Hypertension in 172 Chinese Children: An 8-Year Retrospective Study

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Background: We evaluated children with hypertension and compared those with essential and secondary (including renal and non-renal) hypertension.

Methods: This retrospective study analyzed data from hypertensive children (age, 0-18 years) referred for treatment between January 2008 and December 2015. Demographic factors, causative factors, and medical treatments were evaluated. Treatment failure was defined as a systolic or diastolic blood pressure ≥95th percentile for age, gender, and height on three separate occasions, despite treatment. All patients not meeting the failure criteria were considered to have controlled hypertension. The control rate was defined as the proportion of patients with controlled blood pressure.

Results: Among 172 consecutive patients, 28% had essential hypertension and 72% had secondary hypertension. As compared with children with secondary hypertension, those with essential hypertension had a higher frequency of family history of hypertension (P<0.001), a higher body mass index (BMI) (P=0.001), lower frequency of proteinuria (P=0.003), lower uric acid (P=0.04), and lower triglyceride (P=0.048). The medications used in the controlled group were similar to those used in the uncontrolled group. Angiotensin-converting enzyme inhibitors (ACEIs) were only used in nephrogenic patients, and a higher rate of ACEI use seemed to increase control rates. Control rates did not significantly differ by age, number of drugs, or cause of hypertension.

Conclusions: As compared with children with secondary hypertension, those with essential hypertension were more likely to have a family history of hypertension and had a higher BMI, lower frequency of proteinuria, and lower uric acid and triglyceride concentrations. Treatment guidelines for essential and secondary hypertension should be established for children of all ages.

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Key words: hypertension, essential, hypertension, secondary, children, etiology, medication

Introduction
Hypertension is believed to affect 30% of adults¹. High blood pressure (BP) in childhood, although less common, is an independent risk factor for hypertension later in life²⁻⁵. Childhood hypertension is associated with significant damage to arteries, the heart, and other organs⁶⁻⁷ and is often undetected, unrecognized, and untreated⁸⁻¹⁰.

The exact prevalence of childhood hypertension is unknown because BP screening is not systematic in children, but with the increasing prevalence of childhood obesity, hypertension is becoming a concern¹¹. The prevalence of childhood hypertension was 2.2% among Swiss children aged 10 to 14 years, and the same group had an obesity prevalence of 14%¹². The global prevalence of hypertension in children is estimated to range from 1% to 5%¹³⁻¹⁵, but diagnosis is complicated. Because of diurnal fluctuations and changes in physical activity and emotional stress, BP varies widely during the day in children and adults.

A child should be calm and rested before BP is measured; however, measurement is difficult in young children and crying infants¹⁶. Furthermore, BP norms in
childhood are influenced by height, age, and gender, making it impossible to apply a single BP level in the diagnosis of pediatric hypertension\(^6\). In children, the definition of hypertension is entirely based on BP frequency-distribution curves\(^5\). Thus, BP must be measured according to a standard protocol and repeated several times before a referral is made for further evaluation of hypertension\(^6\).

Chronic kidney disease (CKD) affects 15 to 75 children per million worldwide\(^7\). Although pediatric CKD is rare, associated hypertension is common, and 70% of children with CKD are hypertensive\(^1\). Even in children with CKD, diagnosing hypertension is a challenge, and treating this hypertension is an additional challenge\(^1\).

Because of the lack of evidence and consensus, the present study aimed to examine children with hypertension from the Children’s Hospital of Fudan University and to compare differences between those with essential and secondary (including renal and non-renal) hypertension.

**Materials and Methods**

**Study Design and Patients**

This retrospective chart review analyzed data from all children referred to the Children’s Hospital of Fudan University between January 1, 2008 and December 31, 2015. The inclusion criteria were age 0 to 18 years and a diagnosis of hypertension (average BP ≥95th percentile for gender, age, and height) on three separate occasions\(^7\). BP’s for boys and girls, by age and height percentile, were previously reported\(^1\), as shown in **Table 1, 2**. Children were excluded if they had received a diagnosis of white coat hypertension (BP ≥95th percentile when measured in a physician’s office or clinic and an average BP <90th percentile when measured outside of a clinical setting\(^5\)) or had missing data. Hypertension was classified as essential and secondary. All cases were reviewed and classified by a cardiovascular specialist. This study was approved by the Ethics Committee of Children’s Hospital of Fudan University.

