Reference values for blood pressure of healthy Sri Lankan Tamil children in the Jaffna district

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Abstract

Introduction: Increasing trend of childhood obesity leads to high blood Pressure (BP) in children and adolescents. Ethnic differences in BP have been reported. Normal BP values of Sri Lankan Tamil children are not available.

Objective: To measure BP of healthy Sri Lankan Tamil children in the Jaffna district to get normal BP values and to correlate them with anthropometric measurements.

Method: A population based descriptive cross sectional study was carried out among children and adolescents (950 boys, 972 girls) aged 6 to 18 years in schools in Jaffna district. Cluster sampling was applied to classrooms in the schools. The classes were selected by systematic random sampling. Age, height, weight, waist circumference and hip circumference were taken. Body mass index, waist hip ratio and waist height ratio were calculated. BP was measured with a mercury sphygmomanometer. Pubertal stage was assessed with a self-administered Tanner staging scale.

Results: Mean of the systolic blood pressure (SBP) and diastolic blood pressure (DBP) of boys and girls increased from 98/70 mm Hg and 99/70 mm Hg to 107/73 mm Hg and 107/73 mm Hg until 10 years, decreased slightly up to 13 years (101/64 mm Hg and 102/63 mm Hg) and increased until 18 years to 119/76 mm Hg and 111/70 mm Hg. From the age of 15 years, boys had higher SBP and DBP than girls ($p<0.05$). SBP had significant ($p<0.001$) positive correlations with pubertal staging and all measured anthropometric parameters. Highest correlation was observed with weight (0.522). A normogram for BP was constructed with age and height. Statistically significant ($p<0.05$) increases in SBP and DBP were observed from pubertal stage 3 to pubertal stage 4 in both boys and girls. Jaffna boys up to 15 years and girls up to 10 years have higher BP than Sinhalese children at a *purana* village. After these ages BP values were lower than in Sinhalese children.

Conclusion: BP of healthy Sri Lankan Tamil children in the Jaffna district has significant correlations with anthropometric measurements and Tanner staging.

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(Key words: Blood pressure, Sri Lankan Tamil children)

Introduction

High blood pressure (BP) is a powerful, constant, and independent risk factor for cardiovascular and renal diseases[1]. The definition of hypertension is based on normative distribution of BP [2]. Increasing trend of childhood obesity leads to high BP in children and adolescents[3]. Nowadays behavioural patterns of communities are changing with urbanization and industrialization leading to sedentary life styles and consumption of high fat and energy dense diets which cause obesity. Hypertension is the common childhood condition seen in obese and overweight individuals. Hereditary and environmental factors also influence body mass index (BMI) and body fat which may influence the BP[4]. The biological rationale for relating measures of central adiposity to cardiovascular disease (CVD) risk is that the abdominal adipose tissue is positively associated with waist circumference (WC) and waist–hip ratio (WHR). As the WHR increases, BP increases[5]. Further, BP is important in childhood conditions such as acute glomerular nephritis and dehydration.

Unlike the practice of measuring BP in all adult patients and advising to monitor it regularly, BP in children is measured only when there is a suspicion of alteration in BP. In such instances, interpretation of the measured BP can be of value only if reference norms for the age, sex, height and ethnicity are available. Therefore, normal values of the Jaffna population should be known to be able to diagnose hypertension among children and adolescents in this region. The only report available

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on BP values of Sri Lankan children is from a study on inhabitants of a "*purana*" village of Sri Lanka in 1991[6]. Data on the BP of healthy Sri Lankan Tamil children are not available. Mean BP values were higher in Afro-Caribbean and South Asian men than their white counterparts[7]. Among South Asians, Indians have a slightly higher BP, Pakistanis have a slightly lower BP and Bangladeshis have a much lower BP[8]. This shows that ethnic differences in BP exist.

Objectives

This study aimed at measuring BP in healthy Tamil children in Jaffna to get normal BP values and to correlate them with anthropometric measurements.

Method

This was a population based descriptive cross sectional study. Children aged 6 to 18 years were recruited from schools in Jaffna district as education is compulsory in Sri Lanka. Cluster sampling was applied to classrooms in schools of Jaffna District. Each cluster was a classroom consisting of around 30 students. Number of clusters in each grade was selected according to the percentage of total students in that grade. Classes were selected by systematic random sampling.

