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Relationship of Waist Circumference and Lipid Profile in Children

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Abstract: Introduction: Waist circumference (WC) in children or teenage have a close relation with the prediction to cardiovascular disease and diabetes mellitus type 2. The person that have a high risk is the children with WC percentile <90 which direct us to a study about the relation of waist circumference and lipid profile in children as an early intervention of prevention of cardiovascular disease in children. Methods: We have done a cross sectional study about the relationship of the waist circumference and lipid profile in children. The study samples are the junior high schools of Nusantara's, Frater's, and Islamic Athirah's that met the criteria. The study was done from July 2012 until January 2013. Results: The study samples that met the study criteria are 86 children with 43 of them are with WC percentile >90 and the rest of 43 with percentile <90. By a multivariate analyses, we obtained 3 variables of lipid profile that have a relation to the WC percentile >90, which a cholesterol level total AOR is 12.621 (95% CI 3.72-94.40), triglyceride is AOR 6.945 (95% CI 1.80-54.67) and the ratio of LDL and HDL cholesterol with AOR 4.025 (95% CI 1.03-17.48). Conclusion: According to the study result, we conclude that the cholesterol frequency occurrence is high; the triglyceride is also high, and the ratio of high LDL and HDL cholesterol are more greats in WC children with percentile >90 rather than the percentile <90.

Keywords: Waist Circumference, Lipid Profile, Children

1. Introduction

Waist circumference (WC) is a simple anthropometric measurement, yet accurate enough to evaluate the fat deposit, especially visceral fat. Visceral fat are associated with higher health risk compared to fat on the thighs and other body areas. Children or adolescent WC are strongly related to the prediction of developing diabetes mellitus type 2 and cardiovascular disease. They who are at risk are those percentile >90 of all sex and age.1

In Indonesia, up until now, there has been no consensus about WC standard as a risk factor for cardiovascular disease. Study by Martuti S. et al. in Surakarta in 2005 on 121 overweight and obese children age 5-14 year old about the relationship between WC and cardiovascular risk factors concluded that hyper triglyceride in obese children were 45% and WC above 77.5 cm must be considered as a risk factor predictor of cardiovascular disease.2 Several epidemiological studies stated that the relationship between adipose tissue and risk of disease started at the early age. Adipose tissue had different metabolic activity and related to the risk factor disease according to the fat distribution in the body. Fat tissues were distributed mainly in two areas; intra abdominal and subcutaneous. Intra abdominal fat consist of visceral fat covering oementum and mesenterium, together with a little amount of retroperitoneal fat, while subcutaneous fat are distributed all over the body.3

Metabolic complication on the adult obesity is strongly related to body fat distribution which in the end is highly influenced by sex. Fat distribution pattern based on sex started to appear since puberty, and as well as the overall fat are related to familial factors.4 In male, fat is generally distributed on the upper part of the body either subcutaneous or intra abdominally. This is appearing as bloated/distended belly or apple shaped belly. In female, fat distribution are mainly subcutaneously, especially on the thighs, shaped like pear.5

Study by Watts K et al. in overweight and obese children

in Australia concluded that WC measurement was a better indicator than z-score IMT to predict the risk of cardiovascular disease. Therefore, WC measurement in children can be a screening tool which is easy and not-invasive to identify the children with higher cardiovascular disease.6 WC anthropometric standard measurement are still limited, International Diabetes Federation (IDF) concluded that WC for male and female age 10–16 year old percentile >90 as risk factor for metabolic syndrome.7 Obese children with WC percentile ≥90 had a higher risk for dyslipidemia and insulin resistance compared to obese children with normal WC. This result showed that routine monitoring for WC in obese children could be WC physician in identifying obese children who are at higher risk for diabetes and other cardiovascular diseases.8, 9

We considered it is necessary to conduct a study for early detection of cardiovascular risk in children based on WC measurement. Lipid abnormalities are correlated with WC in children and adolescent. WC is a sensitive and specific measurement to assess upper portion of body fat in older children (adolescent), thus it is very significant in identifying overweight and obese children who are at risk of developing metabolic complication. But, in pre puberty children, the relationship between body fat distribution and risk factor for disease was not fully understand yet.10 Therefore, it is important to conduct studies about relationship between fat distribution and dyslipidemia. Studies on this subject are still very limited, especially in South Sulawesi, so we hope that this study can improve the science development for clinical application. This study aims to prevent the occurrence of cardiovascular disease as early as possible in children with WC percentile >90.

