ORIGINAL RESEARCH ARTICLE

Elevated Blood Pressure and Behavioral Risk Factors of Non-Communicable Disease Among School-Going Adolescents in Chengalpattu District, India: A Cross-Sectional Study

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ABSTRACT

Background: Elevated Blood Pressure (BP), often termed the "silent killer," is characterized by a BP of 140/90 mmHg or higher, influenced by modifiable and non-modifiable factors, particularly during adolescence. Hypertension prevalence among Indian adolescents varies from 2% to 20.5%. Despite the critical impact of adolescent health on India's overall health landscape, literature on the non-communicable disease (NCD) burden and risk factors among Indian adolescents remains limited. The aim is to assess the prevalence of elevated BP and associated risk factors among school-going adolescents in Chengalpattu district.

Methodology: A cross-sectional study was conducted in Chengalpattu district schools. Utilizing ChatGPT, multi-stage simple random sampling was performed to select 206 adolescents. They were surveyed using adapted questionnaire from the WHO Global School-Based Student Health Survey, covering sociodemographic details, behavioral risks, and anthropometric data and data analysis was conducted using SPSS.

Results: Among the 206 participants, 54 (26.2%) had elevated BP. Key predictors of elevated BP were age, gender, family history, physical education, and serious injuries. Cyberbullying was also associated with elevated BP (P=0.020).

Conclusions: The increasing trend of NCDs necessitates school and community-based campaigns for risk reduction. Further research on cyberbullying and long-term health interventions is recommended to improve adolescent health and reduce NCDs in Chengalpattu and beyond.

Keywords: Hypertension, Noncommunicable Disease, Adolescent Behaviours, World Health Organization, WHO-GSHS, AI (Artificial Intelligence)

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INTRODUCTION

WHO defines Adolescents as individuals in the 10 to 19 years age group. These adolescents comprise one-sixth of the world's population which is 1.2 billion[1] with India leading at 253 million[2]. It is often considered a crucial phase in human development as it's the time to establish the basis for long-term health. With the growing technology and emergence of new diseases, this generation is struggling to adapt to these changes happening around them, leading to a significant increase in deaths, illnesses and injuries. It is estimated that 1.1 million adolescents die every year especially due to road traffic injuries, suicide and interpersonal injury. Besides, there are many health issues widespread among adolescents which are alcohol and drug use, tobacco use, mental health, communicable diseases like HIV, Tuberculosis, diarrhoea, pneumonia, early pregnancy and childbirth, overweight and nutrition.[3]

According to the India State-Level Disease Burden Initiative by the Indian Council of Medical Research (ICMR), the proportion of fatalities owing to Non-communicable Diseases (NCDs) in India has grown from 37.9% in 1990 to 61.8% in 2016.[4] Also, 70% of premature deaths occurring during adulthood are the result of health-related behaviours that are initiated in childhood and adolescence.[5] One in two disability-affected life years and one in five deaths among adolescents are caused by NCDs.[6] NCDs like heart disease, diabetes, mental health, stroke, cancer and chronic lung disease are found to be showing an increasing trend in adolescents, which has called for the global health community and established as a universally important issue.[7] The Global Burden of Disease Study has reported that hypertension is the primary source of disease burden in India, accounting for 33.9 million disability-adjusted life years and 1.6 million deaths in 2015.[8] To stress the importance of this even in the sustainable development goal a target has been added which aims to reduce the premature mortality from NCD by one-third by 2030 through prevention and treatment and promote mental health and well-being.[9] Though these NCDs during adulthood can be mitigated with appropriate preventive measures and treatment yet in the early phases of life it is still neglected as they mostly present as asymptomatic.

