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Cardiovascular disease risk factors and anthropometry features among seemingly healthy young adults

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ABSTRACT

We explored association between the levels of total cholesterol (TC) and uric acid (UA) to the middle upper arm circumference (MUAC), waist circumference (WC) and hip circumference (HC) amongst seemingly healthy university students in Kediri, Indonesia aged 17-23 years (n=150); no history of major previous diseases were found (i.e. metabolic syndrome). TC and UA measured from the capillary blood; standardised anthropometry measurements were done by trained medical doctors. Correlation, linear regression, independent t-test or Mann-Whitney analysis were performed with the level of significance of $p<0.05$. We found higher TC ($p=0.053$), UA ($p<0.001$), MUAC ($p=0.009$), HC ($p=0.865$) and WC ($p=0.001$) among males than among females. TC was significantly correlated to the UA with prevalence of hypercholesterolemia of 46.7% and hyperuricemia of 30% of all participants. All anthropometry was significantly correlated to the TC and UA among males ($p<0.001$); TC and UA were strongly corresponded to all anthropometry parameters among males. Hypercholesterolemia and hyperuricemia could be found amongst the seemingly healthy young adults in Indonesia; among males these are strongly correlated to the higher MUAC, WC and HC. Daily physical activity and proper healthy diet might help to decrease these cardiovascular disease risk factors.

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1. INTRODUCTION

Cardiovascular diseases (CVDs) become a global epidemic and have been reported to be associated to the overweight and obesity [1-3]. Middle upper arm circumference (MUAC), waist circumference (WC) and hip circumference (HC) have been demonstrated as the efficient screening parameters for the assessment of obesity and overweight in various ethnic groups other than the body mass index (BMI) [4-6]. These parameters have been proposed to have good correlations to the corporal mass and fat distribution, and could detect nutritional status and several biomarker changes such as occur in the hypercholesterolemia and hyperuricemia [7-9]. Obesity and BMI z-scores were reported to correlate significantly to the occurance of metabolic syndrome, hyperuricemia and hypercholesterolemia although limited data have yet abundance amongst the seemingly healthy young adults [10-12]. In general population, the prevalence of hyperuricemia is approximately 20-25%; whilst the prevalence of hypercholesterolemia (defined as total cholesterol or TC≥5.0 mmol/l) is approximately 37- 40% [11, 13, 14]. Previous studies have been focused on various age groups and clinical background [4-6], however, to the best of our knowledge, data from the seemingly healthy young males and females are still limited. These data are vital for preventive medicine of the cardiovascular diseases to develop in the later life [15-17]. Here we investigate the association between MUAC, WC and HC to the levels of TC and UA as these anthropometry features are proposed to be the indirect indicators to detect hypercholesterolemia and hyperuricemia as the risk factors of CVDs in the seemingly healthy male and female students (17-23 year old).

2. RESEARCH METHOD

The ethical clearance of this study was granted by the Ethical Committee no.179/HRECC.FODM/IV/2019. Each participant signed the informed consent and consent for information papers prior to the study. The participants were recruited from Kediri city, Indonesia (74 males and 76 females, respectively), age 17-23 year old, with no previous health problems i.e. metabolic syndrome, hypercholesterolemia and hyperuricemia. The TC (in mg/dL) and UA (in mg/dL) were analysed from the finger prick capillary blood-test using a stick machine (Easy Touch GCHb, Taiwan) without prior fasting. In this study, hypercholesterolemia was defined when the total cholesterol level was≥200 mg/dL; whilst hyperuricemia was defined if participants having their UA concentration was>7.0 mg/dL (416.4 μmol/L) among males or>6.0 mg/dL (356.9 μmol/L) among females [11, 13, 14]. These cut-off values were selected as they are generally used in clinical laboratories and have been proposed in previous studies in relation to metabolic syndrome and cardiovascular disease outcomes to define hypercholesterolemia and hyperuricemia [11, 18, 19].

All anthropometric measurements were taken in accordance with World Health Organization (WHO) standards by two pre-trained medical doctors (technical personnels trained in research methods) [6, 14, 20]. All anthropometric measurements were taken twice and the average was recorded. If the measurements varied by more than 0.2 cm, a third measurement was conducted. The average of the nearest two measures was recorded. The MUAC, WC and HC were measured in a standing position following standard procedures using calibrated instrument. MUAC was measured with a non-stretchable MUAC measuring tape at a point equidistant between the acromion process of the scapula and the olecranon process of the ulna. Waist circumference was measured midway between the lower rib margin and the iliac crest in the horizontal plane. Hip circumference was measured at the point yielding the maximum circumference over the buttocks using a tape measure [5, 15, 21].