2. Materials and Methods

This study was performed in three selected Junior High school; Nusantara, Islam Athirah and Frater, in Makassar, South Sulawesi. This is a cross sectional study with a cluster random sampling. This study had been approved by the Ethics and Industry Research Committee of the hospital, and the Faculty of Medical, Hasanuddin University, Makassar. Written informed consent was obtained from the patients' parents or legal guardian following full and detail explanation regarding the study's protocol.

Population was junior high school students' age 13 - 15 years in and was coming from family with middle upper socioeconomic status, based on the criteria issued by Department of Education Makassar. A total of 86 children were selected by cluster random sampling that met the inclusion criteria; age 13 – 15 years, and give the written informed consent. While the exclusion criteria are patients suffering from diabetes mellitus, hypothyroid, and nephrotic syndrome.

All children who met the inclusion criteria were recorded for their weight and height by using NCHS 2000 curve, and then the IMT was calculated. Subjects were measured for their WC, and then classified into children with WC percentile >90 and percentile <90, furthermore the lipid profile examination were performed.

Data were processed with Univariate analyses to obtain a basic data description in form of distribution of frequency, mean, standard deviation and range. Bivariate analyses were performed using X2 (Chi-square) test and Mann-Whitney test. The sample characteristic was processed using SPSS for windows 20. It is not significant, when $p>0.05$, significant if $p\leq0.05$, and very significant if $p<0.01$. The study flow scheme can be seen in figure 1.

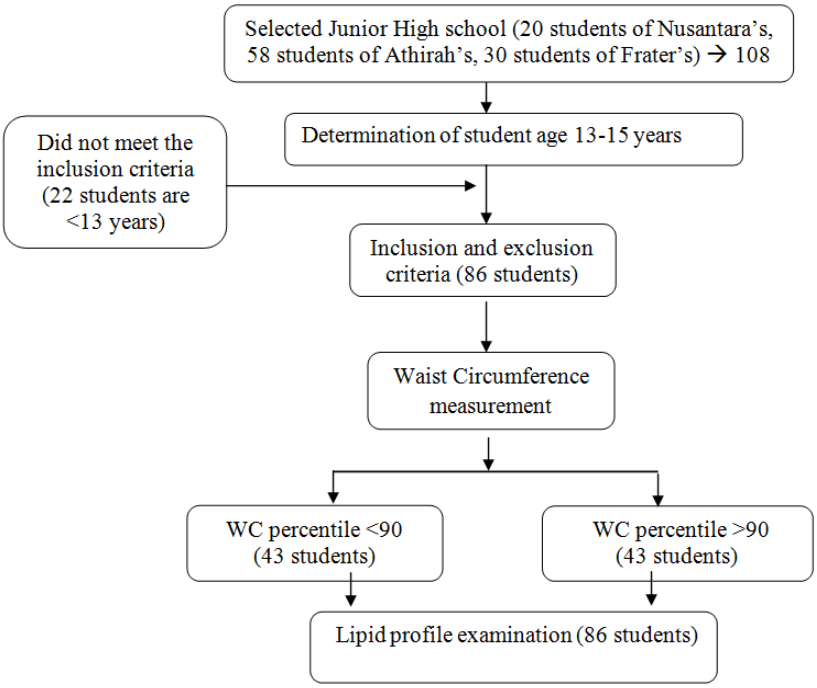

Figure 1. *Study flow scheme.*

3. Results

Table 1 shows the sample characteristic. Total of samples are 86 students which 47 males and 39 females with mean of age is 13.4. Their weight average is 42-105 with mean of 61.2, while their height average is 144-176 with mean of 157.0.

