PHYSIOLOGICAL CARDIO-RESPIRATORY CHANGES OF AMARNATH YATRIES AT DIFFERENT HEIGHTS OF YATRA.AN OBSERVATIONAL STUDY.

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Abstract

Introduction:

More than 3.5 lacs Amarnath Yatries ascend each year to the holy Amarnath Cave situated about 3888 meters from the sea level. During ascent for Yatra in the mountains experiences multiple environmental stressors, but the stress unique to high altitudes is the oxygen-deficient atmosphere. This work focused on Physiological cardio-respiratory changes of Amarnath Yatries at different heights of Yatra.

Methods:

An observational study on Blood Pressure, Oxygen Saturation, Respiratory rate, and Pulse rate was conducted among 75 Amarnath Yatries at different heights during the Amarnath Yatra from June and July in three years 2012, 2013, and 2014 respectively and the researcher himself accompanied those groups during all 3 years after receiving ethical approval from Institutional Review Committee RIMS Ranchi and informed consent from Yatries.

Results:

Oxygen saturation (%) was 97.7±1.8 at Ranchi (control value), this value on exposure to high altitude, at Amarnath Cave (12500 feet) decreased to 75.2±4.3 %. Respiratory Rate (RR) was 15.5±1.8 per minutes at Ranchi (control value), this value on exposure to high altitude, at Amarnath Cave (12500 feet) increased to 31.3±2.9 per minutes. Pulse Rate (PR) was 87.6±11.9 per minutes at Ranchi (control value), this value on exposure to high altitude, at Amarnath Cave (12500 feet) increased to 121.2±10.3 per minutes.

Conclusion:

Blood Pressure, Respiratory rate, and Pulse rate of Amarnath Yatries significantly increase while Oxygen Saturation decreases at Holy Amarnath Cave.

Recommendation:

Recommendations of the study for Amarnath Yatries are slow ascent; take deep breaths and rapid descent to prevent Acute Mountain Sickness.

Keywords: Blood Pressure, Respiratory rate, Oxygen Saturation, Pulse rate, Amarnath Yatries,
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1. Introduction.

High-altitude physiologists are challenged by humans in a hypoxic environment and the true research potentials are presented by high alti-

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tude, where the body is subjected to an essentially isolated hypoxic challenge. The present work concentrates on the changes in cardio-respiratory physiology occurring in Amarnath Yatri on the ascent to high altitude. The majority of persons traveling to the holy Amarnath Cave which is situated about 3888 meters from the sea level, come from the places situated at the sea level. Many of them are in their forties, fifties, or even older. They undergo thorough medical checkups before getting permission to travel. So it can be assumed that they are healthy but unacclimatized. So many suffer from various types of physical and mental illness while traveling, which are very much physiological and are mainly because of oxygen deficient atmosphere. There are other environmental stresses also, which have slightly lesser effect as the atmosphere around the earth changes with the ascent. The most important change from which traveler of high altitude suffers is a deficiency of Oxygen.1 Other changes are gravity, temperature, partial pressure of different atmospheric gases, ultraviolet radiation, exertion during Yatra, etc. But these have a lesser impact on a climber up to a height of 5000 meters.2 At high altitude, Cold temperature and Low barometric pressure are two stresses that are exposed to Amarnath Yatries.3, 4 Temperature declines approximately 1°C for each 150 m elevation and Barometric pressure also decreases with increasing altitude. And harmful effects of hypoxia are experienced by most un-acclimatized subjects at high altitudes. At high altitudes, hypoxia is sensed by the chemoreceptor, which causes an increase in respiratory rate.5,6 However, hyperventilation also causes the adverse effect of respiratory alkalosis, inhibiting the respiratory center from enhancing the respiratory rate as much as would be required7. The inability to increase the breathing rate can be caused by inadequate carotid body response or pulmonary or renal disease. In addition, at high altitudes, the heart beats faster; the stroke volume9 is slightly decreased; and non-essential bodily functions are suppressed, resulting in a decline in blood supply to the gastrointestinal tract. Thus it also results in indigestion, abdominal distention, and diarrhea. Later the body compensates for the respiratory alkalosis by excretion of bicarbonate in urine.11 Eventually, the body has lower lactate production10 (because reduced glucose breakdown decreases the amount of lactate formed), decreased plasma volume, increased hematocrit (polycythemia), increased RBC mass, neovascularisation in skeletal muscle, increased myoglobin, increased number of mitochondria, increase in 2,3-BiPhospateGlycerate,8 pulmonary vasoconstrictions,12 and right ventricular hypertrophy. Pulmonary artery pressure increases to oxygenate more blood.13 Present study concentrates on physiological cardiorespiratory changes due to acute exposure to high altitude particularly on Oxygen saturation, Blood pressure, Pulse rate, and Respiratory rate, of Amarnath Yatri at different heights during Yatra so that high altitude training and useful advice to Amarnath Yatri can be given to prevent medical complications arising during and after Amarnath Yatra.

