OBESITY IS ASSOCIATED WITH HYPERTENSION IN ADOLESCENTS

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ABSTRACT

Obesity has become a global issue. Previous studies in Bali reveal an increase in the proportion of obesity in adolescents. Obesity causes hypertension; hence there should also be an increase in the prevalence of hypertension as well in Bali. Hypertension in obese adolescents could be caused by various factors, hence identification of the risks factors is crucial as a preventive approach. The aim of this study was to prove an association between obesity and hypertension in adolescents, and to look for the risk factors. We used an analitical cross sectional design conducted to 12-14 years old samples. We took body weight, height, waist circumference, hip circumference, and blood pressure measurements with appropriate devices and asked for information regarding life style and familial history by a questionnare filled in by the samples. The association of obese adolescents with hypertension and their risk factors was analyzed by Chi-square and multivariate tests. A total of 225 subjects from Santo Yoseph junior high school students, west Denpasar, Bali, met the inclusion criteria. The proportion of obese subjects in this study was 25.7%. We found that proportion in familial history of obesity was greater in obese than non-obese subjects (70.7 % vs 41.3%). Logistic regression test revealed that obese subjects with hypertension had a body mass index (BMI) > 30 with odds ratio of 7.3 (CI 95% = 1.8 to 28.8) and P = 0.005. We concluded that there was an association between obesity and adolescents with hypertension, and BMI > 30 could be a risk factor for obese adolescents with hypertension. **[MEDICINA 2013;44:150-156]**

Keywords: *adolescence, obesity, hipertension, BMI*

OBESITAS MEMILIKI HUBUNGAN DENGAN HIPERTENSI PADA REMAJA

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ABSTRAK

Obesitas telah menjadi masalah global, penelitian di Bali sebelumnya memperlihatkan peningkatan proporsi obesitas pada remaja. Hipertensi merupakan dampak dari obesitas, oleh karena itu kejadian hipertensi pada remaja obesitas seharusnya juga mengalami peningkatan di Bali. Hipertensi yang terjadi pada remaja obesitas dapat disebabkan oleh berbagai faktor, sehingga penelusuran faktor risiko menjadi sangat penting sebaga usaha pencegahan. Penelitian ini bertujuan untuk membuktikan adanya hubungan antara obesitas dan hipertensi pada remaja serta mencari faktor risikonya. Disain penelitian adalah analitik cross sectional yang dilakukan pada sampel berumur 12-14 tahun. Pengukuran dilakukan untuk mengetahui berat badan, tinggi badan, lingkar perut, lingkar panggul dan tekanan darah dengan alat ukur serta meminta keterangan mengenai gaya hidup maupun riwayat keluarga dengan kuesioner yang diisi oleh sampel. Hubungan antara remaja obesitas dan hipertensi serta faktor risikonya dianalisis dengan uji Chi-square dan uji multivariat. Sebanyak 225 subyek yang merupakan murid SMP Santo Yoseph, Denpasar Barat, Bali memenuhi kriteria inklusi. Proporsi subyek obesitas pada penelitian ini didapat sebesar 25.7%. Kami mendapatkan proporsi subyek dengan riwayat kegemukan pada keluarga lebih banyak dibanding dengan yang tidak obesitas (70.7 % VS 41.3%). Uji regresi logistik memperlihatkan subyek obesitas dengan hipertensi memiliki BMI > 30 dengan rasio odd 7,3 (IK 95% = 1,8 sampai 28,8) dan P = 0,005. Kami menyimpulkan bahwa terdapat hubungan antara obesitas dan remaja dengan hipertensi, dan BMI > 30 dapat menjadi faktor risiko remaja obesitas dengan hipertensi. **[MEDICINA 2013;44:150-156]**

