IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 5 Ver. VIII (May. 2016), PP 36-44
www.iosrjournals.org

Clinical Profile of Hypertension in Children

Dr.Radha Mohan. M[1],Dr Alimelu. M[2],
[1]*Assistant Professor Of Pediatrics, Department Of Paediatrics, Government General Hospital, Government Medical College, Nizamabad.*
[2]*Department Of Paediatrics , Government General Hospital, Government Medical College, Nizamabad.*

Abstract: *Systemic hypertension is an important condition in childhood. It is documented that almost 75% of cases hypertension and 90% of cases of pre hypertension in children and adolescents are undiagnosed [27]. The prevalence of hypertension in children is 1-4%.*
Among the 105 (n=105) children included in the study from 2009 to 2011, in a teaching Hospital, Hyderabad, Telangana State , the etiology of hypertension was determined in 97 (92.4%) cases. Renal parenchymal disease was the most common underlying pathology. Acute glmerulonephritis was found the commonest etiological disease. Others include nephrotic syndrome, reflux nephropathy, renal artery stenosis, acute renal failure etc.Hormonal disorders include pheochromocytoma, hypothyroidism. While in 8 cases (7.6%) cause forhypertension was not found. Percentage of essential hypertension was increased in higher age groups.
Keywords: *Hypertension, Renal parenchymal disease, Acute glomerulonephritis, Secondary hypertension, Essential hypertension, BMI (Body Mass Index).*

I. Introduction

The true incidence of hypertension in the pediatric age group is not known. Large population based studies on hypertension are lacking from India. Smaller studies have suggested incidence between 2-5%.

Review of literature: Said RA, Said SM in 1990 from department of Medicine, Medical School, Jordan University, Amman [38] have noted in a retrospective analysis of 70 patients, aged 1-20 years, over a period of 3 years, that essential hypertension was observed in 6 patients only (8.6%); secondary hypertension 64 (91.4%) was due to renal parenchymal disease in 46 patients (65.7%),reno vascular hypertension in 8 (11.4%),renal transplant in 5 (7.2%), and pheochromocytoma in 1 (1.4%). The etiologies of renal parenchymal disease were acute glomerulo nephritis in 14, idiopathic nephritic syndrome in 10, chronic renal insufficiency in 5 and poly cystic kidney disease in 3 patients.

Other studies include Samboonnanonda A et al. [39], Department of Pediatrics, Faculty of Medicine, Sirraj Hospital, Mahidol University, Bangkok, Thailand from Jan 1999 to Dec 2003; Wyszynska T et al. [29], Department of Nephrology, Child health Centre-Memorial, Warsaw, Poland, between Jan 1982 and Dec 1989; Arar MY et al. [31] in the Southern United States in 1994; Khalil A et al. [33], Department of Pediatrics, Moulana Azad Medical College, New Delhi in 1990; Pankaj Hari et al. [12], Department of Pediatrics, All India Institute of Medical Sciences, New Delhi, between Jan 1983 and Dec 1996. All of these studies have shown secondary hypertension was common in children and the underlying etiology was renal parenchymal disease. (Table 4)

Panja M et al. [42] 1996, Department of Cardiology, Institute of Post Graduate Medical Education & Research, Calcutta evaluated 341 young hypertensives in the age group of 18-30 years over a period of 7 years in Eastern India. Essential hypertension constituted the single largest group (35.8%). Renal pathology was the most common cause of secondary hypertension (26.4%).

In the current study our primary aim is to evaluate the etiology of hypertension in children using variables like age, sex, region (urban or rural), and family history of hypertension and Body Mass Index (BMI).

II. Materials and Methods

The present study is a descriptive study conducted from 2009 to 2011 in a Teaching Hospital, Hyderabad, Telangana State on 105 children with hypertension on the age group of 1-16 yr presenting with various symptoms like facial puffiness, decreased urine output, high colored urine, headache, seizures, sweating, palpitations, pain abdomen. Children who were using drugs like steroids, amphetamines, sympathomimetics. for more than one month were excluded. Before commencing the study the institutional Ethics Committee clearance was taken. Informed consent from the parent or guardian of each and every child enrolled in this study was obtained.

