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Overview Of Hypertension In Adolescents

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ABSTRACT
Hypertension in adolescents can persist into adulthood and has higher morbidity and mortality. Globally, the prevalence of hypertension in adolescents reaches around 10% and 14% experience prehypertension. The increase in hypertension in adolescents is caused by both modifiable and non-modifiable risk factors. Risk factors that cannot be modified include family history of disease, namely hypertension or other cardiovascular disease, genetics, premature birth, low birth weight, gender, race. Modifiable risk factors relate to obesity, dietary habits, salt intake, physical activity, smoking, poor sleep quality. The diagnosis of adolescent hypertension is different compared to adult patients, in the form of a detailed history ranging from fetal growth patterns to habitual history. Physical examination blood pressure measurements are adjusted and classified based on percentiles. Treatment starts from lifestyle changes to administering pharmacology tailored to the patient's condition.

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INTRODUCTION

Hypertension is a common condition across all socio-economic strata and income levels, with 60% of those over 60 experiencing it. Hypertension in adulthood can occur since childhood and adolescence. Hypertension in adolescents can persist into adulthood and has higher morbidity and mortality. According to data from the World Health Organization (WHO), it is estimated that around 1.4 billion people worldwide have hypertension. In addition, hypertension was found to be a major risk factor causing 10.2 million deaths and 208 million disabilities. In Indonesia, based on the results of Basic Health Research, there has been a drastic increase in hypertension cases, namely 25.8% in 2013 to 34.1% in 2018. Globally, the prevalence of hypertension in adolescents has reached around 10% and 14% have prehypertension. [1–4]

The increase in hypertension in adolescents is caused by various risk factors related to diet, such as unbalanced consumption of sodium, carbohydrates and fat, which can lead to obesity. Adolescents who are more than 20% overweight or obese and have high cholesterol levels are at greater risk of developing hypertension. Sodium, fat and sweet drinks can affect blood pressure and vasodilation of blood vessels, lack of physical activity can cause cholesterol which is the cause of hypertension. Risk factors other than nutrition,

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namely smoking, nicotine can cause an increase in blood pressure, this occurs due to hormonal disorders that play a role in the blood vessels and heart.[4.5]

Definition

Unlike in adults, the definition of hypertension (HTN) in children is arbitrary and based on the normal distribution of blood pressure in healthy children, not on cardiovascular morbidity and mortality associated with certain blood pressure levels. Diagnostic criteria for high blood pressure in children are based on the understanding that children's blood pressure increases with age and body size, making it impossible to use a single blood pressure level to determine HTN as is done in adults. According to the European Society of Hypertension, hypertension in children aged 1-15 years is defined when blood pressure is above the 95th percentile, and at age 16 years or more when blood pressure is >140/90. [1.6]

According to the latest guidelines from the American Academy of Pediatrics Hypertension, in children under 13 years of age, Hypertension was defined as blood pressure above the 95th percentile for age, sex, and height, detected in at least 3 examinations. Meanwhile, in adolescents aged 13 years and over, hypertension is now defined as blood pressure ≥130/80, without considering age, gender or height. [4.7]

Epidemiology

Based on data from the Ministry of Health (Kemenkes) from 2013 to 2018, there was an increase in cases of hypertension among those aged 18-24 years. According to WHO, the number of hypertension cases in the world reached 1.13 billion people, while in Indonesia, according to Riskesdas in 2018, there were around 63 million people suffering from hypertension. The death rate related to hypertension in Indonesia reached around 427 people. In East Java, the percentage of hypertension is 22.71%, which is equivalent to 2,360,592 residents, consisting of 18.99% men (808,009 people) and 18.76% women (1,146,412 people). Hypertension in adolescents and young adults aged 15-25 years occurs in 1 in 10 people, while the rate of prehypertension and hypertension in those aged 20-30 years is 45.2%. Riskesdas 2013 data shows that the prevalence of hypertension in adolescents aged 15-17 years is 5.3%, and in adolescents aged 18-24 years it reaches 13.2%. From 2013 to 2018, there was a significant increase in cases of hypertension in adolescents with a difference of 7.9% in five years. [2.5]

RISK FACTORS AND PATOMECHANISMS

The increase in hypertension in adolescents is caused by various factors. Primary hypertension, which accounts for 50% to 90% of cases, is more common in older and younger children, while secondary hypertension is more common in younger children. The factors that cause hypertension are divided into modifiable and non-modifiable factors. [4]

