

Defining hypertension in children

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Abstract

Hypertension is the most common, and potent universal contributor to cardiovascular mortality. Elevated blood pressure, labile or fixed, systolic or diastolic, at any age, in either sex, is a contributor to all forms of cardiovascular disease. Hypertension in children is currently recognised as an important health issue. Treatment includes weight loss and exercise.

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Introduction

Hypertension in children is defined as average systolic and/or diastolic blood pressure (BP) that is \geq 95th percentile for gender, age and height, on three or more separate occasions.¹ The definition of hypertension in children is based on the normative distribution of BP in healthy children. Normal BP is defined as systolic blood pressure (SBP) and diastolic blood pressure (DBP) that are $<$ 90th percentile for gender, age and height. Average SBP or DBP among the 90th and 95th percentiles are characterised as prehypertension.

Prehypertension is an indicator of elevated risk of developing hypertension. *The fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents* provides systolic and diastolic BP levels corresponding to the 50th, 90th, 95th and 99th percentiles based on the child's sex, age and height percentile.²

Measurements below the 90th percentile are considered normal. Prehypertension or hypertension is present when measurements of either SBP or DBP, or both, are at or above the 90th percentile. BP should be measured at least twice during the same assessment, and confirmed on at least three separate occasions.³ Prehypertension is present when the measurement is at or above the 90th percentile, but less than the 95th percentile, as well as when BP reaches or exceeds 120/80 mmHg in an adolescent. Hypertension is present when repeated measurements are at, or above, the 95th percentile. Hypertension is further classified as either Stage 1, in which BP ranges between the 95th and the 99th percentiles plus 5 mmHg, or Stage 2, in which BP is above the 99th percentile plus 5 mmHg. White coat hypertension

occurs when the patient's BP remains above the 95th percentile when measured in a clinical setting, but is normal when measured in a familiar setting. If hypertension is confirmed, BP should be measured in both arms and a leg. The classification of BP influences decisions on evaluation and management.

Measuring blood pressure

The preferred method of measuring BP is auscultation because the BP reference values are based on auscultatory measurements. To confirm hypertension, BP in children should be measured with a standard clinical sphygmomanometer. The use of the bell of the stethoscope may allow Korotkoff sounds to be more audible.^{4,5} Preparation of the child before the measurement can be as important as the technique.^{6,7,8} Correct measurement of BP in children requires use of a cuff that is appropriate for the size of the child's upper right arm.

Current guidelines recommend that all children over three years of age have their BP assessed as part of routine health maintenance.⁹ The assessment setting should be optimised to reduce distractions and stress, and the patient should be in a relaxed state. Although oscillometric devices are currently more frequently used, auscultation and the use of a mercury column sphygmomanometer remain the recommended approach and the method used to derive current normal values of BP upon which cut-off points for decision making are based.¹⁰ BP measurements above the 90th percentile from oscillometric assessment should be reassessed using the auscultatory method, since normal values based on this method are not available. Elevated measurements demonstrated by either method should be

confirmed by repeated assessment at a minimum of three different time points.

For either method, use of an appropriately sized cuff is important, and 80-100% of the inflatable cuff bladder length should encircle the mid-portion of the upper arm. The right arm is preferred, with the child seated (infants can be supine). At least 40% of the arm from the olecranon to the acromion should be covered by the width of the inflatable bladder. Use of a cuff that is too small might falsely elevate readings. Particular care should be taken to ensure the appropriate cuff size when assessing overweight and obese patients. The head of the stethoscope should be placed over the brachial artery pulse, below the lower edge of the cuff. The arm should be relaxed and supported so that the cubital fossa is at heart level. SBP should be taken at the onset of the first Korotkoff sound. Disappearance of the Korotkoff sounds (the fifth one) should be taken as the DBP.¹⁰ In some children, Korotkoff sounds are evident down to 0 mmHg. In this instance, the measurement should be repeated with less pressure on the head of the stethoscope. If the low pressure measurement persists, the fourth Korotkoff sound or muffing may be recorded as the DBP.

For children aged three years or younger, BP should be assessed if a secondary condition, known to be associated with hypertension, is present. BP measurement can be technically challenging in these patients, and the role of pulse palpation or Doppler devices has not been systematically defined. The use of oscillometric devices might be acceptable. Interpretation of the measurements should take into account the level of co-operation or agitation of the child.