2. METHODS.

2.1. Study design.

Analytical observational study was carried out on 75 Amarnath Yatries in 3 groups, who undertook Amarnath Yatra during June and July in three years 2012, 2013, and 2014 respectively and the researcher himself accompanied those groups during all 3 years. In the year 2012 Yatra route was from Pahalgam to Amarnath Cave while in year 2013 and 2014 route was through Baltal. The study was carried out at the Base camps located at different heights. Sample size (by using Cochrane formula) = Z2 x P x (1-P)/e2 z =1.96, P= estimated proportion of the population which has the attribute in question, calculated by conducting Pilot study= 95% and e = error of margin 5%. The total sample size was 76 and therefore to maintain 95% confidence levels, a total of 75 Amarnath Yatries were taken for this study.

2.2. Eligibility Criteria.

Study subjects were selected from the Amarnath Yatri of different age groups varying from 17 years to below 65 years and gender both male

and female population. Eligible participants had to be Amarnath Yatri, healthy, male and female lowland residents (17–65 years old). Before entering the high-altitude area,

2.2.1. The inclusion criteria.

1. No organic disease;
2. Age ≥17 years;
3. Low-altitude dwellers from areas <400 m; and 4) had not been exposed to high altitudes in the previous 3 months.

2.2.2. The exclusion criteria.

1. Age ≥65 years;
2. Were from elevations >2500 feet,
3. Were exposed to high altitude in the previous 3 months, or
4. Were reluctant to cooperate with the investigation, or
5. Subject was not giving consent for the study; or
6. Subject was on medication.

Values for different Parameters recorded at Ranchi are taken as the Control group and values recorded at different altitudes other than Ranchi are taken as the Case group. Parameter values for the control group were denoted as P0, RR0, SBP0, DBP0, and SPO2-0 for pulse rate, respiratory rate, systolic blood pressure, diastolic blood pressure, and oxygen saturation likewise respectively. And P1, P2, P3, P4, and P5 for a pulse rate of case groups were taken at altitudes 1, 2,3,4,5 respectively. Altitudes (heights) were taken in increasing order altitude1 at 1000 feet, altitude2 at 5000 feet, altitude3 at 7000-7500 feet, altitude4 at 9000 feet, and altitude5 at 12500 feet.

2.3. Ethics statement.

All participants who agreed to participate in the study were familiar with the purpose and process of this study. The research was approved by the Institutional ethics committee RIMS, Ranchi. Before the trial, each participant provided written informed consent and was conscious of his right to withdraw without prejudice at any time. The subjects did not take any medication or receive any intervention, and all the data were anonymized before retrieval and analysis.

2.4. Study settings and Location.

1. Amarnath Yatri Base Camp Jammu (1073 feet)
2. Amarnath Yatri Base Camp Pahalgam (7500 feet
3. Amarnath Yatri Base Camp Ganderbal (8990 feet
4. Amarnath Yatri Base Camp Baltal (8980 feet
5. Amarnath Yatri Base Camp Chandanwari (9500 feet
6. Base Camp Srinagar (5000 feet
7. Holy Amarnath Cave (12756 feet
8. Department of Physiology, Rajendra Institute of Medical
9. Sciences, Ranchi, Jharkhand (2000 feet).

My work took three years (from June 2012 – July 2014) to get completed. The Pulse rate, Blood pressure, Respiration rate, and Oxygen saturation were assessed at different heights, of Jammu, Srinagar, Ganderbal, Pahalgam, Chandanwari, Baltal, Sheshnag, Amarnath Cave, before, during, and after Yatra. The blood pressure was measured by the auscultatory method after 10 min rest at different heights of the yatra. Respiration rate was measured in lying down position after 10 minutes of rest at different altitudes with the help of wrist watch. Respiration rate was counted with the watch's movement placed over the abdomen of resting subjects for one minute. Pulse rate was measured in a sitting position after 10 minutes of rest at different altitudes with the help of wrist watch. Radial pulse rate was noted down along with the rhythm, the volume of the pulse, the character of the pulse, and the condition of the arterial wall. Body temperature was measured with the help of a mercury thermometer.