Definition: Hypertension in children and adolescents is defined as systolic or diastolic blood pressure exceeding 95th percentile for age, gender and height.

Staging: Since severity of hypertension influences its management, it should be staged as below.
Pre hypertension: Systolic or diastolic blood pressure between 90th and 95th percentile.
Stage 1 hypertension: Systolic or diastolic blood pressure values exceeding 95th percentile and up to 5mm above the 99th percentile.
Stage 2 hypertension: Systolic or diastolic blood pressure values 5mm or more above 99th percentile.

BMI (Body Mass Index): BMI was calculated by using the following formula.

BMI=weight in kg/height in m^2

According to BMI children were classified as normal (5th -85th percentile), underweight (≤ 5th percentile) and overweight and obese (≥85th and ≥95th percentile) using the CDC growth charts. WHO Child Growth Charts were used for children below 2 years.

Funding: None.

III. Study Procedures

All children were examined in a separate room under good light in calm and quiet atmosphere. Blood pressure measurements were made in right arm in sitting position by using a standard mercury sphygmomanometer with different sized cuffs as per the recommendation of American Heart Association [4]. Blood pressure was recorded three times and the mean blood pressure was recorded.

Once the child was diagnosed as hypertensive, initially underwent the basic investigations like complete blood picture, blood sugar, blood urea, serum creatinine, serum electrolytes, lipid profile, complete urine examination, 24 hr urinary protein, urine spot protein- creatinine ratio, chest-x-ray, ultra sound abdomen, fundus examination, ECG, 2-D Echo.etc. Based on the clinical manifestations and the basic investigations second line investigations like micturating cysto urethrogram, renal angiogram, Doppler flow studies, CT scan, hormonal studies like T3, T4, TSH, urinary catecholamines, urinary cortisol etc. were performed whenever indicated.

The cause of hypertension was identified in most of the children. Essential hypertension was diagnosed only if detailed evaluation did not show an identifiable etiology.

IV. Results

During the study period 105 children with hypertension were observed. Of these 62 were boys and 43 were girls. The age group included in this study was from 1yr to 16 yr. The etiology was determined in 97 (92.4%) cases while 8 (7.6%) cases were diagnosed as essential hypertension. Renal parenchymal disease was the most common underlying pathology found in 72 (68.6%) children with hypertension and acute glomerulonephritis was the commonest etiological disease (Fig.1). Others include nephrotic syndrome, chronic glomerulonephritis, reflux nephropathy, obstructive uropathy and reno vascular hypertension (renal artery stenosis), acute renal failure, multiple cystic diseases of kidney and medullary sponge kidney.

Hormonal disorders include 1case of pheochromocytoma and 1 case of hypothyroidism. Miscellaneous diseases associated with hypertension were IDDM, A-V malformation (vein of Galen), tricuspid regurgitation with pulmonary hypertension with CCF, dilated cardiomyopathy etc.

Most of the patients were presented with renal manifestations like facial puffiness, oliguria, hamaturia and anasarca etc. whereas the rest presented with either non specific symptoms like headache, rashes, loss of weight, loss of appetite or those due to complications of hypertension such as encephalopathy ,CCF etc. There was not much difference between males and females in clinical manifestations and etiology.
The causes of hypertension and percentage of conditions were mentioned here. (n=105)

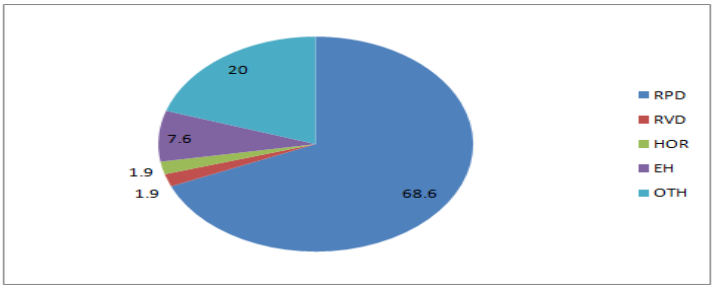


Fig.1

Table 1. **Percentage of conditions**

Condition	Percentage	Number of cases
RPD: Renal parenchymal disease	68.6%	72
RVD: Reno vascular disease	1.9%	2
HOR: Hormonal disorders	1.9%	2
EH: Essential hypertension	7.6%	8
OTH: Others	20%	21

