,200,000 people in 2004. Worldwide, CHD causes 50

million deaths each year, with 39 million of deaths occurring in developing countries. The risk of CHD increases by 50% in men over 40 years of age and 33% in women over 40 years of age [12]. In 2009, 16,419 deaths related to cardiovascular disease occurred among Asians and Pacific Islanders; of these, 7,752 deaths were caused by CHD. According to the Department of Measurement and Health Information, the CHD mortality rate is 480/100,000 people per year in East Asia [10].

One CHD screening test is a treadmill test, which is recommended for all patients with suspected angina, except the elderly and the handicapped. A treadmill test is often used to diagnose obstructive CAD; the test has a sensitivity of 50% and a specificity of 90%. The treadmill test is to used determine: (1) a diagnosis of angina and abnormalities provoking ischemia; (2) risk stratification for patients who have a high risk of coronary events and death; and (3) functional capacity so the patient can be given advice regarding his or her activities.

The cement company PT Indocement Tunggal Prakarsa Tbk (PT ITP) opened its first factory in August 1975. PT ITP has become one of the largest cement producers in Indonesia. A number of shift-work employees of PT ITP in Citeureup, Bogor have died by CHD (i.e., heart attacks); 28% of these deaths occurred from 1984–2005. In 2007, 40% employees of PT ITP died from CHD. In 2005–2007, 62 employees PT ITP were recorded to suffer from CHD, 39 cases of which suffered the mounting balloon/ring and underwent heart surgery.

2. METHODS

This cross-sectional study was conducted from May–June 2016 at PT ITP in Citeureup, Bogor. Employees underwent a treadmill test. Data about age, total cholesterol, LDL (Low Density Lipoprotein) cholesterol, HDL (High Density Lipoprotein) cholesterol, blood pressure, fasting blood glucose levels, Body mass Index (BMI), smoking status, shift-work status, and stress were obtained through the medical checkups conducted in 2014, 2015, and 2016. The minimum sample size required for this study was determined using the hypothesis test to compare two population proportions based on a 95% confidence interval and a test strength of 80%.

3. RESULTS

Tables 1 and 2 show the association between the cement factory workers' CHD risk and their ages and blood pressure levels, respectively. CHD risk increases with an increase

in systolic or diastolic blood pressure. People with high blood pressure have a risk of acquiring CHD that is two to four times greater than those with normal blood pressure.

Table 1: Association between Age and Coronary Heart Disease Risk.

Age	CHD Risk		p value	OR (95% CI)
	Negative	Positive		
< 50	65 (65.7%)	34 (34.3%)	0.000	5.162 (2.668–9.985)
≥ 50	20 (27%)	54 (73%)		

Table 3 shows that total cholesterol and LDL levels are correlated with CHD risk. However, HDL and Fasting Blood Sugar (FBS) levels are not correlated with CFD risk. The statistical test showed that p = 0.761, meaning that there is no significant correlation between HDL levels in the blood and CHD. However, the statistical test might not have found an association between HDL levels and CHD risk because the sample size was small. In total, 61 (35.2%) of the 173 respondents had HDL levels between 40–60 mg/dl, a level at which is not known to increase or decrease the incidence of CHD.

Table 2: Association between Blood Pressure and Coronary Heart Disease Risk.

Blood Pressure	CHD Risk		p value	OR (95% CI)
	Negative	Positive		
< 140/90 mmHg	68 (63%)	40 (37%)	0.000	4.80 (2.44–9. 45)
≥ 140/90 mmHg	17 (26.2%)	48 (73.8%)		

Table 3: Association between Blood Examination Results (Cholesterol, LDL, HDL, and Fasting Blood Sugar) and Coronary Heart Disease Risk.

Blood Examination		CHD Risk		p value	OR (95% CI)
		Negative	Positive		
Total Cholesterol	< 200 mg/dL	50 (61.0%)	32 (39.0%)	0.004	2.50 (1.36–4.61)
	≥ 200 mg/dL	35 (38.5%)	56 (61.5%)		
LDL	< 100 mg/dL	28 (63.6%)	16 (36.4%)	0.036	2.21 (1.09–4.48)
	≥ 100 mg/dL	57 (44.2%)	72 (55.8%)		
HDL	≥ 40 mg/dL	40 (50.6%)	39 (49.4%)	0.761	1.12 (0.61–2.03)
	< 40 mg/dL	45 (47.9%)	49 (52.1%)		
FBS	< 120 mg/dL	54 (56.3%)	42 (43.8%)	0.047	1.91 (1.04–3.51)
	≥ 120 mg/dL	31 (40.3%)	46 (59.7%)		

Smokers have a risk that is two to three times greater than the general population of experiencing major coronary events. Those who smoked 20 cigarettes or more a day had a higher risk of CHD (Table 4).

Excessive weight also increased the risk of heart disease; excessive weight increases total cholesterol levels in the blood and lowers HDL levels (Table 5).

Table 4: Association between Smoking and Coronary Heart Disease Risk.

Smoking	CHD Risk		p value	OR (95% CI)
	Negative	Positive		
No	53 (58.9%)	37 (41.1%)	0.010	2.28 (1.24–4.20)
Yes	32 (38.6%)	51 (61.4%)		

Table 5: Association between BMI and Coronary Heart Disease Risk.

BMI	CHD Risk		p Value	OR (95% CI)
	Negative	Positive		
< 25 (kg/m2)	56 (56.6%)	43 (43.4%)	0.031	2.021 (1,095–3.730)
≥ 25 (kg/m2)	29 (39.2%)	45 (60.8%)		

Table 6 shows that shift workers had increased CHD risk compared to non-shift workers.