Table 1. *Sample characteristics.*

No.	Sample characteristic	Total (N : 86)
1.	Sex	
	Male : Female (%)	47 : 39 (54.7 :45.3)
2.	Age (years)	
	Average	13 – 15
	Mean	13.4
3.	Weight (kg)	
	Average	42 – 105
	Mean (SD*)	61.2 (14.14)
4.	Height (m)	
	Average	144 – 176
	Mean (SD*)	157.0 (6.55)
5.	Waist Circumference (cm)	
	Average	69 – 108
	Mean (SD*)	84.0 (9.60)
6.	Lipid Profile levels (mg/100 ml)	
	Cholesterol Total	
	Average	112 – 297
	Mean (SD*)	51.08 (40.30)
	Triglyceride	
	Average	44 – 581
	Mean (SD*)	119.84 (79.22)
	Cholesterol HDL	
	Average	28 – 80
	Mean (SD*)	51.43 (12.12)
	Cholesterol LDL	
	Average	48-203
	Mean (SD*)	115.38 (35.02)
7.	Cholesterol LDL : cholesterol HDL ratio	
	Average	0.8 – 5.1
	Mean (SD*)	2.40 (1.03)

Table 2 shows the relationship between the total cholesterol and children waist circumference.

The frequency of children with a high total cholesterol (≥200 mg/dl) in children with WC percentile >90 were 54.3% compared to group with WC percentile <90 (5.0%). The statistical analyses showed that there were significant difference between group of children with WC percentile >90 and group of children with WC percentile <90 to the total cholesterol with p = 0.000 (p ≤0.05), and crude odd ratio is (COR) 1.04 with 95% CI (1.01-1.26).

Table 2. *Relationship of total cholesterol on children waist circumference.*

Total cholesterol (mg/dl)	Waist circumference		Total
	Percentile <90	Percentile >90	
≥200	2 (5.0%)	25 (54.3%)	27 (31.4%)
<200	38 (95%)	21 (45.7%)	59 (68.6%)
Total	40 (100%)	46 (100%)	86 (100%)

Chi-square X^2 = 24.190 *df* =1 *p* = 0.000 (*p* ≤0.05) OR: 1.04 95%CI (1.01-1.26)

There were significant difference between WC percentile >90 and WC <90 on total cholesterol.

Table 3 shows the relationship between triglyceride on waist circumference in children. The frequency of children with a high triglyceride (≥150 mg/dl) in group with WC percentile >90 were 37.0% compared to group with WC percentile <90 (5.0%). Statistical analyses showed that there were significant difference between group with WC percentile >90 and group with WC <90 to triglyceride level, with p= 0.000 (p ≤0.05), crude odd ratio (COR) of 1.10 with 95% CI (1.01-1.72).

Table 3. *Relationship between triglyceride on children waist circumference.*

Triglyceride (mg/dl)	Waist circumference		Total
	Percentile < 90	Percentile > 90	
≥150	2 (5.0%)	17 (37.0 %)	67 (77.9%)
<150	38 (95.0%)	29 (63.0%)	20 (22.1%)
Total	40 (100%)	46 (100%)	86 (100%)

Chi-square X^2 = 12.694 *df* = 1 *p* = 0.000 (p ≤0.05) OR:1.10 95% CI (1.01-1.72)

Table 4 shows the relationship between dyslipidemia and WC in children. Frequency of children with dyslipidemia in group WC percentile >90 were 78.3% compared to WC percentile <90 with 10%. Statistical analyses showed that there were significant difference between group of WC percentile >90 and group of percentile <90 to dyslipidemia, with p = 0.000 (p ≤0.05), crude odd ratio (COR) 32.4 with 95% CI (9.30-112.88).

Table 4. *Relationship of LDL-HDL ratio on children waist circumference.*

LDL: HDL ratio	Waist circumference		Total
	Percentile <90	Percentile >90	
≥3	4 (10.0%)	21 (45.7%)	25 (29.1%)
<3	36 (90.0%)	25 (54.3%)	61 (70.9%)
Total	40 (100%)	46 (100%)	86 (100%)

Chi-square X^2= 13.189 *df* = 1 *p* = 0.000 (p ≤0.05) OR: 1.15 95% CI (1.04-1.76)

LDL: low density lipoprotein HDL: high density lipoprotein

Table 5 shows the relationship between ratio LDL-HDL on children waist circumference. The frequency of children with a high LDL-HDL ratio (≥3) in group WC percentile >90 were 45.7% compared to group WC percentile <90 (10.0%) Statistical analyses showed a significant result between the two groups and LDL-HDL ratio and p = 0.000 (p ≤0.05), crude odd ratio (COR) 1.15 with 95% CI (1.04-1.76).