Elevated Blood pressure (EBP) also called a "silent killer" results when the pressure in blood vessels is 130/80mmHg or higher. This prevalence has increased in young children over time in countries all over the world[10] which is linked to childhood obesity, physical inactivity, and low vegetable and fruit consumption[11]. American Academy of Paediatrics (AAP) Clinical Practice Guideline revised the criteria for EBP and hypertension and introduced new tables with normative percentiles based on the blood pressure distribution among children and adolescents of normal weight specific to age, sex, and height.[12] American Academy of Paediatrics defines EBP in adolescents 13 years and older as 120 to 129 mm Hg systolic and < 80 mm Hg diastolic, whereas hypertension is > 130/80 mm Hg.[13] Several modifiable and non-modifiable factors contribute to the development of Elevated Blood Pressure and the risk behaviours are adapted usually in adolescent periods. Apart from targeting the risk factors modification, "tracking" is the single most effective approach to preventing. This enables the potential identification of high-risk groups, facilitating the initiation of early intervention measures.[14] Hypertension, if uncontrolled, may result in kidney failure, heart disease, and stroke.[15] The prevalence of hypertension in adolescents among different publications all over India ranged from 2% to 20.5%[16] and the majority of juvenile hypertension cases today involve primary hypertension rather than secondary hypertension. Though the health of this age group is an important factor influencing India's general health, mortality, morbidity, and population growth scenario, there is limited literature on Non-Communicable Diseases but its risk factors and determinants among adolescents, especially in India. Hence, the purpose of this study was to assess the prevalence of elevated blood pressure in school-aged adolescents and associated risk factors in Chengalpattu district by observing their health risk behaviours, which might lead to poor consequences in the future, including noncommunicable illnesses.

METHODOLOGY

A cross-sectional study was conducted in the schools of Chengalpattu district, Tamil Nadu. The targeted population was school-going adolescents aged from 13 to 17 years old. Students were approached on the first visit and given a consent form to be signed by parents. Parents who gave consent and students who gave assent were included in the study. Adolescents who got consent from parents and gave assent were included in this study. Participants who were on any medications apart from antihypertensives were excluded. The sample size was computed based on the study by Baskar S et al, taking the prevalence as 14.2%[17] with a 95% confidence interval, an acceptable error of 5%, and a 5% non-response rate of 194 and was rounded off to 210, we approached high school 9th to 12th studying students for this study. The sampling method used in this study was multistage simple random sampling. Two blocks were randomly selected from the eight blocks of Chengalpattu district using Chat GPT. After receiving a list of public and private schools in the designated district from the Tamil Nadu Educational Board, two schools (one private and one government) were picked. From each school, 13 students were chosen using the lottery technique from the 9th, 10th, 11th, and 12th grades.

Study tool: A pretested questionnaire consisting of 3 parts was used. The first part includes sociodemographic details of the participants and the second

part includes behavioural risk-assessing questions which were adapted from the "WHO Global School-Based Student Health Survey (GSHS)".[18] There are 10 key core leading causes of mortality and morbidity among children and adolescents which are Alcohol use, Dietary Behaviour, Drug use, Hygiene, Mental Health, Physical Activity, Protective Factors, Sexual Behaviours That Contribute to HIV Infection, Other STIs, and Unintended Pregnancy Module, Tobacco use and Violence and Unintentional Injury. Out of 10, nine were included in this study except for sexual behaviours. As advised by the ethical committee studying sexual behaviour among adolescents is sensitive and controversial, particularly in countries like India hence removed. The third part includes measurements like height, which was measured using a rolling ruler wall-mounted growth stature meter and recorded to the nearest 0.5 cm. Weight was measured using a digital OMRON HN289AP weighing machine and it was measured to its nearest 100g. With WHO Anthro, anthropometric data were collected and z-scores were calculated for body mass index (BMI). Blood pressure (BP) was measured using a digital sphygmomanometer OMRON HEM 7124 in mmHg with appropriate cuff size, two readings were taken in 5-minute intervals and an average was noted. If BP was elevated i.e., 120-129/ < 80 mmHg or stage 1 hypertension, 130-139/80-89 mmHg or stage 2 hypertension ≥140/90 mmHg measurement was repeated after 20 minutes and the average was noted and classified according to American Academy of Pediatrics classification of Hypertension.[19]