Kata kunci: *remaja, obesitas, hipertensi, BMI*

INTRODUCTION

World Health Organization (WHO) has claimed obesity as a global epidemy. The prevalence of obesity has increased significantly in the last three decades.[1] The three critical periodes for the occurance of obesity is gestation and neonate, children age 5-7 years, and adolescence age 10-21 years.[2] Studies in America reveals a 16.9% prevalence of obesity in children and adolescent.[3] A study in Semarang on 12-14 years old adolescents reveals a 18.3% prevalence of obesity,[4] whereas in Bali 1999 reveals no obesity,[5] but in 2004 the proportion of obesity increase to 10.9%.[6] Age 12-14 years old is the early adolescence, whereas in that periode, the prevalence of obesity is said to be associated with puberty caused by hormonal changes.[7] Obesity in adolescence can cause hypertension as a short term impact.[8] The prevalence of hypertension in obese female adolescents in Africa is 33.2%,[9] while in Semarang the prevalence is 37.8%.[4] The mechanism of hypertension in obese adolescents is not yet well understood. There is evidence that an increase in body weight causes an increase in the simpathetic nerve activity.[10] Increased simpathetic nervous system will activate the renin angiotensin aldosteron (RAAS) system, which plays a crucial role in obesity-associated hypertension.[11] Previous studies have reveal a significant association between obesity and hypertension in adolescents.[12-4] These studies have not been conducted in 12-14 years old adolescents in Bali. In obese adults, there are several conditions, life style and hazardous indicators that acts as risk factors for obesity with hypertension, such as genetic factors, exercise, high BMI score, etc. The main goal of this study was to determine the association between obesity and hypertension in adolescents. Another goal was to determine the risk factors for obese adolescents with hypertension.

MATERIALS AND METHODS

This study used an analytic cross sectional design. The study was conducted during Desember 2012 in a junior high school in West Denpasar. Evaluation and ethical clearance were granted by the Commission of Ethics in the Medical School of Udayana University, Sanglah Hospital, Denpasar. The target population was adolescents aged 12-14 years with obesity. The accessible population was adolescents aged 12-14 years with obesity in a junior high school in west denpasar, batch 2012-2013. The samples for this study were students of Santo Yoseph junior high school batch 2012-2013, aged 12-14 years.

Denpasar has 4 regions. We chose West Denpasar as our sample as it is in the same area with our institution. According to the 2010 school database, West Denpasar has 12 junior high schools. We chose one school randomly. The chosen school was then cluster-sampled by choosing 2 classes randomly for each school level.

We used the two proportion formula with 5% a, *power* 20%, *effect size* 20%, proportion of non obese adolescence with hypertension 18% and the ratio of obese to non-obese sample was 1:3, so the minimum sample for the obesity group was 50 and 150 for non-obesity group. This study used primary data collected from direct measurements. We did not perform blinding. Inclusion criteria was adolescents, aged 12-14 years old, and exclusion criteria was rejection to participate in the study.

Body weight and height measurements used a scale with a precision of 0.5 kg and maximum weight 120 kg; and a height measurement ZT-120® standard type measuring body height of 70-190 cm with a precision of 0.5 cm. Those scales were last calibrated in 2011. Subjects were measured for body height without shoes, standing up on the scale and looking straight forward, then the measuring pole was pulled until the top of the head, and we recorded the score. Body weight measurement was done by recording the score pointed by the needle on the scale during the subject was standing on it. Waist and hip circumference measurements used a measuring tape made of non-stretchable plastic, maximum length 150 cm with a precision of 0.5 cm. Waist circumference was measured in a standing position by circling the measuring tape around the belly through the umbilicus, and then marked the score pointed by the edge of the tape. The same method was used to measure hip circumference around the widest buttocks area. Blood pressure was measured using a HEM-7203 Omron® with a medium sized manset suitable for arm circumference of 22-32 cm, with a range of 0-299 mmHg and 1 mmHg precision, last calibrated in 2012. Blood pressure measurement was done with the samples in a sitting position with their left arm on the examination desk, then the manset was circled around the left arm covering minimum 40% of the upper arm, then the examiner pressed the start button and recorded the score shown by the device. Subjects were not allowed to speak or move their left arms during this measurement.

At the beginning of this study, the subjects signed the informed consent and filled in the questionnare, and then were measured for height and weight by one examiner, and then moved to another examiner for measurement of waist and hip circumference, and finally to the last examiner for the blood pressure measurement. If the subject's blood pressure was more or equal to the 95th percentile,

then the measurement was conducted three times with a five minutes interval. The lowest score would be recorded as the subject's blood pressure. All measurements were recorded on the questionnare paper and then collected by the researcher for analisis.

The independent variable of this study was obese or non-obese adolescents. Adolescents were 12-14 years old junior high school students. Obesity was defined as BMI greater than or equal to the 95th percentile, whereas non-obese are subjects with BMI less than the 95th percentile. Body mass index was calculated using WHO anthro plus software for computers using a formula of weight (in kilograms) divided by the square of height (in square meters). Dependent variable was hypertension. Hypertension was defined as systolic and or diastolic blood pressure greater than or equal to the 95th percentile according to age, sex and height after three measurements.