Non-modifiable factors

Nonmodifiable risk factors include a family history of hypertension or other cardiovascular disease, genetic factors, premature birth, low birth weight, gender, and race. [5.8.] The familial aggregation of hypertension is well known, and genetic factors contribute significantly. Research shows that hypertension can be inherited in families and between twins in approximately 30-50%. Interactions between epigenetic and gene-environment factors also likely play an important role. Some perinatal factors, such as low birth weight

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and prematurity, are associated with children's blood pressure, as these factors may interfere with nephrogenesis and influence individual susceptibility to hypertension and salt sensitivity. [4,8]

Disturbances in the perinatal period can reduce capillary density, endothelial function, and kidney development, ultimately leading to hypertension in adulthood. Several studies have tried to understand the relationship between hypertension in adolescents and preterm birth by examining kidney size, kidney function, and circulating angiotensin levels. However, the results showed that kidney volume was positively correlated with systolic blood pressure (SBP) in children aged 4-20 years. Additionally, decreased capillary growth increases vascular resistance, which in turn increases blood pressure. [9–11]

Blood pressure, especially after the age of 12-14 years, tends to be higher in boys than girls. The mechanism underlying this difference is still not completely clear, but it is thought that there is an interaction between sex hormones and kidney function. Several pathways, such as the renin-angiotensin-aldosterone system (RAAS), endothelin, and nitric oxide (NO), also play a role in regulating vascular function. The imbalance between endothelin and NO in juvenile hypertension is supported by studies showing decreased NO activity and increased endothelin. [12,13]

Racial and ethnic minority groups have consistently been shown to have higher rates of hypertension and poorer blood pressure (BP) control. Salt intake influences blood pressure in many individuals and populations, and there are racial differences in sodium and potassium intake and processing. Racial differences also affect sensitivity to salt. It is known that African Americans have a high salt sensitivity, which contributes to increased blood pressure. In addition, racial differences in body mass index have long been recognized, which also reflect variations in blood pressure levels and the prevalence of hypertension. [4,12,14]

Modifiable factors

Modifiable risk factors associated with hypertension include obesity, dietary habits, salt intake, physical activity, smoking, and poor sleep quality. Obesity is a major risk factor for hypertension in children, with the risk of hypertension being 2.6 times greater in children with a BMI percentile >85 and 9.2 times greater in children with a BMI percentile >95. Obesity-associated hypertension can begin early (before 5 years of age) and involves complex mechanisms such as impaired sodium handling, overactivation of the sympathetic nervous system, oxidative stress, hemodynamic changes, and renal or endocrine dysfunction. [4,8]

Obesity is the most frequent risk factor for essential hypertension in pediatric patients. There are several possible pathophysiological pathways to explain why adiposity is associated with increased blood pressure and hypertension. The main principles relate to dysfunctional adipocytes and neurohormonal activation of the sympathetic nervous system (SNS). Activation of the SNS causes activation of the RAAS as well as vasoconstriction of blood vessels. [11,12,15,16]

Sodium intake is closely related to blood pressure. Consuming foods high in salt can increase thirst, which then increases plasma osmolality due to excess sodium. As a result, consuming water with fast food rich in salt can restore plasma osmolality in a healthy body.

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However, excessive salt intake produces a dipsogenic effect that causes a temporary increase in body fluid resistance, which can trigger hypertension in salt-sensitive individuals. This causes an increase in blood volume, which ultimately leads to hypertension. [4,5,16]

Adolescent behavior in adopting unhealthy lifestyles such as lack of physical activity, high levels of sedentary activity, low consumption of high fiber and smoking behavior is closely related to the incidence of obesity in adolescents. The mechanisms underlying the association of physical activity and blood pressure remain unclear, although decreased vascular resistance produced by the sympathetic nervous system and renin-angiotensin system may play a role. Studies in overweight or obese adolescents report that physical activity participation normalizes endothelium-dependent dilatation, contributing to reduced SBP. [15,17,18]

Hypertension is caused by smoking because of the chemical substances in tobacco, namely nicotine, which can stimulate the sympathetic nervous system and the carbon monoxide content which replaces oxygen in the blood, forcing the heart to meet oxygen needs. When tar flows in the blood vessels, it can force the heart to pump blood more strongly and hypertension will occur. [5,8,15]