Data collection: After receiving approval from the Institutional Human Ethics Committee (IHEC-I/2030/23) on 23 June 2023 and obtaining permission from the Head of the Institution, consent was secured from the participants' parents or guardians. During the day of data collection after verifying the consent a written assent was obtained from the participants and the anthropometric measurement was noted. Then a self-administered questionnaire was given and confidentiality was ensured. Participants who had difficulty with the language content validated Tamil translated questionnaire was used. we conducted a content validation of the Tamil-translated questionnaire to ensure its accuracy and relevance. This Tamil questionnaire was reviewed by experts who translated it from English to Tamil followed by reverse translation to English to ensure clarity, relevance, and cultural appropriateness.

Statistical analysis: The collected data was entered in MS Office Excel and analyzed using SPSS, version 27. Qualitative data was expressed as frequencies and proportions and quantitative data as means and standard deviation. Inferential statistics like the Chi-square test were done to associate elevated blood pressure and behavioural risk factors. A probability value (p-value) of less than 0.05 was considered statistically significant. The adjusted Odds Ratio and 95% confidence interval were calculated using a multivariate logistic regression analysis.

RESULTS

Four of the 210 participants' data could not be evaluated due to missing information and a few unanswered questions; thus, of the 206 participants, 94 (45.6%) were men and 112 (54.4%) were women. The participant's age distribution was found to be 13 (13.1%), 14 (14.1%), 15 (15.5%), 16 (33.0%) and 17 (24.3%). The mean systolic and diastolic blood pressure was 111.17 ± 13.308 mmHg and 71.50 ± 9.666 mmHg. The mean height and weight were 162.7015 ± 8.98125 cm and 52.4577 ± 13.54178 Kg respectively. The overall prevalence of elevated blood pressure and hypertension among school-going adolescents was 26.2% (n= 54) (Figure 1). Among the participants, 43 males and 11 females were found to be hypertensive.

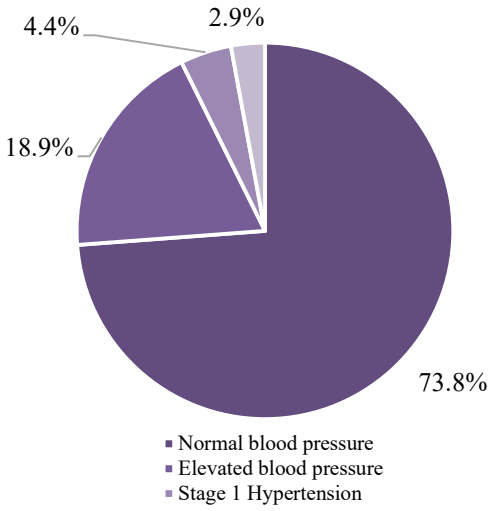

Figure 1: Prevalence of blood pressure classification across study participants

Elevated blood pressure was seen more in males (45.7%) compared to females (9.8%) and this was statistically significant (*P=0.003*). Also, the prevalence was found to be higher in older age adolescents (*P=0.017*). There was also a statistically significant difference between those who had positive (n=92) and negative (n=114) family histories (*P=0.002*). Out of 206, 175 school-going adolescents who have tried alcohol at least once in their lives and those who drank alcohol in a row within a couple of hours (*P=0.033*) and who felt drunk were found to be significant risk factors of elevated blood pressure. Variables like vegetable intake (*P = 0.049*) and carbonated drink consumption (*P=0.022*) in the last 7 days were found to be statistically significant (Table 1). 16 participants have tried drugs in their life at least once but there was no association found between drug use and EBP (Table 2). There was not enough evidence to establish an association between physical activity and EBP, but sleeping for more than 7 hours (*P=0.040*) was found to be statistically significant.