**Data Collection**

Data collected from medical charts included demographic factors (age, gender, weight, height, and family history), clinical symptoms (dizziness and nausea), laboratory tests (creatinine, uric acid, triglyceride, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol), and findings of electrocardiography, echocardiography, and renal ultrasound examinations.

**BP Measurement**

BP was measured with a standard clinical sphygmomanometer in all children. Child-specific BP cuffs of different sizes (including neonate-sized) were used, and the cuffs were available for parents who wished to buy them for use at home. BP measurements were taken by trained nurses at least 5 minutes after resting. With the arm and heart positioned at the same height, BP was measured for the left and right arms and averaged. Hypertension was diagnosed when the average systolic BP or diastolic BP was ≥95th percentile for gender, age, and height on three separate occasions\(^7\). Essential hypertension was diagnosed when BP was ≥95th percentile on three separate occasions in the absence of secondary causes of hypertension and with no concurrent use of medication with the potential to raise BP. Secondary hypertension was diagnosed by extensive evaluation, the first steps of which were a thorough history and physical examination. Laboratory tests were then performed, including blood tests, a urine test, renal ultrasound, and echocardiography. Additional examinations were conducted for some children and under some conditions.

BP control was analyzed. According to the BP reference standards for children, the uncontrolled group was defined as a systolic or diastolic BP ≥95th percentile for age, gender, and height on three separate occasions, despite treatment\(^1\). Patients not meeting the criteria for treatment failure were classified as controlled. The control rate was the proportion of patients in the controlled groups.

**Statistical Analysis**

Descriptive results were compared between groups, in accordance with the distribution of variables. Continuous variables were expressed as mean (±SD) and compared with the Student t-test. Categorical variables were expressed as frequencies and percentages and compared with the chi-square or Fisher exact test. The Fisher exact test was used when more than 20% of the cells had an expected frequency of <5 observations; otherwise, the chi-square test was used. All analyses were performed with Stata 10 (StataCorp LP, College Station, TX, USA). A P value of <0.05 was considered to indicate statistical significance.

**Results**

**Characteristics of Patients**

A total of 172 consecutive patients aged 0 to 18 years (median, 9.3 years) were included; 28% had an unknown cause of hypertension (essential hypertension) and 72%
Table 1  Blood pressure for boys, by age and height percentile\textsuperscript{17}

| Age (years) | BP percentile | SBP, mmHg | DBP, mmHg |
|------------|---------------|-----------|-----------|
|            | 5th           | 10th      | 25th      | 50th      | 75th      | 90th      | 95th      | 5th       | 10th      | 25th      | 50th      | 75th      | 90th      | 95th      |
| 0.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 2.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 3.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 4.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 5.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 6.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 7.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 8.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 9.000       |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 10.000      |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 11.000      |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 12.000      |               |           |           |           |           |           |           |           |           |           |           |           |           |           |
| 13.000      |               |           |           |           |           |           |           |           |           |           |           |           |           |           |

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BP, DBP, mmHg
| Age (years) | BP percentile | SBP, mmHg | DBP, mmHg |
|------------|---------------|-----------|-----------|
| 14         | 50th          | 106       | 107       |
|            | 90th          | 120       | 121       |
|            | 95th          | 124       | 125       |
|            | 99th          | 131       | 132       |
| 50th       | 109           | 112       | 113       |
| 90th       | 122           | 124       | 125       |
| 95th       | 126           | 127       | 129       |
| 99th       | 134           | 135       | 136       |
| 15         | 112           | 114       | 116       |
| 90th       | 125           | 126       | 128       |
| 95th       | 129           | 130       | 132       |
| 99th       | 136           | 137       | 139       |
| 16         | 114           | 115       | 116       |
| 90th       | 127           | 128       | 130       |
| 95th       | 131           | 132       | 134       |
| 99th       | 139           | 140       | 141       |
| 17         | 114           | 115       | 116       |
| 90th       | 127           | 128       | 130       |
| 95th       | 131           | 132       | 134       |
| 99th       | 139           | 140       | 141       |

The 90th percentile is 1.28 SD, the 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure.

