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Association of BMI and Waist to Hip Ratio with the Ratio of LDL to HDL and Total Cholesterol to HDL in Urban Adolescents without Cardiovascular Risk Factor in Jambi City, Indonesia

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ABSTRACT

Incidence of cardiovascular disease in adulthood could not be separated from the continuous interaction from infancy through adolescence. Some risk factors for cardiovascular disease occurred since his teens. High level of low-density lipoprotein and cholesterol is often indicative of increased risk for cardiovascular disease. The ratio of LDL to HDL and total cholesterol to HDL can be used to reveal the risk of it. This research is to estimate the influence of 12 potential factors and to find association of BMI and waist to hip ratio with the level of LDL to HDL and total cholesterol to HDL ratio. A correlation ratio (ETA) design study using primary data which are gathered prospectively among random adolescents in Jambi whose BMI is under weight, normal, overweight, and obese that could participate on the day of the survey. Data on 12 potential factors including daily intake, physical activity, and family history were collected three days. We administered a questionnaire and measured BMI and waist to hip ratio to assess statistical relation with the level of LDL to HDL and total cholesterol to HDL ratio. Category of LDL to HDL and total cholesterol to HDL ratio was stratified from high risk and low risk. Examination of lipid profiles was done at the clinical laboratory of Abdul Manap Regional Public Hospital in Jambi. Duration of research was about 3 months. The study included 50 people with age span of 16 to 20 years old with all of them had low level of LDL to HDL and total cholesterol to HDL ratio. Most of samples were underweight (42%) resulting low risk for cardiovascular disease as well as normal (24%), overweight (26%), and obese (8%) people. BMI was likely to influence the low level of LDL to HDL ($\eta 2=0,705$) and total cholesterol to HDL ratio ($\eta 2=0,765$), confirmed statistically significant. 94% samples with low risk category of waist to hip ratio were likely to have low risk for cardiovascular disease. Waist to hip ratio influenced the low level of LDL to HDL ($\eta 2 =0.003$) and total cholesterol to HDL ratio ($\eta 2 =0.021$). Other factors that associated with the level of LDL to HDL and total cholesterol to HDL ratio were frequency of daily intake including fruit, vegetables, and snacking consumption, physical activity, and family history of uncommunicable disease. The strongest association was a relation of the level of LDL to HDL and total cholesterol to HDL ratio with Body Mass Index. By knowing the risk factors, cardiovascular disease can be prevented at earlier age.

Keywords

Cardiovascular disease, Lipid profile, Adolescent, Body mass index.

Introduction

Cardiovascular disease is a general term to indicate the presence of abnormalities in the heart and blood vessels. Coronary heart disease and stroke belong to the abnormalities of blood vessels of the heart and brain, either single or pair. The risk factor of cardiovascular disease (CVD) can be divided into two, namely uncontrolled and controlled factors [1].

The uncontrolled factors are age, sex, and family heart disease history. While the controlled ones are cholesterol content in the blood, hypertension history, diabetes mellitus, obesity, bad life style such as smoking, seldom doing sports, and stress. These factors are the ones that accelerate or worsen the cardiovascular

disease. Of those risk factors, high cholesterol content is the major factor [2].

In the past it was the elderly people who aged above 60 years old suffering the disease because an age was one of the risk factors to have heart disease and stroke. But now there is a tendency that it is also suffered by patients under the age of 40 years old. This can happen because of lifestyle changes, especially in modern urban adolesents [3].

Incidence of cardiovascular disease in adulthood could not be separated from the continuous interaction from infancy through adolescence. According to the result of research conducted by the scientists of the University of California, San Francisco and published in the Journal of Annals of Internal Medicine, young people in their 20s needed to pay attention to cholesterol because if it had high value it could damage blood vessels and trigger a cardiovascular disease. In the research, a team led by Dr. Mark Pletcher monitoreda group of respondents aged 18 to 30 years. This monitoring was carried out for 20 years. The research result showed that the high cholesterol content at a relatively young age increased the risk of heart disease and stroke when reaching an old age [3].