Table 1: Association of behavioural risk factors by GSHS with EBP among adolescents

GSHS Core questionnaire Module	Behavioural risk factors	Elevated Blood pressure		$\chi 2$	P value
		Absent (%)	Present (%)		
Alcohol use	**Tried alcohol**				
	Yes	132 (75.4)	43 (24.6)	1.621	0.203
	No	20 (64.5)	11 (35.5)		
	Drinks per day				
	0	142 (75.1)	47 (24.9)		
	< 1	3 (60)	2 (40)	2.15	0.341
	> 1	7 (58.3)	5 (41.7)		
Dietary behaviours	**Fruit intake in last 7 days**				
	Did not eat	46 (68.7)	21 (31.3)	6.972	0.137
	1 to 3 times	41 (77.4)	12 (22.6)		
	4 to 6 times	12 (57.1)	9 (42.9)		
	1 time per day	23 (76.7)	7 (23.3)		
	> 2 times per day	30 (85.7)	5 (14.3)		
	Vegetable intake in last 7 days				
	Did not eat	24 (82.8)	5 (17.2)	11.103	
	1 to 3 times	26 (72.2)	10 (27.8)		
	4 to 6 times	23 (63.9)	12 (36.1)		
	1 time per day	32 (86.5)	5 (13.5)		0.049*
	> 2 times per day	23 (82.1)	5 (17.9)		
	> 3 times per day	24 (60)	16 (40)		
	Carbonated drink intake in last 7 days				
	Did not drink	80 (76.2)	25 (23.8)	11.408	
	1 to 3 times	38 (79.2)	10 (20.8)		
	4 to 6 times	4 (40)	6 (60)		0.022*
	1 time per day	21 (80.8)	5 (19.2)		
	> 2 times per day	9 (52.9)	8 (47.1)		

Elevated blood pressure includes elevated blood pressure, stage 1 hypertension and stage 2 hypertension;
GSHS- Global School Health Survey; *P < 0.05; considered statistically significant; $\chi 2$ - Chi-square

Table 2: Association of behavioural risk factors by GSHS with EBP among adolescents

GSHS Core questionnaire Module	Behavioural risk factors	Elevated Blood pressure		$\chi 2$	P value
		Absent (%)	Present (%)		
Drug use	**First drug age**				
	Never tried	143 (75.3)	47 (24.7)	4.528	0.339
	8 or 9 years	1 (33.3)	2 (66.7)		
	10 or 11 years	2 (50)	2 (50)		
	14 or 15 years	1 (50)	1 (50)		
	16 or 17 years	5 (71.4)	2 (28.6)		
Mental health	**Consider suicide attempt**				
	Yes	33 (71.7)	13 (28.3)	0.128	0.72
	No	119 (74.4)	41 (25.6)		
	Plan attempt suicide				
	Yes	32 (66.7)	16 (33.3)	1.64	0.2
	No	120 (75.9)	38 (24.1)		
	Suicide attempt				
	0	120 (73.6)	43 (26.4)	0.727	0.695
	1 time	22 (78.6)	6 (21.4)		
	> 2 times	10 (66.7)	5 (33.3)		
Hygiene	**Wash hand with soap**				
	Yes	131 (63.5)	35 (16.9)	4.71	0.03
	No	25 (12.1)	35 (7.2)		
Physical activity	**Physically active for 60 mins per day**				
	< / = 3 days	102 (72.9)	38 (27.1)	0.195	0.659
	> 4 days	50 (75.8)	16 (24.2)		
	Sleep hours				
	< 4 hours	35 (85.4)	6 (14.6)	6.454	0.040*
	5 to 7 hours	86 (67.7)	41 (32.3)		
	> 8 hours	31 (81.6)	7 (26.2)		
Protective factors	**Miss school without permission in past 30 days**				
	0 day	74 (77.9)	21 (22.1)	2.408	0.661
	1 or 2 days	36 (69.2)	16 (30.8)		
	3 to 5 days	16 (76.2)	5 (23.8)		
	6 to 9 days	9 (75)	3 (25)		
	10 or more days	17 (65.4)	9 (34.6)		