Region wise distribution did not show much difference between rural and urban children. Renal parenchymal disease was found the commonest cause of childhood hypertension in both groups. Family history of hypertension was found in only 2 out of 105 children. One was presented with seizures and the underlying cause of hypertension was not found and second was with CCF and the underlying cause was dilated cardiomyopathy, mild tricuspid regurgitation with pulmonary artery hypertension.

As shown in Fig.2 the percentage of essential hypertension was increased with increasing age and that of secondary hypertension was decreased.

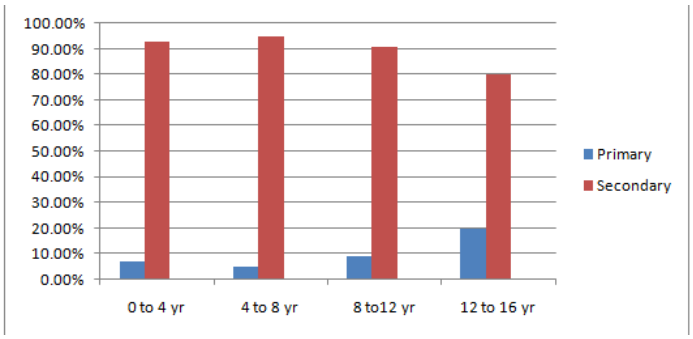


Fig.2

Table 2. **Percentage of primary and secondary hypertension with increasing age:**

Age in yr	Primary HTN	Secondary HTN
0-4	6.90%	93.10%
4-8	5.30%	94.70%
8-12	9.10%	90.90%
12-16	20%	80%

BMI (Body Mass Index) wise distribution: Out of 105 children with hypertension 16 (15.23%) were overweight/obese. Acute glomerulo nephritis was most common cause in children with hypertension with BMI of normal range i.e. 28 patients (48.3%) and in underweight 9 patients (29%). In overweight and obese children with hypertension nephrotic syndrome was observed in 8 (50%) cases. (Table 3)

Follow-up: All the children with hypertension were treated according to the diagnosis and most of them were hospitalized. Anti hypertensive drugs were prescribed for most of the children. After three months we observed that blood pressure was normalized in almost all the children. Anti hypertensive drugs were being continued for the children in whom essential hypertension was diagnosed. All the children were advised for regular check up and there was no significant rise in blood pressure in those who were attending to our hospital, in six months follow up.

Table 3**. BMI wise distribution (n=105)**

Diagnosis	N	O	U
Acute glomerulo nephritis	28	3	9
Chronic glomerulo nephritis	4	2	3
Nephrotic syndrome	13	8	6
Reflux nephropathy	1	0	1
Obstructive uropathy	1	0	1
Renal artery stenosis	2	0	0
Acute renal failure	2	1	2
Other renal disorders	0	0	2
Hormonal disorders	1	0	1
miscellaneous	2	1	3
Unknown cause	4	1	3
Total	**58**	**16**	**31**

N-Normal range; O-Overweight/Obesity; U-Underweight

V. Discussion

We examined 105 children with hypertension in our hospital. An underlying cause was found in most of our patients with hypertension. Renal parenchymal disease was most common among all age groups. The chief renal disorders were glomerulonephritis, nephrotic syndrome, obstructive uropathy, reflux nephropathy. Our observations were comparable to those from other groups from various parts of the world [12, 29, 30, 31, 33, 38, and 39].

Our study is unique in describing the etiology of hypertension in children and having regular follow-up. Children were examined in a separate room under good light in calm and quiet atmosphere. Anxiety and fear in children were removed by talking to them and making the child acquainted with the examiner.

