

The Association between Hypertension and Cognitive Function in Adolescents



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Abstract

Background: The prevalence of hypertension is increasing in childhood and usually asymptomatic but still has target organ damage manifestations. This condition may cause negative impacts on their cognitive function. Early detection and appropriate management on hypertension may lessen cognitive impairment associated with hypertension.

Methods: A cross sectional study was conducted among 193 children aged 12 to 17 years in Singkuang Village, Mandailing Natal Regency, North Sumatera on April 2016. Blood pressure and cognitive test scores were collected. Hypertension was defined as systolic or diastolic blood pressure at ≥ 95 th percentile according to the Fourth report from the National High Blood Pressure Education Program Working Group on Children and Adolescent. Cognitive impairment was defined as borderline and lower cognitive test scores. Chi-square test was used to analyze the association between hypertension and cognitive function. The P value of < 0.05 at 95% confidence interval (CI) was considered significant.

Results: Of 193 adolescents, 28% had hypertension. Adolescents with hypertension had lower Intelligence Quotient (IQ) scores compared with normotensive adolescents for verbal ($P=0.008$; $PR=2.381$; $CI=1.244 - 4.559$), performance ($P=0.021$; $PR=2.134$; $CI=1.115-4.082$), and full-scale domain ($P=0.005$; $PR=2.475$; $CI=1.295-4.730$).

Conclusion: There is a significant association between hypertension and cognitive function in adolescents.

Keywords: Hypertension; Cognitive impairment; Adolescent

Introduction

The prevalence of hypertension in children tends to increase, but the possible neurologic effects are still neglected [1]. Primary hypertension are mostly found in school-age and adolescents, and its prevalence increases with an increased prevalence of obesity [2]. The global prevalence of hypertension in children is unknown globally, and oftenly this condition is undiagnosed. Age, height and obesity are risk factors for increased diagnosis and prevalence of hypertension in children [3]. Based on blood pressure measurement in three separate measurements, the prevalence of hypertension in children is about 1-3% [4]. The prevalence of hypertension and prehypertension in the age range 3-18 years are respectively 3.6% and 3.4%. The prevalence of hypertension and prehypertension in the age range 11 - 17 years are respectively 3.2% and 15.7% [5]. Other studies have shown the prevalence of abnormal blood pressure in adolescents aged 14-17 years is 11.5%, with 2.5% of hypertension and 4% of persistent prehypertension.⁴ The presence of obesity is associated with an increased prevalence of hypertension and about 14% of

prehypertension in adolescents developed into hypertension within 2 years [5].

Mild hypertension in children in young adults causes decreased performance in neuropsychologic test compared to control [6]. Children with chronic hypertension are at higher risk to have learning disturbances and executive function deficits, where cognitive impairments hits the prevalence number of 2.4% [1,7]. The increasing blood pressure at ≥ 90 th percentile is associated with decreased mathematical ability in children aged 6 to 16 years compared to children with blood pressure at < 90 th percentile [8].

This cognitive impairment is possibly caused by disturbance of cerebral blood flow regulation. The increasing blood pressure in children also contributes in the increased risk of early atherosclerosis, which affects blood vessels in acute and chronic fashion. Studies regarding blood pressure in children are still lack in number and further studies to evaluate the clinical effect of hypertension on children's nervous system are mandatory [1,9].

Methods

Study design and sample

A cross-sectional study was conducted in Singkuang Village from April to May 2016. A total of 193 samples were collected consecutively with the inclusion criteria: children aged 12 to 17 years, had blood pressure measured, and cognitive function tested. Hypertension was defined as systolic or diastolic blood pressure at $\geq 95^{\text{th}}$ percentile. Cognitive impairment was defined as borderline and lower cognitive test scores.

Data Collection

Baseline data were collected using questionnaire. Before filling the questionnaire, samples and their parents had explanation about the study. Informed consent was obtained from each sample's parent. Anthropometric measurement was done, including weight and height measurements. Blood pressure was measured three times in a resting and calm condition. Blood pressure was measured using mercury sphygmomanometer with appropriate cuff. A stethoscope was placed on brachial artery projection, proximal and medial to fossa cubiti and below the cuff to detect the Korotkoff sound. Blood pressure was measured at interval of 10 to 15 minutes and the mean value was calculated for systolic and diastolic blood pressure. The mean blood pressure was evaluated according to sex, age, and height, and projected in The Fourth Task Force table. All adolescents who fulfilled the inclusion

criteria had cognitive test by psychologist from Psychology Faculty, Andalas University, Padang using WISC-IV (Wechsler Intelligent Scale for Children) test which consisted of verbal, performance, and full scale components.

Statistical Analysis

Data were analyzed using computer software (SPSS version 19.0) to determine the association between hypertension and cognitive function, we used chi-square test and Fisher's exact test as the alternative. The P value of $< 0,05$ at 95% confidence interval was considered significant.

