Original Article

Relationship between Birth Weight and Hypertension in Adolescents: A School based Study

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Abstract

Background: It has been hypothesized that under nutrition during foetal life can program the development of risk factors for hypertension; and almost half of all adult hypertensives had an elevated blood pressure in childhood. There is a lack of sufficient research on the connection between birthweight and blood pressure in children and adolescents. Objective of this study was to find out the relationship between these two parameters in adolescents. **Material and Methods:** 750 children (450 boys and 300 girls aged 10 to 16 years) were enrolled from four schools of Dibrugarh and stratified into six birth weight groups. Blood pressure, height and weight were measured in school and information regarding birth weight was gathered from parents. Association between blood pressure and weight at birth was analysed while controlling for obesity, a potential confounding factor. **Results:** The overall prevalence of hypertension among the study population was 8%. There were no students with birth weight group of ≤ 1499gm in our study. Children with birth weight group 1500-1999gm had the highest prevalence of hypertension with 37.5% followed by birth weight group 2000-2499gm with 17.14% and 3000 – 3499gm with 9.90%. After adjusting for confounding factor of obesity using multiple logistic regression, birth weight group 1500-1999gm had the highest odds of becoming hypertensive with OR=19.1 followed by birth weight group 2000-2499gm and 3000-3499gm with OR=5.8 and OR = 2.1 respectively. **Conclusion:** We found that lower birth weight groups had high chances of having high blood pressure even after adjusting for BMI.A more in-depth look at fetal development and keeping birth weight within an appropriate range may be essential for preventing primary hypertension.

Keywords: High blood pressure, Nutrition during fetal life, School going children, 10 to16 years age, Weight at birth, Association, Insults during fetal life, Non-communicable disease, North East India, Risk factor.

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Introduction

In 2016, 72% of global death occurred due to non-communicable diseases (NCDs).[1] The prevalence of hypertension among adults was 31.1% globally in 2010 and was higher in lower and middle income countries than in developed countries.[2] According to one study of 2014, prevalence of hypertension in India was 29.8%.[3] With higher rates among the younger generation, hypertension is an emerging public health issue, not only for adults but also for children and adolescents. Another study on hypertension among school going children in India, done in 2021 found the prevalence of hypertension to be 7%, which is more in overweight and urban children.[4] Studies conducted on childhood obesity suggest that it may be plateauing off in some developed countries, while steep increases continue to occur in developing countries.[5,6] Therefore, the prevalence of hypertension and obesity in adolescents constitutes a critical issue in public health and clinical care. We should be aware and work seriously about this growing problem in adolescents. It is important to understand various etiopathogenesis and risk factors for the development of hypertension and obesity among children and adolescents. Among all theories, one of the most argued theory is "fetal origins of adult disease hypothesis", which states that an unfavorable environment, or insults during fetal life, might induce lifetime effects on the subsequent development of body systems and hence give rise to major disease processes such as hypertension, diabetes, arteriosclerosis, asthma, and obesity.[7] There are very few studies showing the relationship between birth weight and hypertension in Indian adolescent population and no published data from North-Eastern region in India. We did this study with the hypothesis that there is a relationship between the weight of the child at birth and hypertension in adolescents.

Materials and Methods

This study was a school-based cross-sectional study carried out within a period of one year from July 2021 to June 2022 in Assam

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Medical College & Hospital, Dibrugarh, Assam, India with the objective of investigating the relationship between birth weight and blood pressure among adolescent students. Ethical clearance was obtained from Institutional Ethics Committee (H) (ref no: AMC/EC/PG/5668) before conducting the study. Study population was school going children of ages 10 – 16 years from Dibrugarh, Assam, India. Considering 95% confidence interval with relative error of 20%, proportion of children with low birth weight who develops abnormal blood pressure to be 11.71%,[8] and non-response rate of 10%, the sample size for the study was calculated to be 750. Adolescents with a diagnosed hypertension, parents who could not recall birth weight and parents who denied consent were excluded from the study. Outcome measures were measurements of systolic and diastolic blood pressure, weight, height and information about birth weight from parents. A total of 750 children (450 boys and 300 girls) were enrolled from four schools of Dibrugarh after excluding 34 students out of total 784 identified children based on exclusion criteria and were stratified into six groups depending on birth weight.

Students were chosen from class V to class X. The consent form and the questionnaires printed in English/Assamese were given to the students to be filled up in their homes with the help of parents.

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured with a mercury sphygmomanometer and appropriate-sized cuff to cover 2/3rd of upper arm, in seating position keeping the forearm on a table to keep the upper arm at the heart level. If BP was found to be high then second BP measurement was taken after 5 minutes and the lower of these 2 measurements was recorded. Either outlier SBP or outlier DBP was defined as hypertension (stage 1 and 2) based on the American Association of Pediatrics (AAP) Guidelines (2017), 2017 AHA and American College of Cardiology (ACC) adult HTN guideline [Table 1].[9,10] These values were plotted in graph and their percentiles were interpreted. The fourth report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents charts,[11] were used for plotting blood pressure according to age and sex.