Several additional variables were also studied to determine risk factors for obesity adolescents with hypertension, as discussed below. Sex was defined as male or female adolescent. Puberty history refers to spontaneous ejaculations in males, and menstruation in female. Age group was divided into age 12, 13 and 14 years old. Life style risk factors include amount of exercise in a week during or outside school hours, watching television as in hours per week, and electronic gaming habits as hours per day. Familial history risk factors were traced until second degree relatives, such as obesity, diabetes mellitus, kidney disorders, and hypertension according to information by subjects. Risk factors according to hazardous indicators were explained below. Hazardous body mass index was BMI greater than 30. Hazardous waist circumference in male adolescent was greater than 100 cm, in female adolescent was greater than 93 cm. Waist hip ratio (WHR) was the ratio between waist circumference and hip circumference, hazardous WHR was greater than 1 for male and greater than 0.8 for females. Waist height ratio (WHtR) was the ratio between waist circumference and height, Hazardous WHtR was greater than 0.5.

Data characteristics were shown in naration and tables. Sample distribution according to study variables were analyzed by univariate analisis. The association between obese adolescents and hypertension along with their risk factors were tested by chi square and prevalence risk (PR) ratio with CI 95% and $P < 0.05$ which was considered as significant. If the Chi-square requirements were not met, the Fisher test was applied. Significant and relevant risk factor variables are tested with multivariate analysis with logistic regression. The entire sample data was recorded on a study form and analyzed using a statistic software using a computer.

RESULTS

The study was conducted on Santo Yoseph junior high school, West Denpasar students batch 2012-2013 during Desember 2012. Measurements were conducted to 270 students from six classes . A total of 225 subjects met the inclusion criteria and were enrolled for this study, no subjects were excluded.

In this study, we found that the proportion of obese adolescents was 25.7% with mean BMI, body weight, waist circumference, and hip cimcumference in obese subjects greater than non-obese subjects. Mean age and height between obese and non-obese subjects were similar. Grade 1 hypertension (blood pressure within 95th-99th percentile) was more dominant in obese subjects. Sex, puberty status and life style of the obese and non-obese subjects were similiar. We found a greater proportion of familial history of obesity in the obese subjects than non obese subjects (70.7% VS 41.3%) Subject characteristics were presented in **Table 1**.

Table 1. Baseline characteristics of study subjects

Characteristics	Obesity (N=58)	Non-obesity (N=167)
Age, years, mean (SD)	13.0 (0.89)	12.9 (0.82)
BMI, kg/m^2, mean (SD)	28.7 (3.45)	19.5 (2.71)
Weight, kg, mean (SD)	71.0 (13.48)	47.3 (8.39)
Height, kg, mean (SD)	157.1 (12.98)	155.4 (7.12)
Waist circumference, cm, mean (SD)	89.8 (10.26)	70.4 (9.00)
Hip circumference, cm, mean (SD)	101.5 (12.39)	84.8 (7.05)
Sex, boys, n, (%)	31 (53.4)	70 (41.9)
Puberty status, n, (%)	46 (79.3)	127 (76.0)
Blood pressure		
< P95, n, (%)	32 (55.2)	131 (78.4)
P95-P99, n, (%)	16 (27.6)	30 (18)
> P99, n, (%)	10 (17.2)	6 (3.6)
Lifestyle		
Watching TV, > 2 hours/day, n, (%)	36 (62.1)	100 (59.9)
Playing games > 3 hours/day, n, (%)	26 (44.8)	66 (39.5)
Physical activity≤ 1 times/week, n, (%)	20 (34.5)	64 (38.3)
Family history:		
Obesity (n,%)	41 (70.7)	69 (41.3)
Diabetes melitus, n, (%)	13 (22.4)	28 (16.8)
Hipertention, n, (%)	17 (29.3)	52 (31.1)
Nephrology problem, n, (%)	6 (10.3)	14 (8.4)

BMI = Body mass index, P95 = percentile 95, P99 = percentile 99, TV = television.

Table 2 presented the association between obese adolescents and hypertension. We found a 21.5% difference of proportion between obese subjects with hypertension and obese subjects with normal blood pressure.

Table 2 revealed a significant association between obesity and hypertension in adolescents, hence we proceeded with a bivariate test to several variables to determine risk factors of the obese subjects with hypertension. **Table 3** presented playing games more than 3 hours per day, hazardous BMI and hazardous waist circumference and a combination of both have P value < 0.25.