Ethical clearance for the study was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Jaffna. Permission was obtained from the Provincial Director of Education, each Zonal Director of Education, School Principals and Class Teachers prior to the study. Informed written consent was obtained from all parents and assent from adolescents 14 years or older. The information sheet and consent form were given to the participants on the day before data collection to get the consent from the parents.

A self-administered questionnaire, which included general information and disease history of the participant, was issued to one parent of each participant. Children with a history of diabetes and children diagnosed to have any type of CVD were excluded. Anyone who had signs and symptoms suggestive of anaemia, cardiac or renal disorders on medical examination during data collection and children having the habit of smoking and alcohol intake were also excluded.

Age was calculated in years as on the last birthday. Body height and weight were measured according to a standardized protocol to the nearest 0.1cm and 0.1kg respectively by using a portable device (Seca). BMI was calculated from measured body weight and height. WC was measured by placing the non-elastic measuring tape midway between the uppermost border of the iliac crest and lower border of costal margin while subject was standing. Measurement was taken at the end of expiration. Hip circumference (HC) was measured by placing a non-elastic tape over the widest part of the hip[9].

The procedure was explained thoroughly to the participants before recording blood pressure and sufficient time was given to allay anxiety and fear. Participants were in a sitting position with the legs uncrossed. BP was measured in right arm by the auscultatory method using a standard mercury sphygmomanometer. The cuff bladder was wide enough to cover at least 80% of the arm and long enough to encircle the arm. The cuff was inflated to at least 30mm Hg above the point at which radial pulse disappeared. The cuff was deflated at a rate of 2-3mm Hg/second. The first Korotkoff sound was taken as indicative of systolic pressure and the disappearance of the sound was the diastolic blood pressure. Three readings were taken at 5 minute intervals. As the first reading was usually higher, the average of second and third readings was considered for analysis.

Participants aged above 8 years were given the self-administered questionnaire with the Tanner staging scale which consisted of pictures of genital organs and breasts at different stages. Participants had to compare their genital organs and breasts with that on the Tanner staging scale and identify and mark the pubertal stage in the questionnaire. This was done in a confidential place separately for males and females after giving clear instructions. One investigator of the same sex was available to clear doubts regarding marking the pubertal stage.

Data analysis was done by Statistical Package for Social Science. Independent t-test was used to compare significance of difference between means. Pearson's correlation coefficient (r) was used to evaluate relationship between BP and height, weight, BMI, WC, HC, WHR and Tanner staging.

Results

There were 950 boys and 972 girls. Anthropometric measurements of the study population are summarized in Table 1.

Mean height of boys and girls of each age showed statistically significant ($p<0.05$) differences beyond 13 years of age. Differences in the mean weight of boys and girls were statistically significant ($p<0.05$) beyond 16 years of age.

Pearson correlation of height, weight, BMI, WC and HC with age were 0.931, 0.817, 0.558, 0.620 and 0.784 respectively in boys and 0.886, 0.810, 0.629, 0.625 and 0.814 respectively in girls. All these were statistically significant at $p<0.001$. Blood pressure values of boys and girls in each age group are summarised in Table 2.