All data were analyzed using SPSS 17.0 (USA) and MaxStat Lite 3.06 (Germany). The Kolmogorov-Smirnov normality test and Bartlett homogeneity test of Bartlett were calculated prior to the independent t-test or Mann-Whitney test to analyze the difference of each variable among males and females. The Pearson or Spearman correlation tests were applied to seek correlations between the TC to WC, to HC and to MUAC in both male and female groups. Linear regression analysis between TC as the dependent variable and UA, MUAC, WC and HC as independent variables were conducted to seek the relationship in males and in females. Level of significance was considered when p<0.05.

3. RESULTS AND DISCUSSION

Of 150 subjects, 76 female and 74 male students completed the study, accordingly. Table 1 shows a summary of their characteristics. The range of TC among males was 105-382 mg/dL, whilst among female was 103-338 mg/dL. Seventy participants had a hypercholesterolemia (46.7%) and the rests were normal. Sixteen males and 14 females had hyperuricemia (30%); whilst the rests were normal. The average and standard deviation of TC, WC, HC and MUAC are detailed in Table 1. The TC, MUAC and HC were homogeneous and normally distributed whilst the UA and WC were not thus we conducted the independent t-test for the parametric and Mann-Whitney test for the non-parametric data as shown in Table 1. We observed higher values in TC, UA, MUAC, WC and HC of males compared to the females. There were significantly differences between the UA, MUAC and WC of males than females (p<0.001, p=0.009, p=0.001, respectively). However no significant differences were found between the TC and HC among males and females (p=0.053 and p=0.865, respectively).

Among males, association between TC to the UA, MUAC, WC and HC was moderate with each beta value of 0.317, 0.374, 0.365 and 0.367, respectively; all of these had a significant coefficient of correlation (p<0.05). The proportion of variance in TC that can be explained by UA was 10.1%; 14% by the MUAC; 13.4% by the WC and 13.5% by the HC. On the other hand, the proportion of variance in UA that can be explained by TC was 10.1%; 16% by the MUAC; 14.2% by the WC and 18.3% by the HC as shown in Table 2. There were positive significant correlations between TC to the UA, or MUAC, or WC, or HC among male students. The strongest correlation was shown between the WC and HC among males with r=0.926 (p<0.001); whilst the weakest correlation was shown between the TC and UA among males although the r was still showing moderate strength at 0.31 (p=0.007). Among females, association between TC to the UA; and between UA to the HC was higher compared to the other variable associations with the beat value of 0.471 and 0.238, respectively; all of these had a significant coefficient of correlation (p<0.05). The proportion of variance in TC that can be explained by UA was 22.2%; whilst only 0.2% by the MUAC; 0.2% by the WC and 0.5% by the HC. On the other hand, the proportion of variance in UA that can be explained by TC was 22.2%; whilst only 0.7% by the MUAC; 2.7% by the WC and 5.7% by the HC as shown in Table 3.

Table 1. Differences between TC, UA, MUAC, WC and HC of males to females

No	Independent t-test (or Mann-Whitney test)	Male (μ±SD)	Female (μ±SD)	p
1	Total Cholesterol in mg/dL	207.39±4.69	193.68±40.28	0.053
2	Serum of Uric Acid in mg/dL	5.95±1.78	4.86±1.43	<0.001*
3	MUAC in cm	28.36±4.77	26.45±3.97	0.009*
4	Waist Circumference in cm	82.1±1.6	74.59±1.1	0.001*
5	Hip Circumference in cm	97.19±9.8	96.93±8.71	0.865
	n	74	76	*sig-2 tailed

Table 2. Association between TC and UA to the MUAC, WC and HC among males

MALES	Linear regression test	Independent variable				
No	Dependent variable	TC	UA	MUAC	WC	HC
1	TC		R^2= 0.101 Beta= 0.317 p= 0.006* B= 8.124	R^2= 0.14 Beta= 0.374 p= 0.00* B= 3.585	R^2= 0.134 Beta= 0.365 p= 0.001* B= 1.209	R^2= 0.135 Beta= 0.367 p= 0.001* B= 1.713
2	UA	R^2= 0.101 Beta= 0.317 p= 0.006* B= 0.012		R^2= 0.16 Beta= 0.4 p<0.001* B= 0.149	R^2= 0.142 Beta= 0.377 p= 0.001* B= 0.049	R^2= 0.183 Beta= 0.428 p<0.001* B= 0.078
Pearson (or Spearman) correlation test. * is statistically significant.						
No	Variable	TC	UA	MUAC	WC	HC
1	TC		r= 0.31 p= 0.007*	r= 0.374 p= 0.001*	r= 0.349 p= 0.002*	r= 0.367 p= 0.001*
2	UA			r= 0.451 p<0.001*	r= 0.455 p<0.001*	r= 0.508 p<0.001*
3	MUAC				r= 0.818 p<0.001*	r= 0.811 p<0.001*
4	WC					r= 0.926 p<0.001*
5	HC					