BP should be measured in the lower extremities when elevated SBP is noted in the upper extremities, or if congenital heart disease, particularly aortic coarctation, is suspected. The child should be supine, and while supine, a comparison should also be made with measurements taken in the upper extremities. The cuff can be placed around the child's thigh, with auscultation or Doppler assessment of the popliteal artery, or around the calf, with assessment of the posterior tibial or dorsalis pedis artery. A large cuff is required, and should cover at least 60% of the distance between either the perineum and the knee, or the knee and the ankle. BP in the upper extremity should not exceed that in the lower extremity. Distal pulse amplification, or a wide pulse pressure, may cause the lower extremity SBP to exceed that of the upper extremity by an average of 5 mmHg in older children and adolescents, although these pressures equalise with exercise.¹¹

Childhood obesity and its consequences are attracting more and more attention in the medical field because of

the increasing prevalence of childhood obesity worldwide, and the long-term effects thereof in adults. Many studies have been performed to explore the association between childhood obesity and its short- and long-term health effects. However, it is not easy to compare the findings of previous studies because of study population diversities, such as differences in sample size, age range and ethnic group. In addition, various determinants of childhood obesity were used in studies, such as the 95th percentile value of the National Center for Health Statistics (NCHS) triceps skin fold thickness, or a body mass index-specific centile value (90% or 95%) that was recently developed by the Centers for Disease Control and Prevention.^{9,12} As a result, the magnitude of the prevalence varies with different definitions of obesity.¹³⁻¹⁵

Many studies reported that obese children had significantly higher BP than did non-obese children, and that the association between age and BP disappears after controlling for weight.¹⁶⁻¹⁸ Pela et al reported that the alterations in BP of the obese children were detected by ambulatory 24-hour monitoring and that higher SBP levels were observed in six- to eleven-year-old obese children both during the day and the night.¹⁹ Figueroa et al also reported that higher SBPs and DBPs were found with the usual BP check in a study of five- to eleven-year-old obese children.²⁰ However, the association between BP and obesity in preschool children has received less attention in previous studies. It was assumed that obesity in the preschool years may not be related to medical problems, or that health problems may not emerge until an individual has been overweight for many years, or that obesity-related health problems may not become evident until adolescence or adulthood.²¹ However, BP in preschool children seemed to be relatively stable in comparison with BP in children > 6 years. It has been reported in several intervention studies that the treatment of obesity by weight loss decreases BP substantially in both hypertensive and normotensive subjects.²² Furthermore, a change in the weight of children was associated with a change in BP in the full range of the population-based study.²³

Epidemiology of hypertension in children of Africa

Seedat summarised the pathophysiology of hypertension and response to treatment as follows: "Black hypertensive patients in South Africa are prone to cerebral haemorrhage, malignant hypertension, and kidney disease leading to uraemia and congestive heart failure, whereas coronary heart disease (CHD) is relatively uncommon.²⁴ In contrast, CHD is the major outcome related to hypertension in the white and Indian communities. In black patients with

hypertension, the responses to antihypertensive medication such as beta blockers and the angiotensin-converting enzymes (ACE) inhibitors are poor, unless these agents are combined with a thiazide diuretic. Black patients respond best to diuretics, vasodilators or calcium-channel blockers".

The impact of hypertension on mortality in an African population was assessed by Kaufman et al in 1996.²⁵ They reported that the risk of death increased by 60% with an increase of 20 mmHg in DBP in rural Nigeria, and estimated that the population-attributable risk (the reduction in total mortality that would have been observed if hypertension were not present) was seven per cent, showing the impact of hypertension on all-cause mortality in rural Nigeria.²⁵

The Birth-to-Ten (BTT) study was a birth cohort study that was initiated in Soweto, Johannesburg, in 1990.^{26,27} This study provided data on the determinants of BP in Sowetan children aged one year.²⁸ The researchers found that 29.3% of the variance of systolic BP in these children was determined by weight, upper-arm circumference, age at which formula feeds were started, and length and volume of the formula. The amount of salt added to the diet approached statistical significance. In a subsample of children, a correlation was found between the infant's BP and that of the mother. When the BTT children were five years old, BP was measured in 964 of them. The mean SBP and DBP was significantly higher in the black children compared with that of the other groups. The black and coloured children had higher rates of raised BP than those of the Indian or white children.