Table 5. *Relationship of dyslipidemia on children waist circumference.*

Dyslipidemia	Waist circumference		Total
	Percentile <90	Percentile >90	
Dyslipidemia	4 (10%)	36 (78.3%)	59 (47%)
No Dyslipidemia	36 (90%)	10 (21.7%)	27 (31%)
Total	40 (100%)	46 (100%)	86 (100%)

Chi-square X^2= 40.072 *df*= 1 *p*= 0.000 (p ≤0.05) OR: 32.4 95%CI (9.30-112.88)

There were significant difference between WC percentile >90 and WC <90 on dyslipidemia.

Table 6 shows multivariate analyses of relationship of the variables on children WC. From the double regression logistic analyses, it was found that the total cholesterol, total triglyceride, and LDL-HDL ratio were really significant in group with WC percentile >90. Odds Ratio (OR) for each variable was Adjusted odds ratio (AOR), this means that children whose WC percentile >90 had the probability of developing dyslipidemia as much as the AOR value.

Table 6. *Multivariate analyses variabel relationship on children waist circumference.*

No.	Variable	B	SE	ddf	SSig	AOR	95% CI
1	Colesterol Total	2.931	0.825	1	0.000	12.621	3.72-94.40
2	Triglyceride	2.295	0.871	1	0.008	6.945	1.80-54.67
3	Ratio LDL/HDL	1.447	0.721	1	0.045	4.025	1.03-17.48

B : Regression coefficient SE : standard error

The total cholesterol, triglyceride, and ratio LDL-HDL was significant in WC percentile >90.

4. Discussion

Visceral lipid give a higher risk for the health problems compared to fat on the thighs or other body part. Children or adolescent with waist circumference could predict the risk for developing diabetes mellitus type 2 and cardiovascular disease.

The frequency of children with a high cholesterol (≥200 mg/dl) in group with WC percentile >90 were 54.3% compare to group of WC percentile <90 (5.0%). Statistical analyses showed that there were significant difference between the group of children with WC percentile >90 and group of children with WC percentile <90 to the total cholesterol with p= 0.000 (p ≤0.05) and Crude odd ratio (COR) 1.04 with 95% CI (1.01-1.26). This means that children with WC percentile >90 had 1.04 times bigger risk to develop high total cholesterol compared to children with WC percentile <90. This is similar to a study by Bilgili on children in a school of Turkey, which report that there were positive correlation between the total cholesterol, waist circumference and BMI (body mass index) which carried a risk to develop the metabolic complication.1 As well as study by Maffeis who reported a significant relationship between the high total cholesterol on WC (WC percentile >90 and WC percentile <90), if it is continued with multivariate analyses, the frequency of high cholesterol in children with WC percentile >90 were still higher compared to WC percentile <90 with AOR = 12.62, this means that the children with WC >90 percentile carried 12.62 times bigger risk of developing high of total cholesterol.11

The frequency of children with a high triglyceride (≥150 mg/dl) in WC percentile >90 were 37.0% compared to WC percentile <90 with 5.0% and there were significant differences between WC percentile >90 and WC <90 to the triglyceride levels, with p= 0.000 (p ≤0.05), COR 1.10 with 95% CI (1.01-1.72). This means that children with WC percentile >90 were 1.10 times more likely to develop increased in triglyceride level (≥150 mg/dl) compared to children with WC percentile <90. This is similar to a study by Basalli in obese children age 7-12 years in America who reported that children with WC percentile >90 had 3 times more risk of developing a high triglyceride compared to children with WC percentile <90.8 Similar results were also found by Ghergerenchi in Iranian children age 4-18 year old, where a significant relationship were observed between high triglyceride and obese children with p= 0.001 (p ≤0.05).4 After a multivariate analyses were performed, the frequency of high triglyceride in children with WC percentile >90 were still higher compared to those with WC percentile <90 and AOR = 6.945, which means that a high triglyceride level were 6.945 more likely to be found in group with WC percentile >90. The insulin resistance caused the increasing of free fatty acid due to uncontrolled lipolysis and decreased the free fatty acid clearance in peripheral, thus lead to hyper triglyceridemia.