Table 1: ***Anthropometric measurements of the study population***

Age (years)	n	Mean (SD)					Waist/Hip ratio
		Ht. (cm)	Wt. (kg)	BMI (kg/m^2)	WC (cm)	HC (cm)	
BOYS							
6	61	119.3 (4.9)	18.2 (2.7)	12.8 (1.2)	46.5 (4.6)	55.3 (3.9)	0.84 (0.05)
7	79	123.7 (5.6)	20.6 (4.5)	13.3 (2.1)	48.6 (6.0)	57.7 (6.1)	0.84 (0.05)
8	75	129.5 (3.9)	23.6 (5.2)	14.2 (2.7)	50.5 (5.9)	60.8 (5.7)	0.83 (0.05)
9	81	132.1 (4.8)	25.3 (6.0)	14.4 (2.5)	52.2 (7.0)	62.3 (6.6)	0.84 (0.05)
10	71	135.1 (5.0)	27.0 (6.9)	14.7 (2.9)	52.7 (8.1)	63.8 (7.2)	0.82 (0.05)
11	76	141.4 (7.3)	32.6 (9.4)	16.1 (3.9)	58.9 (11.8)	68.7 (9.3)	0.85 (0.06)
12	76	145.3 (7.7)	34.9 (9.6)	16.2 (3.3)	59.5 (9.9)	70.4 (8.4)	0.84 (0.07)
13	76	151.4 (8.2)	38.5 (8.1)	16.7 (2.7)	62.2 (8.5)	73.8 (7.3)	0.84 (0.06)
14	72	157.6 (8.6)	43.5 (10.8)	17.2 (2.8)	63.7 (9.5)	76.7 (9.0)	0.83 (0.06)
15	92	163.6 (6.8)	47.6 (10.0)	17.7 (2.9)	64.6 (8.3)	79.0 (7.6)	0.81 (0.06)
16	84	166.5 (6.9)	50.6 (11.3)	18.1 (3.6)	65.8 (9.8)	80.8 (7.9)	0.81 (0.06)
17	56	169.0 (6.9)	55.1 (11.7)	19.2 (3.4)	66.1 (10.2)	84.2 (7.9)	0.78 (0.07)
18	51	171.4 (6.1)	56.9 (8.8)	19.4 (3.1)	67.4 (7.8)	84.7 (6.8)	0.80 (0.06)
GIRLS							
6	63	120.1 (4.8)	18.7 (3.2)	12.9 (1.6)	49.2 (7.4)	57.1 (4.2)	0.84 (0.06)
7	75	123.9 (4.6)	20.4 (3.8)	13.2 (1.9)	49.8 (5.1)	59.1 (4.9)	0.84 (0.05)
8	79	128.1 (4.6)	22.9 (5.8)	13.9 (2.7)	52.3 (6.1)	61.7 (6.3)	0.85 (0.04)
9	79	132.5 (4.9)	26.0 (6.0)	14.7 (2.5)	53.7 (7.0)	63.9 (6.4)	0.84 (0.05)
10	77	136.4 (6.6)	28.0 (5.5)	15.0 (1.9)	54.8 (5.6)	66.5 (5.6)	0.82 (0.04)
11	83	141.4 (7.1)	32.2 (7.0)	16.0 (2.5)	57.5 (6.4)	69.6 (6.9)	0.83 (0.04)
12	72	148.2 (7.5)	37.7 (10.3)	17.0 (3.7)	60.1 (9.1)	74.4 (8.6)	0.81 (0.05)
13	78	151.2 (7.2)	38.9 (7.7)	17.0 (2.5)	60.2 (6.3)	75.1 (6.5)	0.80 (0.05)
14	84	154.2 (6.3)	43.5 (9.4)	18.1 (3.4)	62.8 (7.7)	79.5 (7.6)	0.79 (0.04)
15	99	155.9 (6.4)	45.1 (8.1)	18.6 (3.1)	64.0 (7.7)	82.1 (7.2)	0.78 (0.05)
16	77	157.9 (5.7)	48.6 (7.9)	19.6 (2.7)	65.1 (6.3)	84.4 (6.5)	0.77 (0.04)
17	60	156.9 (6.1)	46.9 (8.3)	19.0 (2.8)	65.9 (8.8)	83.3 (6.5)	0.79 (0.06)
18	46	158.8 (5.3)	50.0 (8.6)	19.8 (3.2)	66.3 (7.5)	86.0 (7.4)	0.77 (0.05)

Ht. – height, Wt. – weight, BMI - body mass index, WC - waist circumference, HC - hip circumference, SD – standard deviation, n - number