### Table 2  Blood pressure for girls, by age and height percentile

| Age (years) | BP percentile | SBP, mmHg | DBP, mmHg |
|------------|---------------|-----------|-----------|
| 1          | 50th          | 83        | 84        |
|            | 90th          | 97        | 97        |
|            | 95th          | 100       | 101       |
|            | 99th          | 108       | 109       |
| 2          | 50th          | 85        | 85        |
|            | 90th          | 98        | 99        |
|            | 95th          | 102       | 103       |
|            | 99th          | 109       | 110       |
| 3          | 50th          | 86        | 87        |
|            | 90th          | 100       | 101       |
|            | 95th          | 104       | 104       |
|            | 99th          | 111       | 111       |
| 4          | 50th          | 88        | 88        |
|            | 90th          | 101       | 102       |
|            | 95th          | 105       | 105       |
|            | 99th          | 112       | 112       |
| 5          | 50th          | 89        | 90        |
|            | 90th          | 103       | 103       |
|            | 95th          | 107       | 107       |
|            | 99th          | 114       | 114       |
Table 2  Blood pressure for girls, by age and height percentile\(^7\) (continued)

| Age (years) | BP percentile | SBP, mmHg | DBP, mmHg |
|-------------|---------------|-----------|-----------|
| 6           | 50th          | 91        | 94        |
|             | 90th          | 104       | 109       |
|             | 95th          | 108       | 111       |
|             | 99th          | 115       | 117       |
| 7           | 50th          | 93        | 97        |
|             | 90th          | 106       | 111       |
|             | 95th          | 110       | 113       |
|             | 99th          | 117       | 119       |
| 8           | 50th          | 96        | 100       |
|             | 90th          | 108       | 113       |
|             | 95th          | 112       | 116       |
|             | 99th          | 119       | 121       |
| 9           | 50th          | 96        | 100       |
|             | 90th          | 110       | 114       |
|             | 95th          | 114       | 118       |
|             | 99th          | 121       | 123       |
| 10          | 50th          | 98        | 102       |
|             | 90th          | 112       | 116       |
|             | 95th          | 116       | 119       |
|             | 99th          | 123       | 125       |
| 11          | 50th          | 100       | 103       |
|             | 90th          | 114       | 118       |
|             | 95th          | 117       | 120       |
|             | 99th          | 123       | 125       |
| 12          | 50th          | 102       | 105       |
|             | 90th          | 116       | 120       |
|             | 95th          | 119       | 124       |
|             | 99th          | 127       | 130       |
| 13          | 50th          | 104       | 107       |
|             | 90th          | 118       | 121       |
|             | 95th          | 117       | 122       |
|             | 99th          | 129       | 132       |
| 14          | 50th          | 106       | 109       |
|             | 90th          | 119       | 122       |
|             | 95th          | 123       | 125       |
|             | 99th          | 130       | 132       |
| 15          | 50th          | 107       | 110       |
|             | 90th          | 121       | 122       |
|             | 95th          | 123       | 125       |
|             | 99th          | 131       | 133       |
| 16          | 50th          | 108       | 111       |
|             | 90th          | 121       | 124       |
|             | 95th          | 125       | 127       |
|             | 99th          | 132       | 134       |
| 17          | 50th          | 108       | 111       |
|             | 90th          | 122       | 123       |
|             | 95th          | 125       | 127       |

The 90th percentile is 1.28 SD, the 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure.
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Table 3 Characteristics of children with essential and secondary hypertension

| Characteristics          | Essential hypertension (n=48) | Secondary hypertension (n=124) | P    |
|-------------------------|------------------------------|-------------------------------|------|
| Family history, n (%)   | 31 (65)                      | 14 (11)                       | <0.001 |
| Male, n (%)             | 35 (73)                      | 78 (63)                       | 0.957 |
| Age (years)             | 9.1±4.4                      | 7.5±4.2                       | 0.907 |
| Body mass index (kg/m²) | 20.9±6.3                     | 16.1±4.3                      | 0.001 |
| Glomerular filtration rate (mL/min) | 157.0±36.5               | 137.5±172.6                   | 0.543 |
| Dizziness, n (%)        | 16 (33)                      | 31 (25)                       | 0.730 |
| Nausea, n (%)           | 14 (29)                      | 32 (26)                       | 0.989 |
| Abnormal electrocardiogram, n (%) | 20 (42)                 | 58 (47)                       | 0.241 |
| Abnormal ultrasonic cardiogram, n (%) | 16 (33)          | 43 (35)                       | 0.897 |
| Abnormal renal ultrasonogram, n (%) | 19 (40)               | 71 (57)                       | 0.478 |
| Proteinuria, n (%)      | 1 (2)                        | 50 (40)                       | 0.003 |
| Uric acid (μmol/L)      | 316.3±123.4                  | 339.7±147.2                   | 0.041 |
| Triglyceride (mmol/L)   | 1.2±0.6                      | 2.1±1.4                       | 0.048 |
| Total cholesterol (mmol/L) | 4.7±0.9                  | 5.1±2.3                       | 0.796 |
| High-density lipoprotein cholesterol (mmol/L) | 135.2±16.3             | 148.5±38.6                    | 0.914 |
| Low-density lipoprotein cholesterol (mmol/L) | 85.0±13.4              | 101.6±33.5                    | 0.932 |