Results

A total of 193 children aged 12-17 years were used as samples, with mean values as follows : age of 14.0 years, body weight according to height of 102.09%, body mass index of 18.6kg/m². The samples consisted of 84 men and 109 women. Nutritional status consists of 2 malnutrition, 30 malnutrition, 115 good nutrition, 27 overweight and 19 obesity samples. There were 54 had hypertension and 139 children with normotency. The proportion of hypertension among junior high school students in Singkuang Village was 28%. There were differences in body mass index and mother's occupation between hypertension and control group (P value 0.019 and 0.035 respectively). The difference in baseline characteristic between both group is shown in (Table 1).

Table 1: Baseline characteristic of sample.

Characteristic	Hypertension	Non-Hypertension (<90th percentile)
	($\geq 90^{\text{th}}$ percentile)	
Gender, n		
Male	18	66
Female	36	73
Age (year), mean (SD)	13.7 (1.10)	14.1 (1.29)
BW/ BH (%), mean (SD)	104.2 (15.66)	101.3 (13.36)
Nutritional status, n		
Severe malnutrition	0	2
Mild malnutrition	7	23
Normal	32	83
Overweight	9	18
Obese	6	13
Body mass index (kg/m ²), mean (SD)	19.1 (3.07)	18.4 (3.41)
Father's education, n		
Elementary school	42	88
Junior high school	8	31
Senior high school	4	19
Diploma	0	1

Mother's education, n		
Elementary school	36	65
Junior high school	15	42
Senior high school	1	25
Diploma	2	5
Bachelor	0	2
Father's occupation		
Government employer	4	23
Private employer	17	27
Entrepreneur	7	22
Farmer/fisher	22	53
Unemployed	4	14
Mother's occupation		
Government employer	10	30
Private employer	13	18
Entrepreneur	3	18
Farmer/fisher	18	62
Unemployed	10	11
Father's income		
< 500.000	7	28
500.000 - 1.000.000	26	60
1.000.000 - 3.000.000	21	51
Mother's income		
< 500.000	27	73
500.000 - 1.000.000	20	48
1.000.000 - 3.000.000	7	18

There was no decreased cognitive function based on sex (P=0.51), age (P=0.696), body weight for body height (P=0.512), nutritional status (P=0.273), father's education (P=0.883), mother's education (P=0.112), father's occupation (P=0.332), mother's occupation (P=0.059), Father's income (P=0.117), and

mother's income (P=0.872). There was a relationship between body mass index and cognitive impairment (P=0.048), where samples with cognitive impairment had higher body mass index compared to samples with normal cognitive function. Factors affecting cognitive impairment were shown in (Table 2).

Table 2: Factors affecting cognitive function.

Characteristic	Full scale cognitive impairment	No cognitive impairment	p
Gender, n			
Male	27	57	0.51
Female	40	69	
Age (year), mean (SD)	14.1 (1.37)	14.0 (1.2)	0.696
BW/ BH (%), mean (SD)	103.3 (15.28)	101.5 (13.39)	0.512
Nutritional Status, n			
Severe malnutrition	0	2	0.273
Mild malnutrition	7	23	
Normal	45	70	

Overweight	7	20	
Obese	8	11	
Body mass index (kg/m ²), mean (SD)	19.0 (3.03)	18.4 (3.46)	0.048
Father's Education, n			
Elementary school	49	81	0.883
Junior high school	12	27	
Senior high school	6	17	
Diploma	0	1	
Mother's Education, n			
Elementary school	34	58	0.112
Junior high school	17	40	
Senior high school	5	21	
Diploma	2	5	
Bachelor	0	2	
Father's Education			
Government employer	8	19	0.332
Private employer	21	23	
Entrepreneur	11	18	
Farmer/fisher	23	52	
Unemployed	4	14	
Mother's Education, n			
Government employer	14	26	0.059
Private employer	15	16	
Entrepreneur	3	18	
Farmer/fisher	24	56	
Unemployed	11	10	
Father's Income			
< 500.000	7	28	0.117
500.000 – 1.000.000	34	52	
1.000.000 – 3.000.000	26	46	
Mother's Income			
< 500.000	33	67	0.872
500.000 – 1.000.000	25	43	
1.000.000 – 3.000.000	9	16	

There was an association between hypertension and verbal domain cognitive impairment (P=0.008). Of 65 samples having verbal domain cognitive impairment, 26 had hypertension and of 128 samples not having verbal domain cognitive impairment, 28 had hypertension. The association between hypertension and verbal domain cognitive impairment was shown in (Table 3). There was an association between hypertension and performance

domain cognitive impairment (P=0.021). Of 65 samples having performance domain cognitive impairment, 25 had hypertension and of 128 samples with normal cognitive function, 29 had hypertension. The association between hypertension and performance domain cognitive impairment was shown in (Table 4).

Table 3. Association between hypertension and verbal domain cognitive impairment.

		Verbal domain			P	PR	CI 95%
		Impairment	Normal	Total			
Blood pressure	Hypertension	26	28	54	0.008	1.716	1.169 – 2.519
	Non-hypertension	39	100	139			
Total		65	128	193			

Table 4: Association between hypertension and performance domain cognitive impairment.