The variables in **Table 3** with P value < 0.25 and several other variables assumed as risk factors in obese subjects with

Table 2. Association between obese adolescents and hypertention

Variables	Hypertension (N=63)	Normal (N=162)	PR	95% CI	P
Obesity, n, (%)	26 (41.3)	32 (19.8)	2.0	1.4 to 3.0	0.002
Non-obesity, n, (%)	37 (58.7)	130 (80.2)			

PR = prevalence ratio.

Table 3. Risk factors for obese adolescence with hypertension

Variables	Obesitas		PR	95 % CI	P
	Hypertension (N=26)	Normal (N=32)			
Sex, boys, n, (%)	14 (53.8)	17 (53.1)	1.0	0.6 to 1.8	0.96
Groups of age					
12 years old, n, (%)	8 (30.8)	14 (43.8)	-	-	-
13 years old, n, (%)	7 (26.9)	6 (18.8)			
14 years old, n, (%)	11 (42.3)	12 (37.5)			
Puberty status, n, (%)	21 (80.8)	25 (78.1)	1.1	0.5 to 2.3	0.81
Lifestyle					
Watching TV > 2 hours/day, n, (%)	15 (57.7)	21 (65.6)	0.8	0.5 to 1.5	0.53
Playing games > 3 hours/day, n, (%)	9 (34.6)	17 (53.1)	0.7	0.4 to 1.2	0.16
Physical activity >1 times/week, n, (%)	16 (61.5)	22 (68.8)	0.8	0.5 to 1.5	0.57
Family history					
Obesity, n, (%)	17 (65.4)	24 (75)	0.8	0.4 to 1.4	0.42
Diabetes melitus, n, (%)	7 (26.9)	6 (18.8)	1.3	0.7 to 2.3	0.46
Hipertention, n, (%)	9 (34.6)	8 (25.0)	1.3	0.7 to 2.3	0.42
Nephrology problem, n, (%)	3 (11.5)	3 (9.4)	1.1	0.5 to 2.7	1.00
Hazardous indicator					
BMI					
Risk, n, (%)	12 (46.2)	4 (12.5)	2.3	1.3 to 3.8	0.004
Not risk, n, (%)	14 (53.8)	28 (87.5)			
Waist circumference					
Risk, n, (%)	6 (23.1)	3 (9.4)	1.6	0.9 to 2.9	0.15
Not risk, n, (%)	20 (76.9)	29 (90.6)			
Combination BMI and WC					
Risk, n, (%)	6 (23.1)	2 (6.3)	1.9	1.1 to 3.2	0.12
Not risk, n, (%)	20 (76.9)	30 (93.8)			
WHR					
Risk, n, (%)	11 (42.3))	13 (40.6)	1.0	0.6 to 1.8	0.89
Not risk, n, (%)	15 (57.7	19 (59.4)			
WHtR					
Risk, n, (%)	26 (100)	30 (93.8)	-	-	0.49
Not risk, n, (%)	0	2 (6.3)			

BMI = body mass index, WC = waist circumference, WHR = waist hip circumference, WHtR = waist height circumference, PR = prevalence ratio.

Table 4. Multivariate analysis to know risk factor for hypertension in obese adolescents

Step	Variables	B	P	OR	95% CI
Step 1	BMI > 30	1.8	0.05	6.3	0.99 to 39.55
	Combination risk BMI and WC	21.3	1.0	1.8E9	0.0001 to 0
	Risk waist circumference	-20.9	1.0	0.0001	0.0001 to 0
	Playing games > 3 hours/day	-1.3	0.06	0.3	0.08 to 1.03
	Puberty status	0.3	0.7	1.4	0.31 to 6.29
	Family history of obesity	-0.7	0.3	0.5	0.13 to 1.87
	Constant	0.1	0.9	1.1	
Step 2	BMI > 30	1.8	0.05	6.2	0.99 to 38.17
	Combination risk BMI and WC	21.3	1.0	1.7E9	0.0001 to 0
	Risk waist circumference	-20.8	1.0	0.0001	0.0001 to 0
	Playing games > 3 hours/day	-1.2	0.06	0.3	0.09 to 1.06
	Family history of obesity	-0.8	0.3	0.5	0.12 to 1.75
	Constant	0.3	0.6	1.4	
Step 3	BMI > 30	1.9	0.05	6.4	1.04 to 39.63
	Combination risk BMI and WC	0.5	0.7	1.7	0.15 to 18.44
	Playing games > 3 hours/day	-1.2	0.07	0.3	0.09 to 1.11
	Family history of obesity	-0.8	0.2	0.4	0.12 to 1.66
	Constant	0.3	0.6	1.4	
Step 4	BMI > 30	2.1	.004	8.2	1.95 to 34.86
	Playing games > 3 hours/day	-1.1	0.08	0.3	0.09 to 1.13
	Family history of obesity	-0.8	0.3	0.5	0.12 to 1.70
	Constant	0.3	0.7	1.3	
Step 5	BMI > 30	1.9	0.005	7.3	1.82 to 28.83
	Playing games > 3 hours/day	-1.0	0.09	0.4	0.11 to 1.18
	Constant	-0.3	0.5	0.7	

