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Tertiary Prevention of Hypertension in Children and Adolescents

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Abstract. Nowadays, with the improvement of the quality of people's lives, an increasing number of children and adolescents are diagnosed with hypertension, which has attracted the attention of the world. However, most of the current studies only emphasize the risk factors and treatment from a clinical disease perspective, thereby ignoring the threats of children and adolescent hypertension (CAH) in public health as a chronic disease. This article analyzes the research on clinical symptoms, risk factors, and illness situation of CAH and obtains its measures of tertiary prevention. There are few policies about CAH at present in China. In primary prevention, the most important thing is to change unhealthy living habits and daily diets that may lead to the obesity problem. In secondary prevention, regular screening to discover the disease is necessary. And a long-term management of chronic disease is the key point in tertiary prevention. The article provides references about relevant data and prevention measures for CAH. Future research can concentrate on the direction of relevant policies' formulation.

Keywords: Hypertension, Chronic diseases, Children and adolescents, Public health.

1. Introduction

With more attention the world pays to public health, the management of chronic diseases becomes an inevitable topic as an important content in the project of public health service. A persistently elevated pressure in the blood arteries is known as hypertension. The vessels transport blood from the heart to every region of the body. Blood pressure（BP） is created by the force of blood pushing against the walls of blood vessels (arteries) as it is pumped by the heart. Hypertension is a typical chronic disease, and it is an important risk factor leading to a variety of cardiovascular diseases (CVDs). Most individuals with hypertension do not experience obvious symptoms, but high blood pressure can cause headaches, blurred vision, chest pain, and other symptoms. In China, the major patients with hypertension were over 65 years old. Based on the definition of hypertension from "Interpretation of Chinese Guidelines for the Prevention and Treatment of Hypertension (Revised 2024 Edition）", the population whose average systolic blood pressure（SBP）≥135mmHg and/or average diastolic blood pressure（DBP）≥85mmHg within 5 to 7 days can be diagnosed as patients with hypertension [1]. In recent years, the average age of people with hypertension in China and even the whole world has decreased, while the prevalence rate of hypertension is increasing trend. Hypertension is not only a senile disease. However, the current prevention and treatment for the

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population with hypertension in China were still focused on the elderly. Although there is more attention on children and adolescents with hypertension, there is still a lack of prevention and treatment methods in detail.

This article reviews the current public policies and research on the tertiary prevention of hypertension systematically according to the analysis of the epidemiological characteristics of hypertension, and gives some suggestions about prevention and treatment methods more comprehensively and specifically for CAH. The aim is to provide a reference basis for the gradual management of "younger" chronic disease management of hypertension in the future.

2. Illness situation and epidemiological analysis of hypertension in children and adolescents

The latest definition of hypertension in children and adolescents is shown in the table 1.

Table 1. Blood pressure categories in children and adolescents (ages 1-18) [2]

Age Group	SBP and/or DBP Criteria	BP Category
Children (1–12 yrs)	Below the 90th percentile for both SBP and DBP, with SBP <120 mm Hg and DBP <80 mm Hg	Normal
	Between the 90th and 95th percentile, or SBP 120–129 mm Hg with DBP remaining under 80 mm Hg	Elevated
	From the 95th to less than 95th percentile +12 mm Hg, or SBP between 130–139 mm Hg and/or DBP 80–89 mm Hg	Stage 1 Hypertension
	At or above the 95th percentile +12 mm Hg, or SBP ≥140 mm Hg and/or DBP ≥90 mm Hg	Stage 2 Hypertension
Adolescents (≥13 yrs)	SBP <120 mm Hg and DBP <80 mm Hg	Normal
	SBP ranging from 120–129 mm Hg while DBP remains <80 mm Hg	Elevated
	SBP in the 130–139 mm Hg range and/or DBP between 80–89 mm Hg	Stage 1 Hypertension
	SBP ≥140 mm Hg and/or DBP ≥90 mm Hg	Stage 2 Hypertension

