

Review article**Adolescent Hypertension: A Challenge for the Future**Danasekaran R¹, Mani G², Annadurai K³**Abstract:**

Hypertension emerges from a complex interplay of genetic, environmental and behavioral factors. Hypertension in the young which is mostly undiagnosed is increasing in prevalence, with much of the increase being fuelled by the increase in obesity among them. Apart from obesity, factors that have an influence on hypertension are hereditary effects, stress, race and diet. It is well established that blood pressure during childhood and adolescence is a predictor of adult blood pressure, which in turn increases mortality from Cardiovascular, Cerebro vascular and other complications, clearly underscores the importance of identification and treatment of hypertension among them.

Keywords: Hypertension; obesity; adolescence; blood pressure; hereditary.

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Introduction:

Hypertension is an iceberg disease with high morbidity & mortality and is a silent threat to the health of the people both in developed and developing countries. It plays a major role in the development of ischemic heart disease, cerebrovascular disease, cardiac and renal failure. Unlike most of the diseases hypertension mostly goes unnoticed before the development of complications. Around 1 billion people in the world were Hypertensives in the year 2000 and this is expected to increase to 1.56 billion by 2025¹. About 54% of all stroke and 47% of all coronary artery disease are attributable to hypertension². Globally, the overall prevalence of raised blood pressure (BP) in adults aged 25 and over was around 40% in 2008. The prevalence of raised BP was highest in the World Health Organization African Region, where it was 46% for males and females combined³.

Adolescent Hypertension:

Hypertension emerges from a complex interplay of genetic, environmental and behavioural factors. Owing to the hereditary component of hypertension, the disorder is considered to have its origin in the childhood. Children and adolescents with high BP tend to maintain those levels of BP in adulthood⁴.

Apart from progression of hypertension into adult life; there are other complications of childhood and adolescent hypertension. Hypertension in the young is increasing in prevalence, with much of the increase being fuelled by the increase in obesity among them. Worldwide prevalence of Hypertension among adolescents is not known. The prevalence of hypertension among children and adolescents in recently done studies in western countries ranged from 7% to 19%⁵.

Classification of Adolescent Hypertension:

According to the Fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents by National High Blood Pressure Education Program Working Group⁶ blood pressure is classified as follows,

Table 1. Blood Pressure classification in Children and Adolescents

Blood Pressure Classification	Systolic BP (SBP) or Diastolic BP (DBP) Percentile
Normal	<90 th Percentile
Prehypertension	90 th -95 th ; or if BP is >120/80 mmHg even if <90 th
Hypertension	>95 th Percentile

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Prevalence of Adolescent Hypertension:

Global prevalence of the disease is not known due to differences in the definition of high BP and measurement of BP. Lurbe et al in their study on prevalence of masked hypertension reported 7.6% of hypertension and 0.8% of sustained hypertension among 592 youths who attended pediatric clinic in a hospital of university of Valencia⁷. In a cross sectional study conducted among 1041 high school students by Nur N et al in Sivas province of Turkey has identified 4.4% of the students were having hypertension⁸. In a cross sectional study among urban Asian Indian adolescents by Goel R et al. the prevalence of hypertension was found to be 6.4%, of which 2.7% had isolated systolic, 2% had isolated diastolic and 1.7% had both systolic and diastolic hypertension⁹.

Etiology of Hypertension among Adolescents:

Among pre adolescent children primary or essential hypertension is exceedingly rare. In these age groups secondary hypertension is more common (Table 2).

Among the secondary causes of hypertension renal diseases tops the list¹⁰. In adolescents, however, essential hypertension accounts for majority of the cases (80-90%). The secondary causes of hypertension are comparable to the list of causes in younger children. Primary hypertension in adolescents is mostly characterized by isolated systolic hypertension. On the other hand diastolic hypertension most often accompanies secondary causes of hypertension¹¹.