Elevated blood pressure includes elevated blood pressure, stage 1 hypertension and stage 2 hypertension
GSHS- Global School Health Survey; *P < 0.05; considered statistically significant; $\chi 2$ - Chi-square

Table 3: Association of behavioural risk factors by GSHS with EBP among adolescents

GSHS Core questionnaire Module	Behavioural risk factors	Elevated Blood pressure		$\chi 2$	P value
		Absent (%)	Present (%)		
Tobacco use	**Days of smoking in past 30 days**				
	0 day	144 (75)	48 (25)	5.875	0.053
	1 or 2 days	5 (83.3)	1 (16.7)		
	> 3 days	3 (37.5)	5 (62.5)		
Violence and unintentional injuries	**Times seriously injured**				
	0 time	85 (55.9)	19 (35.2)	8.483	0.037*
	1 time	26 (17.1)	17 (31.5)		
	2 or 3	29 (19.1)	11 (20.4)		
	>4 times	12 (7.9)	7 (13)		
	Bullied on school property				
	Yes	37 (69.8)	16 (30.2)	0.583	0.445
	No	115 (75.2)	38 (24.8)		
	Cyber bullied				
	Yes	13 (54.2)	11 (45.8)	5.406	0.020*
	No	139 (76.4)	43 (23.6)		

Elevated blood pressure includes elevated blood pressure, stage 1 hypertension and stage 2 hypertension
GSHS- Global School Health Survey
*P < 0.05; considered statistically significant; $\chi 2$ - Chi-square

Table 4: Factors associated with hypertension among the study participants: multivariate logistic regression

Risk factors	aOR (95% Cl)	P
Age		
13 - 15	0.67 (0.50 - 0.91)	0.011*
16 - 17	Ref	
Gender		
Male	8.51 (3.82 - 18.93)	0.000*
Female	Ref	
Family history		
Yes	3.69 (1.74 - 7.80)	0.001*
No	Ref	
Days drinking at least one alcohol drink		
0 to 5 days	0.67 (0.38 - 1.19)	0.176
> 6 days	Ref	
Days of PE		
0-1 day per week	1.34 (1.00 - 1.80)	0.047
> 2 days per week	Ref	
Cyber bullied		
Yes	1.95 (0.79 - 4.85)	0.147
No	Ref	
Times seriously injured		
0 - 4 days	0.94 (0.89 - 1.00)	0.51
> 4 days	Ref	
Body Mass Index (BMI)		
Normal weight	0.92 (0.87 - 0.98)	0.13
Overweight & obese	Ref	

*P < 0.05; considered statistically significant;
aOR- Adjusted Odds Ratio $\chi 2$ - Chi-square; CI- Confidence interval; Ref - Reference

In this study, 46 of our participants reported the use of cigarettes once in life. 20.9% (n=43) of participants have attempted suicide at least once in life and 33% (n=68) often felt lonely. Among our participants, 25% (n=53) were found to be bullied on school property and there is an association between elevated blood pressure and cyberbullying (*P*=0.020) (Table 3).

Then multivariate logistic regression analysis of all the significant factors was done and adjusted Odd's ratio was derived (Table 4). Non-modifiable risk factors compared to females; males have 8.51 times higher odds of developing elevated blood pressure similarly those who have a family history had 3.69 times higher odds of developing EBP. With increasing age, the likelihood of the outcome decreases. The association is statistically significant (p = 0.011), suggesting that age is a protective factor in the modifiable risk factors having <1 physical education class per week had 1.34 times higher odds of developing EBP.