BMI = body mass index, WC = waist circumference

hypertension, were further tested with multivariate analisis. Results of multivariate analisis presented in **Table 4** and demonstrate that BMI > 30 was a risk factor for obese subjects with hypertension since OR was 7.3 (CI 95% 1.8 to 28.8) and P = 0.005.

DISCUSSION

In 2007, a study conducted in Semarang on adolescents resulted in an obesity prevalence of 18.3%.[4] In 1999, a study in Bali revealed no adolescents with obesity,[5] but five years after the proportion was 10.9%.[6] Our study resulted in a proportion of 25.7% adolescent with obesity. This is consistent with the previous studies that shows a two fold increase of obesity prevalence in the last three decades.[15]

Hypertension in children and adolescents can be categorized as primary or essensial hypertension, and secondary hypertension. Essensial hypertension is an epidemic public health in adults, but has its origin during childhood and adolescence. Predisposising factors include obesity, insulin resistance, genetic, dietary, lifestyle, and a familial history of hypertension. Secondary hypertension is more frequent in children, especially caused by kidney disorders.[16] Obesity is an important risk factor for essential hypertension in adolescents, and our study revealed that obese adolescents have twice the risk for hypertension compared to non obese with P = 0.001 and 95% CI 1.4 to 3.0. This was in accordance with previous studies.[12-4] The mechanism of hypertension in obese adolescents is not yet completely understood, there are several pathogenesis of obesity leading to hypertension and will be discussed below. Abdominal obesity causes insulin resistance and an increase in leptin, both of which will directly alter endothelial function and nitric oxide production, hence causing vasoconstriction and increase of periferal resistance.[11,17] Insulin and leptin also increases simpathic nervous system activity which will eventually cause vasoconstriction and hypertension.[18] Another mechanism is activation of the renin-angiotensin-aldosterone system by several mechanisms such as increase of renin caused by simpathic nervous system, increased angiotensinogen due to increase of adipocyte and free fatty acid and other factors that increase aldosterone. Those three mechanisms cause an accumulation of aldosterone in the blood that causes an increase in blood pressure. Increase of sodium

reabsorption is another mechanism of hypertension in obesity. Sodium reabsorption occurs via the simpathic nervous system, hormonal system (aldosterone and insulin) and renovascular (angiotensin 2), causing natriuresis and high arterial pressure to create sodium homeostasis in the body.[18]

In our study, adolescents with familial history of obesity was 2.5 times more prone to becoming obese compare with adolescent without family history of obesity with P = 0.001 and 95% CI 1.5 to 4.2, while environment factors such as lifestyle did not show any effect. This was in accordance with previous studies which showed genetic factors, not environment factors play a role in the prevalence of obesity in adolescents. Six genes have been identified to have a correlation with obesity; 14 locuses from those 6 genes were found to correlate with BMI and two locuses with waist circumference.[19] Previous studies revealed the combination of BMI and waist circumference as a risk factor to identify cardiovascular disorders in obese adults,[20] but in our study, the combination of BMI and waist circumference was not proven as a risk factor for hypertension in obese adolescents.

Multivariate analisis results revealed that obese adolescents with BMI > 30 were seven times more prone to hypertension compared to non-hypertension obese adolescents with P = 0.005 and 95% CI 1.8 to 28.8. At present, the WHO declares BMI > 30 as a criteria to diagnose abdominal obesity.[21] Abdominal obesity or central obesity is the accumulation of visceral fat around the stomach and abdomen. Our study was in accordance with previous studies that demonstrate an association between abdominal obesity and hypertension in adolescents.[13,14]

The limitation of this study was the cross sectional design. We needed a cohort study to reveal a closer association.

CONCLUSION

We found that body mass index > 30 could be a risk factor for obese adolescents with hypertension.

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