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Correlation of anthropometric sizes with blood presure, total cholesterole level, and blood fasting glucose level in young adult

Korelasi ukuran antropometri dengan tekanan darah, kolesterol total, dan gula darah puasa pada orang dewasa muda

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Abstract

Obesity and overweight raised cardiovascular disease risk through metabolic disfunction. Anthropometric is a simple and non invasive examination that can be used to detect metabolic disorders. This study aimed to evaluated correlation of anthropometic sizes (BMI, WC, WHR, and skinfold) with systolic and diastolic blood pressure (BP), total cholesterol (TC), and fasting blood glucose (FBG). This cross sectional study involved 88 young adults as subject in 2019. Total cholesterol and fasting blood glucose was examined by digital rapid test, taken in the morning after 10-12 hours fasting. Datas were analyzed univariately to describe each variable. Then, datas were analyzed bivariately using Pearson correlation test for BMI, WC, WHR, TC, FBG, and Spearman rho test for skinfold and BP. The study showed that BMI correlated with dyastolic BP, and total cholesterol ($p<0,05$). WC correlated with systolic BP and diastolic BP ($p<0,05$). Biceps skinfold correlated with systolic BP, dyastolic BP, and total cholesterol ($p<0,05$). Triceps skinfold correlated with systolic BP, dyastolic BP, and total cholesterol ($p<0,05$). Suprailiaca skinfold correlated with systolic BP, dyastolic BP, and total cholesterol ($p<0,05$). In Conclusion, anthropometric can be used as predictor of total cholesterol level and blood pressure in young adult subjects.
Keywords: Anthropometric, cardiovascular, cholesterol

Abstrak

Obesitas dan *overweight* meningkatkan risiko penyakit kardiovaskuler melalui disfungsi metabolik. Antropometri merupakan pemeriksaan sederhana dan tidak invasif yang dapat digunakan untuk mendeteksi kelainan metabolik. Penelitian ini bertujuan untuk menilai hubungan ukuran antropometri (IMT, LP, RLPP, dan tebal lemak) dengan tekanan darah (TD) sistolik dan diastolik, kadar kolesterol total, dan glukosa darah puasa (GDP) . Penelitian *cross sectional* ini melibatkan 88 orang dewasa muda sebagai subyek penelitian pada tahun 2019. Pemeriksaan kadar kolesterol total dan kadar gula darah menggunakan *digital rapid test,* diambil pagi hari setelah subyek berpuasa 10-12 jam. Data dianalisis secara univariat untuk mendapatkan gambaran masing-masing variabel. Selanjutnya dilakukan uji bivariat menggunakan uji korelasi Pearson untuk IMT, LP, RLPP, Kolesterol total dan GDP serta uji Spearman rho untuk ketebalan lemak dan TD. Hasil penelitian menunjukkan IMT berkorelasi dengan TD diastolik dan kolesterol total ($p<0,05$). LP berkorelasi dengan TD sistolik dan diastolik ($p<0,05$). Tebal lemak bisep berkorelasi dengan TD sistolik, diastolik, dan kolesterol total ($p<0,05$). Tebal lemak trisep berkorelasi dengan TD sistolik, diastolik, dan kolesterol total ($p<0,05$). Tebal lemak subskapular berkorelasi dengan TD sistolik , diastolik , dan kolesterol total ($p<0,05$). Tebal lemak suprailiaka berkorelasi dengan TD sistolik , dan diastolik , dan kolesterol total ($p<0,05$). Kesimpulan, antropometri dapat digunakan sebagai prediktor

tekanan darah dan kadar kolesterol total pada orang dewasa muda.
Kata Kunci: Antropometri, kardiovaskular, kolesterol

Introduction

Cardiovascular diseases are a group of disorders of the heart and blood vessels (WHO, 2017). Cardiovascular disease is the leading cause of death and disability in the world. WHO data shows about 17,9 million people (31%) died from cardiovascular disease in 2016, and about 85% of them occurred in countries with low- to medium-income per capita categories. This is because people in low- and middle-income countries have limitations in early detection and effective health services for cardiovascular disease (WHO, 2018).