Discussion

The prevalence of EBP among school-going adolescents in Chengalpattu district was found to be 26.2% which was higher compared to other studies in India which showed prevalence from 2% to 20.5%.[16] Effects of non-modifiable risk factors like age and gender and the development of EBP[20] have been reported in many previous studies which were on par with our study. Family history was considered a single significant predictor of blood pressure. The chance of getting hypertension among kids was nearly two times greater when one parent was hypertensive, and almost four times higher when both parents were hypertensive[21] which showed a significant association, 3.69 times higher odds in our study population. Studies all over the world have understood the relationship between blood pressure and obesity and it was considered solely a public health problem.[22] The mechanism through which obesity causes hypertension is complex and usually involves the overactivation of the sympathetic nervous system, stimulation of the renin-angiotensin-aldosterone system, and changes in adipose-derived cytokines, insulin resistance and kidney problems.[23] Studies which used the Global school-based student health survey questionnaire have also reported the presence of prehypertension and hypertension in India with risk factors like being overweight found to be signifi-

cant.[24] Previous studies in Tamil Nadu have reported the prevalence of overweight as 10%[25] which was slightly lower than our study's results (15.1%) and the majority of our study participants were in healthy weight this could be due to possible cultural and socioeconomic factors. Studies have shown that alcohol use was linked to a 1.3-fold increased risk of hypertension and a 1.4-fold increased risk of coronary artery disease.[26]

Also, habitual alcohol consumption among adolescents may lead to long-term changes in vascular function and arterial stiffness, thereby increasing the risk of elevated blood pressure over time[27]. Here, EBP was seen in 24.6% of the study participants who had tried alcohol which was significantly higher compared to the previous study (8.7%).[28] Physical activity was widely recognized as a cornerstone of a healthy lifestyle with numerous benefits for cardiovascular health. Contrary to our initial expectations supported by previous studies[29] no significant association was found between physical activity levels and blood pressure. This could be due to insufficient granularity in assessing different types and intensities of physical activity in the self-reporting questionnaire. Numerous studies have demonstrated the positive effects of physical activity in reducing blood pressure and results in a favourable plasma lipoprotein profile[30] further regression analysis having less than one physical education class in a week was found to be 1.34 times higher odds of elevated blood pressure.

Injuries were the leading cause of death and disability in adolescents especially in low and middle-income countries[31] like India with an overall prevalence of 4.7%[32]. When injuries happen, the physiological response exaggerates cardiovascular activity and results in an increased risk for hypertension and cardiovascular disease.[33] In our study, we have also established a relationship between the frequency of serious injury with EBP. Furthermore, our study identified cyberbullying as a significant predictor of EBP. In this digital era, especially after the pandemic this finding could lead us to a new threat shortly. However, no association was found between this and EBP.

Limitations

These results cannot be generalized as the sample does not represent the whole adolescent population of the Chengalpattu district as only school going adolescent were included in the study. Most of the adolescents had checked their blood pressure for the first time in their lives and also the data was a single-day reading which may have resulted in over-diagnosis of EBP might be white collar hypertension. The Elevated Blood Pressure results from multiple factors and all the relevant factors that contributed to elevated blood pressure were not captured. The behavioural risk factors are assessed based on self-reported data and the participants may have offered replies that they feel are socially desirable or that meet their perceived expectations. This can lead to mistakes or biases in the data, especially for sensitive issues like substance use and mental health.

Conclusion

As the trend in NCD is increasing especially in adolescents, campaigns shall be done to combat the risk factor through school programs and community engagement in risk reduction. Long-term follow-up and more frequent screening of high-risk kids should be included in school programs. Also, interventions like health education on a healthy diet and DASH diet for students with elevated blood pressure, quitting smoking and avoiding alcohol and the importance of physical activity and sleep can be explained. In this digital era, a new threat that was established was cyberbullying. Further studies can be done for better understanding of this association. Studies to reduce the risk factor and also refine the existing preventive measures can be promoted and ultimately contribute to the improvement of adolescent health and reduction in NCD in Chengalpattu district and beyond.

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