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Original Article

Blood Pressure Profile of School Children Aged 4 to 18 Years in the City of Bafoussam

Profil tensionnel des élèves âgés de 4 à 18 ans dans la ville de Bafoussam

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ABSTRACT

Introduction. High blood pressure (HBP) is a major public health problem in children, due to the risks of cardiovascular and renal complications associated. Systematic measurement of blood pressure and management of it's elevation in children is not yet clearly codified. The aim of the study was to establish the baseline blood pressure of children aged 4 to 18 years. **Methods**. A cross sectional study was done from January 2019 to June 2019 in 4 primary and secondary schools in the city of Bafoussam using a predesigned questionnaire and making measurements of general and anthropométric following standard guidelines. The data collected was analyzed using appropriate statistical tests. **Results**. The prevalence of high blood pressure among the 1075 subjects included in our study was 2.1%, of whom 2.0% had borderline HBP and 0.1% had confirmed HBP according to the classification of the French Society of Pediatric Nephrology. Factors associated with hypertension were: age between 5-8 years, male gender (95% CI: 0.3 (0.1 - 0.9) P=0.017); obesity (95% CI: 5.5 (2.1 - 14.5), P= 0.002) and weekly duration of sports activity less than 2 hours (95% CI: 0.3 (0.1 - 0.7), P= 0.004). **Conclusion**. This study revealed an elevated prevalence of high blood pressure in Bafoussam, with a number of preventable risk factors. Parents and children should be educated on proper nutrition and the need to practice regular sports activities to avoid overweight and obesity.

RÉSUMÉ

Introduction. L'hypertension artérielle (HTA) est un problème majeur de santé publique chez l'enfant, en raison des risques de complications cardiovasculaires et rénales qui y sont associées. La mesure systématique de la pression artérielle et la gestion de son élévation chez les enfants ne sont pas encore clairement codifiées. L'objectif de notre étude était d'établir les valeurs de la tension artérielle de base chez les enfants de 4 à 18 ans et d'étudier l'association entre l'hypertension et certaines variables. **Méthodes**. Une étude transversale a été réalisée de janvier à juin 2019 dans quatre écoles primaires et secondaires de la ville de Bafoussam à l'aide d'un questionnaire préconçu et en effectuant des mesures anthropométriques selon des directives standardisées. Les données recueillies ont été analysées à l'aide de tests statistiques appropriés. **Résultats**. Parmi les 1075 sujets inclus, la prévalence de l'hypertension était de 2,1 %, dont 0,1 % avaient une hypertension confirmée selon la classification de la Société française de néphrologie pédiatrique. Les facteurs associés étaient : âge entre 5 et 8 ans, sexe masculin; obésité et durée hebdomadaire d'activité sportive inférieure à 2 heures. **Conclusion**. Cette étude a montré une prévalence élevée de l'hypertension artérielle à Bafoussam, avec des facteurs de risque évitables. Par conséquent, les parents et les enfants doivent être éduqués sur une bonne nutrition et la nécessité de pratiquer des activités sportives régulières pour éviter le surpoids et l'obésité.

INTRODUCTION

The World Health Organization (WHO), estimates that cardiovascular diseases are the leading cause of death in the world [1]. Hypertension is a major public health problem in developing countries [2–4] and is estimated to affect 10-15% of the adult population in sub-Saharan Africa [5] with higher rates in urban areas [6, 7]. Among children, the prevalence reported according to studies ranges from 1.8% to 17.8% [8–13].

According to the European Society of Cardiology, blood pressure measurement in children should be systematic from the age of 3 years, leading to early diagnosis and identification of those at risk for better prevention of cardiovascular disease [14].

In Africa, several studies indicate that the prevalence of hypertension in children ranges from 1.8% to 10.1% [8–11]. In Cameroon, previous studies carried out in the cities of Bertoua and Yaounde have found prevalences

of hypertension among students ranging from 1.8% to 2.9% [12, 15, 16]. We formulate the hypothesis that it could be more prevalent in the west region. We thus decided to carry out a study in Bafoussam, a city of West Region of Cameroon, in order to define the blood pressure norms in school-age children and to better understand the factors that can influence them.