Table 4 Causes of secondary hypertension (n=124)

| Causes                      | n (%)       | Median age at diagnosis, (range) | Male, n (%) |
|-----------------------------|-------------|---------------------------------|-------------|
| Renal                       | 68 (55)     | 8.1 (0.7-17.4)                  | 41 (60)     |
| Cardiac                     | 16 (13)     | 9.7 (4.7-13.8)                  | 10 (63)     |
| Endocrine                   | 15 (12)     | 12.0 (6.5-18.1)                 | 10 (67)     |
| Neurological                | 13 (11)     | 6.0 (1.9-11.0)                  | 8 (62)      |
| Autoimmune                  | 12 (10)     | 7.0 (1.3-11.7)                  | 9 (75)      |

Table 5 Causes of hypertension, by age group

| Causes                  | Infancy (<1 year) (n=13) | Preschool (1-5 years) (n=46) | Preteen (6-12 years) (n=88) | Teen (13-18 years) (n=25) | P    |
|-------------------------|--------------------------|-------------------------------|-------------------------------|----------------------------|------|
| Essential, n (%)        | 4 (31)                   | 6 (13)                        | 29 (33)                       | 9 (36)                     | 0.071 |
| Secondary, n (%)        | 9 (69)                   | 40 (87)                       | 59 (67)                       | 16 (64)                    | 0.071 |
| Renal                   | 6 (46)                   | 24 (52)                       | 25 (28)                       | 13 (52)                    | 0.027 |
| Cardiac                 | 0 (0)                    | 3 (7)                         | 12 (14)                       | 1 (4)                      | 0.116 |
| Endocrine               | 3 (23)                   | 4 (9)                         | 6 (7)                         | 2 (8)                      | 0.524 |
| Neurological            | 0 (0)                    | 6 (13)                        | 7 (8)                         | 0 (0)                      | 0.271 |
| Autoimmune              | 0 (0)                    | 3 (7)                         | 9 (10)                        | 0 (0)                      | 0.172 |

had secondary hypertension. Among those with secondary hypertension, 45% had renal hypertension and 55% had non-renal hypertension. Table 3 shows the characteristics of patients with essential and secondary hypertension. As compared with children with secondary hypertension, those with essential hypertension were more likely to have a family history of hypertension (P<0.001) and had a higher body mass index (BMI) (P=0.001), lower frequency of proteinuria (P=0.003), and lower uric acid (P=0.041) and triglyceride levels (P=0.048).

Causative Factors

Analysis of medical records identified causative factors for secondary hypertension (Table 4, 5), namely, renal (nephrotic syndrome, glomerulonephritis, renal artery stenosis, and neurogenic bladder), cardiovascular (congenital heart disease, coarctation of aorta, cardiomyopathy, and cardiac insufficiency), endocrine (diabetes, obesity, metabolic syndrome, neuroblastoma, and pheochromocytoma), neurological (neuromuscular disease, and viral encephalitis), and autoimmune (systemic lupus erythematosus, juvenile idiopathic arthri-
The proportion of children with renal hypertension was lower in those aged 6 to 12 years than in the other age groups (P=0.027) (Table 5).