Table 6: Association between Shift Work and Coronary Heart Disease Risk.

Shift Work	CHD Risk		p Value	OR (95% CI)
	Negative	Positive		
No	37 (60.7%)	24 (39.3%)	0.027	2.056 (1,089–3.881)
Yes	48 (42.9%)	64 (57.1%)		

Table 7 shows that stress also increases CHD risk.

Table 7: Association between Stress and Coronary Heart Disease Risk.

Stress	CHD Risk		p Value	OR (95% CI)
	Negative	Positive		
No	70 (62.5%)	42 (37.5%)	0.000	5.11 (2.55–10.26)
Yes	15 (24.6%)	46 (75.4%)		

Based on logistic regression, age, blood pressure, total cholesterol, fasting glucose, smoking, BMI, and stress could be maintaince (Table 8). These risk factors influence the occurrence of CHD among cement factory workers.

4. DISCUSSION

Employees aged ≥ 50 years have a higher risk of developing CHD . The older the patient, the more likely it is that he or she will develop crust on the walls of his or her coronary arteries; this interferes with blood flow to the heart, especially when atherosclerosis occurs. Thus, older patients have a higher risk of acquiring CHD.

Further, since many parts of the coronary arteries are prone to developing atherosclerosis or crust on their walls, blood flow in these arteries is often disrupted.

Table 8: Analysis of Top Risk Factors of Coronary Heart Disease.

Variable	B	SE	df	Wald	p Value	OR	90% CI
Age	1.069	0.377	1	8.020	0.005	2.912	1.565–5.419
Blood Pressure	0.848	0.388	1	4.784	0.029	2.334	1.234–4.415
Total Cholesterol	0.580	0.364	1	2.541	0.091	1.787	0.982–3.252
Fasting Blood Sugar	0.452	0.367	1	1.517	0.088	1.571	0.859–2.873
Smoking	0.769	0.362	1	4.522	0.033	2.158	1.190–3.911
BMI	0.762	0.360	1	4.479	0.034	2.143	1.185–3.875
Stress	1.069	0.377	1	8.020	0.005	2.912	1.254–4.158

In the long term, high blood pressure can lead to increased tension in the blood vessel walls, causing damage and accelerating atherosclerosis [7]. In addition, total cholesterol in the plasma is positively correlated with atherosclerosis. Cholesterol, or fat in the blood, is strongly associated with CHD. The risk of CHD is increasing continuously due to the increased blood cholesterol levels of the population as a whole. Blood cholesterol levels below 200 mg/dL in mid-adulthood are correlated with a lower risk of CHD [7].

The risk of CHD also increases with greater levels of LDL in the blood, as LDL carries cholesterol from the liver to cells and blood vessels, where it begins cells to line the arterial wall. LDL in the arterial wall settles into a solid consisting of calcium, fibers, and other substances; this is referred to as plaque [3, 4]. Furthermore, diabetes can increase a person's risk of developing CHD two to three times. Diabetes is a risk factor for CHD when blood glucose levels rise, especially when they rise for a long duration, as blood sugar can be toxic to the body, including the cardiovascular system. Uncontrolled diabetes with high glucose levels in the blood contributes to raising cholesterol and triglyceride levels. Smoking is correlated with CHD as well. The risk of CHD from smoking decreases to 50% after one year of quitting smoking and normalizes after four years of not smoking. Smoking is also a major risk factor for heart attacks; smokers are two to four times more likely to experience sudden death from a heart attack (Kengne, Turnbull and MacMahon 2017).

There are also interconnections between CHD and weight, increased blood pressure, increased blood cholesterol, and insulin-dependent diabetes mellitus (Newman et al. n.d.). The Study was conducted in Framingham showed that each 10% increase in body weight in men was caused by a rise in blood pressure of 6.6 mmHg, a rise in blood sugar of 2 mg/dL, and a rise in blood cholesterol levels of 11 mg/dL [6]. In addition, excess

weight can cause load circulation and the heart's workload to increase, enlarging the heart slightly and impairing its function.

On top of these factors, a study found that night-shift workers had a 23% increased risk of heart attack, a 24% increased risk of CHD, and a 5% increased risk of strokes. Poor diet and sleep can lead to high blood pressure, obesity, and increased cholesterol levels [9]. Harrington (2001) analyzed the data on more than 1,900 workers obtained through long-term studies; 43% of people who worked long shifts or hours had cardiovascular problems, including heart attacks, coronary artery disease, heart failure, high blood pressure, and stroke [5]. The risk of heart disease increased by 16% in those who worked 55 hours per week and increased by 35% in those who worked 60 hours per week. The risk increased as much as one percent more if workers had long shifts for ten years or more.

Finally, stress is correlated with CHD. Stress stimulates the cardiovascular system with the release of catecholamine, which increases the heart rate and causes vasoconstriction. Psychological stress activates the sympathetic nervous system, which regulates the heart rate and catecholamine release. It also activates the hypothalamic–pituitary–adrenal axis, which regulates the release of corticosteroids from the adrenal glands. Stress can increase the von Willebrand factor and the amount of fibrinogen, both of which are predisposing factors that cause the onset of atherosclerotic coronary artery disease [2].

5. CONCLUSION

Statistically significant associations between CHD risk and age, blood pressure, total cholesterol, LDL cholesterol, fasting blood sugar, smoking, BMI, shift work, and stress were found by studying cement factory workers using the results of treadmill tests conducted from 2014–2016. No significant correlation was found between CHD risk and HDL levels. Using binary logistic regression, seven risk factors that have the most significant effects on CHD were obtained based on the results of the treadmill tests: age, high blood pressure, total cholesterol, diabetes mellitus, obesity, smoking, and stress.

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