METHODS

Study population and design

We carry out a cross-sectional analytical and descriptive study over a period of six months: from 7th January 2019 to 5th June 2019, in four public and private institutions in the city of Bafoussam.

Study setting

The city of Bafoussam, capital of the Mifi department, is located at 295 km from Yaoundé. It has a population of 365,017 inhabitants.

Sampling and procedure

From a population of students aged from 4 to 18 years, we conducted a random sample with 02 levels of stratification. The first stage consisted of a selection of schools and a systematic draw then, we selected four schools within the study site. The second was the random selection of classroom per school. Using Cohran's formula and the 1.6% [16] prevalence reported by Chelo et al in the central region in 2018, we obtained a minimum sample size of 605 students.

The children enrolled in the study, had to be present in school, with the signed consent form by parents or tutors, and who accepted to participate in the study. The study excluded any child who had any disability not permitting weight, height, or BP taking as recommended by the WHO, and those taking antihypertensive drugs.

The following variables were included: socio-demographic characteristics (age, sex, type of school, class, legal guardian's occupation), lifestyle (eating habits, physical activity), personal (birth weight, diseases) and family history (family history of hypertension, obesity, diabetes), anthropometric parameters (weight, height, BMI) and blood pressure measurements.

Blood pressure measurement

- Before BP measurements taken, the nature of the procedure explained. BP was measured in the sitting position, on the right arm, using the auscultatory method with a pediatric stethoscope, and a standard aneroid sphygmomanometer with appropriate cuff size covering at least 2/3rd of the upper arm and encircling it completely. The child's right arm was supported at the level of the heart during measurements. This was the preferred arm because of the probability of decreased BP on the left arm caused by coarctation of the aorta (8). The stethoscope was placed lightly over the brachial artery. The cuff was inflated to a pressure of 30 mmHg above the level at which the radial pulse was no longer palpable. While slowly deflating the cuff, the Korotkoff phase I was listened while watching the BP gauge. Korotkoff phase I was identified by the first pulse auscultated [17], representing the participant's systolic BP. While watching the sphygmomanometer, the cuff was continuously slowly deflated till an abrupt soft, indistinct, muffling sound was heard (Korotkoff phase IV). This sound was then continuously listened until it disappeared completely (Korotkoff phase V) and recorded; this represented the participant's diastolic BP. The cuff was completely deflated and the child was allowed to rest. For each participant, BP was measured twice in the same visit with a minimum of 30 seconds rest interval and the mean BP calculated. We waited for another 1–2 minutes and repeated the BP measurement procedure on the participant's opposite arm and if a measurement discrepancy existed between the 2 arms, the arm with the highest measurement was noted. BP readings were taken to the nearest 2 mmHg. BP readings were classified according to the recommendations of French Society of Pediatric Nephrology (FSPN) [18] as follows for age, height and gender:
- Normal BP if SBP and/or DBP were less than the 97.5th percentile
- Borderline HBP if SBP and/or DBP were between 97.5th percentile and 97.5th percentile +10 mmHg
- Confirmed HBP if SBP and/or DBP were between 97.5th percentile + 10 mmHg and 97.5th percentile + 30 mmHg
- Threatening HBP if SBP and/or DBP were more than 97.5th percentile + 30 mmHg

Measurement of anthropometric parameters

The weight was measured using an electronic scale giving values to the nearest 0.1 Cm. For the height, the measurement was taken to the nearest 0.1 Cm. Children with a BMI above the 95th percentile for age were obese, between the 85th and 95th percentile overweight, normal with a BMI between the 85th and 5th percentile, and underweight with a BMI below the 5th percentile.

Data collection

Data was collected from filled questionnaires and clinical examination.

Statistical analysis

Analysis was done using Epi-Info™ 3.5.4 and WHO AnthroPlus™ 1.0.4 softwares. The Chi-square test was used to evaluate the association between qualitative variables and the Pearson correlation to evaluate the association between quantitative variables. The degree of association was assessed using the odds ratio and its confidence interval (CI) at 95%, and statistical significance was considered at a P value <0.05.

