Hypovitaminosis D, Dyslipidemia, and Thyroid Dysfunction among Adolescents and Their Associations with Blood Pressure in a Northeastern City of India

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Abstract

Background: Blood pressure (BP) is associated with serum levels of Vitamin D₃, lipid profile, and thyroid hormones among adults. However, limited information is available regarding such associations in adolescents. Objectives: The objectives of this study were to estimate the prevalence of Vitamin D deficiency, dyslipidemia, and thyroid dysfunction among secondary school students of Agartala and to determine their associations with BP. Methodology: This cross-sectional study was conducted from April 1, 2018, to December 31, 2018, among 1000 secondary-level school students of Agartala municipal corporation area, chosen by multistage sampling ensuring proportionate representation. Results: The prevalence of Vitamin D deficiency, thyroid dysfunction, and dyslipidemia was found to be 79.4%, 62.8%, and 37.5%, respectively. Among the respondents, 58.1% had raised BP, 16.7% were overweight, 5.3% were obese, and 48.3% had high waist-hip ratio (WHR). Among them, 70.97% of the fatty participants, 82.27% with high body mass index (BMI), and 69.05% with either low or normal WHR had significantly raised BP (P < 0.05). Out of total, 58.26% of the participants with normal serum D₃ level, 59.95% with either euthyroid or hyperthyroid status, and 62.13% with dyslipidemia had raised BP, though these were not significant (P > 0.05). Binary logistic regression model has identified higher BMI, higher body fat content, high WHR, habit of consuming extra salt, and fast food on a regular basis as significant determinants of raised BP in this population (P < 0.05). Conclusion: Hypovitaminosis D, thyroid dysfunction, and dyslipidemia are prevalent among adolescents of Northeast India, but they did not emerge as significant determinants of BP in this population.

Keywords: Adolescents, blood pressure, dyslipidemia, thyroid dysfunction, Vitamin D

Introduction

Hypertension was known predominantly as a disease of the later life, but these days increasing number of adolescents are also getting affected by it. The prevalence of prehypertension (PHT) and hypertension (HTN) among urban school-going adolescents in a northeastern city of India was found to be 42.40% and 15.70%, respectively. Epidemiological studies have shown associations between low Vitamin D levels, dyslipidemia, and cardiovascular diseases. Studies across different parts of Asia show a widespread prevalence of Vitamin D deficiency among all age groups. In India, several studies have revealed a widespread prevalence of Vitamin D deficiency among all age groups including school-going children, pregnant women, lactating mothers, neonates, and adults. In this country, the prevalence of hypovitaminosis D ranged from 84.9% to 100% among school-going children. The high prevalence of hypovitaminosis D is an important public health issue as it is an independent risk factor for total mortality in the general population. From an earlier study, it was observed that thyroid dysfunction, both hypo- and hyperthyroidism, may increase the risk of developing hypertension. In India, the prevalence of hypothyroidism is approximately 11% which is comparatively higher than the developed nations such as the USA and UK, where it is only 4.6% and 2%, respectively.

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respective study. Studies have shown an association between hypertension and hypothyroidism in adults. Association of serum thyroid-stimulating hormone (TSH) level with systolic and diastolic hypertension in children has also been observed. Population of Northeast India differs from rest of the nation regarding ethnicity, food habit, lifestyle, literacy, geographic factors, etc. This region is included in the goiter belt of India, where thyroid dysfunction is common due to scarcity of iodine in the groundwater. Limited data are available regarding serum Vitamin D₃ level and lipid profile of the adolescents of Northeast India. In this context, the present study was carried out to estimate the prevalence of hypovitaminosis D₃, dyslipidemia, and thyroid dysfunction among secondary school students of Agartala municipal corporation area and also to determine their associations with blood pressure (BP).

**Methodology**

This school-based cross-sectional study was conducted from April 1, 2018, to December 31, 2018, among 1000 students studying in different secondary-level schools located in Agartala municipal corporation area chosen by multistage sampling technique ensuring proportionate representation in the sample. Minimum sample size requirement for this study was determined using the formula for calculating sample size in prevalence studies using proportion, i.e., sample size: \[ n = \left( \frac{Z^2 \cdot 0.05^2}{(p \times q)} \right) + 1 \] assuming 84.9% of the Indian adolescents suffer from Vitamin D₃ deficiency at 95% confidence interval (CI) and 2.5% absolute precision and a design effect of 1.2. It was found to be 946, which was rounded to 1000 adolescent students.

