ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 17, Issue 3, 2024

Online - 2455-3891
Print - 0974-2441

Research Article

A STUDY ON THE PREVALENCE OF PREHYPERTENSION AMONG ADOLESCENTS IN TIRUNELVELI TOWN TAMILNADU

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Received: 06 September 2023, Revised and Accepted: 20 October 2023

ABSTRACT

Objective: The prevalence of hypertensive disease among adolescents is increasing trend. This rise in hypertension (HTN) among adolescents is multifactorial. Prehypertension advances to HTN in due course in adult life, becoming one of the major risk factors for cardiovascular diseases later. We aim to determine the prevalence of prehypertension among adolescents in Tirunelveli town.

Methods: One thousand high school children aged 14–18 years from Tirunelveli city were chosen. The blood pressures (BPs) (systolic and diastolic) were recorded using the standard technique. Physical biometrics was documented.

Results: BP >90th percentile is considered to be abnormal in adolescents. Prevalence of prehypertension is 0.7% (f-0%, m-0.7%), HTN is 4.7% (f-2.5%, m-2.2%), and cumulative abnormal BP is 5.4%. Among the 54 adolescents, only one had body mass index of overweight category surprisingly.

Conclusion: Previous studies indicate approximately 3–4% of adolescents develop consistently elevated BP across many countries. The common causes attributed are physical inactivity, consumption of junk food, besides hormonal changes in adolescents. The results of our study indicate 5.4% of students having more than the 90th percentile nearly corresponds to results of many studies. Early detection of prehypertension in adolescents is cost-effective measure that would further avoid impoverishment to the middle-income group as well as improve the quality and expectancy of life. Effective specific school health programs are needed at the time, especially in developing countries like India.

Keywords: Prehypertension, Adolescent, Hypertension, Body mass index.

 DOI: http://dx.doi.org/10.22159/ajpcr.2024v17i3.49385. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Hypertension (HTN) is the leading cause of morbidity and mortality as well as premature death. The number of people affected by HTN globally was over 1 billion [1]. Prehypertension, HTN accounts for nearly 85 lakh deaths worldwide indirectly through causing cerebrovascular accidents, ischemic cardiac disease, and renal diseases [2,3]. Since HTN stands as one of the risk factors for cardiovascular diseases (CVDs) [4] unhealthy diet, lack of physical activity, tobacco use, obesity, abnormal blood lipid profile, elevated blood glucose, and stress. Long-term exposure to these factors leads to the progression toward the development of atherosclerosis, myocardial infarction, and stroke. In general, CVD risk factors are considered for the overall risk factor profile as suggested by the World Health Organization (WHO) HEARTS package [5]. "HTN affects one in three adults worldwide" as per a report from the news report of the WHO [6]. In 2021 HTN was the primary cause of nearly 6.9 lakhs of reported deaths in the United States of America (USA) as per a report from the Centre for Disease Control and Prevention government of USA [7]. Prehypertension is the stage known to occur earlier than HTN concomitant with atherosclerosis and target organ damage [8]. Life expectancy tends to decrease with prehypertension in adolescents, further compared to persons with HTN diagnosed at a late stage [9]. High blood pressure (BP) has been attributed to left ventricular hypertrophy detected even in children, referred to as target organ damage. It imposes a considerable financial burden sometimes catastrophic expenditure of nearly 40% of their annual income to especially low and middle-income groups of the population done in a study in Mumbai, India [10].

As a systematic analysis showed, 31.3% of adults in the world had HTN in 2010. Levels of BP have been observed to track over time, and children with elevated BP (EBP) are more likely to become hypertensive adults. It is well understood that HTN in children could be considered merely a public health issue emerging in the last few decades as per available literature and studies. Identifying and treating such a high-risk group of prehypertension at an early stage would elude this impoverishment. Detection at an early age can avert a reduction of life expectancy in untreated conditions. Recording the BP once a year with the anthropometric parameters in adolescents may be recommended for early detection strategies as mentioned above. Adults diagnosed with HTN were found to have increased BP [11].

