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Correlation between Diabetes Mellitus Type 2, Cholesterol with Calcium Score in Patient with Hypertension and Obesity

Hubungan Diabetes Melitus, Kolesterol dengan Skor Kalsium pada Pasien Hipertensi dengan Status Gizi Obesitas

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ABSTRACT

Background: Obesity is more of a nutritional problem that becomes one of the double nutritional problems that must be overcome. A person with obesity tends to have a higher risk of developing hypertension, diabetes mellitus type 2, and the possibility of having a heart attack, which can show calcium scores in the heart.
Objectives: This research aimed to analyze the relationship and look at differences in the incidence of DM type 2, cholesterol, and calcium scores in patients suffering from hypertension and obesity.
Methods: This research used a cross-sectional study design with a quantitative method. The data collection was conducted at Siloam Hospital Surabaya (2018-2021). The determination of the sample adjusts to the criteria set by the researcher. Sample withdrawal used the purposive sampling method. The sample number was 59 men and 59 women. Research instruments were a questionnaire, interview, collecting data anthropometry, hypertension history, and cholesterol history.
Results: Most of the subjects were elderly (38.1%). There were differences in the cholesterol history of women and man subjects (p=0.002). There was no noticeable difference in the history of DM type 2 in the subjects (p=0.092). There was no noticeable difference in calcium scores in the subjects (p=0.062). Most subjects other than having DM type 2 also had a history of cholesterol (73.3%). There was no noticeable correlation between cholesterol with DM type 2 in subjects (p=0.006). Most subjects with a history of DM type 2 was in a meaningful calcium score (26.6%). No association between DM type 2 and calcium score in subjects (p=0.102).
Conclusions: There was no association between the incidence of diabetes mellitus type 2 and cholesterol and the incidence of DM type 2 with calcium scores in patients. There was a noticeable difference in the incidence of cholesterol in the subjects. No difference in the incidence of DM type 2 and calcium scores was found in subjects who were patients with a history of hypertension and obesity.

INTRODUCTION

Obesity is one of the multiple nutritional problems that must be prevented. A person is categorized as obese if they have a BMI of ≥27.0 kg/m^2 [1]. Nowadays, obesity is a significant health problem in Indonesia, considering that the prevalence of obesity in adults (>18 years) is relatively high, 21.8% of which generally occurs in women (29.3%) and the age group of . The high prevalence of hypertension in Indonesia is high (34.11%), making this health problem one of the acute diseases. Hypertension generally occurs in women (36.85%) above 75 years (69.53%)[5]. A person 40-44 years (29.6%)[2]. Obesity is an essential concern because a person with this health problem tends to have a greater risk of hypertension[3]. A person with obesity has a 3.8 times greater risk of developing hypertension than a person who is not obese[4]. Fat accumulation in obese persons causes blockages in blood vessels, leading to increased blood pressure
can be classified as hypertensive when the diastolic blood pressure is ≥90 mmHg and/or systolic ≥140 mmHg[6].

Obesity is closely related to hypertension, type 2 DM disease, and heart attacks as part of coronary heart

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disease (CHD). Coronary heart disease is caused by fat deposits and high cholesterol in the heart's arteries. In someone who is obese, there is a tendency to have high cholesterol levels. Obesity, hypertension, type 2 DM, and CHD are interrelated. An obese person generally has excess fat deposits (adipocyte cell hypertrophy), causing a cell response β-pancreas, reducing their activity when the blood glucose is high. This condition decreases insulin receptor sensitivity and results in insulin resistance. Ultimately, the ability to take blood glucose decrease and triggers type 2 diabetes mellitus (DM). In addition, due to the accumulation of fat in adiposity cells, there is an increase in the angiotensin renin system, so that blood volume increases and triggers high pressure in capillary blood vessels, and there is a risk of endothelial dysfunction and vascular dysfunction, which causes hypertension. A positive relationship exists between CHD in type 2 DM patients with hypertension and obesity[7].