Table 1: New blood pressure classification for children, adolescents, and adults [10]

HTN classification	Children aged 1-12 years (percentile based)	Everyone ≥ 13 y old (mm Hg based)
Normotensive	< 90th percentile	< 120/<80
Elevated blood pressure	≥ 90th percentile or ≥ 120/80 mm Hg (lower) to < 95th percentile	120-129/< 80
Stage 1 hypertension	≥ 95th percentile to < 95th percentile + 12 mm Hg or 130/80 to 139/89 (lower)	130-139/80-89
Stage 2 hypertension	≥ 95th percentile + 12 mm Hg or ≥ 140/90 (lower)	≥ 140/90

An electronic weighing machine and height measuring scale stadiometer were taken to the schools for measuring weight and height. BMI was calculated as weight (kg)/ height (m2). Revised IAP 2015 charts,[12] were used for plotting BMI. Children with BMI more than 95th percentile for age were considered as obese.

The statistical analysis of data was performed using the Microsoft excel 2019 and SPSS Software. Results on Categorical values were compared using chi square test. Results on continuous measurements were presented as mean ± standard deviation and compared using analysis of variance (ANOVA). Multiple logistic regression was used for adjusting confounding factors. P value of < 0.05 was taken as significant.

Results

Out of the total 750 participants, 450 were males with a M:F ratio of 1.5:1. 518 participants (69%) were in the age group of 10 – 13 years and 232 (31%) were in the age group of 14 – 16 years. 60 students (8%) were hypertensive [Table 2]. Hypertension was found to be present 0% in upper (0/16) and lower socio-economic classes (0/5), 10.6% (27/254) in upper middle class, 7.4% (32/431) in lower middle class and 2.2% (1/44) in upper lower class. No significant association was found between hypertension and family history of hypertension in the family. Obesity was present in 52 students (6.9%) [Table 3]. There was no significant association between obesity and socio-economic class.

Based on the birth weight, the study participants were stratified into 6 categories (≤ 1499gm, 1500 – 1999 gm, 2000 – 2499 gm, 2500 – 2999 gm, 3000 – 3499 gm and > 3500 gm) and parameters in various birth weight groups were analyzed. There was no student in the ≤ 1499gm birth weight group. Prevalence of hypertension and obesity in different birth weight groups were shown in [Table 2 and 3] respectively.

Birth weight wise distribution of mean systolic and diastolic BP was shown in [Table 4] and relationship between birth weight groups and hypertension after adjusting obesity as a confounding factor was shown in [Table 5].

Table 2: Relationship of hypertension with various variables

Age group	Total No. of students750 (100%)	No. of hypertensive children n (%)	P value (Chi square test)	Odds ratio
10 -13 yrs	518 (69.1)	44 (5.9)	0.49	-
14 – 16 yrs	232 (30.9)	16 (2.1)	-	-
Gender				
Male	450 (60)	38 (5.1)	0.61	-
Female	300 (40)	22 (2.9)	-	-
Birth weight (gm)				
≤ 1499	0 (0)	0	-	-
1500 – 1999	16 (2.1)	6 (0.8)	< 0.0001	15.8(95% CI = 4.94 - 50.80)
2000 – 2499	105 (14)	18 (2.4)	< 0.0001	5.4(95% CI = 2.53 - 11.78)

2500 – 2999	329 (43.9)	12 (1.6)	1	1
3000 – 3499	212 (28.3)	21 (2.8)	0.0043	2.9(95% CI = 1.39 - 6.03)
≥ 3500	88 (11.7)	3 (0.4)	0.91	0.93

Table 3: showing Relationship of obesity with various variables

Age group	Total no of students 750(100%)	Total no of obese children 52(100%)	P value (Chi square test)	Odds ratio
10 -13 yrs	518 (69.1)	39 (5.2)	0.37	-
14 – 16 yrs	232 (30.9)	13 (1.7)	-	-
Gender				
Male	450 (60)	37 (4.9)	0.11	-
Female	300 (40)	15 (2)	-	-
Birth weight (gm)				
<1499	0 (0)	0 (0)	-	-
1500 – 1999	16 (2.1)	0 (0)	-	-
2000 – 2499	105 (14)	4 (0.5)	0.54	0.65 (95% CI = 0.17 - 2.52)
2500 – 2999	329 (43.9)	13 (1.7)	0.48	0.68 (95% CI = 0.23 - 1.96)
3000 – 3499	212 (28.3)	30 (4)	0.04	2.73 (95% CI=1.02 - 7.30).
>3500	88 (11.7)	5 (0.7)	-	-

(P value was calculated using Chi-square test)

Table 4: showing Birth weight wise distribution of mean Systolic and Diastolic BP