2.5. Statistical analysis.

This was done using paired t-test, ANOVA analysis, frequency distribution data analysis, and Lake Louise AMS Scoring. Software Graphpad-Prism6, Medcalc, and Microsoft Excel were used to analyze data and make graphs.

2.6. Bias.

Rise in Blood pressure due to Exertion (rapid ascent) was tried to handle by giving 10 min rest to Yatries before recording the parameters.

3. OBSERVATION AND RESULT.

The observations of this series of work comprise a total of 75 cases and 75 controls. Different cardio respiratory parameters in all these cases and controls have been evaluated during Yatra at different altitudes.

The observed table showed the total number of cases/controls was 75. The mean SPO2 among controls was 96.98 with S.D. 2.08(P<0.0001). The maximum SPO2 recorded was 100% with a median value of 98.0. SPO2 recorded at altitude1 (JAMMU-1000 FT)was 95.45±2.91, at altitude2 (SRINAGAR-5000FT)was 89.77±2.61, at altitude3 (GANDERBAL/PAHALGAM-7500FT) was 84.77±3.36, at altitude4 (BALTAL-9000 FT) was 80.05 ± 5.69, and altitude5 (AMARNATH CAVE-12500 FT) was 73.88 ±4.9. Mean values at different altitudes showed a significant (p<0.0001) decrease in oxygen saturation. The minimum value recorded was 62% at Amarnath Cave (12500 ft). F Test showed a significant study with an F value of 5.57 and a p-value less than 0.001. SPO2-0 denotes oxygen saturation values at altitude1 (RANCHI-2000 FT) of the control group while SPO2-5 denotes oxygen saturation values of the case group at altitude5 (AMARNATH CAVE-12500 FT). Paired samples t-test clearly showed a significant decrease in SPO2 after exposure to Amarnath Yatri at high altitude.

Oxygen saturation (%) of 15-24 yrs controls was 97.71±1.85. total number of controls was 14. In case group SPO2 was 95.64±3.38 at JAMMU, 90±3.59 at SRINAGAR (5000 FEET), 84±3.87 at 7000 FEET, 81±6.1 at 9000 FEET and 75.21±4.37 at 12500 FEET. Observations showed a decreasing trend of SPO2 among the 15-24 yrs age range on increasing altitudes. The total number of females both in the control and case groups was 10. The oxygen saturation (%) of the control recorded was 95.50±3.5 this decreases on exposure to high altitude (12500 feet) and SPO2 recorded was 71.40±4.8 with a p-value less than 0.0005. The minimum SPO2 among females was 62%. The mean SBP among controls was 115.73 with S.D. 9.62. The maximum SBP recorded was 140 mm of Hg with a median value of 120 mm of Hg. SBP recorded at altitude1 (JAMMU-1000 FT) was 117.94±10.65, at altitude2 (SRINAGAR-5000FT was122.73± 12.55,at altitude3 (GANDERBAL/PAHALGAM-7500FT) was 128.13±10.00, at altitude4 (BALTAL-9000 FT) was 133.41±10.30 and altitude5 (AMARNATH CAVE-12500 FT) was 138.77±11.28. Mean values at different altitudes showed a significant (p<0.0001) increase in systolic blood pressure. Paired samples t-test clearly showed a significant increase in SBP after exposure to Amarnath Yatri at high altitude.

DBP-0 denotes DIASTOLIC BLOOD PRESSURE values at altitude1 (RANCHI-2000 FT) of the control group while DBP-5 denotes DIASTOLIC BLOOD PRESSURE values of the case group at altitude5 (AMARNATH CAVE-12500 FT). Paired samples t-test (t =17.799) clearly showed a significant increase in DBP after exposure to Amarnath Yatri at high altitude. MAP of controls was 90 mm of Hg which increased to 107 mm of Hg at 12500 feet (Amarnath Cave). Pulse pressure also increased from 38 mm of Hg to 48 mm of Hg with exposure to high altitude. The mean value of pulse rate of this group was 87.6 with SD 11.9, among the control group mean pulse rate varied from 89.9± 12.5 to 121.2±10.3, which shows the increasing pattern of pulse rate with an increase in height. The median value also increases from 90 to 124 per minute. Respiratory rate mean value increased from 16.5±1.8 to 31.3± 2.9 per minute which denotes an increasing pattern with an increase in altitude. Overall observation shows an increasing pattern of respiratory rate values.