Other risk factors that influence blood pressure are sleep duration and sleep quality. Short sleep duration was associated with greater consumption of caffeinated drinks and soda, increased screen time, and less physical activity, while poor sleep quality was associated with these factors coupled with increased consumption of fried foods, sweets, energy foods. other heights, and snacks. A person's homeostatic system is disturbed due to poor sleep quality. Disturbances in homeostatic mechanisms can cause increased brain activity. Increased workload in the brain can stimulate hormone secretion, affecting the periphery, such as through the epinephrine and norepinephrine pathways. Epinephrine causes a peripheral increase resulting in an increase in blood pressure. Another theory is that poor sleep quality increases brain activity and stimulates adrenaline secretion, leading to impaired fat metabolism. [8.19]

Diagnosis

Anamnesis

As with other clinical entities, a thorough history and clinical examination should be the first step in the evaluation of juvenile HTN. A detailed history of fetal growth patterns, birth weight, maternal hypertension, perinatal infections, and neonatal hospitalization should be recorded followed by information regarding nutritional history including daily intake of salt, fat, fast food, vegetables, fruit, and nuts. nuts. Likewise, a history of physical activity, gadget *screen time , and sleep disorders* should be sought. Sleep disorders can be related to hypertension. A family history of hypertension, and kidney disease should be noted. Likewise, a psychosocial history of a stressful childhood, early anxiety and depression, or obesity related to school bullying should be noted. [20,21]

Physical examination

All children identified as having HTN should have their height and weight measured and classified according to percentiles. Other than the findings of HTN itself and obesity, physical examinations in children with HTN are mostly normal. For the most accurate reading, the patient should sit quietly for at least three to five minutes with their back

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supported, and their legs uncrossed and flat on the floor. Cuffs of appropriate size should be used, with the cuff being at least 40% of the arm circumference and the cuff length being 80% to 100% of the arm circumference. Arm circumference was measured at the midpoint between the acromion and olecranon. Blood pressure should be measured with the arm supported at heart level. Tools that can be used to measure BP are *auscultatory mercury sphygmomanometer, oscillometric, ambulatory blood pressure monitoring* (ABPM). [20–22]

After measuring blood pressure, determining whether a teenager has hypertension can be seen based on the blood pressure classification as follows:

Table 1. Classification of blood pressure according to AAP (2017)

TD/HTN	Ages 1-13 years	Age > 13 years
BP Normal	Below the 90th percentile	<120/80 mmHg
TD Increased	Percentile ≥90 to ≤95 or BP 120/80 to percentile <95	120/<80 – 129/<80 mmHg
HTN *Stage 1*	percentile ≥to <95th percentile + 12 mmHg or 130/80-139/89 mmHg	130/80 – 139/89 mmHg
HTN *Stage 2*	Percentile ≥95+12 mmHg or 140/90 mmHg	≥140/90 mmHg

(Source: American Academy of Pediatrics, 2017) [22]

Supporting Examination

Initial tests are performed to evaluate the underlying etiology, identify other CVD risk factors, and detect target organ damage. In general, basic examinations such as hemoglobin estimation, renal function, serum electrolytes, serum lipids, blood glucose, creatinine ratio and chest x-ray may be considered. In patients with BMI percentile >95, HbA1c, SGPT, SGOT, TSH, drug screening, and sleep studies in systolic hypertension will be helpful. Apart from the above examinations, echocardiography, renal ultrasonography, CT/MR angiography are very helpful for the proper management of hypertension. [20,21]

Treatment Management

Management of adolescent hypertension aims as follows: (1) preventing organ damage due to hypertension; (2) appropriate diagnosis and treatment of the patient's secondary hypertension; and (3) improvement of adolescent essential hypertension by modifying a healthy lifestyle and preventing progression to adult essential hypertension. [11,20,22]. The following are strategies for managing adolescent hypertension:

1. Lifestyle changes

   All children with high blood pressure or hypertension should make therapeutic lifestyle changes to lower blood pressure and reduce the risk of developing additional CVD risk factors. [6.20]. *Dietary Approach to Stop Hypertension (DASH)* and specific elements of the diet have been the primary dietary strategy tested in the literature. These elements include a diet high in fruits, vegetables, low-fat dairy products, whole grains, fish, poultry, nuts, and lean red meat; it also includes limited intake of sugar and sweets along with lower sodium intake (less than 5g per day). [4.22]

   Children with a BMI below the 85th percentile can maintain their weight to prevent *overweight*. Children with a BMI between the 85-95th percentile can maintain or slowly reduce their weight to reach a BMI below the 85th percentile. Meanwhile,