High mortality from cardiovascular disease is associated with a high prevalence of overweight and obesity (Tirosh et al., 2011). Some studies show that overweight and obesity are risk factors for cardiovascular disease (Tirosh et al., 2011; Schmidt et al., 2013; WHO, 2016). Being overweight causes metabolic dysfunction and increases blood pressure, cholesterol, and blood glucose, which increase the risk of ischemic heart disease (Obregon, 2010; McPhee et al., 2011; WHO-SEARO, 2011).

Obesity and overweight are conditions of being overweight. Obesity and overweight can be identified by anthropometry. Anthropometry is the science of predicting or estimating body composition based on measures of weight, height, body circumference, and thickness of subcutaneous fat. Anthropometry was already known at the end of the 19th century and has been widely used in human biological research (Heymsfield, 2006). As a simple and non-invasive test for the detection of metabolic disorders, anthropometric measures can be used efficiently in clinical and epidemiological studies. As a simple and non-invasive test for the detection of metabolic disorders, anthropometric measures can be used efficiently in clinical and epidemiological studies (Yang et al., 2017).

Anthropometric measures have their own advantages and disadvantages in predicting body fat levels. There is no single ideal anthropometric measure for predicting cardiometabolic risk from early childhood to adulthood (Al, 2015). Anthropometric measures that are widely used for adults are body mass index, waist circumference, waist-pelvic circumference ratio, and thick fat under the skin (Heymsfield, 2006).

Research on anthropometric size and its relationship with cardiovascular risk factors has been widely conducted in Western countries, but not much in Indonesia, especially in young adults. Young adults (18–25 years) are an important target for preventive interventions for health problems because this age is associated with a transitional period in which there are significant lifestyle changes that affect health (Tsai et al., 2013).

This study aims to determine the relationship of anthropometric measures with blood pressure, total cholesterol levels, and fasting blood glucose levels in young adult groups. In this case, the young adult group was represented by students of the Faculty of Medicine at HKBP Nommensen University (FK UHN).

Methods

This research was conducted at the Faculty of Medicine, HKBP Nommensen University Medan, in 2019. The subjects of the study were students of the classes of 2016, 2017, and 2018, who were taken with purposive sampling techniques. The research design used was cross-sectional.

This study involved 88 students aged 18–25 who were willing to be research subjects. The minimum sample size calculated based on the correlation sample size formula is 72 people. The exclusion criteria of this study were a history of using drugs that affect total cholesterol, blood glucose, and blood pressure in the past month, following a diet management program, being a smoker, and being sick.

Prospective research subjects who have been briefed on the research are required to sign a research approval sheet before being scheduled for fasting, anthropometric measurements, and blood tests. This research has received permission from the Health Research Ethics Commission of FK UHN with No. 069/KEPK/FK/XI/2018 issued on November 22, 2018.

Body weight was weighed twice with a digital scale, and the average value was taken.

The study subjects were asked to use thin clothing when weighing themselves. The measurement was reported as body weight in kilograms (kg).

Height measurement is carried out using a stature meter. During measurement, the subjects' footwear was removed, and they were asked to stand upright with the back of the body against the wall, both arms at the sides of the body, a straight look at the head, and the line of sight parallel to the ground. The stature meter is in the middle of both feet of the subject. Height was measured when research subjects were inspired within. Height is measured twice; the average value is taken and recorded as a number after the comma in m.

Next, the weight value (kg) is divided by the square of the height (m) to get the body mass index (BMI) value. The result of the calculation is recorded one number after the comma.

Subjects were then asked to remove their upper clothing, waist straps, and loosen pants for waist circumference measurements. The measuring tape is pulled starting from the protrusion of the right pelvic bone (crista illiaca dextra) towards the navel horizontally parallel to the floor and then looped to its original position. The subject was asked to breathe normally, and the waist circumference was taken when the subject exhaled (end of expiration). Waist circumference is measured twice, and then the average value is calculated and recorded one number after the comma in cm.

For pelvic circumference measurement, study subjects were asked to wear thin pants. The zero end of the meter is placed on the right thigh joint, folding top, and then the meter is looped around the widest buttocks horizontally and parallel to the floor. The circumference of the pelvis is measured twice, then the average value is calculated and recorded one number after the comma in cm units.

After obtaining the size of the waist and pelvic circumference, calculate the ratio of the Waist to Hip Ratio (WHR). The WHR value is recorded one digit after the comma.