4. DISCUSSION.

Different cardiorespiratory parameters in Amarnath Yatries had been studied during Yatra at different altitudes. Work was focused on the

Table 1: **Showing age and sex distribution.**

S/N	AGE GROUP(YRS)	MALE	FEMALE	TOTAL	%AGE GROUP
1	15 – 24	13	01	14	18.7
2	25 – 34	22	03	25	33.3
3	35 – 44	16	00	16	21.4
4	45 – 54	10	05	15	20
5	55 - ABOVE	04	01	05	6.6
	TOTAL	65	10	75	100

Table 2: **Paired samples t-test of spo2 before and after exposure to high altitude.**

Sample 1	SPO2_0SPO2-0
Sample 2	SPO2_5SPO2-5

Table 3: **Paired samples t-test of spo2 before and after exposure to high altitude.**

	Sample 1	Sample 2
Sample size	75	75
Arithmetic mean	96.9867	73.8800
95% CI for the mean	96.5060 to 97.4673	72.7447 to 75.0153
Variance	4.3647	24.3503
Standard deviation	2.0892	4.9346
Standard error of the mean	0.2412	0.5698

Table 4: **Paired samples t-test of SBP.**

Test statistic t	18.878
Degrees of Freedom (DF)	74
Two-tailed probability	P < 0.0001

physiological effects of acute exposure to high altitude (Amarnath Cave). The emphasis was on the oxygen saturation and blood pressure changes experienced at different altitudes during Yatra. The exposure to high altitude was connected with a noticeable rise in systolic and diastolic blood pressure and has been also noted in other studies by Rhodes HL, et al. 14 SBP increases due to an increased dominant sympathetic activation by hypoxic stress, which is agreed with reports of Kanstrup IL, et al. 15 and reports of Mazzeo RS, et al.16 It was reported that an elevation of SBP tends to normalize or decrease after a few days at altitude, which was also observed in my study. My research did not show that any rise in SBP was related to AMS; however, in the severe AMS group, SBP was higher. Hypoxia may be a stimulant as suggested by Siques et al., who demonstrated a relationship between decreased SaO2 values and increased DBP values.17 And the increase of sympathetic activity may be due to religious faith in Lord Shiva and natural response by non-adapted low lander Amarnath Yatries to counteract the effects of hypoxia. According to Bartsch P, et al. indeed, hypoxia directly increases total peripheral resistance, resulting in increased blood pressure of yatries and increases respiratory rate by stimulating peripheral chemoreceptors.18 Significant changes in Blood Pressure and Oxygen Saturation of Amarnath

Yatries were probably due to rapid ascent to the holy cave for earlier Darshan of LORD SHIVA LINGA made by naturally frozen ice in a cave, lack of sleep, acute exposure to cold, decrease in barometric pressure, hypoxia and most important due to unacclimatization.

5. CONCLUSION.

The study results indicated an increase in both systolic and diastolic blood pressure and a decrease in oxygen saturation with an increase in altitudes. Taken together, this study suggested that blood pressure did not manifest significant monotonic changes with time and increasing altitude. BP is most important to monitor among amaranth yatries as it increases Acute Mountain Sickness. Oxygen saturation decreases in all subjects exposed to high altitude. Pulse rate and Respiratory rate also increase in all subjects exposed to high altitude. More studies are needed to take different religions and ethnicity into consideration to counter religious sympathetic stimulus.

6. LIMITATION.

Religious stimulation of the sympathetic nervous system, overcrowding of Yatries, and exertion due to faster ascent limits this study.

7. RECOMMENDATION.

Recommendations of the study for Amarnath Yatries are slow ascent, taking a deep breath, rapid descent if AMS develops, maintaining cleanliness, taking a carbohydrate-rich diet, take proper rest/ sleep at the base not at peaks of the mountain, drinking plenty of warm water and wear warm clothes so that Mountain Sickness can be prevented.

8. ACKNOWLEDEGEMENT.

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9. LIST OF ABBREVIATION.