Table 4. **Comparative Data on Etiology of hypertension in children.**

Condition	Khalil [33] n=23	Pankaj [12] n=246	Said [38] n=70	Samb [39] n=66	Wysz [29] n=636	Arar [31] n=132	Present study n=105
Renal parenchymal disease	47.8%	77.2%	65.7%	62.7%	68%	50%	68.6%
Reno vascular disease	13.0%	6.1%	11.4%	7.5%	10%	9.8%	1.9%
Pheochromocytoma	4.4%	-	1.4%	1.5%	-	-	0.9%
Essential hypertension	8.7%	1.6%	8.6%	7.5%	11%	7%	7.6%
Overweight/ Obesity	-	-	-	15.1%	-	-	15.23%

Care was taken while choosing the appropriate sized cuff that would encircle the arm and the inner bladder should go more than half way ($2/3^{rd}$) around the arm and width should go from antecubital fossa to comfortably place the stethoscope at the lower edge of the cuff to prevent the obstruction of axilla. Recording of blood pressure was accurate, as it was recorded 3 times and the mean blood pressure was recorded. Our study is comparable to other studies mentioned above and shows similar findings.

However this study was conducted in children, who were admitted in our hospital. Thus our findings may not represent the etiology of hypertension in the population.

Recommendations: It is known fact that the hypertension slowly establishes itself during the late childhood if there are provocative factors present in the childhood. This onset of hypertension can definitely be prevented if routine blood pressure recording is done in children and interventions made so that the serious complications of hypertension in adult life can be minimized.

Conditions such as stenosis of renal artery or its branches and pheochromocytoma may present with raised blood pressure alone. The diagnosis in these conditions may be difficult and requires detailed evaluation. Surgical treatment is possible in a small number of patients where as others require prolonged anti hypertensive treatment.

VI. Conclusion

Our results suggest that most of the children with hypertension will found to have an underlying etiology. Renal parenchymal disease is the commonest underlying pathology, including acute glomerulonephritis predominantly followed by nephrotic syndrome, reflux nephropathy and obstructive uropathy. Occasionally it is detected incidentally with no clinically obvious renal or cardiovascular cause. As age increases percentage of essential hypertension will be increased.

References

[1]. Munter P, He J, Cutler JA, Wildman RP, Whelton BK. Trends in blood pressure among children and adolescents. JAMA 2004; 291:2107-2113.

[2]. Mohan B, Kumar N, Aslam N, Rangbulla A, Kumbkarni S, Sood NK et al. Prevalence of sustained hypertension and obesity in urban and rural school going children in Ludhiana. Indian Heart J 2004; 56: 310-314.

[3]. Lane DA, Gill P. Ethnicity and tracking blood pressure in children. J Human Hypertension 2004; 18: 223-228.

[4]. National High Blood Pressure Education Program Working Group. The fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents. Pediatrics 2004; 114 (suppl): 555-576.

[5]. National Heart, Lung and Blood Institute. Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure: The JNC 7 report. JAMA 2003; 289: 2560-2572.

[6]. Report of the Second Task Force on Blood Pressure Control in Children 1987. National Heart Lung Blood Institute, Bethesda, Maryland. Pediatrics 1987; 79; 1-25.

[7]. Stabouli S, Kotsis V, Toumanidis S, Papamichael C, Constantopoulos A, Zakopoulos N,. White coat and masked hypertension in children; association with target organ damage. Pediatr Nephrol 2005; 20; 1151-1155.

[8]. Pickering TG. Principles and techniques of blood pressure measurement. Cordial Clin 2002; 20:207-223.