Levitt et al showed that the SBP of the children at five years was inversely related to birthweight, independent of current weight, height, gestational age or socio-economic status.²⁹ The highest level of systolic BP at five years was found in the children who had a low birthweight and who had a normal birthweight since birth, while the lowest BP was recorded in those children who had a normal birthweight, and who had gained the least weight since birth.

In a study in the North West Province among black children aged 10-15 years conducted by Schutte et al, a few nutrients that were significantly associated with BP parameters in boys with hypertension were identified by means of stepwise regression analysis.³⁰ These nutrients were biotin, folic acid, pantothenic acid, zinc and magnesium. In girls with hypertension, energy intake, biotin and vitamin A were associated with BP parameters. No such associations were found in the children with normal BP levels. The intake of all of these nutrients was below the recommended dietary reference intakes. In this same population, BP was recorded using the Finapres apparatus and analysed by means of the Fast Modelflow[®] software programme.^{31,32} The awareness of hypertension, the use of hypertension medication and the control of hypertension (cut-off point < 160/95 mmHg) among subjects with hypertension,

increased with increasing wealth, and were highest in the richest group. Interestingly, higher levels of education among the participants with hypertension added no better treatment status than that achieved by being wealthier. In fact, for people with hypertension, a participant above age 44 years was about 28 times more likely to have controlled BP, compared with one who was between 15 and 25 years.

The finding that young people with hypertension have poor hypertension control is of particular concern as they could be exposed to high BP for many years. This would result in serious end-organ damage, affecting their eyes, kidneys and coronary and cerebral arteries. Hypertension control in men was far less than that for women, suggesting that the group of people with least degree of hypertension control is young, poor men, irrespective of their population group.

Hypertension and dyslipidaemia

Hypertension is a traditional risk factor for dyslipidaemia. Glowiska et al studied 285 children (79 control group, 49 obese, 56 obese and hypertensive, 58 hypertensive and 122 diabetic) and found that the highest concentrations of low-density lipoprotein were seen in obese children and in obese hypertensive children.³³ The authors also observed that the highest levels in triglyceride concentration, over 70% higher than those of the controls, were observed in children with obesity and coexisting hypertension. Moreover, this group showed the highest values regarding lipid profile.

In another study, the authors noticed that homocysteine (Hcy) concentrations in healthy children showed a significant link between both SBP and DBP of black and white children.³⁴ Glowinska, in her study, found that children who were hypertensive had the highest concentrations of Hcy.³³

Management of hypertension in children

Lifestyle changes

Lifestyle changes are recommended for children with hypertension (defined as BP > 95th percentile) or prehypertension (defined as BP > 90th-95th percentiles, or if BP exceeds 120/80 mmHg).³⁵

Lifestyle changes include the following:

- Weight loss for obesity-related hypertension;
- Regular exercise;
- Dietary changes, including reducing salt intake and avoiding alcohol;
- Although cigarette smoke does not directly affect BP, exposure to cigarette smoke is a risk factor for cardiovascular disease and should be avoided;
- Whatever lifestyle changes are recommended, a family-centred, rather than a patient-oriented approach, is usually more effective.

Weight loss

Children who are between the 85th and 95th percentiles are said to be overweight, while children who are above the 95th percentile are said to be obese. In children who are obese or overweight, losing weight can help to lower BP.³⁶⁻⁴² In some cases, the child will be referred to a nutritionist, who can work with the child and parents to formulate a healthy eating plan. Weight loss is most effective in reducing BP when it is combined with exercise.

Exercise

Regular exercise can help to lower BP in children.⁴³⁻⁵⁰ Although exercise recommendations for an individual child may vary, general recommendations include walking, swimming and biking, but not weight lifting or strength training.

Exercise is physical activity that is planned, structured and repetitive for the purpose of cardiovascular conditioning, strength and resistance training, and flexibility.

Clinical studies have shown that regular exercise has numerous benefits, including the following:

- Preventing weight gain and maintaining a healthy weight;
- Reducing BP and cholesterol;
- Improving co-ordination;
- Improving self-esteem and self-confidence;
- Decreasing the risk of developing diabetes and cardiovascular disease;
- Increasing life expectancy.