Ethical considerations

After obtaining authorizations from the Regional Delegation of Basic Education at Bafoussam and high schools, an ethical clearance was delivered by from the Institutional Ethics Committee of Université des Montagnes and informed consent from parents.

RESULTS

We are enrolled 1075 students from 4 schools selected in the study area.

Sociodemographic characteristics of study population

Of 1075 students recruited, 497 (46.1%) were males, and 579 (53.9%) were females, giving a sex ratio of 0.86. 522 (48.56%) students were from public schools and 553 (51.44%) were from private schools. The mean age was 10.68±3.68 years with the most represented age range of 11-14 years (32.8%). The most represented sector of activity of parents was liberal professions (Table 1).

Table 1 Socio-demographic **characteristics of the study population**

Variable	Frequency (n)	Percentage (%)
Gender		
Males	287	26.7
Females	292	27.2
Age		
[4 – 8[	280	26.1
[8 – 11[	229	21.3
[11 – 14[	353	32.8
[14 – 18]	213	19.8
Type of school		
Public	522	48.56
Private	553	51.44
Profession of legal tutor		
Non liberal	248	23.1
Liberal	606	56.4
Unemployed	221	20.5

Anthropometrics parameters of study population

With CDC classification, 816 (75.9%) students had a normal weight; 128 (11.9%) were overweight, and 69 (6.4%) were obese (Table 2). 62 (5.8%) of students were undernourished. From 197 (18.3%) students with overweight/obesity, the majority 113 (57.36%) was represented by females.

Table 2 BMI classification of the study subjects

BMI	Frequency (n)	Percentage (%)
≥5th – 85th percentile < (normal)	816	75.9
<5thpercentile (underweight)	62	5.8
≥85th – < 95th percentile (overweight)	128	11.9
≥ 95th percentile (obesity)	69	6.4

BMI=Body Mass Index

Distribution of blood pressure in the study population

The mean of blood pressure in the study population was respectively 102.6 (±15.7) mmHg for systolic blood pressure and 62.3 (± 9.2) mmHg for diastolic blood pressure (Table 3).

Table 3 Distribution of blood pressure in population study

Age range	Frequency (n)	PAS (Mean ± Standard deviation in mmHg)	PAD (Mean ± Standard deviation in mmHg)
< 5	105	84.6 ± 7.8	54.4 ± 10.3
[5 – 8[	175	89.3 ± 10	58.1 ± 8.5
[8 – 11[	229	98.9 ± 11.1	62.3 ± 7.7
[11 – 14[	353	107.04 ± 11.9	63.6 ± 8.1
[14 – 17[	186	118.8 ± 12.3	67.2 ± 8.4
≥ 17	27	120.1 ± 11.5	69.9 ± 5
Population study	1075	102.6 ± 15.7	62.3 ± 9.2

PAS=Pression Artérielle Systolique
PAD= Pression Artérielle Diastolique

According to the French society of pediatric nephrology, we obtained the curves of blood pressure percentiles in population study among boys and girls (Table 4-5).

Table 4 Prevalence of hypertension in the population study

Variables	Frequency (n)	Percentages (%)
Hypertension		
Patients with High BP	23	2.1
Patients with Normal BP	1052	97.9

BP= Blood Pressure

Table 5: Hypertension's associated factors in the population study

Variables	Odds ratio	95% CI	P value
Pupil's age [5 – 8[years	0.3	0.1 – 0.6	0.001
Obesity in children	5.5	2.1 – 14.5	0.002
Male gender	0.3	0.1 – 0.9	0.017
Physical activity < 2 per week	0.3	0.1 – 0.7	0.004
Birth weight ≥ 4000g	3.1	1.1 – 8.6	0.039

Prevalence of hypertension and associated factors

Out of the 1075 subjects of study 23 (2.1%) were found to be hypertensive (Table 4). The associated factors were, the pupil's age [5 – 8[years old (P=0.023), obesity in children (P=0.002), male gender (P=0.017), physical activity < 2 per week (P=0.004), birth weight ≥ 4000g (P=0.039) (Table 5).