Among females, there were positive significant correlations between TC to UA (r=0.408, p<0.001); between UA to HC (r=0.245, p=0.033); between MUAC to WC (r=0.789, p<0.001); between MUAC to HC (r=0.768, p<0.001) and between HC to WC (r=0.848, p<0.001). The strongest correlation was shown between the WC and HC among females with r=0.848 (p<0.001); whilst the weakest correlation was shown between the TC and WC among females (r=0.065, p=0.578). Reversed correlation was shown between TC and MUAC with r=-0.041 (p=0.727). In our study, 1 point increase on the UA corresponded to 8.124 points increase on the TC; 1 point increase on the MUAC corresponded to 3.585 points increase on the TC; 1 point increase on the WC corresponded to 1.209 points increase on the TC; and 1 point increase on the HC corresponded to 1.713 points increase on the TC of males. Furthermore, among males, 1 point increase on the TC corresponded to 0.012 points increase on the UA; 1 point increase on the MUAC corresponded to 0.149 points increase on the UA; 1 point increase on the WC corresponded to 0.049 points increase on the UA; and 1 point increase on the HC corresponded to 0.078 points increase on the UA. On the other hand, among females, 1 point increase on the UA corresponded to 13.234 points increase on the TC; with 1 point increase on the MUAC corresponded to 0.413 points decrease on the TC; 1 point increase on the WC corresponded to 0.168 points increase on the TC; and 1 point increase on the HC corresponded to 0.343 points increase on the TC. Among females, 1 point increase on the TC corresponded to 0.017 points increase on the UA; 1 point increase on the MUAC corresponded to 0.031 points increase on the UA; 1 point increase on the WC corresponded to 0.024 points increase on the UA; and 1 point increase on the HC corresponded to 0.039 points increase on the UA.

Table 3. Association between TC and UA to the MUAC, WC and HC among females

FEMALES No	Linear regression test Dependent variable	Independent variable TC	UA	MUAC	WC	HC
1	TC		R^2= 0.222 Beta= 0.471 p<0.001* B=13.234	R^2= 0.002 Beta= -0.041 p= 0.727 B= -0.413	R^2= 0.002 Beta= 0.04 p= 0.732 B= 0.168	R^2= 0.005 Beta= 0.074 p= 0.525 B= 0.343
2	UA	R^2= 0.222 Beta= 0.471 p<0.001* B= 0.017		R^2= 0.007 Beta= 0.085 p= 0.466 B=0.031	R^2= 0.027 Beta= 0.163 p= 0.16 B= 0.024	R^2= 0.057 Beta= 0.238 p= 0.038* B= 0.039
Pearson (or Spearman) correlation test. * is statistically significant.						
No	Variable	TC	UA	MUAC	WC	HC
1	TC		r= 0.408 p<0.001*	r= -0.041 p= 0.727	r= 0.065 p= 0.578	r= 0.074 p= 0.525
2	UA			r= 0.132 p= 0.255	r= 0.194 p= 0.093	r= 0.245 p= 0.033*
3	MUAC				r= 0.789 p<0.001*	r= 0.768 p<0.001*
4	WC					r= 0.848 p<0.001*
5	HC					

Here we observed higher MUAC, WC and HC among males compared to females. The anthropometric measures are the result of both genetic and environmental factors. The interaction between these factors could be explaining the differences within and between groups [22-24]. A pilot study conducted amongst 100 participants aged 17-60 year old in Singapore showed that the mean stature, weight, and body mass index were 173.2 cm, 69.5 kg and 23.2 kg/m^2 for males; whilst 161.1 cm, 56.8 kg and 21.9 kg/m^2 for females, respectively. They reported that males had larger body dimensions than females; differences between genders were about 0.7 to 17.4 cm [20]. In other study, it was reported that males have more lean mass, whilst females have more fat mass than males. Males are more likely to accumulate adipose tissue around the trunk and abdomen, whereas females generally accumulate adipose tissue around the hips and thighs [20-24]. Previous study showed that females have lower percentage of visceral adipose tissue and higher percentage of subcutaneous trunk abdominal adipose tissue than males. These sex-specific differences in body composition are associated with sex-based differences in energy substrate-utilization patterns; that is, females store more lipids and have higher whole-body insulin sensitivity than males, while men tend to oxidize more lipids than females. These patterns are influenced by the unique actions of sex hormones and adipokines in each sex as well as by nutritional status and physical fitness in both sexes [8, 9, 12].