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children with a BMI above the 95th percentile must reduce their weight by around 1-2 kg every month to reach below the 85th percentile. This BMI is expected to reduce BP because it can reduce blood volume and/or cardiac output, suppress SNS, reduce RAAS activity, and increase insulin sensitivity. [6,8]

Children and teens aged 5-17 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity for 3 to 5 days each week. Amount of physical activity of more than 60 minutes provides additional health benefits. Most daily physical activity should be aerobic. Vigorous intensity activities should be incorporated, including activities that strengthen muscles and bones, at least three times per week. Avoid sedentary activities for more than 2 hours every day. Competitive sports participation should be limited to the presence of uncontrolled *stage 2 hypertension.* [6,21,22]

Tobacco and alcohol use should be avoided in all children, and this is especially important in children with hypertension because smoking increases the risk of CVD, and excessive alcohol intake is known to increase blood pressure in adolescents. The heart and vascular system is particularly vulnerable to tobacco smoking. Preventing maternal smoking and maintaining a strict smoke-free environment is critical because of accumulating evidence about the importance of fetal and early life factors in determining cardiovascular risk. In adolescents, promoting smoke-free rules at home can help prevent cigarette consumption. [6,14,16]

2. Pharmacological Therapy

Pharmacotherapy is indicated for children with hypertension who meet the following criteria: persistent hypertension despite nonpharmacological therapy involving lifestyle modification for 3–6 months; symptomatic hypertension; secondary hypertension requiring pharmacotherapy; concurrent development of target organ damage as evidenced by proteinuria, microalbuminuria (>30 mg/g creatinine), and cardiac hypertrophy with CKD and the presence of diabetes mellitus . [11.20]

Therapy should be initiated with a single drug at the lower end of the dose range. Depending on repeat BP measurements, the initial treatment dose may be increased every 2 to 4 weeks until BP is controlled (e.g., <90th percentile), maximal dose is reached, or side effects occur. Although the dose can be titrated every 2 to 4 weeks using home blood pressure measurements, patients should be checked every 4 to 6 weeks until blood pressure normalizes. [21.22]

The choice of drug should be targeted to the child's underlying pathophysiology and the presence of concomitant disorders. Primary HTN is a growing problem in the pediatric age group, intrinsically linked to the increasing incidence of global obesity. ACE inhibitors, Calcium channel blockers (CCB), thiazide diuretics are safe and well tolerated in children. ACE inhibitors or ARBs are recommended as initial agents for children with hypertension and chronic kidney disease, proteinuria, or diabetes. A recent systematic review shows that lisinopril shows absolute BP lowering results compared to other antihypertensive drugs. If this cannot be tolerated, *Calcium Channel Blockers* are a reasonable alternative. Given their known effects on glucose metabolism and insulin resistance, it makes sense to avoid the use of *beta-blockers*

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without vasodilatory capacity and thiazide diuretics. Calcium channel blockers or hydrochlorothiazide may be selected for adolescent women at risk of pregnancy to avoid the potential fetal risks of other classes of medication. [4,20,23]

Once the appropriate agent has been selected, the child should be started on the lowest recommended dose. This dose should be increased until blood pressure is within the target range or until the maximum recommended dose is reached, at the same time carefully monitoring the development of side effects. These are drug specific, and some require regular monitoring, for example assessment of renal function and potassium balance in children receiving ACEi and ARBs. Some drug-related adverse effects may be dose-limiting, resulting in early addition of a second agent or complete replacement of the initial agent. [6.20]

Prognosis

Although uncontrolled adult hypertension is clearly associated with cardiovascular disease and death, there is limited evidence for hypertension in adolescents. What is clear is that there is substantial evidence that elevated blood pressure during adolescence persists into adulthood and that pediatric hypertension increases the risk of subclinical cardiovascular disease (" *Target Organ Damage* "). BP tracking between adolescents and adults and among obese individuals is more robust. Individuals with persistent hypertension (through childhood and adolescence) are 7.6 times more likely to develop adult hypertension. However, there are also those who experience normalization of BP over time. Factors associated with blood pressure normalization include decreased body mass index, increased vegetable intake, decreased alcohol use, and improved socioeconomic status. [4.12]

Juvenile hypertension is associated with target organ damage, which in turn is associated with future cardiovascular disease. Adolescents with hypertension have higher left ventricular mass index and left ventricular hypertrophy (LVH). There are also patients experiencing increased carotid intima media thickness, higher pulse wave velocity, arterial calcification and atherosclerotic changes, retinal microvascular disease, and microalbuminuria. [12.24]

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