Blood Pressure Status and Physical Activity among Adolescents of Hilly area

Authors

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Abstract

Blood pressure is listed as an important physiological condition of the adult and geriatric population. The high blood pressure observed among children living at high altitude may be due to greater effects of high altitude on body weight and height, blood viscosity, and cardiac output than on peripheral vasodilatation. A cross sectional study was conducted on school and college going adolescent group (Class 9-12) of Bandarban district. A total of 297 students whose age was in the range of 14-18 years and had consented to be a respondents were included in the study. A semi-structured questionnaire and a checklist were used for data collection through a face to face interview procedure. In this study about 57.6% were female of 16 years of age (33.7%). About 12.8% respondents had family history of hypertension in spite of good physical activity (77.4%). Mean of systolic blood pressure of male respondents were 123.52 ± 10.19 mm of Hg and in female respondents were 120.20 ± 10.10 mm of Hg. Mean of diastolic blood pressure of male respondents were 71.88 (± 7.18) mm of Hg and in female 72.23 ± (7.78) mm of Hg. Mean of pulse pressure of male respondents were 51.63 (± 7.86) mm of Hg and in female 47.97 (± 7.61) mm of Hg. Mean of mean arterial pressure of male respondents were 89.09 (± 7.44) mm of Hg and in female 88.22 ± (7.84) mm of Hg. Strenuous efforts targeting detrimental behaviors and imparting the sense of healthy lifestyle enhancing practices are vital to control this situation.

Keywords: Blood pressure, Physical activity, Adolescents, Hilly area.

Introduction

Blood pressure is listed as an important physiological condition of the adult and geriatric population\textsuperscript{1,2}. During the past 30 years, prevalence has increased in the infant-juvenile age group in the world scenario\textsuperscript{3}. National and international publications have shown a prevalence of high arterial pressure in children and adolescents, ranging between 1% -12% and 2%-10%, respectively\textsuperscript{3,4,5}. In the context of hypertension in infancy and adolescence, the main risk factors of elevated primary levels of arterial pressure are family history of the disease, overweight, smoking (passive and/or active) and alcohol consumption\textsuperscript{6,7}. The main repercussions of the disease in adulthood and old age are the cerebrovascular diseases, coronaries, cardiac and chronic renal failure and other vasculopathies\textsuperscript{7}.
During acute exposure to hilly/high altitude area, important ventilatory and cardiovascular adaptations develop in response to changing environmental conditions\(^8,9\), in particular to hypo-baric hypoxia, in order to maintain homeostasis\(^9\). The reduction in oxygen partial pressure in the inspired air determines a reduction in venous blood re-oxygenation\(^9,10\).

As a consequence of reduced quantity of blood transported oxygen, oxygen extraction to peripheral tissues is also reduced\(^11\), leading to a significant reduction in exercise capacity\(^11,12\). A proper adaptive cardiovascular response to altitude is thus essential\(^12\).

The high blood pressure observed among children living at high altitude may be due to greater effects of high altitude on body weight and height\(^13\), blood viscosity\(^13\), and cardiac output\(^13\) than on peripheral vasodilatation\(^13,14\). Another explanation is insufficient vascular adaptive changes at this age group since high altitude did not result in hypertension in adults\(^15,16\).

**Materials and Methodology**

**Study Population, Setting, and Design**

A cross sectional study was conducted on school and college going adolescent group (Class 9-12) of Bandarban district. A total of 297 students whose age was in the range of 14-18 years and had consented to be a respondents were included in the study.

**Data Collection Instruments**

A pre-tested semi-structured questionnaire consisting information about socio-demographic characteristics and physical activity status of respondents which was adopted from International Physical Activity Questionnaire-Short Form\(^17\) was used for data collection. A checklist was used to evaluate blood pressure, height and weight and they were measured by using an automated digital blood pressure machine, metal measuring tape and digital weight measuring machine, respectively.