AMS: Acute Mountain Sickness
P: Pulse Rate
RR: Respiratory Rate
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure
SPO_2: Percentage Oxygen Saturation
MAP: Mean Arterial Pressure.

10. Source of funding.

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11. Conflict of Interest.

There was no conflict of interest.

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13. REFERENCES.

1. Beidleman BA, Fulco CS, Muza SR, Rock PB, Staab JE, Forte VA, Brothers MD, Cymerman A: Effect of six days of staging on physiologic adjustments and acute mountain sickness during ascent to 4300 meters. High Alt Med Biol2009, 10:253–260. Liuet al. Military Medical Research2014, 1:19 Page

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2. Beidleman BA, Tighiouart H, Schmid CH, Fulco CS, Muza SR: Predictive models of acute mountain sickness after rapid ascent to various altitudes. Med Sci Sports Exerc2013, 45:792–800.
3. Bernardi L, Passino C, Wilmerding V, Dallam GM, Parker DL, Robergs RA, Appenzeller O: Breathing patterns and cardiovascular autonomic modulation during hypoxia induced by simulated altitude. J Hypertens 2001, 19:947–958.
4. D'Este D, Mantovan R, Martino A, D'Este F, Artusi L, Allibardi P, Franceschi M, Zerio C, Pascotto P: The behavior of the arterial pressure at rest and under exertion in normotensive and hypertensive subjects exposed to acute hypoxia at a median altitude. G Ital Cardiol1991, 21:643–649.
5. Kanai M, Nishihara F, Shiga T, Shimada H, Saito S:Alterations in autonomic nervous control of heart rate among tourists at 2700 and 3700 m above sea level. Wilderness Environ Med2001, 12:8–12.
6. Ledderhos C, Pongratz H, Exner J, Gens A, Roloff D, Honig A: Reduced tolerance of simulated altitude (4200 m) in young men with borderline hypertension. Aviat Space Environ Med2002, 73:1063–1066.
7. Levine BD, Zuckerman JH, de Filippi CR: Effect of high-altitude exposure in the elderly: the Tenth Mountain Division study.Circulation1997, 96:1224–1232.
8. Muza, SR; Fulco, CS; Cymerman, A (2004): Altitude acclimatization guide.
9. Purkayastha SS, Ray US, Arora BS, Chhabra PC, Thakur L, Bandopadhyay P, Selvamurthy W: Acclimatization at high altitude in gradual and acute induction. J Appl Physiol1995, 79:487–492.
10. Rhodes HL, Chesterman K, Chan CW, Collins P, Kewley E, Pattinson KT, Myers S, Imray CH, Wright AD: Systemic blood pressure, arterial stiffness and pulse waveform analysis at altitude. J R Army Med Corps2011, 157:110–113.
11. Shrestha S, Shrestha A, Shrestha S, Bhattarai D:Blood pressure in inhabitants of high altitude of Western Nepal. JNMA J Nepal Med Assoc 2012, 52:154–158.
12. Young, Andrew J; Reeves, John T. (2002): Human adaptation to high altitude.
13. Chronic hypoxia increases blood pressure and noradrenalin spillover in healthy humans. J Physiol2003, 551:379–386
14. Rhodes HL, Chesterman K, Chan CW, Collins P, Kewley E, Pattinson KT, Myers S, Imray CH, Wright AD(:Systemic blood pressure, arterial stiffness and pulse waveform analysis at altitude. J R Army Med Corps2011, 157:110–113.
15. Kanstrup IL, Poulsen TD, Hansen JM, Andersen LJ, Bestle MH, Christensen NJ, Olsen NV(: Blood pressure and plasma catecholamines in acute and prolonged hypoxia: effects of local hypothermia. J Appl Physiol1999, 87:2053–2058).
16. Mazzeo RS, Bender PR, Brooks GA, Butterfield GE, Groves BM, Sutton JR, Wolfel EE, Reeves JT(:Arterial catecholamine responses during exercise with acute and chronic high-altitude exposure. Am J Physiol1991, 261:E419–42.
17. Siques P, Brito J, Banegas JR, Leon-Velarde F, de la Cruz-Troca JJ, Lopez V, Naveas N, Herruzo R: Blood pressure responses in young adults first exposed to high altitude for 12 months at 3550 m.High Alt Med Biol 2009, 10:329–335.
18. Bartsch P, Gibbs JS: Effect of altitude on the heart and the lungs. Circulation2007, 116(19):2191–2202.

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