Hypertension Therapy

The drugs used to treat pediatric hypertension are shown in Figure 1, 2. Calcium channel blockers (CCBs), angiotensin-converting enzyme inhibitors (ACEIs), β-blockers, and diuretics were frequently prescribed, and nifedipine, metoprolol, fosinopril, enalapril, and spironolactone were the most frequently prescribed drugs, in their respective classes, for pediatric hypertension. Figure 2 shows that the drugs used in the controlled groups were similar to those used in the uncontrolled groups for all
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Fig. 3 Class of antihypertensive drugs prescribed, by patient age.
C, controlled group; F, uncontrolled group; BB, β-blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CCB, calcium channel blocker; AB, α-blocker.

causes of hypertension. ACEIs were only prescribed to patients with nephrogenic hypertension, and the rate of ACEI use was positively associated with the control rate.

The most commonly used drugs, by age group, are shown in Figure 3. CCBs were most frequently prescribed to teenagers, and angiotensin receptor blockers (ARBs) and α-blockers were only prescribed to the preschool and preteen groups. The proportions were similar in the controlled and uncontrolled groups. ACEIs appeared to be more suitable for children aged 1 to 5 years, and effectiveness was positively associated with ACEI use.

Of the 172 children treated with antihypertensives, BP was classified as controlled for 66.3%. BP control rates, by antihypertensive, are shown in Table 6. The control rate did not significantly differ in relation to age, number of drugs prescribed, or cause of hypertension. Control rates were comparable between patients with essential hypertension and those with secondary hypertension. Among patients with secondary hypertension, control rates were much lower for those with endocrine disease than for those with other diseases. Hypertension in infants and teens was not adequately controlled by medication. However, control rates for the non-medication and monotherapy groups were higher than those for the other groups.

Discussion

The prevalence of hypertension in children and adolescents has increased in recent years, and childhood hypertension is an independent risk factor for adult hypertension\(^5\). In addition, development of hypertension early in life is associated with changes in cardiovascular target organs that predict cardiovascular outcomes in adulthood and lead to substantial morbidity and mortality\(^31\). In China, over 2 million deaths were attributed to hypertension in 2010, and management of hypertension, including childhood hypertension, is an important public health concern. Because of the lack of data and consensus, this study examined children with hypertension and compared differences between those with essential and secondary hypertension. Essential hypertension was associated with a family history of hypertension and elevated BMI, while secondary hypertension was associated with increased proteinuria and triglyceride concentration. Disease-specific treatment guidelines should be established for essential and secondary hypertension in children of all ages.

In this study, 28% of the pediatric population had essential hypertension and 72% had secondary hypertension. Flynn\(^35\) reported that secondary hypertension was the main cause of childhood hypertension and that >50% of secondary hypertension cases at tertiary centers were
Table 6  Rates of control of pediatric hypertension, by age, number of components, and cause of hypertension

| Variables                          | Controlled, n (%) | Failed, n (%) | P    |
|-----------------------------------|-------------------|---------------|------|
| **Age group**                     |                   |               |      |
| Infancy (n=13)                    | 7 (54)            | 6 (46)        | 0.118|
| Preschool (n=46)                  | 29 (63)           | 17 (37)       |      |
| Preteen (n=88)                    | 65 (74)           | 23 (26)       |      |
| Teen (n=25)                       | 13 (52)           | 12 (48)       |      |
| **Number of components**          |                   |               | 0.375|
| 0 (n=25)                          | 19 (76)           | 6 (24)        |      |
| 1 (n=47)                          | 33 (70)           | 14 (30)       |      |
| 2 (n=38)                          | 26 (68)           | 12 (32)       |      |
| 3 (n=29)                          | 14 (48)           | 15 (52)       |      |
| 4 (n=22)                          | 15 (68)           | 7 (32)        |      |
| 5 (n=11)                          | 7 (64)            | 4 (36)        |      |
| **Cause of hypertension**         |                   |               | 0.138|
| Essential (n=48)                  | 33 (69)           | 15 (31)       |      |
| Secondary (n=124)                 | 81 (65)           | 43 (35)       |      |
| Neurological (n=13)               | 8 (62)            | 5 (38)        |      |
| Endocrine (n=15)                  | 6 (40)            | 9 (60)        |      |
| Cardiac (n=16)                    | 11 (69)           | 5 (31)        |      |
| Autoimmune (n=12)                 | 11 (92)           | 1 (8)         |      |
| Renal (n=68)                      | 45 (66)           | 23 (34)       |      |

Attributable to renal parenchymal diseases. We found that overweight children with elevated BPs were most likely to receive a diagnosis of essential hypertension, as in previous studies. In this study, 65% (31/48) of the patients with essential hypertension had a family history of the disease, highlighting the genetic predisposition to essential hypertension. In addition, BMI was higher for children with essential hypertension than for those with secondary hypertension, which confirms previous findings. A previous study showed that children with essential hypertension presented at an older age and had a higher frequency of family history of the disease, supporting the present study. Unfortunately, data on preterm birth were not available for all patients, so we could not assess the effect of this factor. Gupta-Malhotra et al. reported an association of essential childhood hypertension with preterm birth, which warrants further study. As is the case for adult hypertension and in a previous study of childhood hypertension, males were predominantly affected, both for essential and secondary hypertension.