The measurement of the thickness of fat under the skin is carried out using a skinfold caliper. The study subjects were asked to remove their clothes and use only underwear. Thick fat under the skin is examined at four locations, namely the triceps, biceps, subscapular, and suprailiaca. Measurements are taken twice, and then the average is taken.

The subjects' blood pressure was measured in a sitting position after a five minute break. Blood pressure is measured twice, then averaged and reported in mmHg.

Cholesterol and blood sugar checks are performed using a digital rapid test using peripheral blood. Blood samples were taken from 8:00 to 9:00 in the morning after the subjects fasted for 10–12 hours.

Univariate data analysis is carried out to get an overview of the characteristics of the variables studied and assess the distribution of the data. Furthermore, bivariate analysis was carried out to assess the relationship between research variables. The relationship between variables that have normal distributions (BMI, Waist Circumference/WC, Waist-to-Hip Ratio/WHR, total cholesterol, and Fasting Blood Glucose/FBG) is carried out with the Pearson correlation test, while for variables that have abnormal distributions (biceps, triceps, subscapular, suprailiac, cytolic, and diastolic blood pressure), the Spearman rho correlation test is carried out.

Result and Discussion

Description of Research Subjects

This study involved 88 FK UHN students with an age range of 18–25 who met the criteria. Of all the study subjects, 28 were men and 60 were women.

Description of Anthropometric Measures, Blood Pressure, Total Cholesterol Levels, and Blood Sugar Levels of Subjects

Table 1 shows descriptions of BMI, AC, WHR, skinfold, systolic and diastolic blood pressure, total cholesterol, and fasting blood glucose (FBG) across study subjects. Based on table 1, it is known that the mean BMI value of the sample is 24,43 kg/m2, waist circumference and WHR are still in the normal category in both men and women, and the median value of waist circumference, WHR, biceps fat, triceps, subscapular, and suprailiac is higher in the male group than in women. The median value of systolic and diastolic blood pressure is still within normal limits. The mean value of fasting blood glucose is within normal limits, and the mean value of total cholesterol belongs to the desired category.

The results showed the mean BMI value of the sample was 24,43 kg/m2, including the overweight category according to the International Obesity Task Force Western Pacific (Asia Pacific Criteria) (Soegih, 2004). This shows that the incidence of obesity in young age groups is quite high. The WHO report shows that in 2016, about 39% of the adult population was overweight. This figure is almost three times the percentage in 1975. The prevalence of overweight and obesity is also increasing in children and adolescents. The increase went from about 4% in 1975 to 18% in 2016 (WHO, 2019).

The median values of waist circumference, WHR, subscapular, and suprailiac were higher in the male group than in the female group. This suggests that central obesity is more common in males. This is related to the male body shape, which is generally an android type. The male body shape is generally shaped like an apple because excess fat in men is stored under the skin, abdominal wall, and abdominal cavity, while in women, the gynoid type is generally shaped like a pear because excess fat is stored under the skin of the pelvic area and thighs (Kumar & Abbas, 2009).

The median values of systolic and diastolic blood pressure samples obtained in this study are within normal limits. These results are in line with previous research results showing that students' systolic and diastolic blood pressures were largely normal (Abaa et al., 2017).

The average value of total cholesterol obtained in this study was 203,99 mg/dl (including desirable criteria). The results of research in Jordan showed similar results: the proportion of total cholesterol in students (aged 18–25 years) was mostly in the normal category, with an average value of 194,27 mg/dl (Alquraishi & Rababah, 2016).

The results of this study showed an average value of fasting blood sugar levels of 94,52 mg/dl (including normal criteria). This result is in line with previous research that showed the blood glucose levels of college students generally (93,55%) were found to be in the normal category (Rorong et al., 2011).

Table 1. Description of anthropometric measures, blood pressure, total cholesterol, and blood sugar of research subjects

Variable	n	Minimum	Maximum	Mean/ Median	SD
BMI (kg/m^2)					
Male	28	17,27	46,04	26,06*	6,42
Female	60	16,25	42,7	23,67*	5,42
Combined	88	16,25	46,04	24,43*	5,83
WC (cm)					
Male	28	63	126,5	87,75*	15,78
Female	60	60,6	108,7	78,34*	10,27
Combined	88	60,6	126,5	81,36*	12,96
WHR					
Male	28	0,77	1	0,88*	0,07
Female	60	0,72	0,99	0,83*	0,06
Combined	88	0,72	1	0,84*	0,06
Biceps (mm)					
Male	28	2	20	5**	4,29
Female	60	1	14	2,5**	2,85
Combined	88	1	20	4**	3,63
Triceps (mm)					
Male	28	3	39	11,5**	8,53
Female	60	3	18	7**	4,13
Combined	88	3	39	8**	6,59
Subscapular (mm)					
Male	28	6	46	18**	9,9
Female	60	2	18	6**	3,62
Combined	88	2	46	8**	8,72

