www.jmscr.igmpublication.org Impact Factor 3.79
ISSN (e)-2347-176x

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Study of Blood Pressure Changes with Altitude at Shimla

Authors
Dr. Meenu Agarwal[1], Dr. Narinder Mahajan[2]
[1]Resident Medical Officer, Indian Institute of Advanced Study, Rashtrapati-Nivas, Shimla
[2]Assistant Professor, Department of Community Medicine, Indira Gandhi Medical College Shimla
Email: *meenuiias@rediffmail.com*

ABSTRACT

Objective: Residence at high altitude has been associated with elevation in systemic blood pressure. This study was designed to determine the effects of median altitude on blood pressure.

Methods*:* 100 subjects were interviewed and their blood pressures were measured at Shimla (India) located at a height of 2,205 meters. Their previous blood pressures at lower altitudes of approximately 271 meters were noted from their previous records as well as from their statements.

Results*:* Mean Arterial Pressure was found to be increased in 82 subjects.

Interpretation: Our findings imply that moderate altitude living results in significantly greater blood pressure

Key words: altitude, blood pressure

INTRODUCTION

This study was undertaken at city of Shimla in India as blood pressure was found to be raised in many patients visiting the health centre for blood pressure check up or other ailments as compared to their previous blood pressure readings at lower altitude. The health center is located in Indian Institute of Advanced Study where scholars from all over India and Abroad come for research work in social sciences.

Review of literature-High altitude exposure causes many physiological and biochemical changes in man. It has been reported that increased sympathetic stimulation and autonomic activity contribute to a rise in systemic blood pressure at high altitude (1).

Systemic arterial pressure rises on acute exposure to high altitude and change in blood pressure and endothelial function may be important in the pathogenesis of clinical syndromes occurring at high altitude (2).

There is marked inter-individual health disparities at high altitude including blood pressure responses at altitude.

Various altitude ranges are described according to the height above sea level according to medical dictionary in Table 1:-

Table 1:-Various Altitude Ranges above Sea level

Altitude	Height in meters above sea level
Low	Below 1,524
Medium	1,524 to 2,438
High	2,438 to 3,658
Very High	3,658 to 5,487
Extremely High	Above 5,500

Major clinical syndromes that fall under the category of altitude sickness are (1) Acute mountain sickness. (2) High altitude pulmonary edema. (3) High altitude cerebral edema.

Symptoms of Acute mountain sickness are dizziness, headache, shortness of breath, nausea, vomiting, loss of appetite and insomnia.

It has been documented that sojourn at high altitude is accompanied by increased blood pressure, possibly sympathetically mediated (3). This increase has been seen in both systolic and diastolic pressures.

Systolic pressure measure the amount of pressure that blood exerts on arteries and vessels while the heart is beating.

Diastolic pressure is the pressure that is exerted on the walls of various arteries around the body in between heart beats when the heart is relaxed.

METHODS

Participants were scholars who come on fellowship to the Indian Institute of Advanced study from different parts of India and abroad. They visited the health centre for routine blood pressure check up with history of hypertension and other ailments. 100 subjects (age range 30 to 77 years) average age of 55.41 years,average height of 166.25cms. ,average weight of 71Kg. average Body Mass Index (BMI) of 26.8 participated in the study. Study period was from April 2008 to June 2010.Blood Pressure, Pulse, Height and Weight were recorded in a health centre at Shimla situated at a height of 2205 mtrs. Above sea level, Body Mass Index (BMI) was calculated as weight in kg. Divided by square of height in meters. Average altitude of residence was 271 meters above sea level. 15 subjects were smokers. Previous blood pressure recordings from their native places were noted from their health records. Their blood pressure in Shimla was monitored within one week of their arrival to two years. Informed consent was obtained from each subject. They were not paid anything for their participation. Participants were educated about blood pressure following the study. Participants were prescribed medication for high blood pressure that were found to have high blood pressure as a result of the study and other participants who were already on medication their doses had to be increased for the period they were in Shimla. The study was approved by local ethics committee. Mean Arterial Blood Pressure (MABP) values were calculated as MABP=(SBP-DBP/3)+DBP, here SBP is Systolic blood pressure and DBP is Diastolic blood pressure.