The possibility of an underlying disorder should be considered in all children with elevated BPs, even those with an obvious family history and obesity. Young children and children with clinical signs that suggest the presence of systemic conditions associated with hypertension should be examined more extensively. Secondary hypertension was more predominant in preschool children, and the main cause was renal disease. Proteinuria was present in 2% (1/48) of essential hypertension patients and in 40% (50/124) of secondary hypertension patients; thus, patients with proteinuria are possibly more likely to have secondary hypertension. Furthermore, because kidney disease caused by hypertension was the first cause of secondary hypertension, children with elevated BPs should first undergo urinalysis.

Treatment of pediatric hypertension targets the cause, and the goal is to lower BP to within the normal range. Because of the high risks of adult hypertension and morbidity later in life, patients with secondary hypertension require specialist treatment of the underlying cause. Those who need pharmacological treatment could benefit from a consultation with pediatric hypertension specialists. According to guidelines, patients with prehypertension and stage 1 hypertension should receive a BMI-based behavioral intervention before drug treatment. Specific methods include regular physical activity and diet control. A diet plan is made by a dietitian. If behavioral interventions fail, drugs are prescribed. Behavior modification is the initial treatment for hypertension. Because of the possible adverse effects of pharmacological therapy, it should be reserved for those who do not benefit from behavior modification. CCBs and ACEIs were the most frequently prescribed drugs for children with essential hypertension. Those with secondary hypertension...
were most often treated with CCBs, β-blockers, and ACEIs. The proportion of the present children prescribed ACEIs was much lower than in previous studies\(^4\), especially in the teen group\(^5\). Future studies should attempt to explain these differences.

Control rates were lower in the infant and teen groups than in the other groups, perhaps because of differences in disease state and physiology, and the lack of BP data for newborns\(^6\). In this study, ARBs were only prescribed to nephrogenic patients. Greater use of these drugs was associated with better BP control. Herder et al.\(^7\) reported that ARBs are mainly used to treat chronic renal diseases, with or without hypertension, especially in cases refractory to ACEI treatment. Although combination therapy is more effective than monotherapy in controlling hypertension\(^8\), we found that the control rate was higher in the non-medication and monotherapy groups than in the other groups, perhaps because of confounding factors such as resistant hypertension, lifestyle, and nutrition. Unfortunately, these factors could not be assessed in the present study, mainly because data for these variables were not consistently entered on medical charts. Nevertheless, the present study revealed that children with hypertension received a variety of treatments; thus, it is critical to establish disease-specific treatment guidelines for essential hypertension and secondary hypertension in children of all ages.

The limitations of this study include those of any retrospective observational study and the small sample size, which prevented comparison of essential and secondary hypertension and limited the analyses to identification of factors associated with each type of hypertension. Secondly, because there was no control group of children with normal BP, we could not perform multivariate logistic regression analysis to identify the different risk factors for essential and secondary hypertension. Thirdly, the present patient data were collected from several departments, and there may be differences in prescription behavior among the specialties. Fourthly, this study did not focus on control of the primary disease in children with secondary hypertension, and the analysis of drug effects was susceptible to bias. A well-designed prospective study should analyze detailed information, including the clinical and BP characteristics of hypertensive patients, contributors to the disease, and disease management. We expect to gradually expand the present sample size. As the study progresses, accumulating evidence should yield insights into clinical treatment of pediatric hypertension.

As compared with children with secondary hypertension, those with essential hypertension were more likely to have a family history of hypertension and had a higher BMI, a lower frequency of proteinuria, and lower uric acid and triglyceride levels. Treatment guidelines should be established for essential and secondary hypertension in children of all ages.

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**Conflict of Interest:** The authors declare no conflict of interest.

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