Variable	n	Minimum	Maximum	Mean/ Median	SD
Suprailiac (mm)					
Male	28	5	37	18,5**	9,29
Female	60	2	15	7,5**	2,95
Combined	88	2	37	8**	8,39
Systolic Systolic Blood					
Pressure (SBP) (mmHg)	28	100	150	120**	10,52
Male	60	90	140	110**	8,73
Female	88	90	150	120**	9,92
Combined					
Diastolic SBP (mmHg)					
Male	28	60	90	75**	9,2
Female	60	60	90	70**	7,05
Combined	88	60	90	70**	7,82
Total Cholesterol (g/dl)					
Male	28	109	379	172,18*	57,74
Female	60	118	373	218,83*	57,60
Combined	88	109	379	203,99*	61,33
FBG (g/dl)					
Male	28	74	118	97,5*	13,07
Female	60	72	137	93,13*	13,42
Combined	88	72	137	94,52*	13,89

*Mean Value, **Median Value, SD= Standard Deviation

Correlation of Anthropometric Size with Blood Pressure, Total Cholesterol, and Fasting Blood Sugar

The results of the hypothesis test showed that BMI was correlated with diastolic Blood Pressure (BP) and total cholesterol levels. Previous research found that an increase in BMI every 4 kg/m2 increases the likelihood of developing cardiovascular disease through the mechanism of intermediate factors such as hypertension and dyslipidemia (Nordestgaard et al., 2012). BMI describes obesity in general. Increased BMI increases the risk of increased BP and the occurrence of hypertension (Parker et al., 2016). An increased BMI is related to an increase in fat in the body. One form of fat in the body is cholesterol. Excess fat in the body increases peripheral resistance, which in turn raises blood pressure (Kumar V., Abbas A., 2009; Guyton and Hall, 2012).

The correlation of BMI with diastolic BP and weak total cholesterol in this study may occur because this study was conducted on healthy and young subjects. Hypertension and hypercholesterolemia are degenerative disorders that increase with age. Research in the elderly group (>60 years) shows BMI has a significant relationship with hypertension (Zhao et al., 2022).

Based on the results of the analysis using the Spearman rho test, it was found that WC was positively correlated with systolic and diastolic blood pressure. These results are in accordance with a Brazilian study that found waist circumference had a significant relationship with systolic BP (r = 0,39) and diastolic BP (r = 0,28) (Oliviera et al., 2014). The results of a study of school-age children in India also showed the same results (Kapil et al., 2013). Waist circumference and WHR are good anthropometric measures for identifying central obesity (Anggraeini, 2012; Pazin et al., 2017). Waist circumference describes excess fat in the abdominal area (visceral fat tissue) (Rizk & Yousef, 2012).

Central obesity is one of the risk factors for hypertension (Kotchen, 2012; Whelton et al., 2018). Waist circumference is one of the anthropometric measurements that describes visceral fat in the body. Increased fat in the body can lead to increased vascular resistance, cardiac output, increased sympathetic nerve activity, and increased activity of the renin-angiotensin system, which contributes to increased blood pressure (Guyton & Hall, 2012). Heart output and vascular resistance determine blood pressure. Increased cardiac output and vascular resistance due to fat accumulation in the body have an impact on increasing blood pressure (Kumar & Abbas, 2009).