[9]. Working Group on Blood Pressure Monitoring Of European Society of Hypertension. International protocol for validation of blood pressure measuring devices in adults. Blood pressure monit 2002; 7: 3-17.
[10]. Butani L, Morgenstern BZ. Are pitfalls of oscillometric blood pressure measurements preventable in children? Pediatr Nephrol 2003; 18: 313-318.
[11]. Srivastava RN, Bagga A. Hypertension. In: Srivastava RN, Bagga A. Pediatric Nephrology, 4th ed. New Delhi: Jaypee Brothers, 2005, p.292-315.
[12]. Hari.P, Bagga A, Srivastava RN. Hypertension in children. Indian Pediatr 2000; 37: 268-274.
[13]. Croix B, Feig DI. Childhood hypertension is not a silent disease. Pediatr Nephrol 2006; 21: 527-532.
[14]. Vaughan CJ, Delanty N. Hypertensive emergencies. Lancet 2000; 356: 411- 417.
[15]. Linakis J. The assessment and management of hypertensive emergencies and urgencies in children. Pediatr Emergency Care 2005; 21:391-396.
[16]. Flynn JT, Alderman MH. Characteristics of children with primary hypertension seen at a referral centre. Pediatr Nephrol2005; 20: 961-966.
[17]. Council on Sports Medicine and Fitness and Council on School Health. Active healthy living: Prevention of childhood obesity through increased physical activity. Pediatrics 2006; 117: 1834-1842.
[18]. American Academy of Pediatrics Committee on Sports Medicine and Fitness. Athletic participation by children and adolescents who have systemic hypertension. Pediatrics 1997; 99:637-638.
[19]. Appel LJ, Brands MW, Daniels SR, Karanja N, Elmer PJ, Sacks FM. Dietary approaches to prevent and treat hypertension. A scientific statement from the American Heart Association. Hypertension 2006; 47: 296-308.
[20]. Bhave S, Bavdekar A, Otiv M, IAP National Task Force for Childhood Prevention of Adult Diseases: Childhood obesity. Indian Pediatr 2004; 41: 559-575.
[21]. Yang Y, Ohta K, Shimizu M, Nakai A, Kasahara Y, Ychie A, et al. Treatment with low dose angiotensin converting enzyme (ACE) inhibitor plus angiotesin II receptor blocker (ARB) in pediatric patients with Ig A nephropathy. Clin Nephrol 2005; 64: 35-40.
[22]. Kaplan NM, Opie L.H. Controversies in hypertension. Lancet 2006; 367: 168-176.
[23]. Hogg RJ, Fruth S, Lemley KV, Portman R, Schwartz GJ, Coresh J et al. National Kidney Foundation's Kidney Disease Outcomes Quality Initiative clinical practice guidelines for chronic kidney disease in children and adolescents: Evaluation, classification and stratification. Pediatrics 2003; 111: 1416-1421.
[24]. Fenves AZ, Ram CV. Drug treatment of hypertensive urgencies and emergencies. Semin Nephrol 2005; 25: 272-280.
[25]. Calvetta A, Martino S, Von Viger RO, schmidtko J, Fossali E, Bianchetti MG. What goes up must immediately come down! Which indication for short acting nifedipine in children with arterial hypertension? Peditr Nephrol 2003; 18: 1-2.
[26]. Yiu V, Orrbine E, Rosychuk RJ, Mac Laine P, Goodyer P, Girardin C et al. the safety and use of short acting nifedipine in hospitalized hypertensive children. Pediatr Nephrol 2004; 19: 644-650.