		Performance domain			P	PR	CI 95%
		Impairment	Normal	Total			
Blood pressure	Hypertension	25	29	54	0.021	1.609	1.091 – 2.373
	Non-hypertension	40	99	139			
Total		65	128	193			

There was an association between hypertension and full scale cognitive impairment (P=0.005). Of 67 samples having full scale cognitive impairment, 27 had hypertension and of 126 samples

not having full scale cognitive impairment, 29 had hypertension. The association between hypertension and full scale cognitive impairment was shown in (Table 5).

Table 5: Association between hypertension and full scale domain cognitive impairment.

		Performance domain			P	PR	CI 95%
		Impairment	Normal	Total			
Blood pressure	Hypertension	25	29	54	0.021	1.609	1.091 – 2.373
	Non-hypertension	40	99	139			
Total		65	128	193			

Discussion

In this study, hypertension increased the incidence cognitive impairment by factor 1.5, in verbal domain (PR=1.176; 95% CI=1.169 - 2.519), in performance domain (PR=1.609; 95% CI=1.091 - 2.373), and in full scale domain (PR=1.378; 95% CI=1.196-2.524). We used WICS-IV (Wechsler Intelligence Scale for Children-IV) test to evaluate cognitive function of samples.

The result of this study was confirmed by a study in United States in 1988 to 1994 by The National Health and Nutrition Examination Survey III. Children with systolic and diastolic blood pressure at ≥90th percentile had lower mathematical ability compared to children with blood pressure at <90th percentile.⁸The cognitive function was measured using Wechsler Intelligence Scale

for Children, Revised (WISC-R) and Wide Range Achievement Test, Revised (WRAT-R). A study in United States in 2009 showed that children with hypertension and obesity had significantly higher executive disturbance compared to children with normal blood pressure, and children with hypertension had lower internalization and externalization score [10]. The measurement tools used in the study were Behavior Rating Inventory of Executive Function (BRIEF) form which was filled by parents, and Child Behavior Checklist (CBCL) to measure internalization and externalization ability. Another study from United States in 2009 reported that children with blood pressure at ≥90th percentile had lower performance score of IQ WASI (92.4 vs 96.1; P=0.03) and full scale score of IQ WASI (93.4 vs 97.0; P=0.04). Multivariate analysis showed that there was an association between low IQ score and

increased blood pressure (increased blood pressure, $\beta=-3.7$, 95% CI: -7.3 -(-0.06); systolic blood pressure, $\beta=-1.16$, 95% CI: -2.1 -(-0.21); diastolic blood pressure, $\beta=-1.17$, 95% CI: -1.8 -(-.055). The neurocognitive examinations consisted of: intellectual function measurement with Wechsler Abbreviated Scales of Intelligence (WASI); basic academic achievement with Wechsler Individual Achievement Test-II-Abbreviated (WIAT-II-A); attention regulation with Conner's Continuous Performance Test-II (CPT-II) and executive function level with Behavior Rating Inventory of Executive Function (Parent BRIEF) [11].

A study in United States in 2010 reported that children with primary hypertension had higher learning disturbance prevalence compared to children with normal blood pressure (OR:4.1; 95% CI:1.8 - 9.4) [12].

The process of cognitive decline in hypertensive patients begins with pathological changes in the blood vessels of the brain, and as a result of this, the blood perfusion to the brain will be disrupted and will cause abnormalities in brain tissue, resulting in cerebral hypoperfusion that will cause decreased cognitive function. Damage that occurs in the decline in cognitive function due to hypertension risk factors are dependent with the areas of the cerebral disorders. Cognitive impairment that can occur are decreased attention (attention and concentration), memory and information storage disorders, language disorders such as sensory and motor sensory, visuospatial disorders, impaired executive function such as decreased calculation or ability to calculate, decision making and abstract thinking disorders [13,14].

This study shows that there is a difference in body mass index when compared with the incidence of hypertension, in which adolescents with hypertension have higher BMI than non-hypertension adolescents. Incidence of hypertension is increased in children with obesity, and previous studies have reported that obesity is a risk factor for hypertension (OR = 2.61) [1,3]. Obesity and hypertension increase the incidence of impaired executive function in children [15].

This study showed that there was a difference in body mass index between both groups. Adolescents with hypertension had higher body mass index compared to adolescents with normal blood pressure. The incidence of hypertension was increased in obese population. Previous study stated that obesity was the risk factor for hypertension (OR=2.61) [1,3]. Both obesity and hypertension contributed to executive function disturbance [15]. The proportion of hypertension in this study was 28%, which was higher than global proportion (15.7%) [15]. Further evaluation regarding risk factors for hypertension is mandatory to grant adequate management. Hypertension in children and adolescents is associated with cognitive impairment and adult hypertension.

Proper management of hypertension will give significant improvement [11].

Conclusion

There is statistically significant association between hypertension and cognitive function in adolescents.

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