HTN is defined simply in adults as EBP (>120–129 mmHg systolic and <80 mmHg diastolic) or HTN (≥130 mmHg systolic and ≥80 mmHg diastolic). The 2004 4th report submitted by the National Heart Lung Blood Institute (NHLBI) of USA (4th R) defines abnormal BP as ≥90th percentile (for age, height, and gender [AGH]), prehypertension as ≥90th percentile but <95th percentile (AGH), and HTN as ≥ 95th percentile (AGH) at 3 separate visits. In adolescents, HTN is often undetected because they are generally healthy and seldom visit a physician unless there is an obvious illness. For this reason, routine measurement of BP among children and adolescents is recommended. Detecting adolescents with prehypertension and HTN would aid early treatment. Studies in recent times have demonstrated that the level and trend in BP vary from population to population. In fact, among children and adolescents, growth patterns, age, and gender strongly influence BP levels. Equally, sociodemographic factors, overweight, and obesity in children have been associated with high BP [12]. Our study aims to determine the prevalence of prehypertension among adolescents in Tirunelveli district.

METHODS

This study is a cross-sectional study, involving 1000 adolescents from secondary schools around the area of Tirunelveli town. Subjects were selected by a multi-stage sampling method. Ethical clearance was obtained from the Institutional Ethics Committee. Healthy subjects were selected, while those with a history of wheezing, kidney diseases, or on medication for some other illness were excluded. Using pre-test questionnaire demographic and anthropometric parameters were documented. Using age-specified international cutoff values for defining obesity and overweight were classified [13]. American Heart Association recommendations were followed to record BP with a mercury sphygmomanometer [14]. The first Koratkof sound was taken as systolic and the fifth sound as diastolic BP [15]. An average of three readings was recorded in the datasheet. Prehypertension and HTN classification was done with a recommendation by the 7th report NHLBI of USA as mentioned above [16]. Those who were found to have high BP at the first visit were reviewed in the same venue after a week interval and followed the same procedure for staging as high BP classification. Analysis of the package was done with SPSS version 15.0. Unpaired Student's t-test was carried out to compare BP and other numeric variables.

RESULTS

The distribution of the study group is shown in Table 1, Figs. 1 and 2. The percentage of males and females is around 52.70% and 47.30%, respectively. The height, weight, and body mass index (BMI) were compared against systolic BP (SBP), and diastolic BP (DBP) in mean value (Tables 2–5), in various intervals of groups. Most of the subject's BMI falls under normal values and only 5% of the subject's BMI is increased which is around 25–30. SBP is measured for all the subjects. More than the 90th percentile is taken as pre-hypertension; among 1000 subjects 54 adolescents had raised SBP above 90th percentile. The percentage is around 5.40% (Tables 1 and 6 and Figs. 1 and 2). The prevalence of prehypertension and HTN was shown in the table below, respectively, 0.7% and 4.7% cumulatively 5.4% was reported with 1000 participants in this study. Similarly, for the same subjects, the DBP is also raised above the 90th percentile (Table 7). "The National Family Health Survey reports have so far used the adult cut-offs for nutritional assessment for this age group; that is, those with a BMI <18.5 kg/m^2 are thin; BMI 25–29.9 kg/m^2 are overweight and those with a BMI 30 kg/m^2 are considered obese [17-19]".

Among various ranges of height, males 136–140 cm have more increase in SBP than others (Table 8 and Fig. 3).

Table 1: Frequency distribution of normal BP and high SBP and DBP

SBP	Frequency	Percentage
<120	946	94.60
>120	54	5.40
Grand total	1000	100.00
DIA BP		
<80	946	94.60
>80	54	5.40
Grand total	1000	100.00

BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 2: Mean value of systolic and diastolic blood pressure in both gender

Participants	The mean value of systolic blood pressures	The mean value of diastolic blood pressure
Female n=473	100.34	68.58
Male n=527	100.69	67.62
Grand total n=1000	100.53	68.08

Among various ranges of weight in females range of 40–45 kg occurred a high proportion of increased SBP followed by more than 45–55 kg while in male participants, the proportion of high SBP was trendy until it reached maximum in the range 50–55 kg (Table 9 and Fig. 4).

In females, the BMI range of 20–25 got more proportion of increased SBP, while male participants' BMI of more than 25 had a maximum proportion of increased SBP compared to others (Table 10 and Fig. 5). The DBP changes also follows same pattern as above (Fig. 7), although Mean value of SBP, DBP considering only gender failed to show much difference (Fig. 6).