Hypercholesterolemia is caused by several factors. They include the factors of heredity, obesity, lack of exercise, diet, stress-, and smoking habits. The prevalence of hypercholesterolemia in Indonesia tends to be more in women than men of 55 years old and above in urban areas. The data show that the prevalence of hypercholesterolemia of people aged 20-34 years old is 9.3%, and aged 55-64 years old 15.5%, in women 4.5%, men8.6%, in urban population 13.3%, and rural population 10.9% [4].

The 1986 Household Health Survey (HHS) conducted in 7 provinces in Indonesia resulted in the prevalence of coronary disease and others in the 15-24-year-old group which was 18.3 per 100,000 people. This number increased sharply in the 45-54-year-old group which was 174.6 per 100,000 people and 461.9 per 100,000 people at 55 years old and above. While deaths due to cardiovascular with the major causes of ischemic heart disease and others were17.5 per 100,000 people and deaths associated with the disease were 27.4 per 100,000 people [4] (Figure 1).

Cholesterol is one of the main risk factors triggering atherosclerosis (the hardening of arteries). Deposition of the cholesterol on the inner walls of the arteries can disturb the flow of the blood and inhibit oxygen to reach the heart muscle and blood vessels of the brain that it can eventually lead to heart attacks and stroke. The amount of cholesterol in the blood circulation is affected by the amount of cholesterol produced by our body [5,6].

In line with the advances in knowledge and examination technology, based on the recognition of lipoproteins, in 1970 beta-lipoprotein was examined and in the end of 1970 the examination was carried out with low density lipoprotein (LDL) and high density lipoprotein (HDL). In this case, the examination was focused on the contents of HDL and LDL cholesterol. The latter is considered as a bad one and the former is considered as a good one/protector [5,6].

The ratio of LDL to HDL cholesterol and the ratio of total cholesterol and HDL can be used to assess the risk of CVD. This ratio is the most predictive value for the incidence of atherosclerosis. Maintaining a good ratio of LDL to HDL cholesterol and the ratio of total cholesterol to HDL is a good way to reduce the risk of heart disease and stroke [5,6].

Previous research showed that being overweight increases the risk of heart disease. Obesity indicators such as Body Mass Index (BMI) are still used by researchers as an instrument to predict health problems. Waist to hip circumference ratio (the figures obtained from the results between waist size and hip size) and self-measurement of waist circumference was also an accurate instrument for identifying anyone at highest risk. Some people who had a normal BMI score but had an above-average waist circumference score were at significantly higher risk for CVD [3].

The presence of risk factors for CVD, especially the controllable one, is an interesting phenomenon for further investigation. The following study aimed to relate the ratio of LDL to HDL cholesterol and the ratio of total cholesterol to HDL cholesterol with BMI and the ratio of waist to hip circumference of the urban adolescents in Jambi city against their relationship with the risk of CVD.

Risk Factors of Cardiovascular Disease (CVD)

There have been found several factors known as risk factors that increase susceptibility to the occurrence of CVD in certain individuals. They are divided into two, namely uncontrollable factors and controllable factors. Biological factors that are uncontrollable include age, sex, and history of CVD in the family [7].

Uncontrollable Factors [7]

Age

Vulnerability to coronary heart disease increases along with the increase of age of an individual. Age over 45 years in men and 55 years in women are the most vulnerable ages for this disease.

Sex

On the whole, the cardiovascular disease is more risky in men than in women. Women are relatively immune to this disease until the age of after menopause, and then become as vulnerable as men in menopause. The protective effect of estrogen is thought to explain the presence of female immunity at the age before menopause. It is assumed that the higher the content of estrogen in the body, the higher the content of HDL cholesterol, which one of its functions can reduce and inhibit the process of atherosclerosis in the blood vessels, including the blood vessels of the heart and brain.

History of heart disease in the family

The presence of a family history of heart disease, a brother or a parent having cardiovascular disease before the age of 50,

increases the likelihood of early atherosclerosis. The offspring of a person with early CVD are known to cause changes in early atherosclerotic indication, for instance reactivity of the brachial artery and increased carotid artery intima tunica and thickening of the media tunica. The presence of hypertension such as an increase in homocysteine and increased lipid is found in the individual. The presence of family history reflects a genetic predisposition to endothelial dysfunction in coronary arteries.