DISCUSSION

Our study aimed to determine the baseline blood pressure in children 4–18 years and to study the association between hypertension and selected variables. The prevalence of high blood pressure was 2.1%, Factors associated with hypertension were: age between 5-8 years, male gender (95% CI: 0.3 (0.1 - 0.9) P=0.017); obesity (95% CI: 5.5 (2.1 - 14.5), P= 0.002) and weekly duration of sports activity less than 2 hours (95% CI: 0.3 (0.1 - 0.7), P= 0.004).

Out of the 1075 subjects of study, 497 (46.1%) were boys and 579 (53.9%) were girls, giving a sex ratio of

0.86. Bissohong in 2014 in Bertoua [12] and Chelo in 2018 in Yaounde [16] reported this similar tendency which correspond to the repartition of students observed in that area. 197 subjects had overweight/obesity with 69 (6.4%) students having an obesity. The predominance in obesity was observed in girls. These results were less than to these obtained by Choukem and al in 2017 [19] , in urban area, with a prevalence of 12.5% of overweight/obesity although the girls were more affected. This result could be explained by positive association demonstrated in studies between the standard of living and the occurrence of childhood obesity [20–22].

We found an increase in blood pressure with age in our study. Similarly, studies carried out in Gambia in 2017 [23] on a population of subjects aged from 5 to 18 years, then by Wang and al [24] in China, and Ataei and al [25] in 2017 found an increase of blood pressure with age which can be explained by the increase in weight, height and sexual maturity that occurs with age [26–28]. Moreover, there is an increase in arterial rigidity with age in children, which may be responsible for the increase in blood pressure observed in our study population [29].

We found a prevalence of HBP of 2.1% in our study population. Out of the hypertensive students, 22 (2.0%) had borderline hypertension and 1 (0.1%) had confirmed hypertension according to the classification of the FSPN. These results are closed to the prevalence of HBP reported in previous studies, such as the study conducted by Bissohong and al in Bertoua in 2015 [12], which found a prevalence of HBP of 2.9%. This could be explained by the fact that, the cities of Bertoua and Bafoussam are in semi-rural areas; which suggests that, physical activities and standard of living of the populations living there, are practically the same. Also, a study carried out in Yaounde in 2018 by Chelo and al, on a population of 822 students found a prevalence of hypertension of 1.6% [16]; it could be explained by the fact that the size of the study population was smaller than ours and by the use of American references for interpretation of blood pressure data in this study population. A similar study realized in Nigeria by Okpokowuruk and al. in 2017 in children found a prevalence of hypertension of 3.5% [30]. This result could be reflected in the small sample size of the study population (200 students) and the preponderance of an age group from 13-17 years old (56%) knowing that blood pressure increases with age [29].

After a multivariate analysis, the risks factors found to be associated with HBP in our study were: male gender, BMI > 95th percentile, a weekly sports activity duration < 2 hours and a birth weight ≥ 4000 grs.

The association between obesity and hypertension was reported by Bissohong and al in 2014 in Bertoua [12], Chelo and al in 2018 in Mbankomo [16] and Bhimma and al in 2018 in South Africa [31] . This could be explained by the over-activation of the renin-angiotensin and sympathetic systems, insulin resistance, and abnormalities in vessel structure observed in obese individuals[32–34]. It has been shown that in the obesity, adipokines are also known to cause over-activation of the sympathetic nervous system (SNS) [35, 36]. Furthermore, increase of BMI has been associated with increased renin release [37], which through its vasoconstrictor effects and activation of the renin-angiotensin-aldosterone system contributes to increased blood pressure [38].

Weekly fitness duration less than 2 hours per week was statistically significantly associated with HBP. This result was similar to that found by Bissohong and al in Bertoua in 2015 [12]. Studies reported that practice sports for 40 minutes at a rate of 3 to 5 times per week is required to reduce blood pressure in children [39, 40], in addition to a reduction in BMI [41] and would therefore prevents the development of hypertension in children [42].

We had a statistically significant association between a birth weight > 4000 grs and the occurrence of HBP. Bowers and al reported in 2011 in a population of 15600 children in China [43] which found that, overweight at birth and rapid post-natal weight gain were positively associated with the occurrence of hypertension in children. This could be explained by the predominant role of obesity in the occurrence of HBP in children[33, 36–38], with rapid post-natal weight gain being a factor of exposure to obesity and HBP in children [44, 45].