The mean value of SBP and DBP seem to have a lower number in the extreme height range, especially beyond 161 centimeters in both genders (Table 3). The same pattern has also been noticed in the mean value of SBP about weight ranges in both extremes in the female gender while in the male gender, no changes occur in extreme weight range value (Table 4).

For unknown reasons, females with overweight BMI were found to have lower mean SBP compared to other ranges of BMI of female participants as well as in male participants (Table 5).

DISCUSSION

The prevalence of pre HTN is 0.7% (F-0%, M-0.7%) and HTN 4.7% (F-2.5%, M-2.2%) in our study. The prevalence of HTN is similar to

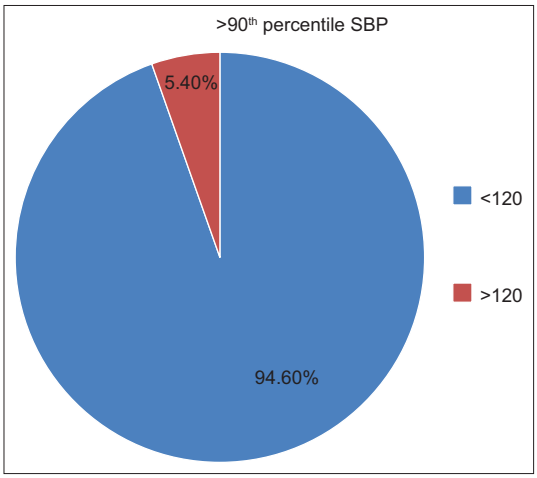

Fig. 1: Percentage distribution of normal and abnormal systolic blood pressure

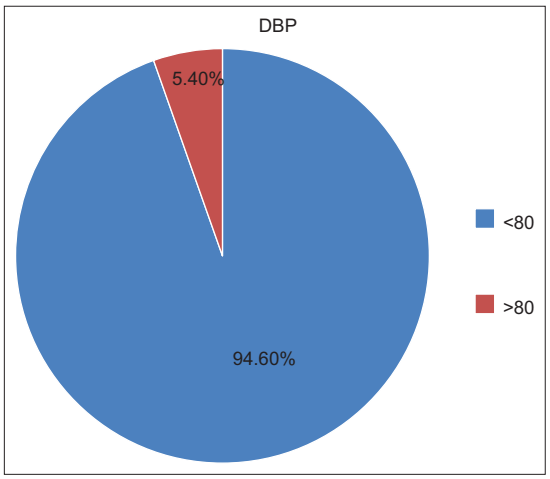

Fig. 2: Percentage distribution of normal and abnormal diastolic blood pressure

Table 3: Mean value of SBP and dBP with standard deviation in various range of heights and gender

Height (cm)	Frequency	The mean value of SBP±SD	The mean value of DBP±SD
Female n=473	473		
131–135	3	97.33±4.62	67.33±6.11
136–140	4	99.50±5.26	68.00±5.42
141–145	106	100.94±9.93	69.66±6.25
146–150	153	100.48±8.58	68.30±6.29
151–155	75	100.83±8.94	68.67±6.64
156–160	98	99.55±8.51	67.76±6.09
161–165	34	99.41±6.99	68.88±5.87
Male n=527	527		
131–135	27	100.89±9.55	67.41±4.53
136–140	10	102.80±14.91	70.40±9.56
141–145	84	100.02±9.62	67.17±5.14
146–150	118	100.53±8.74	67.76±5.82
151–155	116	101.53±10.51	67.71±6.77
156–160	126	101.54±9.31	68.00±6.36
161–165	46	97.30±5.7	66.35±5.65
Grand total	1000	100.53±9.13	68.08±6.18

BP: Blood pressure, SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 4: Mean value of SBP and DBP with standard deviation in various ranges of weight and gender

Weight (kg)	Frequency	The mean value of SBP±SD	The mean value of DBP±SD
Female n=473	**473**		
25–30	51	98.59±4.01	67.73±4.96
30–35	72	98.22±4.46	68.06±4.38
35–40	133	100.60±8.82	67.86±6.38
40–45	91	102.51±11.42	70.07±7.22
45–50	99	100.53±9.90	68.87±6.82
50–55	25	100.72±7.98	69.36±6.16
55–60	2	92.00±0.00	66.00±0.00
Male n=527	**527**		
25–30	63	100.35±8.47	67.24±4.49
30–35	68	100.24±9.25	66.94±6.48
35–40	147	100.98±9.96	68.00±6.18
40–45	151	101.11±9.44	67.31±5.61
45–50	78	99.79±9.11	68.38±7.19
50–55	18	101.67±11.46	68.11±7.59
55–60	2	100±0	64±2.83
Grand total	**1000**	100.53±9.13	68.08±6.18