The incidence of heart attacks in people with CHD often occurs in addition to other symptoms such as shortness of breath and chest pain. The high chance of a heart attack is seen from the calcium score in arterial blood vessels, a cardiovascular disease marker. The presence of a total calcium score in the heart may indicate that there is also a coronary artery disease. Coronary artery disease is closely related to high cholesterol levels, obesity, hypertension, and type 2 diabetes mellitus (DM). When some calcium in arterial blood vessels is left in the blood, this condition tends to produce fat or cholesterol deposits that cause plaque in the coronary arteries. With calcium in the coronary arteries, the plaque will harden, inhibiting the circulatory process by the heavier heart working. In addition, a heavier heart working will damage arterial blood vessels and cause blood clots (thrombosis). This incident begins early detection by conducting a Calcium CT Scan (calcium coroner scan) to check for calcium deposits on the arterial walls that trigger heart disease. This research studied the relationship between cholesterol, obesity, hypertension, and type 2 DM in men and women. To best our knowledge, research that discusses the correlation between type 2 DM and calcium scores as a marker of cardiovascular events in patients who focus on hypertension and obesity still needs to be done[8].

The study aimed to analyze whether there was a relationship between a history of type 2 DM with cholesterol and calcium scores in patients suffering from hypertension and obesity. In addition, this research also looked at the presence or absence of differences in the incidence of cholesterol, diabetes mellitus (DM) type 2, and calcium scores in male and female patients with hypertension and obesity. This study indirectly illustrates whether there is a correlation between type 2 DM and calcium scores. Calcium scores can describe the level of heart attack risk, especially in patients with hypertension accompanied by obesity, to evaluate and learn that hypertension accompanied by obesity is a disease and nutritional problem that must be resolved.

METHODS

A cross-sectional study design was used in this study. The type of research was analytical observational with a quantitative approach. The data collection place was collected at Siloam Hospital Surabaya. This hospital was chosen because they had many patients with a risk of heart disease. The data shows that of the 1,764 patients who underwent treatment at Siloam Hospital Cardiac Poly, 536 had a high risk of heart disease. Data collection was selected in 2018-2021 based on primary data of Cardiac Poly patients at Siloam Hospital Surabaya. The research was declared ethically feasible and received approval from the Director of Siloam Hospital with number 103/DIR-SHSB/III/2018.

The selection of samples was taken based on sample inclusion criteria: (1) Male and female patients who were treated at Siloam Hospital Surabaya, (2) Patients who had a hypertension history, (3) Obese specified patients (BM≥25 kg/m^2), and (4) Had conducted a calcium score test at Siloam Hospital Surabaya. The research sample was drawn using purposive sampling. The total number of samples obtained was 59 male and 59 female subjects.

This study used primary data including several factors: (1) Characteristics of subjects based on gender, age, height, and weight, (2) Whether or not there is a history of type 2 DM, (3) There is a history of total cholesterol levels, (4) A history of hypertension, and (5) Calcium scores.

Interviews with subjects carried out sex and age data. Gender was classed into male and female. The division of age was based on the Ministry of Health of the Republic of Indonesia, namely: (1) late adolescents (17-25 years), (2) early adults (26-35 years), (3) late adults (36-45 years), (4) early elderly (46-55 years), (5) late elderly (56-65 years), and (6) seniors (>65 years). Height data was measured using OneMed brand microtoise with an accuracy level of 0.1 cm. Subjects' body weight (BW) was measured using OneMed brand weight scales (accuracy level 0.1 kg). Data on body weight (BW) and height were processed to obtain the Body Mass Index (BMI) value by dividing body weight (kg) by the square of height (m). The BMI subjects specified in this study were those with a BMI of ≥ 27 kg/m2, indicating an obese patient.

Data collection of type 2 DM and cholesterol level history was taken using interviews by answering whether or not there was a history of DM type 2 disease and cholesterol in the last 5-10 years. Hypertension history data was collected by conducting periodic blood pressure checks by doctors every time the subject sought treatment using an Omron HEM-8712 brand sphygmomanometer. Hypertension was categorized using diastolic blood pressure ≥90 mmHg and/or systolic ≥140 mmHg. Calcium score was conducted using an electron beam, multi-detector computed tomography scan (CT-Scan), and the American Heart Association (AHA) guidance. The classification of calcium scores was grouped into five: (1) 0 (zero) if the calcium score was 0, (2) minimal (very mild) if the calcium score was 1-10, (3) mild (mild) if the calcium score was 11-100, (4) moderate (moderate) if the calcium score was 101-400, and (4) significant if the calcium score is 401 and above.