The positive association found between the male gender and HBP in our study is similar to results reported by Bissohong and al in 2014 in the city of Bertoua [12]. Similar studies found an increase of systolic blood pressure in boys compared to girls, particularly during the pubertal period [46, 47], suggesting the possibility that the differences observed in male blood pressure may be due to the impact of sex steroids. Indeed, after the growth spurt, sexual maturation plays a major role in the increase in blood pressure observed in both sexes, with a greater effect of testosterone [48].

From the blood pressure curves obtained in both sexes, we notice that our curves have inflection points (figures 5 & 6). This could be reflected by our relatively small sample size compared to the one used to establish the curves of the FSPN, which was 17067 subjects [18]. According to the FSPN, used for the interpretation of blood pressure data in our study population, no subject had threatening hypertension. This is probably due to the fact that for each of the curves shown above, we noted that the blood pressure thresholds in our population are relatively low compared to those defined by the FSPN [18]. This could be explained by the increase in the prevalence of overweight and obesity from years 1975 to 2016 [49] in the Caucasian population compared to the Central African population in children and adolescents aged 5 to 19 years [49], thus exposing these Caucasians to higher blood pressure cut-offs.

However, a limitation of the study was the reluctance of parents to involve their children in the study, thereby reducing the sample size.

CONCLUSION

The blood pressure thresholds in our population are relatively low compared to those of FSPN. The risks

factors associated with HPB in our study population were: male gender, BMI > 95th percentile, a weekly sports activity duration < 2 hours and a birth weight ≥ 4000 grs. We therefore recommend: to integrate BP measurement as a routine part of medical visits, encourage children to be physically active in sports clubs and home and then encourage them to eat of a healthy and balanced diet.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

ETHICAL STATEMENT

The study was approved by the Institutional ethic committee (N°2019/141/UdM/PR/CIE) of the Higher Institute of Health Sciences. Informed written consent was obtained from the parents before data was collected.