Factors influencing Hypertension among Adolescents:**a) Obesity and Hypertension**

The prevalence of obesity in the children and adolescents has increased markedly in the last two decades. Primary hypertension in the adolescents is becoming increasingly common in association with obesity. Moore WE et al. in their study healthy Kids Project reported 28% of overweight among 769 students from Anadarco student population. They found that BMI more than 95th percentile

was strongly associated with elevated BP (RR-3.8; 95%CI:2.6-5.4)¹². Paradis G et al. found that BMI was associated with SBP and DBP consistently in all the ages and both the genders. BMI was 4-6 kg/m² higher among those with SBP >95th percentile¹³. In a study conducted in China by He Q et al. hypertension was seen in 19.4% of obese children and 7% in non obese children with P<0.0001¹⁴. Burgos et al. conducted a study among 1666 school students in Brazil and found that 26.7% of them were overweight or obese and 35.9% had body fat percentage moderately high. Hypertension was prevalent among 12.1% of students and there was a significant correlation with BMI (P<0.05)¹⁵.

a) Family History and Hypertension

Recently published studies have demonstrated that large numbers of adolescents with essential hypertension have a positive family history of hypertension in a parent. Falkner F et al. followed up adolescents with BP between 90 to 95th percentile. They found that many of them developed hypertension and those who developed hypertension had a strong family history of Hypertension¹⁶. A study done in Punjab among 2560 school children by Verma M et al. has reported that family history of hypertension was significantly associated with elevated blood pressure (P<0.01)¹⁷. Khan MI et al. in their study on hypertension and its risk factors among adolescent boys reported that family history of hypertension and hypertension among boys were having significant association (P<0.001)¹⁸.

b) Diet Pattern and Hypertension

Role of diet in adolescent hypertension is mostly restricted to sodium intake. Role of calcium and potassium in adolescent hypertension is being explored. Soudarssanane MB et al has also reported that there was no significant association between diet (vegetarian or non vegetarian) and hypertension¹⁹. In a meta analysis done by He FJ and MacGregor GA on the effect of salt on BP in children, it was found that reduction in salt intake by 42% resulted in significant reductions in blood pressure: systolic-1.17 mmHg (95%CI: -1.78 to- 0.56 mmHg; P<0.001); diastolic-1.29 mmHg (95%CI: -1.94 to-0.65 mmHg; P<0.0001).²⁰

c) Physical Activity and Hypertension

Parker ED et al. in their CARDIA study done among 3993 participants on physical activity and incident hypertension on 15 years follow up reported 634 cases of incident

Table 2. Estimated Causes of Hypertension in Children and Adolescents

Type	Children	Adolescents
Primary / Essential	15-30%	85-95%
Secondary Hypertension	70-85%	5-15%
Renal parenchymal	60-70%	
Renovascular	5-10%	
Endocrine	3-5%	
Aortic coarctation	10-20%	

hypertension. Those with more physical activity had a less risk of incident hypertension than the less physical activity group (Hazard rate ratio=0.83; 95% CI: 0.73-0.93) ²¹.

Consequences of Adolescent Hypertension:

The most important consequence of elevated BP among children and adolescents is that it predicts the development of adult hypertension. The long term sequelae of adult hypertension such as myocardial infarction and stroke do not occur in children. But it has been proved that persistent elevation of BP in children and adolescents can produce other target organ damages such as left ventricular hypertrophy, etc.

a) *Hypertension during adulthood (Tracking of BP)*

It is increasingly clear that adult hypertension have their origin in childhood itself. "Tracking" is persistence of rank order of BP from childhood to adult stage. Many studies have been done to support this phenomenon. In the Bogalusa cohort, 40% of those with systolic BP and 37% of those with diastolic BP above the 80th percentile at baseline continued to have BP above the 80th percentile 15 years later²². Zinner SH et al found a significant relation between BP readings taken initially and follow up reading taken after 4 years. (p <0.001 for SBP and 0.14, p = 0.001 for DBP). This data proves that stratification of BP into peer groups occurs in childhood itself²³.

b) *Increased Cardiovascular Disease in Adulthood*

As of now there are no clear data on relationship between hypertension during young age and cardiovascular morbidity and mortality in adult life. But studies have shown that BP and cardiovascular risk factors in childhood predict the subsequent presence of Carotid intima-media thickness and arterial stiffness, both of which are accepted markers of atherosclerosis¹⁰. In the Cardiovascular Risk in young Finns study Juonala M et al. studied the relationship between childhood BP and endothelial dependent brachial flow mediated dilation in adulthood. They reported an inverse relationship between SBP among male adolescents and adulthood flow mediated dilation²⁴. In addition studies have demonstrated that children with hypertension are at increased risk of developing metabolic syndrome during adulthood which is an important predictor of cardiovascular morbidity.