Controllable Factors

Hypercholesterolemia

When consuming a lot of food containing cholesterol, one will have excessive cholesterol content in his/her blood. It is called hypercholesterolemia [9]. Excessive cholesterol content in blood will be stored in the lining of artery walls as plaque which then becomes harmful to the body. An increase in cholesterol levels whose figure is more than 200 is the most important single risk factor in the CVD [8].

Hypertension

Chronic high blood pressure mainly affects the heart and arteries. Having high blood pressure means the heart must work harder than usual and circulate blood throughout the body. After a time this makes the heart wear out, and like other muscles, enlarged by excessive effort, which affects its work in pumping blood [2]. Consequently, ventricular hypertrophy occurs to increase contraction strength. However, the ability of the ventricles to maintain cardiac output with compensatory hypertrophy is ultimately exceeded, and dilatation and heart failure occur. The heart is increasingly threatened by the increasingly severe atherosclerosis [8].

Diabetes Mellitus

Diabetes mellitus induces hypercholesterolemia and significantly increases the likelihood of atherosclerosis. It deals with the proliferation of smooth muscle cells in coronary artery blood vessels, cholesterol synthesis, triglycerides and phospholipids, elevated levels of LDL and low HLD levels.

Ratio of LDL to HDL Cholesterol and total cholesterol to HDL

A number of researches conducted by the experts made criteria for figures of threshold limit of fat profiles such as total cholesterol, LDL, HDL, and triglycerides. The purpose was that if the figure was met, one would be considered having low risk on the formation of plaque on the arteries that can lead to heart attack and stroke. But it is not easy to meet all the fat profiles in the blood at low levels, while total cholesterol, LDL, and triglycerides are within the limits of the specification, to easily memorize the figure of threshold limit of cholesterol and triglyceride, the following table describes the summary of them [9] (Table 1).

Ratio of Waist to Hip Circumference

Knowing the total of fat in the body is important to find out the obesity level or risk of having a disease. It is necessary to find out where the fat distribution/location is. Fat around the abdomen causes higher health risk than that around the thigh or other parts of the body. To find out the fat is by measuring waist circumference [10-12].

Ratio of waist and hip circumference is a way of assessing of finding out the distribution or location of fat around the abdomen and hip because it causes higher health risk than the fat in thigh area or other parts of the body. Ratio of waist to hip circumference is used to measure one's risk of cardiovascular disease [13]. The normal value of the ratio is less than 0.80 for women and less than 0.90 for men. The higher value indicates a person is at high risk of cardiovascular disease (CVD) [14]. The threshold limit of ratio of waist/hip circumference (Table 2).

	Low risk (desirable)	Moderate risk	High risk	Desirable value
Trigliseride	< 150	150-400	400	< 130
Total cholesterol HDL LDL	< 200 > 40 < 130	201-24 q 0 35-40 131-160	240 < 35 > 160	< 150 < 100
Ratio Total cholesterol to HDL	< 4,5	4,5-6,0	> 6,0	
Ratio LDL to HDL	< 3,0	-	> 3,0	

Source : DR.K.H. Cooper, M.D.,M.P.H., *controlling cholesterol 1989*

Table 1: Threshold Limit of Cholesterol and Triglyceride Levels in Blood.

Measurement	Man		Woman	
	Increased Risk	Very Increased Risk	Increased Risk	Very Increased Risk
Waist circumference Ratio of	> 94 cm	> 102 cm	> 80 cm	> 88 cm
Waist circumference/ hip circumference	0.9	1.0	0.8	0.9

Table 2: Threshold Limit of Ratio of Waist/Hip Circumference.

Body Mass Index

BMI is interpreted differently for children and teens even though it is calculated as weight ÷ height [2]. Because there are changes in weight and height with age, as well as their relation to body fatness, BMI levels among children and teens need to be expressed relative to other children of the same sex and age. These percentiles are calculated from the CDC growth charts, which were based on national survey data collected from 1963-65 to 1988-94.