**Data Collection Techniques**

Data was collected by face to face interview. At a time 10 students were taken to a room and were allowed to sit for 10 minutes. Meanwhile, in order to make them relaxed the purpose and procedure of the study was explained to them. The respondents were instructed to avoid caffeine, exercise and smoking for at least 30 min before measurement and ask to empty their bladder if there was an urge and avoided talking during blood pressure measurement was properly maintained\(^18\). Appropriate size cuff as per arm circumference was used to measure blood pressure. The cuff was placed 2-3 cm above the antecubital fossa with rubber bag centralized over brachial artery. Blood pressure was measured in the seated position with the right arm supported at heart level. Blood pressure was taken three times with 5 minutes’ interval\(^19\).

**Results**

In this cross-sectional study among 297 respondents about 57.6% were female of 16 years of age (33.7%). About 12.8% respondents had family history of hypertension in spite of good physical activity (77.4%). Prevalence of paternal, maternal, paternal grandparents’ and maternal grandparents’ history of hypertension are enlisted in table 01. About 37.7% took extra salt during meal and 80.8% took salt preserved fish with meal. About 8.8% respondents used tobacco for smoking purpose (Table 01).

Mean of systolic blood pressure of male respondents were 123.52 ± 10.19 mm of Hg and in female respondents were 120.20 ± 10.10 mm of Hg. Mean of diastolic blood pressure of male respondents were 71.88 (± 7.18) mm of Hg and in female 72.23 ± (7.78) mm of Hg. Mean of pulse pressure of male respondents were 51.63 (± 7.86) mm of Hg and in female 47.97 ± (7.61) mm of Hg. Mean of mean arterial pressure of male respondents were 89.09 (± 7.44) mm of Hg and in female 88.22 ± (7.84) mm of Hg (Table 02).
Table 1: Socio-demographic characteristics, smoking behaviours and eating habits of respondents

| Traits                          | Hilly (%) | p Value |
|---------------------------------|-----------|---------|
| Gender                          |           |         |
| Male                            | 42.4      | 0.118   |
| Female                          | 57.6      |         |
| Age                             |           |         |
| 14                              | 7.7       |         |
| 15                              | 28.3      |         |
| 16                              | 33.7      | <0.0001 |
| 17                              | 25.3      |         |
| 18                              | 5.1       |         |
| Religion                        |           |         |
| Muslim                          | 27.6      |         |
| Hindu                           | 6.4       |         |
| Buddhist                        | 36.7      | 0.000   |
| Christian                       | 16.2      |         |
| Krama                           | 13.1      |         |
| Level of education              |           |         |
| Class 9                         | 18.2      |         |
| Class 10                        | 43.1      | 0.000   |
| Class 11                        | 22.9      |         |
| Class 12                        | 15.8      |         |
| Familial history of hypertension|           |         |
| Father                          | 6.4       | 0.868   |
| Mother                          | 9.1       | 0.676   |
| Paternal Grandparents           | 0.7       | 0.020   |
| Maternal Grandparents           | 1.0       | 1.000   |
| Behaviour Characteristics       |           |         |
| Consumption of extra table salt with meal | 37.7 | 0.101 |
| Consumption of salt preserved fish | 80.8 | 0.000 |
| Use of tobacco                  | 8.8       | 0.000   |
| Category of physical activity   |           |         |
| Low                             | 22.6      |         |
| Moderate                        | 54.9      | 0.000   |
| High                            | 22.6      |         |
| BMI status                      |           |         |
| Under weight                    | 25.9      |         |
| Normal weight                   | 70.0      | 0.000   |
| Over weight                     | 3.4       |         |
| Obese class I                   | 0.7       |         |

Table 2: Means of different measures of blood pressure of respondents

| Blood Pressure | Hilly (%) | p Value |
|----------------|-----------|---------|
| Male           |           |         |
| SBP            | 123.52 ± 10.19 | <0.0001 |
| DBP            | 71.88 ± 7.18 | 0.000   |
| PP             | 51.63 ± 7.86 | 0.000   |
| MAP            | 89.09 ± 7.44 | 0.000   |
| Female         |           |         |
| SBP            | 120.20 ± 10.10 | 0.000   |
| DBP            | 72.23 ± 7.78 | 0.043   |
| PP             | 47.97 ± 7.61 | 0.000   |
| MAP            | 88.22 ± 7.84 | 0.000   |

SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure, PP=Pulse Pressure, MAP= Mean Arterial Pressure

Discussions
The high blood pressure observed among adolescent living at hilly area may be due to greater effects of altitude on body weight and height, blood viscosity, and cardiac output than on peripheral vasodilatation. Another explanation is insufficient vascular
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adaptive changes at this age group since high altitude did not result in hypertension in adults\textsuperscript{20}. A few studies in this regard reveal contradictory views on difference of blood pressure of people living in high and low altitude areas. It is generally believed that both systolic blood pressure (SBP) and diastolic blood pressure (DBP) are lower in the high than in the low-altitude populations\textsuperscript{21}. Initial exposure to high altitude leads to increase in BP which is attributed largely to increased autonomic or sympathetic activity. SBP and DBP gradually decline, after years of residence at high altitude, even falling below those observed at sea level\textsuperscript{22}. Compared with residents living at sea level, Andean residents at high altitude have lower resting BP, especially SBP. Furthermore, high altitude residents who migrate to sea level show gradual elevations in BP levels\textsuperscript{23}. Studies on US Whites born at low altitude living at high altitude showed that the degree of decline in systemic BP is a function of length of time at residence at high altitude\textsuperscript{24}. The long-term residents and natives of high altitude Andes show reduced BP, lower rates of hypertension, and lower cardiac anomalies. This observation is also observed in some other high-altitude populations like Sherpa’s, natives of Tien Shan and the Pamir and the people in the Ambers region in Ethiopia\textsuperscript{25}. The cause of decline in BP at high altitude has been attributed to relaxation of vascular smooth muscle, an increase in collateral circulation, increased vascularization, higher red blood cell level and haemoglobin level, hypocaloric stress and diseases like respiratory tract ailments\textsuperscript{25,26,27}. Some studies on the natives of Andes, native Americans of Chile, natives of Mongolia and an agricultural population of India did not find any effect of altitude on BP\textsuperscript{28}. However, a few studies on high altitude natives of Ethiopia, high altitude natives of Saudi Arabia, Tibetans of Lhasa and high altitude cold zone cattle-breeders of Mongolians showed just the opposite relationship, that is, high-altitude residents showing higher BP\textsuperscript{29}. Another study on Tibetans from a refugee settlement in India at low altitude report lower BP values\textsuperscript{17}. Studies on other high-altitude Himalayan populations like Sherpa, who trace their ancestry to Tibet reported lower blood pressure at high altitude and a much smaller age-related increase in blood pressure. But a recent study on Sherpa in the modernizing Nepal showed elevated BP for both the altitudes\textsuperscript{18}.

The risk factors independently associated with high BP in this study are obesity, altered food habits, and physical inactivity\textsuperscript{30}. In obese children, activation of sympathetic nervous system shifts the arterial pressure control mechanism of diuresis and natriuresis to higher BP levels might be the possible reason illuminating the association\textsuperscript{31}.

Conclusions
Systolic blood pressure, diastolic blood pressure, mean arterial pressure and pulse pressure were almost similar in both gender in spite of their good physical exercise. Most of them consume salted fish product which may be a significant cause of blood pressure variation. Strenuous efforts targeting detrimental behaviors and imparting the sense of healthy lifestyle enhancing practices are vital to control this situation.

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Limitations
In this present study, as a hilly area Bandarban was selected purposively. So the conclusion from this study may not necessarily represent the all hilly areas in Bangladesh. Fast food and alcohol consumption was not measured in this study. As physical activity was assessed using IPAQ (short)
questionnaire, there could have been some recall bias when respondents tried to recall their 7-day activities in responses to questions asked.

Declarations

Funding: No funding.

Conflict of Interest: No competing interests relevant to this study to disclose for all authors. Full forms submitted and on file for all authors.