We found the TC and UA of males were higher than these of females. Although, Zhu *et al*. reported that the total cholesterol levels were significantly higher among females than that of male group. However they also observed that the BMI, WC and waist to hip ratio were significantly associated to the CVD risk factors showed in the higher occurrence of dyslipidemia especially among females [25]. Here we also found that higher TC correlated significantly to the higher MUAC, WC and HC among males; a females however, higher TC was significantly correlated only to higher HC. It was reported that MUAC was correlated well to the BMI and could indicate the nutritional status amongst adults. The WC and HC have also been demonstrated to have a good association to the nutritional status and BMI [3, 8, 16]. A large hip circumference seems to convey strong and independent protection against development of CVD or early mortality in women. Hip size does not seem to be related to CVDs in men. However, it cannot be excluded entirely that wide hips may be protective against early total mortality in men. On the contrary, the waist circumference generally represents the abdominal or central obesity. This type of obesity would largely correlate to the higher risk of CVD amongst adults. The waist to hip ratio is widely studied in terms of its correlation to several metabolic diseases and the increased value commonly associated to the excess fat located in the upper abdominal region (visceral fat). If the waist circumference is higher than the hip circumference the apple shaped body is formed; whereas the waist circumference is lower than the hip circumference then this would be the pear shaped body. Males have been reported to have apple shaped body than females, and vice versa. This leads to the proposed protective HC among females from the risk of developing metabolic syndrome and CVD [8, 16, 21].

From our study, the total cholesterol level was predominantly correlated to the uric acid level and to MUAC compared to other anthropometry measurements. Raised cholesterol is reported to cause approximately 2.6 million deaths and 29.7 million disability adjusted life years. It is a risk factor for ischemic heart disease and stroke. High cholesterol levels could be occurred due to heredity i.e. familial hypercholesterolemia, excessive weight, exercise and/ or physical activity, age and sex, alcohol use and mental stress are some of determinants for. After approximately age 50 year old, women often have higher total cholesterol levels than men of the same age; whilst at pre-menopause women tend to have lower total cholesterol levels than men of the same age. Cholesterol is a fat-like substance needed to build various structures in the human body as well as to produce chemicals and hormones that are essentials for the body's function. However, excess amounts can be deposited at the vascular walls as the plaques thus might be decreasing the amount of blood flow to the organs [22, 24, 26].

Among males, we observed strong correspondence between each of the anthropometric measurement to the UA levels whilst similar pattern was only found between HC and UA among females. On the other hand, the uric acid levels in the current study were highly corresponded to the level of the total cholesterol in both genders. Where there is an imbalance between the breakdown of purines and the rate of uric acid excretion, hyperuricemia is produced. The uric acid in the blood is saturated at approximately 6.4 to 7 mg/dL; where the urate is filtered through the glomerulus whilst reabsorbed, secreted and the reabsorbed again in the proximal tubule of the kidney. The increased in the serum urate level would increase the urate excretion [11, 18, 19]. Hyperuricemia have been associated to the increased the mortality rate in the patients of hypertension and stroke. It is reported that hyperuricemia is higher in the patients suffered from the metabolic syndrome. The underlying pathology may include the increased inflammatory pathway signaled by the raising of the level of c-reactive protein (CRP) and the IL-1 cytokine in the obesity which in turn would alter the structure of the kidney thus glomerular filtration function [11, 18, 19].

Previous study reported that persons with obesity would have higher risk to develop the metabolic syndrome and CVD. In obesity the insulin resistance tend to easily occur and has been associated to the raised inflammatory cytokine levels i.e. TNF-α and leptin levels with low adiponectin levels [10, 22, 24]. These would subsequently facilitating the development of metabolic syndrome that increase the risk for suffering the diabetes mellitus type 2 (DM-2) and/or cardiovascular disease (CVD) [10, 22, 26]. Preventive and promotive medicine should be emphasized especially amongst the seemingly healthy youths to lowering the incidence of these diseases in the later life. These may include to having healthy diet for example foods rich in polyphenols i.e. berries and green tea [27, 28]. Whilst practicing daily exercise and/or routine physical activity to balance the tendency of sedentary life style affected by too much of gadget use in this modern world would be beneficial even in the metabolically healthy obese persons to decrease the cardiovascular disease risks [29, 30].

4. CONCLUSION

The risk factor of CVDs could be found amongst the seemingly healthy young adults in our study. All anthropometry and biochemical markers studied were higher among males than among females. The total cholesterol and uric acid levels were significantly associated to all anthropometry studied among males, whilst among females strong correlation was only found between the hip circumference and the uric acid level.

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