RESULTS

Table 2. Comparison of number of patients in three ranges of blood pressure at shimla and lower level

City	Systolic			Diastolic		
	<120	120 - 140	>140	70 - 90	90 - 100	>100
Shimla	5%	50%	45%	64%	28%	8%
Lower Altitude	8%	88%	4%	97%	3%	0

45% patients had more than 140 mmHg of systolic blood pressure at Shimla as compared to only 4% at lower altitude.97% patients had diastolic blood pressure within normal range of 70-90 mmHg at lower altitude as compared to only 64% at Shimla as described in table -2.

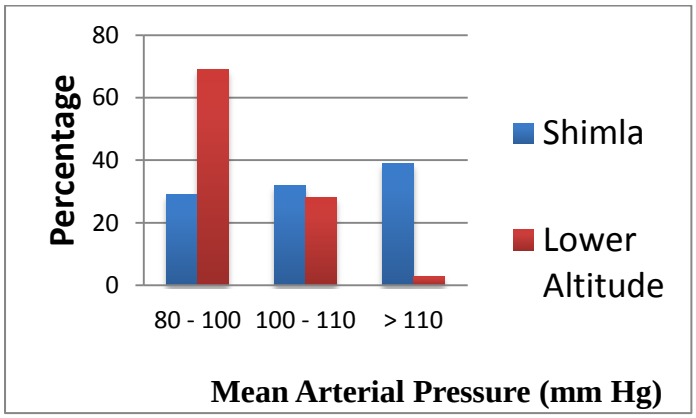

Figure 1 :-Comparison of MAP at Shimla with Lower Altitude

Mean Arterial Pressure was higher in Shimla as compared to lower altitude.29% of patients at Shimla had their MAP (mean arterial pressure) within normal range of 80-110,whereas 69% of patients at lower altitude recorded MAP within normal range. 32% of patients at Shimla had MAP between 100-110 and 28% of patient at lower altitude had their MAP in this range. 69% of patients at Shimla recorded MAP of >110 as compared to only 3% at lower altitude as shown in Figure 1.

DISCUSSION

In this study we evaluated the blood pressure response to moderate altitude in 100 subjects at an altitude of 2205 meters. Our results show that stay at moderate altitude increases systemic blood pressure. When the patients returned back to their native places at low altitude, they recorded lower blood pressure and some of them had to reduce their dosage of medicine. Limitation of study is that the blood pressure was recorded from their medical records at lower altitude. The altitude induced increase in blood pressure has been attributed to an increased and dominant sympathetic tone [4]. . Blood volume and red blood corpuscles (RBCs) are larger in high altitude dwellers as a result of increased erythropoietin levels to compensate for oxygen shortage. Since increased blood volume and RBC mass increase heart work requirements at high altitudes, this may also contribute to the elevation in blood pressure.

Most studies show that residence at high altitude is associated with elevation in blood pressure. Because plasma epinephrine and norepinephrine

also increase at altitude, hypothesis is that heightened sympathoadrenal activity may cause increased arterial pressure (5). Similar observations were made in a study in Italy (6). An immediate increase in blood pressure and heart rate was observed in healthy untrained subjects of a wide age range after exposure to 2950 meters. Many additional factors such as temperature, humidity, sensory stimulation also play important role. In the present study these factors were controlled as the participants were scholars, and there was little physical activity and they went back in winter vacations, therefore temperature was controlled and was kept close to 20°C during all the recordings. Their stay in Shimla was for two years.