Ethical Approval: All the procedures were conducted following the ethical guidelines of institution’s ethical committee (Institutional Review Board) at National Institute of Preventive and Social Medicine (NIPSOM). The ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards will be followed wherever applicable. Before initiation of data collection, a brief introduction on the aims and objectives of the study were presented to the school and college authority. They were informed about their full right to participate or refuse to participate in the study.

References

1. Islam, J.Y., Zaman, M.M., Haq, S.S., Ahmed, S. and Quadir, Z.A., 2018. Epidemiology of hypertension among Bangladeshi adults using the 2017 ACC / AHA Hypertension Clinical Practice Guidelines and Joint National Committee 7 Guidelines, 2018. Journal of Human Hypertension. Available at: http://dx.doi.org/10.1038/s41371-018-0087-5
2. Pandey, S., Singh, R.K., Jha, S.K., Singh, A. and Bartwal, J., 2016. An epidemiological evaluation of risk factors for hypertension among a hilly rural population of India: a matched case – control study. Journal of Medical Science and Public Health, 5(09), pp.1835-1840.
3. Raina, S.K., Chander, V., Prasher, C.L. and Raina, S., 2016. Prevalence of Hypertension in a Tribal Land Locked Population at High Altitude. Scientifica, 2016(3589720), pp.1–8.
4. Vats, P., Ray, K., Majumadar, D., Amitabh., Joseph, D.A., Bayen, S., Akunov, A., Sarbaev, A. and Singh, S.B., 2013. Changes in cardiovascular functions, lipid profile, and body composition at high altitude in two different ethnic groups. High Alt MedBio, 1 (14), pp.45–52.
5. Tripathy, V. and Gupta, R., 2007. Blood pressure variation among Tibetans at different altitudes. Annals of Human Biology, 34(4), pp.470–483.
6. Marticorena, E., Ruiz, L., Severino, J., Galvez, J. and Penaloza, D., 1969. Systemic Blood Pressure in White Men Born at Sea Level: Changes After Long Residence at High Altitudes. The american journal of cardiology, 23, pp.364–368.
7. Bera, S., 2006. A study on blood pressures between the Tibet born and India born Tibetans who are permanently residing in Northern India. Coll Antropol, 30, pp.749–752.
8. Ariani, A., Lisma, T.E., Lubis, I.Z., Ramayati, R. and Rusdidjas., 2003. Study of blood pressure in elementary school children at hill and seashore areas. Paediatrica Indonesiana, 43(1), pp.6–9.
9. Fiori, G., Facchini, F., Pettener, D., Rimondi, A., Battistini, N. and Bedogni, G., 2000. Relationships between blood pressure, anthropometric characteristics and blood lipids in high- and low-altitude populations from Central Asia. Annals of human biology, 27(1), pp.19- 28.
10. Norboo, T., Stobdan, T., Tsering, N., Angchuk, N., Tsering, P., Ahmed, I., Chorol, T., Sharma, V.K., Reddy, P., Singh, S.B., Kimura, Y., Sakamoto, R., Fukutomi, E., Ishikawa, M., Suwa, K., Kosaka, Y., Nose, M., Yamaguchi, T., Tsukihara, T., Matasubayashi, K., Otsuka, K. and Okumiya, K., 2015. Prevalence of hypertension at high altitude: cross-sectional
survey in Ladakh, Northern India 2007–2011. BMJ, 2015(5), pp. 1–15.

11. Marticorena, E., Ruiz, L., Severino, J., Galvez, J. and Penaloza, D., 1969. Systemic Blood Pressure in White Men Born at Sea Level: Changes After Long Residence at High Altitudes. The american journal of cardiology, 23, pp.364–368.

12. Sique, P., Brito, J., Banegas, J.R., Velarde, F.L., Cruz-troca, J.J.D.L., Lopez, V., Naveas, N. and Herruzzo, R., 2009. Blood Pressure Responses in Young Adults First Exposed to High Altitude for 12 Months at 3550 m. High altitude medicine & biology, 10(4), pp.329–335.

13. Rahman, A.F.M.M., Afroze, A. and Islam, M.N., 2005. Prevalence and Risk Factors of Hypertension Among School Going Children of Dhaka City. Bangladesh j child health, 29(3), pp.82–87.