[27]. Hansen ML, Gunn PW, Kaelber DC. Under diagnosis of hypertension in children and adolescents. JAMA 2007; 298(8): 874-879.
[28]. M. Behjati, K.Barkhordari. The Relation between Blood Pressure and Body Mass Index in Iranian School Age Children. Iran j Med Sci 2006; 31(1): 33-36.
[29]. Wyszynska T, Cichoka E, Wieteska-Kimczak A, Januszewickz P. A single pediatric centre experience with 1025 children with hypertension. Acta Pediatr 1992; 81: 244-246.
[30]. Gill DG, Mendis DA, Costa B, Cameron JD, Joseph MC, Ogg CS, Chantler C. Analysis of 100 children with severe and persistent hypertension. Arch Dis Child 1976; 51: 951-956.
[31]. Arar MY, Hogg RJ, Arrant Jr BS, Seikaly MG. Etiology of sustained hypertension in children South Western United States.Pediatr Nephrol 1994; 8: 186-189.
[32]. Chadha SL, Tondon R, Shekhawath S, Gopinath N. An epidemiological study of blood pressure in school children (5-14 yr) in Delhi. Indian Heart J 1999; 51: 178-182.
[33]. Khalil A, Singh TP, Arora R, Puri RK. Pediatric hypertension: Clinical profile and etiology. Indian Pediatr 1991; 28: 141-146.
[34]. Brewer ED. Evaluation of hypertension in childhood diseases. In: Barratt TM, Avner ED, Harmon WE eds. Pediatric Nephrology. 4th ed. Baltimore, MD: Lippincott, Williams & Wilkins; 2004: 1179-1197.
[35]. Kay AJ, Sinako AR, Daniels SR. Pediatric hypertension. Am Heart J. 2001: 142 (3): 422-432.
[36]. Reid C, Chantler C. Systemic hypertension, London: Churchill: Livingstone: 2002; 1966 pp.
[37]. Agarwal V.K., Rajiv Sharan, Srivastava A.K., Prem Kumar Pandey C.M.1983. "Blood Pressure Profile in Children of age 3-14 years" Indian Pediatrics 20: 921-925.
[38]. Said RA, Said SM. Department of Medicine, Medical School, Jordan University, Amman. Pediatr Nephrol. Hypertension in Jordan Children. Sep.1990. 4; (5): 520-522.
[39]. Samboonnanonda A, Chongcharoensuk C, Supavekin S, Pattargarn A. Department of Pediatrics, Faculty of Medicine, Sirraj Hospital, Mahidol University, Bangkok, Thailand J Med Assoc Thai. Persistent hypertension in Thai children: etiologies and outcome. 2006 Aug; 89 Suppl 2: S28-32.
[40]. Charles Agyemang, William K Redekop, Ellis Owusu-Dabo and Mark A Brujinzeels. Blood pressure patterns in rural, semi urban, urban children in the Ashanti region of Ghana, West Africa BMC Public Health 2005, 5: 114 doi: 10. 1186/1471- 24585-114.
[41]. Jonathan Wiesen, BA, Mathew Adkins, Sherwin Fortune, Judah Horowitz, Nava Pincus, BA, Rachel Frank RN, CNN, Suzanne Vento, RN,Cathy Hoffman RN, Beatrice Goilav, MD, Howard Trachtman, MD. Evaluation of Pediatric Patients with Mild to Moderate Hypertension: Yield of Diagnostic Testing. Pediatrics Vol.122 No. 5 November 1, 2008 pp. e988-e993.
[42]. Panja M, Kumar S, Sarkar CN, Sinha DP, Ray S, Chatterjee A, Panja S, Mitra D, Kar AK, Pahari DK. Hypertension in the young in eastern India. Indian Heart J. 1996 Nov-Dec; 48(6): 663-666.