Hypertensive Target Organ Damage in Adolescents:

a) *Left ventricular hypertrophy (LVH)*

Among the hypertensive children and adolescents the prevalence of LVH was found to be between

10-38% in various studies. This difference occurs due to variation in echo cardio graphic protocol. Sorof M J et al. in their comparative study between hypertensive children identified by school based screening and referred cases found that the prevalence of LVH was 37% among them. Referral subjects had more left ventricular mass index²⁵. McNiece K L et al. found that among hypertensive subjects those with stage 2 hypertension have increased odds for LVH. And the risk for LVH was similar among subjects with stage 1 and masked hypertension whereas the risk was same for those with white coat hypertension and normal subjects²⁶.

b) *Carotid intimal thickening*

Atherosclerosis begins in childhood and the common carotid artery intima media thickness is a marker of pre clinical atherosclerosis. Carotid intima-media thickness has become a marker of hypertensive vascular damage. In a prospective cohort study conducted by Raitakari OT et al. 2229 participants were examined during young age (3-18 yrs) and re examined 21 years later. Intimal medial thickness has showed significant association with childhood SBP (P<0.001), BMI (P=0.007) and LDL cholesterol²⁷. Lande MB et al. in their matched case control study found that the median carotid intima media thickness in hypertensives was greater than controls (0.67vs 0.63 mm; P=0.045) ²⁸.

c) *Impaired cognitive function*

Recently, impaired cognitive function has been described as one of the target organ damage due to hypertension in the children and adolescents. This finding requires confirmation, but adds value to the recommendation of starting anti hypertensive therapy in children with persistently elevated BP. Lande MB et al. compared the cognitive scores of children with elevated BP and normal BP. They found that children with elevated SBP had lower scores for digit span (p=0.01), block design (p=0.03) and mathematics (p=0.01). Children with elevated DBP had lower scores on block design (p=0.01) ²⁹.

d) *Retinal artery narrowing*

In a population based study conducted in two countries- Australia and Singapore involving 1952 students by Mitchell P et al. found that children in the higher quartiles of BP were having narrow retinal arterioles than those with normal BP. They reported that for every 10 mmHg increase in SBP there was narrowing of retinal arterioles by 2.08µm³⁰.

Management of Adolescent Hypertension:

The management of hypertension among children and adolescents is largely empirical in contrast to management of hypertension in adults, which is guided by many number of clinical trials. The decision as to whether a child to be started on drug therapy or not should be individualized³¹. Treatment of hypertension should start with non pharmacological measures. Although the magnitude of change in BP may be modest with the measures like weight loss, dietary changes and regular exercise, all of them have shown to reduce BP in adolescents successfully.

Accepted indications for usage of anti hypertensives for treating hypertension in children and adolescents include the following: a) symptomatic hypertension; b) secondary hypertension; c) Type 1 or 2 diabetes; d) Hypertensive target organ

damage or e) persistent hypertension despite of non pharmacologic measures. Pharmacologic reduction of BP in hypertensive children who fall into the above categories is likely to result in health benefits. Other indications for starting drug therapy have been proposed. For example, it is suggested that anti hypertensive therapy is initiated if the child has hyperlipidemia⁶. The anti hypertensives commonly used include Angiotensin converting enzyme inhibitors, Angiotensin Receptor Blockers, α and β adrenergic antagonists and Calcium channel blockers³¹.

The following table shows the classification of blood pressure among adolescents, its evaluation, life style changes for each category and also the pharmacological treatment. (Table 3)

Table 3. Classification and Management of Hypertension in Adolescents¹⁰

Classification	SBP or DBP percentile	Frequency of measurement	Therapeutic Lifestyle changes	Pharmacologic Therapy
Normal	<90 th percentile	Next scheduled examination	Encourage healthy diet, physical activity	-
Pre hypertension	90-95 th percentile or >120/80	Recheck after 6 months	Counsel for weight management, introduce physical activity and diet management	Do not start therapy unless compelling indications like CKD, diabetes, heart failure, LVH exist
Hypertension	>95 th percentile	Recheck in 1-2 weeks; if persistently elevated in 2 additional occasions, evaluate or refer within 1 month	Counsel for weight management, introduce physical activity and diet management	Initiate therapy or if compelling indications as above

Conclusion:

As the symptoms of childhood and adolescent hypertension are largely nonspecific, most children with hypertension are likely to be undiagnosed. But there are ample evidences proving the development of hypertensive end organ damage in hypertensive children and there are data suggesting hypertension

in young may have adverse cardiovascular effects in adulthood. To conclude, blood pressure to be monitored routinely even among adolescents and those who are identified as having high blood pressure should be treated early in order to avoid progression of the disease, which may prove to be a serious health challenge in the future.

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