The frequency of children with the high LDL-HDL ratio (≥3) in group with WC percentile >90 was 45.7% compared to group with WC percentile <90 (10.0%). The statistical analyses showed that there were significant results between the group with WC percentile >90 and group with WC <90 to LDL-HDL ratio, with p= 0.000 (p ≤0.05), COR 1.15 with 95% CI (1.04-1.76). This means that children with WC percentile >90 were 1.15 times more likely increased to experience in LDL-HDL ratio (≥3) compared to children with WC percentile <90. LDL directly take the cholesterol from liver to the tissue for membrane cell synthesis, while HDL take the used cholesterol from cells back to liver to be excreted; therefore, the balance between the two can be used as predictor for cardiovascular disease. A high LDL and low HDL would increase the incidence of coronary artery disease, and both were still valuable measurement to evaluate the risk of cardiovascular disease. In multivariate analyses, the frequency of LDL-HDL ratio in children with WC percentile >90 was still higher compared to group with WC percentile <90 with AOR= 4.02, this means the frequency of high LDL-HDL ratio as many as 4.025 times more likely compared to group of WC percentile >90. In Himah study it was observed that LDL-HDL ratio had a prognostic value better than LDL or HDL levels alone, therefore LDL-HDL ratio became useful methods to predict the risk of developing a cardiovascular disease.12 A study showed that LDL increasing 1% were associated with the increased risk >2% of developing coronary artery disease and decreased in HDL <1% were related to increased risk 3-4% of developing artery coronary disease.13

Frequency of children with dyslipidemia in group WC percentile >90 were 78.3% compared to group with WC

percentile <90 (10%). Statistical analyses showed that there were significant difference between the two groups of WC to dyslipidemia incidence with p= 0.000 (p ≤0.05), COR 32.4 with 95% CI (9.30-112.88). This means that children with WC percentile >90 had 32.4 greater risk of having dyslipidemia compared to children with WC percentile <90. This result is similar to a study by Gergerenchi in Iranian obese children and adolescent age 4-18 years, which found that the dyslipidemia incidence in obese children was 69.58% compared to non obese children with p <0.004 (p ≤0.05).4

In bivariate analyses, there were five variables showed to have a significant relationship on WC group in children, such as total cholesterol, triglyceride, LDL-LDL ratio, and frequency of dyslipidemia. While, multivariate analyses only have three variables appeared to be independent risk factor on group WC percentile >90, such as the total cholesterol, triglyceride, and LDL-HDL ratio.

Limitation of this study is because of the affect of race, genetic, diet, and physical activity were not analyzed, though we know that these factors can influence the waist circumference and lipid profile. This was also a cross sectional study; therefore, it is only compared at one time. Other limitation is this study had no quality control on doing of WC circumference to minimize the possible error. The strength of this study is the selected school had health room service which was running well, so the teachers, parents, and students themselves had attention/interests on health. Therefore, the results of this study were hoped to be able to give a feedback to the schools and students parent in order to increase a preventive effort in incidence of central obesity and lipid profile abnormality. The result can give a big contribution, considering there are still a few studies available on the matter of waist circumference and lipid profile relationship in Indonesian children.

Based on our study, we concluded that there were significant difference between the frequency of high total cholesterol, high triglyceride, and high LDL-HDL ratio in group with WC percentile >90 compared to group with WC percentile <90. We recommended to conduct the follow up/ monitoring on children with WC percentile >90 and those with atherogenic lipid profile change, so the prevention and early intervention can be performed on the risk of cardiovascular diseases later in life. This data provide insight not only to the parents but also to the health professional, and government to understand the importance of WC measurement and lipid profile examination in children who were at risk of developing obesity as prevention and protection against cardiovascular diseases. This set of data can also provide insight to education unit in order to formulize a strategy in schools in effort to prevent dyslipidemia in children with WC percentile >90.

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