Table 2: ***Blood pressure values of boys and girls in each age group***

Age (years)	n	BOYS		n	GIRLS		*p* SBP	*p* DBP
		Mean (SD)			Mean (SD)			
		SBP (mm Hg)	DBP (mm Hg)		SBP (mm Hg)	DBP (mm Hg)		
6	61	98 (8)	70 (9)	63	99 (9)	70 (9)	0.632	0.451
7	79	101 (8)	72 (8)	75	102 (10)	69 (8)	0.540	0.069
8	75	105 (9)	70 (10)	79	103 (9)	73 (9)	0.125	0.018
9	81	105 (9)	71 (7)	79	107 (9)	75 (8)	0.122	0.009
10	71	107 (11)	73 (9)	77	107 (10)	73 (9)	0.986	0.906
11	76	106 (11)	70 (10)	83	105 (12)	69 (9)	0.723	0.607
12	76	104 (13)	67 (10)	72	103 (10)	66 (11)	0.794	0.313
13	76	101 (10)	64 (9)	78	102 (9)	63 (10)	0.712	0.258
14	72	108 (12)	67 (10)	84	106 (9)	68 (9)	0.230	0.789
15	92	114 (12)	70 (12)	99	105 (9)	67 (10)	0.000	0.015
16	84	112 (11)	69 (9)	77	108 (9)	68 (8)	0.015	0.701
17	56	113 (11)	69 (8)	60	109 (10)	67 (9)	0.093	0.170
18	51	119 (12)	76 (11)	46	111 (11)	70 (7)	0.002	0.002

SBP- systolic blood pressure, DBP – diastolic blood pressure, SD – standard deviation, n - number

When the mean difference between each age of the same sex was analysed, in boys, an increase in SBP (2.25 mm Hg/year) was observed until the age of 10 years. However, this increase was statistically significant (p<0.05) from 6 to 7 and 7 to 8 year age groups. From 10 years of age SBP reduced (2 mm Hg/year) until the age of 13 years, but this reduction from one age group to the next was not statistically significant. From 13 years onwards SBP increased 6.5 mm Hg/year up to 15 year age group. After this statistically significant (p<0.05) increase (6 mm Hg) was observed between 17 and 18 year age groups. DBP showed

a statistically significant (p<0.05) increase from 13-14 years and from 17-18 years.

In girls the mean SBP increased (2 mm Hg/year) until 10 years and then it decreased (1.66 mm Hg/year) until 13 years of age and increased by 1.8 mm Hg/year) thereafter. But this increase from one age to the next is statistically significant (p<0.05) in 8 to 9 year age groups and 13 to 14 year age groups only. The DBP showed a statistically significant (p<0.05) increase from one age to the next in 7 to 8 years and 13 to 14 years. However, from 6 to 10 years of age DBP increases and then there is a reduction until 13 years of age and DBP increases again until 18 years of age. Similar variation in DBP was observed in both boys and girls.

From the age of 15 years, boys had observably higher SBP than girls of the same age which was statistically significant (p<0.05). Considering the DBP, girls in the ages of 8 to 9 years had significantly higher values than boys of the same age.

When the difference between mean DBP of each age group of boys was analysed, statistically significant (p<0.05) increase in DBP was observed from 13 to 14 year and from 17 to 18 years. In girls, statistically significant (p<0.05) increase from one age to the next is observed in 7 to 8 years and 13 to 14 years of age groups. However, from 6 to 10 years of age DBP increases and then there is a reduction until 13 years of age and increases again until 18 years of age. This pattern was observed in both boys and girls.

Pearson correlation between anthropometric measurements and BP are summarised in Table 3.

Table 3: ***Correlation coefficient (r) of BP with anthropometric measurements***

Anthropometric measurements	BOYS		GIRLS	
	SBP	DBP	SBP	DBP
Age	0.382*	-0.011	0.208*	-0.167*
Height	0.461*	0.042	0.277*	-0.107*
Weight	0.522*	0.134*	0.351*	-0.034
BMI	0.462*	0.174*	0.356*	0.037
Waist circumference	0.460*	0.114*	0.334*	0.036
Hip circumference	0.513*	0.125*	0.334*	-0.018

** indicates p<0.001*

Statistically significant (p<0.001) positive correlations of SBP were observed with age, height, weight, BMI, WC and HC of both boys and girls. In boys, DBP had a significant small positive correlation with weight, BMI, WC and HC, whereas in girls DBP had a statistically significant small negative correlation with age and height.