PHT was defined as systolic BP between 120 and 139 mmHg and/or diastolic BP of 80–89 mmHg. Hypertension (HTN) was defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg or on BP-lowering medications. In this study, participants having either PHT or hypertension were considered as having raised BP.

Special physical exercise for good health was defined as prescribed or recommended amount of walking, jogging, skipping, running, swimming, freehand exercises, gym-based exercises, etc., aimed at achieving or maintaining health. Fast food items were considered as items which were available at restaurants or at roadside stalls and usually contained high fat and calorie. BG Prasad’s socioeconomic status classification (2017) was used for classifying the socioeconomic status of the students.

A list of secondary-level schools was collected from the Directorate of School Education. Agartala municipal area had four administrative zones. Separate sampling frames for each zone consisting of eligible schools of that particular zone were constructed. In the first stage of sampling, two schools were selected from each municipal zone by simple random sampling without replacement. In the second stage, students studying in classes IX–XII of the selected schools were chosen by simple random sampling without replacement using the attendance registers as sampling frames on the day of data collection.

For measuring weight, the participants with minimum possible clothing were asked to stand erect and barefooted over the digital bathroom weighing scale placed upon an even surface. The weighing scale was calibrated daily before starting data collection by putting standard weight upon it. For measuring height, the study participants were asked to stand erect, bare, and close footed over the footplate of the stadiometer in such a way that the occiput, back, hip, and the heals lie in contact with the stadiometer stand. Then, the head plate of the stadiometer was gradually brought down upon the head to place firmly. In this position, height readings were taken.

After finishing the interview and anthropometry, venous blood samples were collected from the respondents and transported to the “Multidisciplinary Research Unit” (MRU) located at Agartala Government Medical College (AGMC) following standard guidelines for analysis. Laboratory technicians, and laboratory assistants of the MRU, AGMC assisted the authors for conducting interview, anthropometry, and blood sample collection.

Data entry and analysis were performed with a computer using “SPSS 25.0 for windows. (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Chi-square test with Yates’ correction was used for studying the association between categorical variables. Binary logistic regression analysis was used to predict the development of elevated BP by using significant independent variables. A probability value <0.05 was considered statistically significant.
significant. This study was approved by the Institutional Ethics Committee of AGMC.

RESULTS

Among the students, 41.1% were male, 82.6% belonged to upper socioeconomic, 16.2% to upper middle, 11.1% to middle, and only 0.1% to lower socioeconomic class as per B. G. Prasad’s socioeconomic status classification.[7] Out of total, 41% belonged to general category, 18.4% to scheduled caste, 15.2% to scheduled tribe, and 25.4% to other backward communities. Among the study participants, 95.60% were nonvegetarians, and out of the nonvegetarians, 37.34% used to take meat more than twice a week and 13.70% of participants used to take fast food from outside the home regularly. Regular consumption of table salt was reported by 34.50% and regular physical exercise by 36.80% of the participants. History of smoking and occasional alcohol consumption was revealed by only 0.40% and 0.05% of the students, respectively. About guardians of the students, 1.7% were illiterate, 24.2% had primary education, and 74.1% studied up to either secondary level or above.

The prevalence of Vitamin D₃ deficiency, thyroid dysfunction, and dyslipidemia was found to be 79.4%, 62.8%, and 37.5%, respectively. Out of total, 58.1% of the study participants had raised BP (42.40% prehypertensive and 15.70% hypertensive), 34.1% were fatty, 16.7% were overweight, 5.3% were obese, and 48.3% had high waist–hip ratio (WHR). Mean (standard deviation) systolic and diastolic BP of the study participants were found to be 117.24 (±9.0) and 75.50 (±7.17) mmHg, respectively. The distribution of all the study participants based on normal BP and elevated BP among the different subgroups of the variables, namely Vitamin D₃, body mass index (BMI), and thyroid status are shown in Table 1.

Mean BMI and TSH were found to be significantly higher among the students with elevated BP, whereas mean serum D₃, low-density lipoprotein, WHR, and body fat content did not differ significantly between normotensive participants and the participants having elevated BP [Table 2].

Binary logistic regression analysis showed that an adolescent had a 73.4% (95% CI = 0.570–1.904) higher chance of having raised BP with every unit of decrease in his serum D₃ level though it was not significant (P = 0.087). Whereas, the chances of having raised BP were 47.6% (95% CI = 1.024–2.921) with every unit increment of BMI and it was found to be statistically significant (P = 0.000). Likewise, participants with higher body fat content and high weight–hip ratio, habit of consuming extra salt, and fast food on a regular basis had significantly higher chances of developing raised BP. The rest did not attain the level of statistical significance [Table 3].