The pathophysiology of altitude related high blood pressure is primarily related to hypoxia, compensatory hyperventilation, and low carbon dioxide levels as a result of reduced bariatric pressure. Cold induced diuresis with loss of blood volume causing hemoconcentration, secondary polycythemia, and increased blood viscosity, eventually contributing to increased blood pressure has been described.(7).Similar study in Spain showed that Human population living at moderate altitude and many lowlanders travelling to mountains are potentially exposed to the risk of developing hypertension and sympathetic overactivity. (8)As such, in a study performed in Arabia, it was found that blood pressure of the people living at high altitude was higher, and this was attributed to higher Body Mass Index (BMI) and polycythemia of those people (9).In a study in Turkey blood pressure in children living in moderate altitude of 1725 meters was found to be higher than those living at sea level (10).A study performed in adults in Russia demonstrated that systolic blood pressure (SBP) and diastolic blood pressure (DBP) Increased significantly in males and females living at 2540 meters in comparison to those living at sea level in all age groups (11).Likewise hypertension has been reported to be frequent in Tibetans (12).Similar observations were also made in Yemen (13). In Ethopia also blood pressures among highland Ethopians were found to be greater than among lowlanders (14).

What this study adds- In conclusion this study adds that exposure to even moderate altitude easily and often reached by general population causes a small but significant increase in blood pressure leading to health disparities. Some physiological factors (e.g. lower environmental temperature and lifestyle modification) together with hypoxia seem responsible for this change. Therefore people travelling to these places need to be aware of these changes and should take necessary precautions during their stay at moderate altitude.

REFERENCES

1. Kumar Ratan, Pasha Qadar M.A, Khan Amjed P,Khan., Gupta V,Grover. S.K, Norboo T, Srivastava K.K, Selvamurthy W, Brahamchari S.K. Association of high altitude systemic hypertension with the deletion allele of the angiotensin converting enzyme (ACE) gene. Int. J Biometeorol (2003)48:10-14.
2. Rhodes HL, Chesterman K, Chan C.W., Collins. P., Kewley E, Pattinson K.T.S, Myers S, Imray CHE, Wright AD.

Systemic blood pressure,arterial stiffness and pulse waveform analysis at altitude. J Royal Army Medical Corps.2011;157(1):110-3.

3. Hansen J, Sander M. Sympathetic neural overactivity in healthy humans after prolonged exposure to hypobaric hypoxia. J Physiol (2003)546.3pp921-929
4. Sizlan A, Ogur R, Ozer M, Irmac M.K. Blood Pressure Changes in young male subjects exposed to a median altitude. J Clin Auton Res(2008) 18:84-89
5. Wolfel E.E., Selland M.A., Mazzeo R.S., Reeves J.T. Systemic Hypertension at 4,300 m is related to sympathoadrenal activity. J. Appl. Physiol. April 1994, 76:1643-1650
6. Vegilo M, Maule S, Cametti G, Cogo A, Lussiana L, Madrigale G, Pecchlo O. The effect of exposure to moderate altitude on cardiovascular autonomic function in normal subjects. J Clinical Autonomic Research 1999, 9;123-127
7. Rami N. Khouzam, Ramy K.Aziz.A Case Report: Can Altitude change blood pressure that much. J Clinical Hypertension 2009:11:498-499.
8. Calbet a.l. Chronic hypoxia increases blood pressure and noradrenaline spillover in healthy humans . J Physiol (2003), 551.1pp.379-386.
9. Khalid M E, Ali M E, Ahmed E K, Elkarib A O. Pattern of blood pressures among high and low altitude residents of southern Saudi Arabia. J Hum Hypertens.1994 oct;8(10):765-9.
10. Arslan S,Arslan N, Soylu A.,Akgun C,Tepebasili I,Turkmen M,Kavukcu S. High Altitude and Blood Pressure in Children. J Biology and Medicine 76 (2003), pp. 145-148
11. Olziikhutag A, Dondog N, and Batmunkh G.Arterial pressure in cattle breeders living in different climatic and geographic zones of Mongolia. Kardiologiia 1979;19;58-62
12. Sun SF, Epidemiology of hypertension on the Tibetan Plateau. Hum. Biology 1986;58:507-15
13. Ali M, Ahmed Y, Naomi A M , Rashid A, Rahman A. Prevalence of coronary risk factors, clinical presentation, and complications in acute coronary syndrome patients living at High vs Low altitudes in Yemen.J Med Gen Med. 2006;8(4):28.
14. Clegg E.J, Jeffries D.J, and Harrison G. A. Determinants of blood pressure at high and low altitudes in Ethopia. J Proc. R. Soc. Lond. B. 194. 63-82 (1976).