Stepwise regression analysis was done to derive prediction equations for SBP and DBP based on age, height (H), weight (W), and BMI.
SBP (male) =0.201 H+0.408 W-1.06 age+75.54 R^2= 0.281, SEE = $\pm$10.11
SBP (female) = 0.943 BMI+ 0.209 H- 0.75 age+ 68.454 R^2= 0.143, SEE =$\pm$ 9.37
DBP (male) = 0.28 W-1.08 age+71.637 R^2= 0.058, SEE =$\pm$ 9.45
DBP (female) = 0.641 BMI- 0.852 age + 68.6 R^2= 0.06, SEE = $\pm$ 9.25

As can be seen, the regression analysis of the entire data seems to be unreliable because of the very low value of R^2. This may be due to the variation of blood pressure of different age groups.

A normogram was constructed with age and height to keep in line with the current practice of diagnosing hypertension in children and adolescents using the data of each age group separately. However, the present study showed better correlation between BP and body weight than with height.

Height percentile values (25^{th}, 50^{th}, 75^{th}) of each age group are summarised in Table 4.

The 50^{th}, 90^{th}, 95^{th} values of both SBP and DBP were analysed according to height percentiles (25^{th}, 50^{th}, 75^{th}) of each age group and summarised in Table 5. Both 90^{th} and 95^{th} percentiles of BP were derived as the definitions for hypertension and pre-hypertension are based on those percentiles respectively.

Tanner scale staging was analysed and summarised in Table 6.

Table 4: ***Percentile values of height according to age***

Age	No	BOYS Height (cm) percentile			No	GIRLS Height (cm) percentile		
		25th	50th	75th		25th	50th	75th
6	61	115.8	119	123	63	116.5	120	124
7	79	119.5	124	128	75	121	124	127.5
8	75	127	130	131.5	79	125	128	130.5
9	81	130	131.5	135.5	79	130	131.5	135
10	71	131.5	134	138	77	131.5	136	140.3
11	76	136.2	140.3	146.5	83	136	142	146
12	76	141.6	145.3	149.4	72	143	148.5	153.4
13	76	144.6	150.3	157.75	78	146.9	152	156.1
14	72	151	159.3	164	84	151.5	154.8	159
15	92	159	163.3	167.9	99	151.5	155	160.5
16	84	162	166.9	171	77	153.8	158.5	162
17	56	165.6	168.8	173.8	60	153	157.5	161.5
18	51	167.5	172	175	46	154.9	158.3	162.6

Table 5: ***Reference values of blood pressure according to age and height***

Age (years)	BP centile	Boys						Girls					
		Systolic BP Height percentile			Diastolic BP Height percentile			Systolic BP Height percentile			Diastolic BP Height percentile		
		25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
6	50th	95	99	101	69	71	77	95	99	102	70	68	73
	90th	110	110	112	80	82	82	112	112	117	80	81	83
	95th	114	114	116	82	84	85	118	117	119	82	83	85
7	50th	98	101	102	70	73	72	99	102	104	66	70	74
	90th	109	109	115	80	82	81	106	116	122	74	81	82
	95th	113	113	118	84	84	85	111	118	132	77	92	86
8	50th	103	104	107	70	66	70	100	101	108	74	73	75
	90th	114	115	127	79	85	84	109	116	118	85	86	86
	95th	116	124	128	87	88	92	112	120	131	86	92	86
9	50th	101	105	108	72	72	71	102	110	113	72	73	82
	90th	114	115	125	81	81	81	113	122	128	81	85	88
	95th	119	123	126	83	82	83	115	124	130	83	87	90
10	50th	103	106	112	76	72	73	107	104	111	70	71	76
	90th	119	122	127	83	84	89	121	120	126	82	83	90
	95th	122	123	132	89	86	93	122	130	134	86	93	96
11	50th	104	103	112	66	73	74	96	106	107	68	70	67
	90th	116	118	125	78	80	82	120	122	128	80	82	84
	95th	121	125	126	80	83	85	129	126	134	82	84	90
12	50th	100	102	111	67	66	68	99	99	113	65	66	71
	90th	119	117	129	75	80	88	104	116	118	73	81	81
	95th	120	130	140	78	89	90	110	118	125	73	81	90
13	50th	95	101	109	62	65	65	100	102	102	62	62	66
	90th	110	115	116	76	76	76	108	117	118	69	79	79
	95th	111	120	121	77	80	80	113	130	123	77	81	86
14	50th	97	109	115	65	68	69	105	105	111	70	70	74
	90th	115	126	132	79	77	90	115	119	119	79	75	82
	95th	122	131	135	80	79	90	117	124	126	80	80	83
15	50th	105	114	120	68	70	73	102	105	107	68	67	67
	90th	128	130	136	82	86	94	116	119	122	78	80	81
	95th	130	130	145	85	90	104	122	127	127	84	83	83
16	50th	107	112	121	63	71	70	103	110	107	65	70	68
	90th	121	122	142	76	82	84	116	119	124	72	80	84
	95th	124	128	144	82	84	90	119	127	133	75	82	89
17	50th	109	110	119	69	68	72	104	109	108	67	66	70
	90th	126	132	134	81	79	87	121	124	126	83	78	82
	95th	134	138	139	82	83	88	127	126	127	87	84	85
18	50th	116	115	123	75	75	76	105	112	115	69	71	71
	90th	134	140	140	89	91	98	122	128	135	78	79	80
	95th	135	142	141	94	104	100	123	130	136	80	81	83