The BMI-for-age percentile growth charts are the most commonly used indicator to measure the size and growth patterns of children and teens in the United States. BMI-for-age weight status categories and the corresponding percentiles were based on expert committee recommendations and are shown in the following table [15]. The threshold limit of Body Mass Index (Table 3).

Weight status category	Percentile range
Underweight	Less than the 5th percentile
Normal	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

Table 3: The threshold limit of Body Mass Index.

Correlation between Body Mass Index (BMI) and Waist to Hip ratio and Risk of Having Cardiovascular Disease

A big waist circumference (reflecting abdomen fat) is very dangerous. Bigger hip circumference can protect against the cardiovascular disease. Ratio of waist to hip circumference is the best assessment of obesity to measure the risk of heart attack. It is concluded in the global research of the experts of Mc Master University of Canada, published in the newest journal of the Lancet. If obesity is determined by using the ratio of the waist and hip circumference, in addition to using Body Mass Index, one is increasingly at risk of getting heart attack by threefold [13]. Previous study showed that obesity increased the risk of heart disease. It was conducted in the population of Europe and North America that the result of the study in the other population was seldom found [16].

Methods

A correlation ratio (ETA) design study approach on the relationship between cardiovascular risk factors viewed from the ratio of BMI and ratio of waist to hip circumference with ratio of LDL to HDL and ratio of total cholesterol to HDL. All sample data were taken from primary data which are gathered prospectively among random adolescents in Jambi whose BMI is underweight, normal, overweight, and obese that could participate on the day of the survey. Data on 12 potential factors including daily intake, physical activity, and family history were collected three days. We administered a questionnaire and measured BMI and waist to hip ratio to assess statistical relation with the level of LDL to HDL and total cholesterol to HDL ratio. Category of LDL to HDL and total cholesterol to HDL ratio was stratified from high risk and low risk. Examination of lipid profiles was done at the clinical laboratory of Abdul Manap Regional Public Hospital in Jambi. Duration of research was about 3 months.

Results

The study included 50 people with age span of 16 to 20 years old. There were 12 people (24%) having normal BMI, 21 people (42%) having BMI below normal (underweight), 13 people (26%) having BMI above normal (overweight), and 4 people (8%) having obesity. The ratio of waist to hip circumference from the samples show that 3 people (6%) having high risk category and 47 people (94%) having low risk category. The frequency of all potential factors is listed in the table below (Table 4).

Factors	Category	Frequence (%)
Age	15 years old	1 (2.0)
	16 years old	9 (18.0)
	17 years old	16 (32.0)
	18 years old	6 (12.0)
	19 years old	7 (14.0)
	20 years old	11 (22.0)
Gender	Male	13 (26.0)
	Female	37 (74.0)
BMI	Underweight	21 (42.0)
	Normal	12 (24.0)
	Overweight	13 (26.0)
	Obesse	4 (8.0)
Waist to hip ratio	High risk	3 (6.0)
	Low risk	47 (94.0)
Daily intake	2 times	12 (24.0)
	3 times	25 (50.0)
	4 times	11 (22.0)
	5 times	2 (4.0)
Fruit & vegetables consumption	Never	4 (8.0)
	Seldom	25 (50.0)
	Frequent	17 (34.0)
	Always	4 (8.0)
Fast food consumption	Never	2 (4.0)
	Seldom	5(10.0)
	Frequent	21 (42.0)
	Always	22 (44.0)
Snacking times	Seldom	5 (10.0)
	Frequent	26 (52.0)
	Always	19 (38.0)
Physical activity	Never	9 (18.0)
	Seldom	29 (58.0)
	Frequent	11 (22.0)
	Always	1 (2.0)
Smoking habit	Yes	42 (84.0)
	No	8 (16.3)
Alcohol consumption	Yes	47 (94.0)
	No	3 (6.0)
History of NCD in Family	Yes	42 (84.0)
	No	8 (16.0)

Table 4: Frequence of all potential factors.

All of samples had low level of LDL to HDL and total cholesterol to HDL ratio (Chart 1). Most of samples were underweight who show the result of developing low level of LDL to HDL ratio and total cholesterol to HDL ratio as well as normal, overweight, and obese people.