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FIGURES

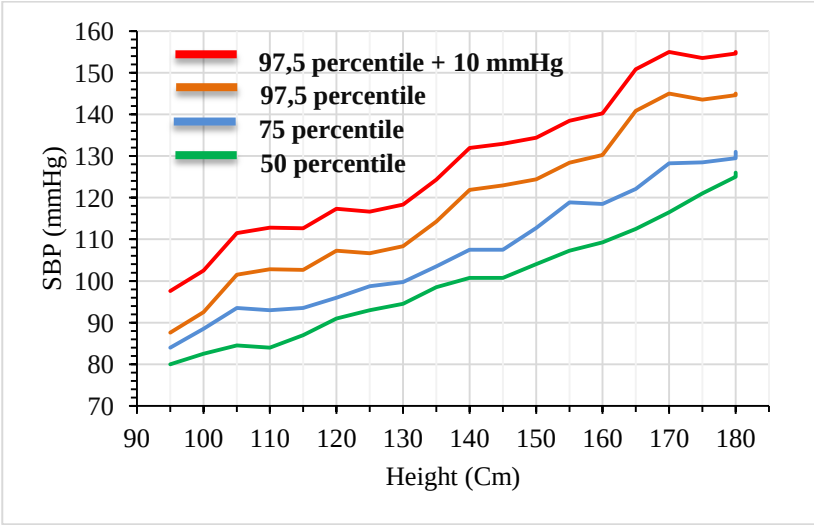

Figure 1 Curves of SBP in boys
SBP = Systolic Blood Pressure

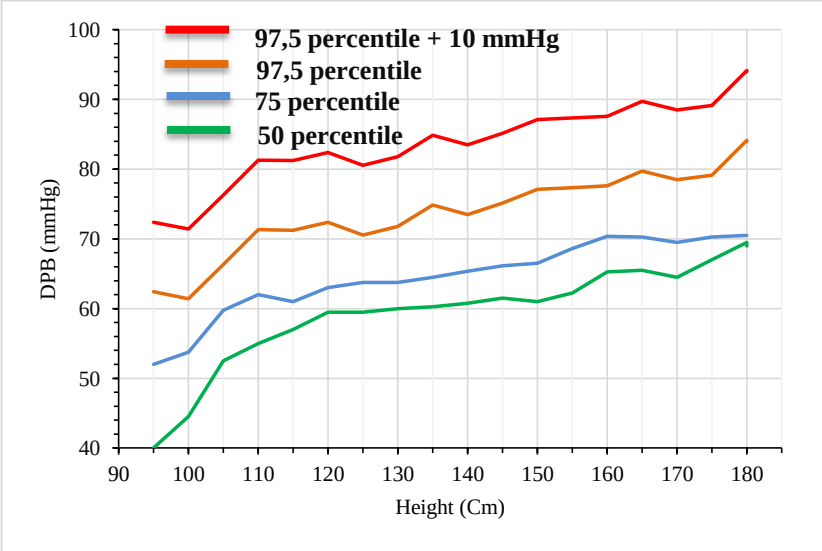

Figure 1 Curves of DBP in boys
DBP = Diastolic Blood Pressure

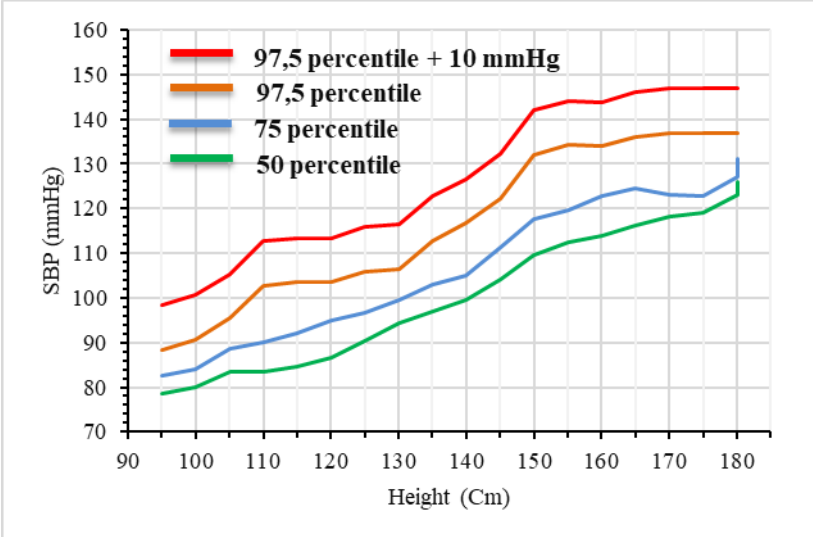

Figure 2 Curves of SBP in girls