Table 6: ***Mean age, height and blood pressure according to Tanner scale***

Stages	Boys							
	Pubic hair				Penile development			
	No.	Age (SD)	SBP	DBP	No.	Age (SD)	SBP	DBP
Stage 1	275	10.8 (1.5)	106 (10)	69 (10)	173	10.7 (2.0)	106 (11)	71 (9)
Stage 2	90	12.6 (1.8)	103 (12)	68 (10)	166	11.7 (1.7)	107 (12)	69 (10)
Stage 3	106	13.5 (1.8)	106 (13)	67 (9)	147	13.6 (2.0)	105 (13)	66 (11)
Stage 4	216	16.0 (1.3)	114 (12)	71 (10)	177	15.7 (1.6)	113 (12)	71 (10)
Stage 5	53	16.5 (1.3)	115 (11)	69 (10)	77	16.4 (1.1)	113 (10)	69 (9)
Stages	**Girls**							
	Pubic hair				**Breast development**			
	No.	**Age (SD)**	**SBP**	**DBP**	**No.**	**Age (SD)**	**SBP**	**DBP**
Stage 1	136	9.8 (1.1)	106 (10)	73 (9)	99	9.8 (1.1)	104 (11)	71 (8)
Stage 2	135	11.1 (1.2)	104 (11)	69 (10)	115	10.5 (1.2)	106 (11)	74 (10)
Stage 3	97	12.9 (1.5)	104 (10)	64 (11)	118	12.2 (1.6)	105 (10)	65 (10)
Stage 4	256	15.0 (1.6)	107 (10)	68 (10)	320	14.9 (1.8)	106 (9)	67 (10)
Stage 5	131	15.9 (1.6)	108 (10)	68 (8)	103	15.9 (1.5)	111 (10)	68 (8)

Based on the pubic hair stage, the SBP of boys decreases from stage 1 to stage 2 and thereafter increases from stage 3 until stage 5. Tanner staging based on penile development shows that there is 1 mm Hg increase in SBP from stage 1 to stage 2, 2 mm Hg reduction from stage 2 to stage 3 and then there is 8 mm Hg increase from stage 3 to stage 4. However, statistical significance ($p<0.05$) was observed only between stage 3 and stage 4. In girls, there is a reduction of BP from stage 1 to stage 2 according to pubic hair stage, but, in contrast, breast developmental stage shows an increase in BP from stage 1 to stage 2. Statistical significance ($p<0.05$) in SBP was observed only from stage 3 to stage 4 based on breast development stage. In both boys and girls, there was a reduction in DBP from stage 1 to stage 3 and then it increased in stage 4. However, these differences were not statistically significant.