Exercise consists of cardiovascular conditioning, strength and resistance training, and improving the functioning of the heart, lungs and muscles. In general, the American Heart Association recommends at least 60 minutes each day for children and adolescents. Examples of exercises that elevate the heart rate are cycling, jumping rope, brisk walking, dancing, soccer and basketball.

For children aged two to five years, physical activities should emphasise basic movements. Examples of appropriate activities for this age group include rolling and bouncing a ball, mimicking animal movements and pedalling a tricycle.

For children aged five to eight years, physical activities should emphasise basic motor skills (eye-hand coordination). Parents should alternate sedentary activities with active indoor and outdoor games.

Diet

The Dietary Approaches to Stop Hypertension (DASH) Study has recently shown that implementation of a diet rich in fruits, vegetables, non-fat dairy products and whole grains, can effectively lower BP in adults with hypertension. Although there are no comparable clinical trial data in

children, there is no reason to suspect that the DASH diet would not be safe to implement in older children and adolescents, as long as protein and calorie needs are met.^{51,52} Decreased consumption of sugar and saturated fatty acids and increased consumption of fruits and vegetables are recommended by a number of studies.⁵³⁻⁵⁶

Although it is generally accepted that reduction of sodium consumption would be beneficial to hypertensive individuals, evidence of a direct relation between sodium and BP level in children with hypertension has been less conclusive.⁵⁷ Some studies support the contention that sodium reduction in children and adolescents is connected with small reductions in BP.^{58,59-62} In addition, increased intake of potassium and calcium also has been suggested as a nutritional strategy to lower BP.^{63,64} Fresh herbs, spice blends without sodium, citrus and flavoured vinegar, make tasty alternatives to the salt shaker. Fresh fruits and vegetables are generally low in sodium. In addition, a diet rich in fruits and vegetables provides additional benefits in lowering BP.

Smoking

Children who have hypertension should not smoke because it significantly increases their risk of heart disease and lung cancer. Family members of a child with hypertension are encouraged to quit smoking as well because exposure to second-hand smoke also increases the child's risk of developing heart disease.

Cigarette smoking doubles the risk of developing coronary heart disease, and smoking cessation can rapidly reduce this risk.⁶⁵ One year after stopping smoking, the risk of dying from coronary heart disease is reduced by about one-half, and continues to decline over time. In some studies, within two years of quitting smoking, the risk of heart attack was reduced to the rate in non-smokers.

Smoking increases the risk of long-term lung diseases such as chronic obstructive pulmonary disease. While much of the lung damage caused by smoking is not reversible, stopping smoking can reduce further damage to the lungs, and many smokers with chronic cough and sputum (phlegm coughed up from the lungs) note an improvement in these symptoms during the first year after stopping smoking.⁶⁵

Asthma and sudden infant death syndrome are more common among children exposed to smoke. Cigarette smoking makes it more difficult to treat asthma.

Cigarette smoking is responsible for almost 90% of cases of lung cancer. Smoking cessation reduces the risk of lung cancer within five years of stopping, although former smokers still have a higher risk of lung cancer than people who have never smoked.

Drug therapy

The treatment of hypertension with drugs is recommended when there is symptomatic hypertension, Stage 2 hypertension, or Stage 1 hypertension that persists despite therapy without drugs.

Pharmacological therapy, when indicated, should be initiated with a single drug. The most common drugs that can be used in children are ACE inhibitors, angiotensin-receptor blockers (ARBs), beta blockers, calcium-channel blockers and diuretics. The newer classes of antihypertensive drugs, including ACE inhibitors, calcium-channel blockers, and ARBs, appear to be safe and effective for short-term use in children.⁶⁶⁻⁶⁹ Hypertensive emergencies should be treated by an intravenous antihypertensive that can produce a controlled reduction in BP. The reduction should be by < 25% over the first eight hours, and the BP should then be gradually normalised over 26-48 hours.⁷⁰⁻⁷¹

Conclusion

Hypertension in children has become a major problem and can be viewed as a significant risk factor for the development of cardiovascular disease in adulthood. Obesity in children is a risk factor for later coronary diseases. In order to prevent or decrease the target organ damage, it is necessary to modify the risk factors in childhood. Non-pharmacological treatments include weight reduction, exercise and dietary changes.

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