The data came from secondary data on cardiology specialist patient visits and medical record data, then processed and analyzed. Furthermore, in interviews with patients (the qualitative data), there was

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an explanation of the informed consent form for patients before they were willing to follow the data collection process by the researcher. The data collection process involves health workers in Siloam Hospital, including medical record staff, nurses, radiographers, and Cardiology Specialists (auto anamneses). The data collection process began with interviews with patients using questionnaires, looking at the anamnesis of medical record data.

Data processing (editing, coding, entry, cleaning, and analysis) was done after collecting data. The apps used were Microsoft Excel 2019 and the SPSS application version 16.0. This study used descriptive analysis to describe the variables studied and inference analysis using causality tests and correlation tests (determination of normality from the date of the study results using the Kolmogorov-Smirnov Test). The Mann-Whitney test was conducted to analyze differences in type 2 diabetes mellitus (DM), cholesterol history, and calcium scores in hypertensive patients with obese men and women. The Chi-Square test was conducted to analyze the correlation of type 2 DM and Cholesterol with calcium scores in hypertensive subjects with obesity.

RESULTS AND DISCUSSION

In this study, the respondents or subjects treated at Siloam Hospital Surabaya were outpatients (Rawat Jalan patients). A total of 118 people were selected, including 59 male subjects (50%) and 59 female subjects (50%). The age distribution of subjects was 23-78 years, and most subjects were in the late elderly group (38.1%) (The age distribution is shown in Table 1). The subjects who seek treatment at Siloam Hospital Surabaya are generally the elderly because hypertension is one of the diseases often suffered by the elderly, which is 57.6%[10]. The elderly are susceptible to degenerative diseases because their physiological functions decrease due to aging. Moreover, the elderly are susceptible to infectious disease infections due to a decreased endurance and aging process[11].

Table 1. The division of age classification of subjects

Age Categories	n	%
Late Adolescence (17-25 years old)	1	0.8
Early Adulthood (26- 35 years old)	2	1.7
Late Adulthood (36-45 years old)	11	9.3
Early Seniors (46-55 years old)	33	28.0
Late Seniors (56-65 years old)	45	38.1
Seniors (>65 years old)	26	22.0
Total	118	100,0

Male subjects, mostly having a history of hypertension accompanied by obesity, did not have a history of high cholesterol (62.7%), while female subjects mostly had a history of high cholesterol (66.1%) (Table 2). Total cholesterol levels in the blood indicate the risk of cardiovascular disease (CVD), especially heart disease and stroke. People who are overweight or obese generally have higher blood cholesterol levels than those with an average weight. Blood cholesterol levels tend to increase in someone with obesity, smokers, and those who lack exercise[12]. Besides related to obesity, cholesterol levels in the blood also affect blood pressure. High blood pressure, when it occurs repeatedly, can be classified as hypertensive. Relevant and meaningful associations were found between total blood cholesterol levels and systolic and diastolic blood pressure in previous research subjects[13].

Table 2. The distribution of data on the history of cholesterol and type 2 diabetes mellitus (DM) in subjects

History of the disease		Gender				Mann-Whitney Test
		Male		Female		
		n	%	n	%	
Have a History of Total cholesterol>200 mg/dL	Yes	22	37.3	39	66.1	0.002
	No	37	62.7	20	33.9	
Have a History of Type 2 Diabetes Mellitus	Yes	11	18.6	19	32.2	0.092
	No	48	81.4	40	67.8	

As hypothesized, the results of the study's Mann-Whitney difference test found a noticeable difference in Cholesterol history in male and female subjects (p=0.002). It shows that certain conditions, including a history of hypertension and obesity in the subject, can be used as one of the factors that cause a history of high cholesterol in both male and female subjects. The presence of a history of high cholesterol in this study's subjects occurred in the early elderly, late elderly, and elderly. This result supported a previous study that age is relevant to high cholesterol levels. The older a person is, the more blood cholesterol levels in a person's body increase. The same study also showed that gender did not affect cholesterol levels, but there was a relationship with BMI. That is, the more the BMI value increases, the more the blood cholesterol level in the blood[14].

The results of this study showed that subjects with a history of hypertension accompanied by obesity mostly did not have type 2 DM, both in male subjects

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(81.4%) and female subjects (67.8%) (Table 2). Thus, in line with previous research conducted by distinguishing subjects with obesity, subjects who are not obese, subjects who have a history of type 2 DM, and subjects who do not have a history of type 2 DM. The results showed that most obese subjects had no history of type 2 DM (77.1%). However, the same study showed a relationship between obesity and DM type 2[15]. Meanwhile, other studies have shown that hypertension[16] also follows people with diabetes. Instead, this research did not study this variable.