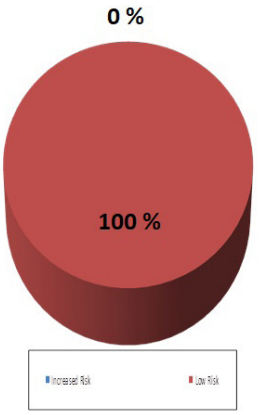

Chart 1: Distribution and Frequence of the ratio of LDL to HDL and total cholesterol to HDL.

Theoretically, the excessive body weight increases the risk of CVD by looking at the blood cholesterol content because the body weight can affect one's cholesterol value. Each loss of 1 kilogram (2 pounds), the HDL can increase 0.35 mg/dl and approximately 1 mg/dl for every 3 kg (6 pounds). Calculating the ratio of LDL and HDL is one way of measuring the cardiovascular risk factor. This ratio is the most predictive value for atherosclerosis incidence. If the ratio of LDL to HDL is more than 3, it can increase the risk of CVD [13]. This study aimed to find out if BMI correlated with the assessment of cardiovascular risk factor based on one's ratio of LDL to HDL and total cholesterol to HDL using correlation

ratio design study. BMI was likely to influence the low level of LDL to HDL ratio (η2=0,705) and total cholesterol to HDL ratio (η2=0,765), confirmed statistically significant. 94% samples with low risk category of waist to hip ratio were likely to have low risk for cardiovascular disease. Waist to hip ratio influenced the low level of LDL to HDL (η2 =0.003) and total cholesterol to HDL ratio (η2 =0.021). Other factors that associated with the level of LDL to HDL and total cholesterol to HDL ratio were frequency of daily intake including fruit, vegetables, and snacking consumption, physical activity, and family history of incommunicable disease (Tables 5 and 6).

No	Factors	Correlation Coefisien	Eta square	F count	Signi-ficance	Information
1	Gender	0,427	0,183	10,728	0,000	Not Linear
2	BMI	0,840	0,705	0,958	0,564	Linear
3	Waist to hip ratio	0,059	0,003	0,165	0,686	Linear
4	Daily intake	0,483	0,239	4,661	0,006	Not Linear
5	Fruit and vegetables consumption	0,253	0,064	1,052	0,379	Linear
6	Fast food consumption	0,411	0,169	3,117	0,035	Not Linear
7	Snacking frequence	0,305	0,093	4,116	0,101	Linear
8	Physical activity	0,205	0,042	0,672	0,573	Linear
9	Smoking habit	0,448	0,200	12,031	0,001	Not Linear
10	Alcohol consumption	0,107	0,011	0,551	0,462	Linear
11	History of having Non-communicable disease	0,009	0,000	0,004	0,952	Linear
12	History of cardiovas-cular disease in family	0,023	0,000	0,024	0,877	Linear

Table 5: Correlation of the potential factors with ratio of LDL to HDL cholesterol.

No	Factors	Correlation Coefisien	Eta square	F count	Signi-ficance	Information
1	Gender	0,534	0,285	19,171	0,000	Not Linear
2	BMI	0,875	0,765	1,304	0,304	Linear
3	Waist to hip ratio	0,146	0,021	1,050	0,311	Linear
4	Daily intake	0,512	0,512	5,456	0,003	Not Linear
5	Fruit and vegetables consumption	0,169	0,028	0,448	0,720	Linear
6	Fast food consumption	0,423	0,179	3,345	0,027	Not Linear
7	Snacking frequence	0,386	0,149	4,116	0,023	Not Linear
8	Physical activity	0,386	0,034	0,532	0,662	Linear
9	Smoking habit	0,440	0,193	11,502	0,001	Not Linear
10	Alcohol consumption	0,030	0,001	0,044	0,834	Linear
11	Noncommunicable disease	0,128	0,016	0,796	0,377	Linear
12	History of cardiovas-cular disease in family	0,006	0,000	0,002	0,967	Linear

Table 6: Correlation of the potential factors with ratio of total cholesterol to HDL.

Conclusion

The strongest association was a relation of the level of LDL to HDL and total cholesterol to HDL ratio with Body Mass Index. By knowing the risk factors, cardiovascular disease can be prevented at earlier age.

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