Birth weight (gm)	mean Systolic BP ± SD (mm Hg)	p value (One way Anova test)	mean Diastolic BP ± SD (mm Hg)	p value (One way Anova test)
1500 – 1999	108 ± 42.4	<0.01	67.59 ± 8.21	<0.01
2000 – 2499	108.15 ±42.3	0.08	67.58 ± 8.19	<0.01
2500 – 2999	106.69 ± 13.1	0.89	66.7 ± 8.19	1
3000 – 3499	106.65 ± 12.5	1	67.55 ± 8.18	<0.01
>3500	106.37 ± 12.7	0.29	67.61 ± 8.23	<0.01

(Analysis of variance was used to calculate mean systolic and diastolic blood pressure of each birth weight groups. One way ANOVA test was used to find out p value)

Table 5: showing Birthweight wise distribution of hypertensive children with BMI adjustments

Birth weight (gm)	Total no. of children 750(100%)	Hypertensive children n (%)	Obese children n (%)	Adjusted Odds Ratio	p value (One way Anova test)
<1499	0 (0)	0 (0)	0 (0)	-	-
1500 – 1999	16 (2.1)	6 (0.8)	0 (0)	19.1	<0.01
2000 – 2499	105 (14)	18 (2.4)	4 (0.5)	5.8	<0.01
2500 – 2999	329 (43.9)	12 (1.6)	13 (1.7)	1	1
3000 – 3499	212 (28.3)	21 (2.8)	30 (4)	2.1	<0.06
>3500	88 (11.7)	3 (0.4)	5 (0.7)	-	<0.82
Total	750 (100)	60 (8)	52 (6.9)	-	

(Multiple logistic regression was used to adjust obesity as a confounding factor)

Discussion

In this study, we examined the prevalence of obesity and hypertension among students of age group, 10 to 16 years from four schools of urban Dibrugarh and the relationship between birth weight and hypertension among them. Prevalence of hypertension was 8% in our study population. We had chosen 2 English medium schools and 2 Vernacular medium schools so that study subjects represent children from all socio-economic classes. A systematic review and meta-analysis on prevalence of hypertension among Indian children and adolescents <18 years in the year of 2021 found the prevalence of hypertension to be 7%which is almost similar to our study.[4] We found obesity in 6.9% of students like 2 Indian studies where they have found in 6% and 6.8% of children respectively.[13,14]

To the best of our knowledge, this was the first study to investigate the associationbetween birth weight and childhood hypertension in this part of the country. Our study found maximum number of hypertensive students (37.5%) in the birth weight group of 1500 – 1999 gm (there was no children with birth weight group of ≤ 1499 gm in our study) followed by birthweight group 2000 – 2499 gm and 3000 – 3499 gm [Table 2]. It showed that birth weight had a negative association with development of hypertension in adolescent students. Chong Lai et al conducted a cross-sectional study among 17035 participants, aged 7–17 years and found a U-shaped association between birth weight and the prevalence of hypertension.[8]

There were no significant differences between prevalence of hypertension in both age groups and sexes. There was no difference in prevalence of hypertension among different socio-economic classes. While analyzing the systolic and diastolic BP separately, we found that birth weight was negatively related to systolic BP but not significantly with diastolic BP [Table 3] like the study done by Huang et al.[15]

In this study prevalence of obesity was 6.9% and we found that children with obesity had OR=7 of becoming hypertensive with a p value of <0.01. After adjusting obesity as a confounding factor, we found that low-birth-weight group 1500 -1999 gm had

the highest odds of becoming hypertensive with OR = 19.1(p = <0.01) [Table 4].

The fetal origin of adult disease hypothesis was postulated by various researchers for increasing prevalences of non-communicable diseases in children and adolescents. Simonetti et al. demonstrated in their study that renal mass is reduced in children born with low birth weight (LBW) and depends on the degree of growth retardation, which then determines lower glomerular filtration rate (GFR), increased salt sensitivity, and elevated BP.[16] This study proves the fetal origin of adult hypertension.

Parental family history of hypertension played an important role in predicting the hypertension phenotype among adolescents with normal weight.[17] In this study, significant association between positive family history and hypertension was found in only in birth weight group of 2000 – 2499 (p = 0.03).

Limitations of the study: A larger sample size with a diverse population both from urban and rural areas would have been better for generalizability of the topic. Secondly, birth weight may not be correct in all the students as birth certificate was not as documentation.

Conclusion

It is a matter of great concern that prevalence of hypertension is increasing in children and adolescents. We have found a significant negative association between low birth weight and hypertension. Due to improved medical care the survival of LBW babies is increasing globally. Hence, we should give emphasis on prevention of birth of LBW babies to decrease the prevalence of hypertension in future generations. However, more environmental factors, genetic factors are to be included in further studies to increase the scientific level of this study.

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Conflicts of interest

There are no conflicts of interest.

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