SBP = Systolic Blood Pressure

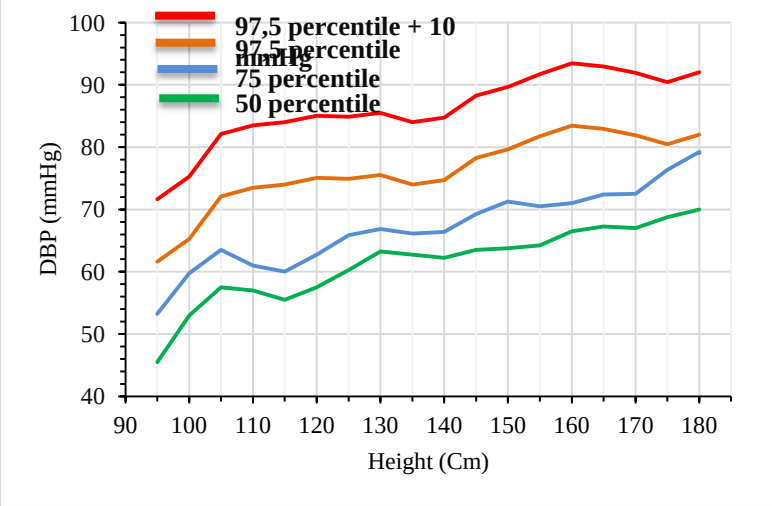

Figure 3 Curves of DBP in girls
DBP = Diastolic Blood Pressure

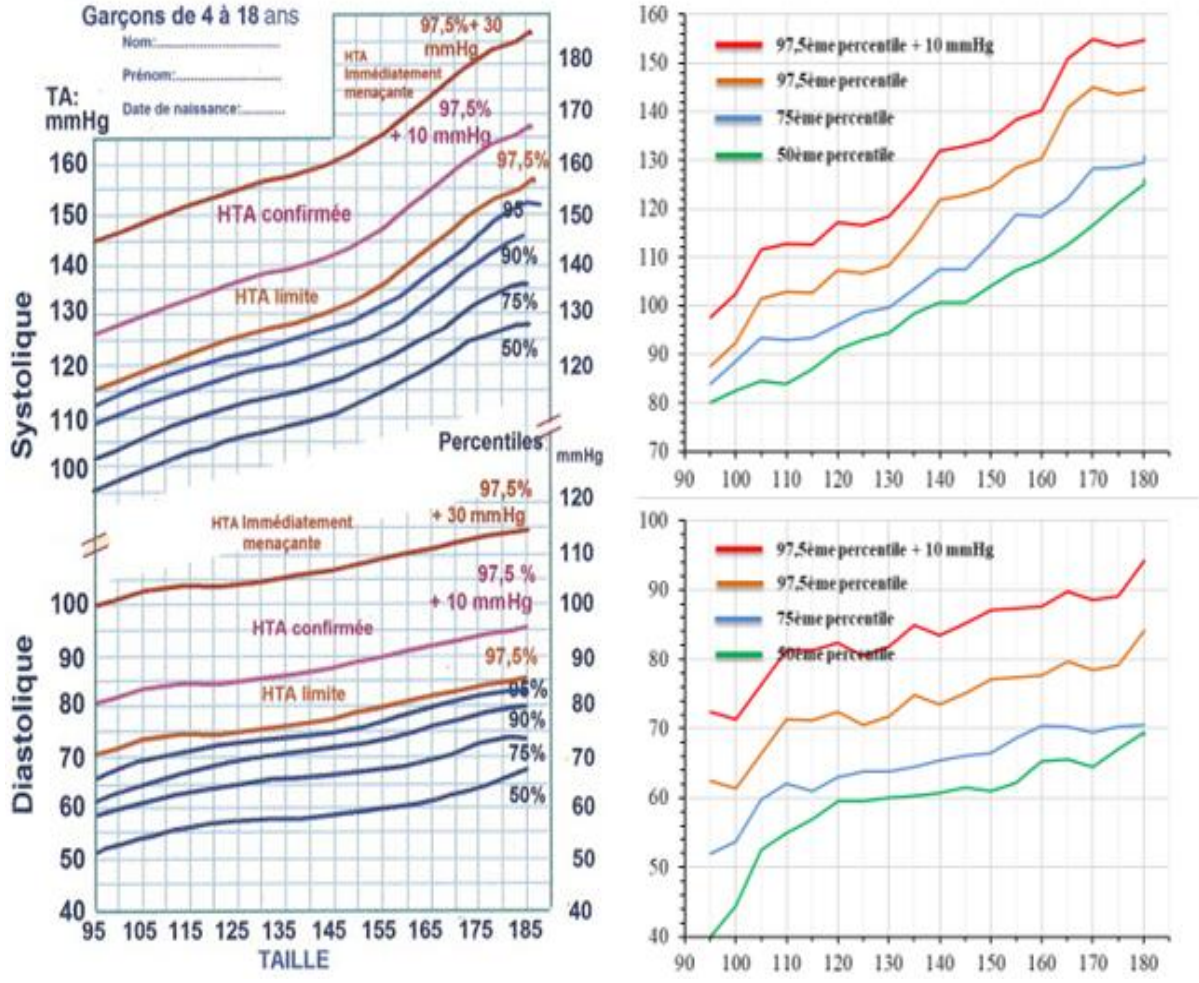

Figure 4 Curves of study (left-side) to curves of FSPN (right-side). Boys from 4-18 years
FSPN= French Society of Pediatrics Nephrology