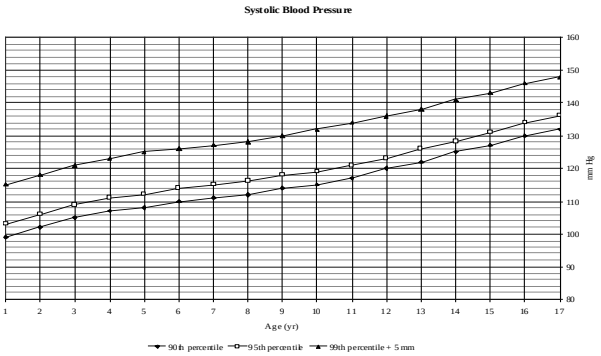
ANNEXURE

TABLE I–*Blood Pressure (BP) Levels for Boys by Age and Height Percentile*

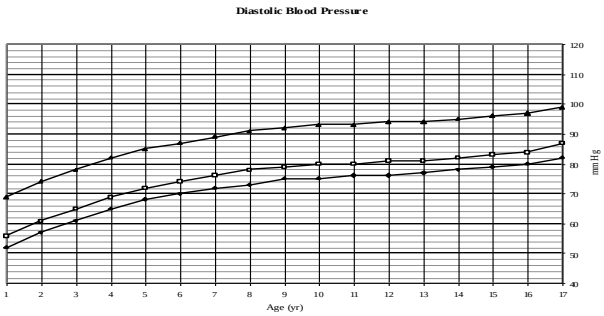
Age (yr)	BP percentile	Systolic BP (mm Hg)							Diastolic BP (mm Hg)						
		Height percentile							Height percentile						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89	34	35	36	37	38	39	39
	90th	94	95	97	99	100	102	103	49	50	51	52	53	53	54
	95th	98	99	101	103	104	106	106	54	54	55	56	57	58	58
	99th	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	50th	84	85	87	88	90	92	92	39	40	41	42	43	44	44
	90th	97	99	100	102	104	105	106	54	55	56	57	58	58	59
	95th	101	102	104	106	108	109	110	59	59	60	61	62	63	63
	99th	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	50th	86	87	89	91	93	94	95	44	44	45	46	47	48	48
	90th	100	101	103	105	107	108	109	59	59	60	61	62	63	63
	95th	104	105	107	109	110	112	113	63	63	64	65	66	67	67
	99th	111	112	114	116	118	119	120	71	71	72	73	74	75	75
4	50th	88	89	91	93	95	96	97	47	48	49	50	51	51	52
	90th	102	103	105	107	109	110	111	62	63	64	65	66	66	67
	95th	106	107	109	111	112	114	115	66	67	68	69	70	71	71
	99th	113	114	116	118	120	121	122	74	75	76	77	78	78	79
5	50th	90	91	93	95	96	98	98	50	51	52	53	54	55	55
	90th	104	105	106	108	110	111	112	65	66	67	68	69	69	70
	95th	108	109	110	112	114	115	116	69	70	71	72	73	74	74
	99th	115	116	118	120	121	123	123	77	78	79	80	81	81	82
6	50th	91	92	94	96	98	99	100	53	53	54	55	56	57	57
	90th	105	106	108	110	111	113	113	68	68	69	70	71	72	72
	95th	109	110	112	114	115	117	117	72	72	73	74	75	76	76
	99th	116	117	119	121	123	124	125	80	80	81	82	83	84	84
7.	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	90th	111	112	114	115	117	109	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90
11	50th	99	100	102	104	105	107	107	59	59	60	61	62	63	63
	90th	113	114	115	117	119	120	121	74	74	75	76	77	78	78
	95th	117	118	119	121	123	124	125	78	78	79	80	81	82	82
	99th	124	125	127	129	130	132	132	86	86	87	88	89	90	90
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	50th	106	107	109	111	113	114	115	60	61	62	63	64	65	65
	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	136	138	139	140	87	87	89	90	91	92	92
15	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