Statistically significant correlations were observed between SBP and Tanner staging by pubic hair (0.337) and penile developments (0.287) in boys. In girls SBP had correlations ($p<0.05$) of 0.173, 0.214 with pubic hair and breast development. Respective correlations ($p<0.05$) with DBP were -0.168, -0.186.

Discussion

In this study population, mean BP increases from 6 to 10 years of age and then there is a reduction until 13 years followed by an increase up to the age of 18 years. A similar pattern can be noticed in the SBP and DBP of both boys and girls. A study done in Madhya Pradesh, India showed a continuous increase in SBP from 7 to 14 years of age[10]. Children from Calcutta, India showed a different pattern[11]. In boys, there was a decrease in SBP from 6 to 9 years and then a gradual increase whilst in girls SBP gradually increased with drops in 7 and 10 years[11]. This variation in SBP among children from Calcutta and Jaffna suggests that there may be some factor influencing SBP during these ages. This could be due to pubertal or environmental factors. There is no documented reason for this fluctuation in BP. There is a coincidental factor affecting children of 9-10 years in Sri Lanka because they have to sit for a highly competitive scholarship examination which determines grade 6 admission in many schools. Intense coaching for this examination starts even when they are in grade 5. This factor was not anticipated at the time of planning the study. Another study may be needed to see whether the stress of this examination affects the BP.

When the mean SBP was compared with that of Indian children from two studies[10,11], it is seen that up to the age of 11 years, SBP was higher in the present population than in Indian children. However, from 12 years of age, the SBP of Sri Lankan Tamil children was lower than that of the Indian children. This was observed in both boys and girls. DBP was higher in Sri Lankan boys than in Indian boys. However, after 10 years of age, DBP was lower in the present study than in the children from Calcutta. In girls, DBP was lower in the present study after 12 years of age than in the children of both Indian studies. These observations appear to confirm the ethnic differences in BP.

Mean SBP and DBP of Sinhalese boys of the 6-10 year age group at a *purana* village were 93.5±2.1 mmHg and 62.3±1.5mmHg[6]. When we calculated the respective means, they were 103.5±9.4 and 71.1±8.8 mmHg respectively. Similarly, mean SBP and DBP of Sinhalese boys of 11-15 year age group at a *purana* village were 96.7±1.8mmHg and 63.8±2.2mmHg[6]. In the current study the mean values of boys were 107.0±12.6mmHg and 67.8±10.2mmHg respectively. Girls of the 6-10 year age group at a *purana* village had mean SBP and DBP of 97.7±2.3mmHg and 64.7±1.9mmHg respectively[6]. In the current study the values were 103.8±9.7mmHg and 72.1±8.8mmHg. Similarly, mean SBP and DBP of Sinhalese girls of 11-15 year age group were 110.4±3.8mmHg and 72.1±2.9mmHg. The present values were 104.4±10 mmHg and 66.6±10mmHg respectively. This shows that Jaffna boys up to 15 years and girls up to 10 years have higher BP than Sinhalese children at a *purana* village. After these ages, both SBP and DBP of the current study population were lower than Sinhalese children. In the study at a *purana* village, BP was recorded only once and DBP was recorded at muffling of sounds. These two factors may explain the higher values than the present study although the life style and food habits of the *purana* villagers would also have affected the BP.

Statistically significant increase in SBP and DBP observed in boys in the ages of 13 to 15 years coincides with the higher rate of somatic growth (6cm/year) during this age. But in girls statistically significant increase was observed only in 13-14 years. This observation agrees with the findings of Wanzu *et al*[12] who reported that the BP increases in puberty more in males than females. Observably higher BP in boys than the girls of same age after 15 years old suggests that boys attain puberty during this stage which influences the BP of boys. Higher DBP in girls than the boys in the ages of 7 to 9 years also may be due to influence of pre-pubertal factors. Increase in BP from stage 3 of Tanner staging scale to stage 4 shows that the puberty influences the BP.

This study was done in a large number of healthy children and adolescents. There is no previously published data of BP values available for healthy Tamil children in Sri Lanka. The Normogram developed can be used in clinical practice.

Conclusions

BP of healthy Sri Lankan Tamil children in the Jaffna district has significant correlations with anthropometric measurements and Tanner staging.

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