14. Hirschler, V., Gonzalez, C., Molinari, C., Velez, H. and Nordera, M., 2019. Blood pressure level increase with altitude in three argentinean indigenous communities. AIMS Public Health, 6(4), pp.370–379.

15. Shah, S., Olhaj, A. and Aziz, F., 2014. Blood Pressure in Children: Role of High Altitude? Pediatrics, 135(12), pp.512–513

16. Shrestha, S., Shrestha, A., Shrestha, S. and Bhattarai, D., 2012. Blood Pressure in Inhabitants of High Altitude of Western Nepal. J Nepal Med Assoc, 52(188), pp.154–158.

17. Grace Lavelle, Marika Noorkoiv, Nicola Theis, Thomas Korff, Cherry Kilbride, Vasilios Baltzopoulos, Adam Shortland, Wendy Levin, Jennifer M. Ryan, Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF) as a measure of physical activity (PA) in young people with cerebral palsy: A cross-sectional study, Physiotherapy, Volume 107, 2020, Pages 209-215, ISSN 0031-9406, https://doi.org/10.1016/j.physio.2019.08.013

18. Frese, Ethel M et al. “Blood pressure measurement guidelines for physical therapists.” Cardiopulmonary physical therapy journal vol. 22,2 (2011): 5-12.

19. Ogedegbe, Gbenga, and Thomas Pickering. “Principles and techniques of blood pressure measurement.” Cardiology clinics vol. 28,4 (2010): 571-86. doi: 10.1016/j.ccl.2010.07.006

20. Kotsis V, Stabouli S, Papakatsika S, Rizos Z, Parati G. Mechanisms of obesity-induced hypertension. Hypertens Res. 2010;33:386–93.

21. Sundar JS. Prevalence and determinants of hypertension among urban school children in the age group of 13-17 years in, Chennai, Tamilnadu. Available from: https://www.omicsonline.org/prevalence-and-determinants-of-hypertension-among-urban-school-children-in-the-age-group-of-years-in-chennai-tamilnadu-2161-11651000130

22. Ostrowska-Nawarycz L, Nawarycz T. Prevalence of excessive body weight and high blood pressure in children and adolescents in the city of Lodz. Kardiol Pol. 2007;65:1079–87.

23. Kar S, Khandelwal B. Fast foods and physical inactivity are risk factors for obesity and hypertension among adolescent school children in east district of Sikkim, India. J Nat Sci Biol Med. 2015;6:356–9.

24. Gupta AK, Ahmad AJ. Childhood obesity and hypertension. Indian Pediatr. 1990;27:333–7.

25. Carter MA, Tremblay M. Do childhood excess weight and family food insecurity share common risk factors in the local environment? An examination using a Quebec birth cohort. Applied Physiology, Nutrition, and Metabolism. 2014;39:404. [Doi: 10.1139/apnm-2013-0447]

26. Musaiger AO, Al-Mannai M, Zagzoog N. Association between food intake frequency
and obesity among adolescent girls in Saudi Arabia. Int J Adolesc Med Health. 2014;26:145–7.

27. Durrani AM, Waseem F. Blood pressure distribution and its relation to anthropometric measurements among school children in Aligarh. Indian J Public Health. 2011;55:121–4.

28. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al. Recommendations for blood pressure measurement in humans and experimental animals: Blood pressure measurement in humans. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15699287

29. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, et al. 2000 CDC growth charts for the United States: Methods and development. Available from: https://www.cdc.gov/growthcharts/2000growthchart-us.pdf

30. Xu H, Hu X, Zhang Q, Du S, Fang H, Li Y, et al. The association of hypertension with obesity and metabolic abnormalities among Chinese children. Int J Hypertens 2011. 2011:987159.

31. Schommer VA, Barbiero SM, Cesa CC, Oliveira R, Silva AD, Pellanda LC. Excess weight, anthropometric variables and blood pressure in schoolchildren aged 10 to 18 years. Arq Bras Cardiol. 2014;102:312–8.