BP: Blood pressure, SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 5: Mean value of SBP and DBP with standard deviation in various ranges of BMI and gender

BMI	Frequency	The mean value of SBP±SD	The mean value of DBP±SD
Female n=473			
10–15	76	98.13±4.69	67.50±4.63
15–20	314	100.22±8.50	68.20±6.17
20–25	81	103.09±11.73	71.14±7.31
25–30	2	92.00±0.00	66.00±0.00
Male n=527			
10–15	112	100.13±8.39	67.21±4.51
15–20	343	100.60±9.30	67.48±6.09
20–25	69	101.65±11.13	68.81±7.70
25–30	3	110.00±17.32	71.33±12.86
Grand Total	1000	100.53±9.13	68.08±6.18

BP: Blood pressure, SD: Standard deviation, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

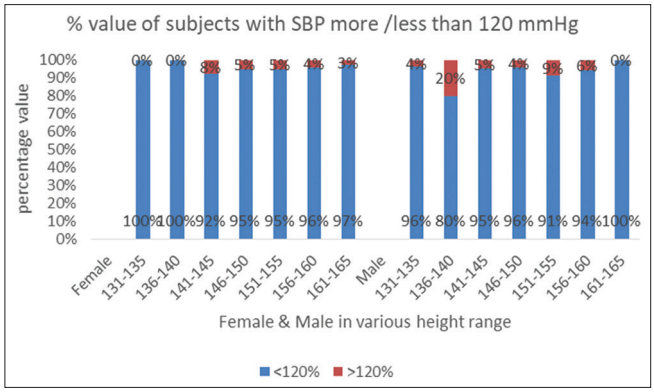

Fig. 3: Percentage distribution of normal and high systolic blood pressures concerning various ranges of height in both gender

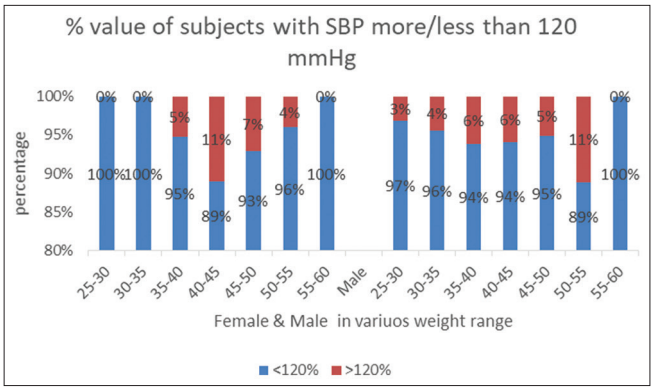

Fig. 4: Percentage distribution of normal and high systolic blood pressures concerning various ranges of weight in both gender

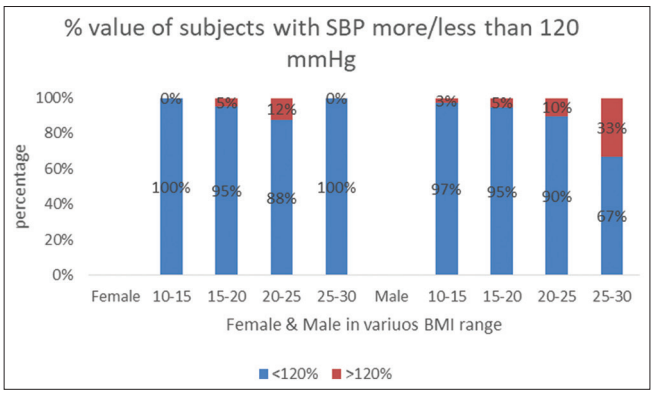

Fig. 5: Percentage distribution of normal and high systolic blood pressures concerning various ranges of body mass index in both gender