DISCUSSION

The present study reported a much higher prevalence of hypertension where 58.1% of the school-going adolescents from this part of Northeast India had raised BP. In this study, BP of the students showed a positive correlation with BMI, which is consistent with the report of Shetty et al.[8] Voors et al. studied the effect of BMI and age in determining BP, and the role of BMI was found to be significant.[9]

Studies have shown that hyperthyroidism can cause hypertension.[10] It has been demonstrated that hypothyroidism has a positive correlation with BP.[10] Increased peripheral vascular resistance and low cardiac output have been suggested to be the possible link between hypothyroidism and raised diastolic BP. In the present study, 57% of the adolescents suffering from hypothyroidism had significantly raised BP, and this finding was at par with the findings of the study conducted by Itterman et al.[5] India has got high burden of hypothyroidism, and a study conducted by Stabouli et al. had found it to have a positive correlation with BP level.[11] The present study has found significantly elevated TSH levels among adolescents with raised BP. Similarly, Itterman et al. have also found significant associations between serum TSH level and BP of the adolescents. Velayudhan and Sasidharan and Dolinsky et al. in their studies have found significant associations between serum D₃ level and BP status of the children and adolescents.[12,13] Similarly, the present study has also found that 58.1% of the adolescents with low serum D₃

Table 1: Association of blood pressure with physical and biochemical parameters

| Variables                  | Subgroup          | Normotensive, n (%) | Elevated BP, n (%) | Significance (χ², P) |
|----------------------------|-------------------|---------------------|--------------------|---------------------|
| Vitamin D₃ level           | Low               | 333 (41.94)         | 461 (58.06)        | 0.001, 0.976       |
|                            | Normal            | 86 (41.74)          | 120 (58.26)        |                    |
| Thyroid status             | Hypothyroid       | 266 (42.97)         | 352 (57.03)        | 0.748, 0.387       |
|                            | Eu and hyperthyroid | 153 (40.05)     | 229 (59.95)        |                    |
| Lipid profile              | Eulipidemic       | 277 (44.32)         | 348 (55.68)        | 3.749, 0.052       |
|                            | Dyslipidemic      | 142 (37.87)         | 233 (62.13)        |                    |
| BMI                        | Low and normal    | 380 (48.72)         | 400 (53.28)        | 66.433, 0.000      |
|                            | High              | 39 (17.73)          | 181 (82.27)        |                    |
| Body fat                   | Lean              | 320 (48.56)         | 339 (51.44)        | 34.398, 0.000      |
|                            | Fatty             | 99 (29.03)          | 242 (70.97)        |                    |
| WHR                        | Low and normal    | 160 (30.95)         | 357 (69.05)        | 51.815, 0.000      |
|                            | High              | 259 (53.62)         | 224 (46.38)        |                    |

BP: Blood pressure, BMI: Body mass index, WHR: Waist-hip ratio
level were having raised BP. Likewise, a negative correlation between serum D$_{3}$ level and BP status was observed among adolescents by Debora and Giannini.[14]

In the present study, 62.13% of the dyslipidemic adolescents had raised BP, but binary regression model failed to detect any significant effect of dyslipidemia up on their BP status. This fact was at par with the study conducted by Baroncini et al.[15] In this study, BMI and WHR of the adolescents were found to be significantly associated with raised BP. This was at par with the findings of Kuciene and Dulskiene.[10] The present study has found that habit of consuming extra salt with cooked food and consumption of fast food on a regular basis are significantly associated with raised BP among the adolescents. This was also at par with the findings of Debara and Giannini.[14] Although Vitamin D deficiency, thyroid dysfunction, and dyslipidemia were found to be prevalent among adolescents living in this part of Northeast India, they did not emerge as significant determinants of BP in them. Higher prevalence of elevated BP among school-going adolescents implies the changing scenario of cardiovascular diseases in the current era. This may be attributable to sedentary lifestyle, consumption of junk food, and raised mental stress. Hence, performing physical activity in an outdoor environment, with sun exposure, would help the adolescents to maintain their body fitness along with sufficient Vitamin D3 level in their body.

**Conclusion**

Vitamin D3 deficiency, thyroid dysfunction, and dyslipidemia are prevalent among the school-going adolescents of Agartala, a northeastern city of India, but these are not found to be the significant determinants of BP in this population.

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**Conflicts of interest**

There are no conflicts of interest.
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