The results of the Mann-Whitney difference test showed no noticeable difference in the history of type 2 DM between male and female subjects (p=0.092). The gender of subjects with certain conditions, obesity accompanied by hypertension, does not affect the presence or absence of a history of type 2 DM in male and female subjects. Contrarily, these results were not similar to other studies, which showed that a person with hypertension and type 2 DM was generally experienced by women[16]. This research showed different results because the number of subjects with a history of type 2 DM in this study is low compared to subjects who do not have a history of type 2 DM.

The age factor also showed no influence on the results of this study. Most subjects with no history of type 2 DM were those with the age categories of early elderly, late elderly, and seniors. In other words, the age of subjects with no history of type 2 DM starts from 46 years and above. This finding was inconsistent with previous studies that a person who is ≥ 45 years old will experience more type 2 DM than someone < 45 years old. A person who is ≥ 45 years old will have an eight times greater risk of contracting type 2 DM disease than someone < 45 years old[17]. The history of type 2 DM in the subjects was only asked through interviews, with no direct blood sugar measurements, either regular blood sugar, 2 hours postprandial blood sugar, or fasting blood sugar. Interviews with subjects only asked whether the subjects had a history of type 2 DM disease in the last 5-10 years. In the absence of direct measurement of blood sugar levels, it could not be seen whether there was a significant development in the history of type 2 diabetes mellitus disease in the subjects. This study's limitations relied on the subject's memory in the last 5-10 years.

The research found that most male subjects had a mild category in the calcium score (23.7%), while the female subjects were in the zero (40.7%). The distribution of calcium score classification in subjects can be seen in Table 3. Male subjects were spread across every classification of calcium scores ranging from zero to meaningful categories. The same result was also shown by previous studies in the distribution of coronary artery calcium classification scores in male study subjects, which was spread almost evenly across all classifications. Whereas in female subjects, it was mostly at zero classification[19]. However, the difference was that in this study, the subjects studied were subjects with a history of hypertension and obesity, while previous studies used healthy populations.

Table 3. The distribution of calcium score classification data in subjects

Calcium Score Classification	Gender				Mann-Whitney Test
	Male		Female		
	n	%	n	%	
Zero (Calcium score 0)	11	18.6	24	40.7	0.062
Very Light (Calcium score 1-10)	9	15.3	3	5.1	
Light (Calcium score 11-100)	14	23.7	11	18.6	
Moderate (Calcium score 101-400)	12	20.3	14	23.7	
Significance (Calcium score >400)	13	22.1	7	11.9	
Total	59	100.0	59	100.0	

The results of the Mann-Whitney difference test in this study found no significant difference in calcium scores between male and female subjects with a history of hypertension with obesity (p=0.062). This condition was most likely due to the distribution of male subjects in this study in all categories, in contrast to female subjects, primarily in category zero. The results obtained are the same as those from previous research, showing that the zero calcium score was found predominantly in female subjects in the study with a younger age group[19].

In addition to gender factors, age also showed no relationship with calcium scores in study subjects. Most of the subjects studied had zero calcium scores in the early elderly category (42.9%), very mild calcium scores in the early elderly category (50%), mild calcium scores in the late elderly category (44%), moderate calcium scores in the seniors' category (42.3%), and meaningful calcium scores in the final elderly category (55%). There was a positive association between age and coronary artery calcium scores in both genders. The distribution of the classification of coronary artery calcium scores is strongly influenced by age and gender as we get older, along with an increase in coronary artery calcium scores[19].

The study's results stated that most subjects with a history of type 2 DM also had a history of cholesterol (73.3%). Meanwhile, subjects with no history of type 2 DM also had no history of cholesterol (55.7%) (Table 4). The results of this study were under the previous year's research related to the condition of the study subjects who had a history of hypertension. The study stated a relevant or significant difference in cholesterol-LDL levels with subjects who had type 2 DM with hypertension compared to subjects with type 2 DM without hypertension[20].