Table 2. Correlation of anthropometric size with blood pressure, total cholesterol, and fasting blood sugar

Variable	Systolic BP		Diastolic BP		Total Cholestero		FBG	
	r-value	p-value	r-value	p-alue	r-value	p-value	r-value	p-value
BMI	0,09	0,198	0,24	0,013**	0, 29	0,003*	0,09	0,204
WC	0,24	0,012**	0,22	0,020**	0,15	0,08*	0,12	0,130
WHR	0,15	0,083	0,08	0,238	0,10	0,174	0,08	0,227
Biceps	0,28	0,004**	0,33	0,001**	0,25	0,010**	-0,06	0,285
Triceps	0,22	0,020**	0,31	0,002**	0,27	0,006**	0,07	0,248
Subscapular	0,30	0,002**	0,30	0,003**	0,30	0,002**	0,06	0,276
Suprailiac	0,31	0,002**	0,28	0,005**	0,42	0,000**	0,13	0,123

* significant based on the Pearson correlation test ($p < 0,05$)
** significant based on Spearman rho correlation test ($p < 0,05$)

The ratio of waist and pelvic circumference did not correlate with total cholesterol, FBG, systolic, or diastolic BP. Research in Yogyakarta found no significant relationship between WHR and total cholesterol levels (p = 0,919) (Jennifer, 2016). Research conducted in Africa shows that WHR is not associated with fasting blood glucose levels (p = 0,120) (Busayo et al., 2014). Research conducted on young adult women showed that there was no significant association between WHRand blood pressure, either systolic or diastolic (Astuti et al., 2017). It was previously known that men tend to have a greater RLPP than women. In this study, the sample was dominated by women. This can be the cause of the insignificant correlation of WHR with other variables (Kumar & Abbas, 2009).

Thick fat under the skin (biceps, triceps, subscapular, and suprailiac) was found to correlate with total cholesterol, systolic Blood Pressure (BP), and diastolic BP levels. This suggests that thick fat under the skin is quite good at describing the amount of fat in the body. Fatty deposits in the body are distributed to the central as well as peripheral organs. Central fat can be assessed by abdominal circumference, pelvic circumference, and the ratio of both (WHR), while peripheral fat distribution is assessed through the thickness of fat under the skin, commonly examined in the biceps, triceps, subscapular, and suprailiac regions. Previous research has shown that thick fat under the skin in adults can estimate the amount of fat present in the body (Anggraeini, 2012). Increased fat in the body has the effect of increasing blood pressure (Guyton & Hall, 2012).

The results showed no correlation between all anthropometric measures and fasting blood glucose. These results can occur because the study sample is a group of young adults. Research in the older age group (>60 years) shows diabetes is more often found in the overweight group compared to the normal group in the same age range (Giron & de la Vega, 2022). Diabetes is a degenerative disease caused by insulin resistance and impaired insulin production (Cho et al., 2017). The underlying mechanism of the increased risk of diabetes in obesity is the occurrence of insulin resistance. Insulin resistance can occur in conditions of excess calories over a long period of time that cause insulin receptors on cells to become insensitive so that glucose in the blood cannot be converted into glucose reserves (glycogen) in tissues (Kumar & Abbas, 2009; Angi & Chiarelli, 2020). In young people with good body compensation, insulin resistance may not have occurred so that glucose can be maintained within normal limits. Previous research results showed obesity since childhood will cause symptoms of diabetes at the average age of 40 years (Angi & Chiarelli, 2020).

This study has limitations in terms of the sample used, where two-thirds of the sample is female. This can affect the results obtained, especially with regard to suprailaca thickness and WHR, because there are differences in fat distribution between men and women, where fat deposits in women tend to occur in the pelvic body and in men generally in the abdomen. In addition, a blood glucose examination should be supported by checking HbA1c levels to determine the risk of diabetes in subjects.

Conclusion

BMI has a correlation with diastolic BP and total cholesterol. WC correlates with systolic and diastolic BP. Thick fat under the skin (biceps, triceps, subscapular, and suprailiac) correlates with total cholesterol, systolic BP, and diastolic BP levels. However, WHR did not correlate with systolic and diastolic BP, total cholesterol, or FBG, and there was no correlation across anthropometric measures with fasting blood glucose. So, it can be concluded that most anthropometric measures can be used as predictors of BP and total cholesterol levels in young adults.

Further research in elderly and elderly adult subjects is needed to provide a clearer picture and comparison of the risk factors for cardiovascular disease. In addition, periodic anthropometric assessments need to be carried out as an initial screening of cardiovascular disease risk factors for each patient who visits the Health Service Center. If possible, periodic anthropometric assessments at school or campus as well as education on the dangers of obesity and overweight can be carried out, given the trend of increasing prevalence of obesity and overweight in children and young people recently.

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