TABLE II–*Blood Pressure (BP) Levels for Girls by Age and Height Percentile*

Age (yr)	BP percentile	Systolic BP (mm Hg)							Diastolic BP (mm Hg)						
		Height percentile							Height percentile						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	90th	97	97	98	100	101	102	103	52	53	53	54	55	55	56
	95th	100	101	102	104	105	106	107	56	57	57	58	59	59	60
	99th	108	108	109	111	112	113	114	64	64	65	65	66	67	67
2	50th	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	90th	98	99	100	101	103	104	105	57	58	58	59	60	61	61
	95th	102	103	104	105	107	108	109	61	62	62	63	64	65	65
	99th	109	110	111	112	114	115	116	69	69	70	70	71	72	72
3	50th	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	90th	100	100	102	103	104	106	106	61	62	62	63	64	64	65
	95th	104	104	105	107	108	109	110	65	66	66	67	68	68	69
	99th	111	111	113	114	115	116	117	73	73	74	74	75	76	76
4	50th	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	90th	101	102	103	104	106	107	108	64	64	65	66	67	67	68
	95th	105	106	107	108	110	111	112	68	68	69	70	71	71	72
	99th	112	113	114	115	117	118	119	76	76	76	77	78	79	79
5	50th	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	90th	103	103	105	106	107	109	109	66	67	67	68	69	69	70
	95th	107	107	108	110	111	112	113	70	71	71	72	73	73	74
	99th	114	114	116	117	118	120	120	78	78	79	79	80	81	81
6	50th	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	90th	104	105	106	108	109	110	111	68	68	69	70	70	71	72
	95th	108	109	110	111	113	114	115	72	72	73	74	74	75	76
	99th	115	116	117	119	120	121	122	80	80	80	81	82	83	83
7.	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90th	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95th	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99th	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90th	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95th	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99th	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90th	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95th	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99th	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90th	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95th	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99th	123	123	125	126	127	129	129	84	84	85	86	86	87	88
11	50th	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	90th	114	114	116	117	118	119	120	74	74	74	75	76	77	77
	95th	118	118	119	121	122	123	124	78	78	78	79	80	81	81
	99th	125	125	126	128	129	130	131	85	85	86	87	87	88	89
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90
13	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	90th	117	118	119	121	122	123	124	76	76	76	77	78	79	79
	95th	121	122	123	124	126	127	128	80	80	80	81	82	83	83
	99th	128	129	130	132	133	134	135	87	87	88	89	89	90	91
14	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	90th	119	120	121	122	124	125	125	77	77	77	78	79	80	80
	95th	123	123	125	126	127	129	129	81	81	81	82	83	84	84
	99th	130	131	132	133	135	139	136	88	88	89	90	90	91	92
15	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	90th	120	121	122	123	125	126	127	78	78	78	79	80	81	81
	95th	124	125	126	127	129	130	131	82	82	82	83	84	85	85
	99th	131	132	133	134	136	137	138	89	89	90	91	91	92	93
16	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	90th	121	122	123	124	126	127	128	78	78	79	80	81	81	82
	95th	125	126	127	128	130	131	132	82	82	83	84	85	85	86
	99th	132	133	134	135	137	138	139	90	90	90	91	92	93	93
17	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	90th	122	122	123	125	126	127	128	78	79	79	80	81	81	82
	95th	125	126	127	129	130	131	132	82	83	83	84	85	85	86
	99th	133	133	134	136	137	138	139	90	90	91	91	92	93	93

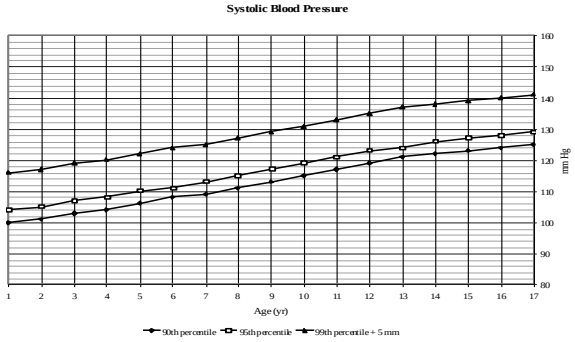


1 (a)

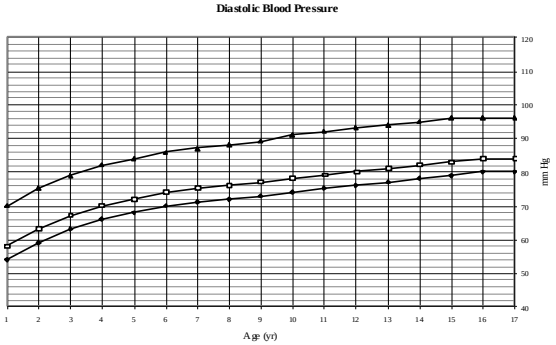


1 (b)

Fig. 1. Blood pressure levels for boys at 50th percentile for height. Chart depicting 90th (closed diamonds), 95th (open circles) and 99th + 5 mm (closed triangles) percentile values for (*a*) systolic and (*b*) diastolic blood pressures, representing cut off values for the diagnosis of pre-hypertension, stage I and stage II hypertension respectively in boys (based on reference 4).



2 (a)



2 (b)

Fig. 2. Blood pressure levels for girls at 50th percentile for height. Chart depicting 90th (closed diamonds), 95th (open circles) and 99th + 5 mm (closed triangles) percentile values for (*a*) systolic and (*b*) diastolic blood pressures, representing cut off values for the diagnosis of pre-hypertension, stage I and stage II hypertension respectively in girls (based on reference 4).