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Table 4. Distribution of data on the history of type 2 diabetes mellitus (DM) and cholesterol in subjects

History		Cholesterol				Chi-Square Test
		Yes		No		
		n	%	n	%	
Type 2 diabetes mellitus	Yes	22	73.3	8	26.7	0.006
	No	39	44.3	49	55.7	

The Chi-Square Test showed no significant correlation between cholesterol and type 2 DM in subjects with hypertension and obesity (p=0.006). Thus, it was not following previous studies stated that there was a real or significant relationship between elevated LDL-cholesterol levels and hypertension in subjects with type 2 diabetes mellitus (DM)[20]. Other studies in subjects with type 2 DM found no real relationship between BMI and total cholesterol levels[21]. What may be an influential factor and a deficiency in this study was the history of type 2 DM, and cholesterol was only asked through open-ended questions without regular measurements. The open-ended question only asks whether the subject has a history of type 2 DM and cholesterol within the last 5-10 years. However, no periodic measurement of blood sugar levels and total cholesterol levels was done to see if there was any development.

This research proved that most subjects with a history of type 2 DM and hypertension accompanied by obese were having meaningful calcium scores (26.6%). Meanwhile, those who did not have a history of type 2 DM were in the zero calcium score (Table 5). This finding shows that subjects with obesity, hypertension, and type 2 DM generally have a risk of heart attack and other cardiovascular diseases, indicated by the high calcium score well over the classification (calcium score >401). Pathological studies show a real and meaningful relationship between the presence of coronary calcium scores and coronary artery disease. Calcium artery scores and age are also associated with the incidence of coronary heart disease and can predict the incidence of stroke[22].

Table 5. Distribution of type 2 diabetes mellitus (DM) history data and calcium score classification in subjects

History		Calcium Score Classification					Chi-Square Test
		Nol	Very Light	Light	Medium	Meaningful	
Type 2 diabetes mellitus	Yes	5 (16.7 %)	2 (6.7 %)	5 (16.7 %)	10 (33.3 %)	8 (26.6 %)	0.102
	No	30 (34.1 %)	10 (11.4 %)	20 (22.7%)	16 (18.2 %)	12 (13.6 %)	

The results of the Chi-Square Test in the study proved that there was no actual or significant association between type 2 DM and calcium scores in subjects with hypertensive conditions accompanied by obesity (p=0.102). This finding is unsupported because obesity, hypertension, and type 2 DM disease are some risk factors that cause heart attacks and cardiovascular diseases indicated by high calcium scores. The systematic review and meta-analysis study results concluded that coronary artery calcium scores could predict all causes of death and cardiovascular disease in subjects with type 2 DM. People with a <10 coronary artery calcium score had a 6.8 times lower risk of having a cardiovascular[23]. However, other studies state that obesity and type 2 DM and its consequences with micro and macrovascular complications still require several approaches. Coronary artery calcium scores also identified a subgroup of patients with diabetes who were at low risk for death from cardiovascular disease[24].

Hypertension and obesity are nutrition and health problems that are important to pay attention to in the community, especially for the elderly. Although there was no association between cholesterol and type 2 DM and between type 2 DM and calcium score, it is essential to pay attention to calcium scores which are markers of heart attack risk and cardiovascular disease. The advantage of this study was that it focuses on subjects with certain conditions, including a history of hypertension with obesity. Meanwhile, the limitations of this study were that more complete and periodic data were still needed, such as total cholesterol levels in the blood and blood sugar levels in the subjects during the study period (2018-2021).

CONCLUSIONS

There was no correlation between type 2 DM with Cholesterol and type 2 DM with calcium scores in patients with a history of hypertension with obesity. There was a marked difference in high cholesterol in female and male subjects. In addition, no noticeable differences were found in type 2 DM and calcium scores in male subjects who were patients with a history of hypertension accompanied by obesity. Further and more in-depth research on the importance of considering the regular intake of cholesterol levels and blood sugar levels should be carried out to obtain more relevant and in-depth data. In addition, future studies can assess the risk of heart disease using methods to measure data on food consumption, physical activity levels, blood pressure measurements, and total Cholesterol (LDL, HDL, and Triglycerides). Furthermore, specific calcium score assessment methods such as ECG, X-Ray, Coronary Angiogram, Nuclear Perfusion Scan, and others could be done in the future to strengthen the diagnosis of a person at risk of suffering from heart disease to correct deficiencies in this study.

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