the study results of Ujunwa *et al.* [20] like 5.4% of HTN and 17.3% Pre HTN. The same study showed a higher prevalence in females (6.9%) when compared to males (3.8%). Our study showed a minor difference in the prevalence of HTN in gender (Table 6) and 0% in pre HTN in females. A study by Ejike *et al.* [21] reported higher DBP in nonurban male adolescents compared to their urban counterparts, with association to higher BMI as attribution, though significant only in female participants. The difference in prevalence rates may be due to changing methodologies, varying criteria for diagnosis of HTN and geographic factors. The above studies suggest that the detection of HTN in adolescents is evident across many countries. The necessity of screening a healthy population seems evident in reports across countries. Early detection makes early treatment possible to achieve the ultimate goal of preventing target organ damage thereby. The

Table 6: Prevalence of prehypertension and hypertensionwith BMI factor

BP	BMI	Frequency
Prehypertension		7 (0.7%) F (0%), M (0.7%)
120–129 mmHg (SBP)	10–15	1
	15–20	2
	20–25	4
Hypertension		47 (4.7%) F (2.5%), M (2.2%)
130–140 mmHg (SBP)	10–15	2
	15–20	31
	20–25	13
	25–30	1
Grand total		54 (5.4%)
Hypertension	BMI	Frequency
80–90 mmHg DBP	10–15	3
	15–20	33
	20–25	17
	25–30	1
Grand total		54

BP: Blood pressure, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 7: Normal and abnormal DBP and their ratio distribution with BMI range

BMI range	DBP<80 mmHg	DBP>80 mmHg	DBP<80 mmHg (%)	DBP>80 mmHg (%)
Female	448	25	95	5
10–15	76	0	100	0
15–20	299	15	95	5
20–25	71	10	88	12
25–30	2	0	100	0
Male	498	29	94	6
10–15	109	3	97	3
15–20	325	18	95	5
20–25	62	7	90	10
25–30	2	1	67	33
Grand total	946	54	95	5

BMI: Body mass index, DBP: Diastolic blood pressure

Table 8: Distribution of normal blood pressure and high systolic blood pressure; their percentage ratio concerning various ranges of height in both gender

Height (cm)	<120 mmHg	>120 mmHg	<120 mmHg (%)	>120 mmHg (%)
Female	448	25	94.71	5.29
131–135	3	0	100.00	0.00
136–140	4	0	100.00	0.00
141–145	98	8	92.45	7.55
146–150	145	8	94.77	5.23
151–155	71	4	94.67	5.33
156–160	94	4	95.92	4.08
161–165	33	1	97.06	2.94
Male	498	29	94.50	5.50
131–135	26	1	96.30	3.70
136–140	8	2	80.00	20.00
141–145	80	4	95.24	4.76
146–150	113	5	95.76	4.24
151–155	106	10	91.38	8.62
156–160	119	7	94.44	5.56
161–165	46	0	100.00	0.00
Grand total	946	54	94.60	5.40

diagnostic criteria of measurement of BP more than the 95th percentile for age, height, and gender would be appropriate as suggested by the 7th report of JNC of NLHBI [16].

Table 9: Distribution of normal blood pressures and high systolic blood pressures; their percentage ratio concerning various ranges of weight in both gender

Weight (kg)	<120 mmHg	>120 mmHg	<120 mmHg (%)	>120 mmHg (%)
Female	448	25	94.71	5.29
25–30	51	0	100.00	0.00
30–35	72	0	100.00	0.00
35–40	126	7	94.74	5.26
40–45	81	10	89.01	10.99
45–50	92	7	92.93	7.07
50–55	24	1	96.00	4.00
55–60	2	0	100.00	0.00
Male	498	29	94.50	5.50
25–30	61	2	96.83	3.17
30–35	65	3	95.59	4.41
35–40	138	9	93.88	6.12
40–45	142	9	94.04	5.96
45–50	74	4	94.87	5.13
50–55	16	2	88.89	11.11
55–60	2	0	100.00	0.00
Grand total	946	54	94.60	5.40

Table 10: Distribution of normal blood pressure and high systolic blood pressure; their percentage ratio concerning various ranges of BMI in both gender