2.1. Clinical symptoms of CAH

In general, children and adolescents with hypertension do not have obvious clinical symptoms. However, part of them may feel pain in the temple or forehead and show weakness and palpitation. Even hypertensive retinopathy occurs on account of the occlusion of the central retinal artery, and it also has a relevant classification, such as the Keith–Wagener–Barker classification. The patients with long-term hypertension may experience target organ damage, such as the heart and the kidneys. Study proves that the pulse pressure of patients with atherothrombosis is an important risk factor leading to CVD, myocardial infarction, and heart failure caused by left ventricular hypertrophy [3]. Chronic kidney disease(CKD), a primary contributor to global mortality, which refers to a continuous estimate of glomerular filtration rate(eGFR) of less than 60 mL/(min·1.73m2), albuminuria (albumin/creatinine ratio ≥30 mg/g), or other markers of kidney injury for an extended period of time (at least 3 months), has already appeared in patients with mild to moderate elevations of BP and affected both males and females [4].

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2.2. Risk factors of CAH

Risk factors refer to some potential conditions that may induce the disease and threaten people's health. Clearing the risk factors of hypertension can make it more convenient to predict and prevent the disease.

Genetic factors play an important role in the development of hypertension. A study conducted a cross-sectional analysis of 3996 children and adolescents aged 10 to 18 years (including 2224 boys and 1772 girls) and their parents to evaluate the risk ratio (OR) of hypertension in their children. The results showed that if one parent had hypertension, the risk of congenital hypertension (CAH) in the offspring increased by about two times; if both parents had hypertension, the risk of the offspring increased by more than four times [5]. This finding suggests that the history of hypertension in parents is closely connected to the BP level of their offspring, and genetic factors may play a key role in the development of hypertension. As a complex multi-gene disease, the occurrence of hypertension is related to multiple hereditary factors, especially sex chromosomes and gene mutations (such as single nucleotide polymorphisms, SNPs) [6]. For example, four SNPs in the ABCA1 gene (rs2297406, rs2472433, rs2472510, and rs2515614) were found to be closely related to the occurrence of hypertension and its related mechanisms, especially to low HDL (high-density lipoprotein) levels [7,8]. In addition, studies have also shown that the sex of the offspring may have a certain impact on the manifestation of genetic effects.

In addition, the issue of obesity caused by environmental factors, diet, and exercise habits is also one of the important risk factors for hypertension in children and adolescents. Hypertension is easily induced by foods with heavy oils, high sugar, and high salt.

The last point is that sleep duration and mental health are associated with an enhanced chance of elevated blood pressure. Because long-term mental tension will keep the sympathetic nerve excited, thereby causing an increase in BP.

2.3. Three-dimensional distributions of hypertension in children and adolescents

The three-dimensional distributions of epidemics refer to the state of existence and the laws of development and occurrence of the disease in different groups of people, times, and regions.

The population distribution of children and adolescents' hypertension can be monitored from the patients' age, gender, and race. It is found that BP increases with age; the prevalence in adolescents is higher than in children. And due to the protective effect of estrogen on blood vessels, the prevalence of hypertension among men is higher than women after entering adolescence. From the perspective of race, the probability of hypertension occurring in Hispanic and Black children is higher than in others [9,10].

The prevalence of hypertension varies between regions. For example, the incidence of hypertension in developed areas is usually higher than that in poor areas. This is because with economic development, the dietary structure, living environment and medical conditions have improved, especially the diagnosis technology and treatment methods of hypertension. Wen Peng et al.'s research pointed out that compared with national data, the obesity rate and hypertension burden of the Tibetan people and people in plateau areas are heavier. Among Tibetan children, about one-sixth have obesity problems, and their hypertension prevalence (31.4%) is significantly higher than the national (27.5%) and global averages (22.0%) [8]. This phenomenon suggests that altitude may be an important factor in screening the distribution of hypertension in children.

In recent years, the population with CAH has increased rapidly. The incidence rate of CAD in winter is significantly higher than in summer, because of the vasodilation and vasoconstriction with

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the change in climate and temperature.

3. Prevention measures of CAH

The theory of tertiary prevention was proposed by Kaplan in the 1960s, which aimed to prevent and protect the health of all people. Preventive medicine's core strategy and basic principle is tertiary prevention. The tertiary prevention specifically classifies the target population into three grades for different stages and arranges corresponding public health measures. People can conduct research and interventions in environmental factors, life behavior and habit, and sanitation service with the solution of tertiary prevention.

3.1. Primary prevention

Primary prevention is also known as causal prophylaxis, which refers to taking measures to prevent the cause of the disease or risk factors before the disease causes harm. It is the fundamental measure to eliminate disease. To realize primary prevention, a variety of measures can be taken. The typical strategies are a high-risk strategy, a strategy for a high-risk crowd, and a population-based strategy. The population-based strategy reduces the exposure risk of the overall population by eliminating harmful exposure factors instead of identifying the high-risk groups.

Currently, the major risk factor of CAH is obesity. To solve this problem, what children and adolescents should do is to change their poor dietary patterns and living habits, and cultivate a regular exercise routine. A study in 2021 proves that it is effective to stop hypertension through diet. 159 adolescents aged between 11 and 18, who had been diagnosed with elevated BP or stage 1 hypertension, were assigned to either DASH participants or routine care participants in a random manner. The result showed that the group of DASH achieved significant improvement in SBP (–2.7 mmHg, P=0.03, –0.3 z-score, P=0.03), flow-mediated dilation (2.5%, P=0.05), and DASH score (13.3 points, P<0.0001) [11,12]. Currently, the DASH diet and the Mediterranean diet have been validated to be resultful in controlling hypertension. Moreover, conducting a risk gene of hypertension before a child’s birth can also be adopted.

3.2. Secondary prevention

Secondary prevention is also called “three early” prevention(early detection, early diagnosis, early treatment). It can improve the cure rate of diseases by detecting, diagnosing, and treating diseases timely manner in the early stage of the diseases to prevent and control them from developing and deteriorating. The secondary prevention in children and adolescents’ hypertension is regular screening and monitoring. Especially the population with a familial predisposition of hypertension and the crowd with long-term exposure to the risk factors. If diagnosed, timely intervention and partner treatment are necessary.

3.3. Tertiary prevention

Tertiary prevention means disease management, which is usually used after the symptoms of diseases become apparent. The children and adolescents who are diagnosed with hypertension should take medicine and treatment under medical supervision to prevent the disease from further deterioration. Establish the awareness of long-term management, such as the regular tests of target organ function.

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4. The current policy of CAH in China

The National Health Commission of China has defined 2025-2027 as the Year of Pediatrics and Mental Health Services, which aims to strengthen the prevention and control of chronic diseases in children. It is planned to build 2,000 child-friendly hospitals, optimize children's health services in the medical environment and service processes, and cover the management of chronic diseases such as hypertension. Besides, the diseases caused by CAH were included in the scope of chronic and special outpatient diseases, so the burden of long-term medication might be mitigated. From this, it can be seen that in China, there are few policies about CAH at present. And the policies mentioned above lack pertinence in ‘hypertension’ or ‘children’.

5. Conclusion

This article systematically reviews the hypertensive illness situation and epidemiological analysis in children and adolescents. Introduce the classification and risk factors of CAH. Analyze its distribution characteristics and emphasize the increasing proportion in the whole hypertension crowd through the relevant data and literature. And give the suggestions from the perspective of tertiary prevention and current policy in China.

The major risk factor causing hypertension in children and adolescents is obesity, so the unhealthy living habits and daily diets should be changed. Hypertension in children and adolescents belongs to chronic non-communicable diseases, which can be prevented and controlled by the approach of tertiary prevention. Another issue is that in China, the policies for hypertension have shortcomings in the field of children, and the policies for children are lacking in lack of specificity for hypertension diseases; thus, the government and children's health organizations are expected to devote more attention and resources to the development of relevant policies. The article provides basic data and advice on CAH to make a contribution to future research.

On account of some limitations, there are also shortcomings in the accurate data of the mortality rate and the detailed treatment of CAH. Therefore, there is significant hope that one may be able to enhance global awareness and add statistics of CAH and formulate relevant prevention policies.

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