BMI	<120 mmHg	>120 mmHg	<120 mmHg (%)	>120 mmHg (%)
Female (47.30%)	448	25	94.71	5.29
10–15 (7.60)	76	0	100.00	0.00
15–20 (31.40)	299	15	95.22	4.78
20–25 (8.10)	71	10	87.65	12.35
25–30 (0.20)	2	0	100.00	0.00
Male (52.70%)	498	29	94.50	5.50
10–15 (11.20)	109	3	97.32	2.68
15–20 (34.30)	325	18	94.75	5.25
20–25 (6.90)	62	7	89.86	10.14
25–30 (0.30)	2	1	66.67	33.33
Grand total 100%	946	54	94.60	5.40

BMI: Body mass index

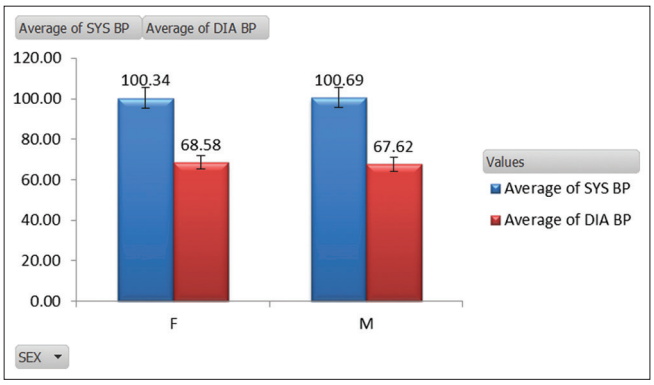

Fig. 6: Mean value of systolic and diastolic blood pressure in both gender

"Epidemiologic studies suggest that populations show a progressive increase in average BP as the distance from the equator increases (i.e., higher north) [22,23]." Our study did not consider such geographic factors although the study population are South Indian. Some chronic diseases such as nephritic syndrome, tumors of the adrenal gland, hypercholesterolemia, and chronic kidney disease may present as elevated BP at the very initial stage in due course of illness. We realize

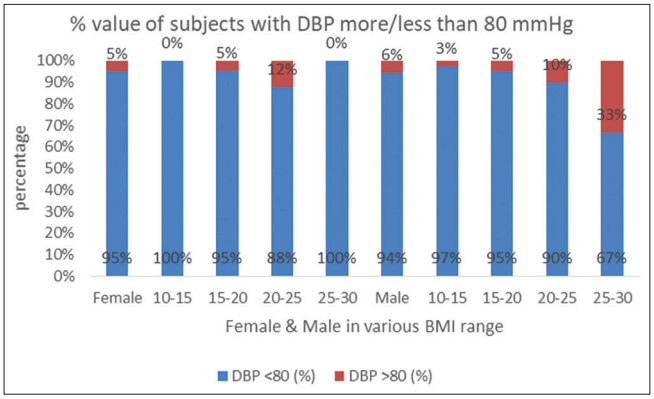

Fig. 7: Percentage distribution of normal and high diastolic blood pressure concerning various ranges of body mass index in both gender

the necessity of extending the diagnostic or screening laboratory investigations to these hypertensive adolescents toward diagnostic workup for chronic illness. Although pubertal changes in the endocrine system and physical growth spurt may have a systemic effect on the cardiovascular system, and its systemic effects cannot be denied in adolescents, we cannot rule out psychological changes allied with menarche for prevalence in the female gender.

CONCLUSION

The common causes attributed to prehypertension are physical inactivity and consumption of junk food, besides hormonal changes in adolescents. Risk factor modification stands important measure among adolescents. "Lifestyle interventions (balanced diet with exercise, abstinence from alcohol intake, and smoking) should be recommended for all children with HTN, with pharmacologic therapy instituted for higher levels of BP or if insufficient response to lifestyle modifications occurs. Use of anabolic steroid hormones for bodybuilding should be strongly discouraged" as per the 7th report of JNC mentioned above. Early lifestyle modification and a Reinforcement of the school health program are recommended. It is important to assess BP among children periodically, as doing so, will provide information for the formulation of health-care policy and prevention strategies especially in developing countries where data are scarce.

AUTHORS' CONTRIBUTION

First author – concept and design of study, second author – literature research, collection of study material; third/corresponding author – manuscript writing, designing, analysis interpretation of data, drafting the article and submission to the journal; and fourth author – acquisition of data.

CONFLICTS OF INTEREST

Nil.

AUTHORS FUNDING

Nil.

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