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Effect of Lifestyle Factors and Genetic Predisposition on Development of HASH in Armed Forces Personnel

Devdeep Ghosh[1], Biswajit Sinha[2], Kunal Bagul[3]
(Assistant Professor, Aerospace Medicine, Institute Of Aerospace Medicine, Bengaluru, India)
(Scientist F & HoD, Space & Environment Physiology, Institute Of Aerospace Medicine, Bengaluru, India)
(Pathologist, Dept of Pathology, Military Hospital, Gangtok, India)

Abstract:
Background: *High altitude deployment of Indian Armed Forces personnel is encountered with medical issues including High Altitude Associated Systemic Hypertension (HASH). Despite being fit in their High Altitude Medical Test (HAMT), it has been observed that a good number of air warriors are found unfit during deployment. The organization encounters human resource issue due to non-availability of trained personnel at right time at right place. Thus arises the need to analyse the causal association to find the possible way out.*
Materials and Methods: *Data of first half of 2023 of HAMT cleared 85 male with age 32.6±9 yrs from two Indian Air Force units of an operational command which has frequent deployment at High Altitude Area (HAA), was analyzed. Fitness during acclimatization and final deployment, types of disabilities, previous history of HAA exposure, status of unfitness during previous deployment, family history of hypertension, smoking history, alcohol consumption, metabolic comorbidities and post-deinduction clinical status had been analyzed. Comparative analysis was carried out between high altitude unfitness data of Indian Army and IAF. Data were analysed using descriptive statistics and non-parametric test. Chi square test was applied to find out the association of categorical independent variables. Binary logistic regression analysis was used to examine the probability factors of categorical or continuous independent variables with HASH.*
Results: *Incidence of unfitness during deployment in individuals who have been declared fit in HAMT was 29-31%. Hypertension contributed to majority of these unfit individuals (68%). Amongst 85 HAMT fit IAF personnel, 20% developed HASH. In HASH cases, 82% has family history of HTN to 1st degree relative, 12% are active regular smoker, 71% are moderate alcohol consumer, 94% has previous HAA deployment history, all of the HASH cases developed HTN during their previous HAA deployment, 94% carries out adequate physical exercises and 29% were continued with antihypertensive medication post de-induction. Statistically significant correlation of family history of HTN, previous history of HAA deployment and previous detection of HTN during HAA deployment ($p<0.05$) in respect of HASH were found.*
Conclusion: *Development of hypertension in high altitude deployment is attributable to service, that may lead to increased financial burden and adversely affect the trained man power availability of the organization. The goal during HAMT should be to declare a person fit only if he can sustain the impending physiological stressors of HAA. In this way, associated cause for development of HTN may be predicted and mitigated.*
Keyword: *HASH, HAMT, Human resource*

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I. Introduction

Exposure to hypoxia at high altitude is increasingly being recognised as a risk factor for hypertension [1, 2]. Troops of the Indian armed forces are deployed in the high altitude area. Deployment at these altitudes are encountered with multiple medical issues known as High Altitude Illnesses (HAI). The least described and minimally studied among these HAIs is the commonly occurring High Altitude Associated Systemic Hypertension (HASH). It is defined as presence of sustained hypertension (>150/90 mmHg) in low landers at High Altitude Area (HAA) i.e. >2700 metre. The prevalence of systemic hypertension at HAA has been reported from 37 - 62.4% in scientific literature [3]. Specific guideline is in place to evaluate an air warrior prior to deployment in high altitude areas. They have to undergo an array of clinical, haematological, radiological and electrocardiographic evaluation at their concerned medical facilities before being declared as fit for deployment. Subsequent medical evaluations are carried out at different stages of acclimatization. It has been observed that a good number of air warriors are found unfit at deployment posts despite being fit in their High Altitude Medical Test (HAMT). The organization encounters human resource issue due to non-availability of trained personnel at right time at right place. This arises the need to analyse the causal association to find the possible way out.

II. Materials and Methods

Subjects. Data of first half of 2023 from two Indian Air Force (IAF) units of an operational command which has frequent deployment at HAA, was analysed. Total number of deployed personnel was 85 healthy male with mean age 32.6±9 years, who were declared fit in HAMT at parent unit before deployment. Smoker status was defined as active regular smokers only and moderate alcohol consumer was defined as less than 02 drinks of alcohol (20 gm)/ day. 150 minutes of moderate intensity aerobic exercise was considered as adequate exercise for the participants. 25 male IAF personnel with mean age 29.2 ± 3.32 years returned as unfit from HAA during the assessment period.

Procedure. Details of body parameters, types of disabilities, history of HAA exposure and status of unfitness during previous deployment had been documented. Special emphasis was given on hypertensive individuals. In those cases, family history, smoking, alcohol consumption status and metabolic comorbidities were analysed. Along with this, post deployment clinical status and prescribed medications had been analysed. Comparative analysis had been done between available HAA unfitness data of Indian Army (IA) - 03 mountain divisions and IAF - 02 units. Institute Ethics Committee approval was obtained prior to commencement of the study.

Statistical analysis. The study was conducted with prospective, randomised, experimental study design. Statistical analyses were performed with the use of the Statistical Package for the Social Sciences (version 26.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics was applied for continuous data and frequency analysis was applied for categorical data. Chi Square Test was applied to find out the association of categorical independent variable. Binary logistic regression analysis was used to examine the probability of (categorical or continuous) independent variables with one dichotomous dependent variable i.e. HTN status in HAA. Categorical independent variables were family history, smoking, alcohol consumption history, history of previous HAA exposure, history of previous HTN in HAA, physical exercise and continuous variables were age, BMI and WHR. The level of statistical significance was set at a p-value less than 0.05.

III. Result

This study revealed incidence of unfitness during deployment in individuals who were declared fit in HAMT was 29-31% in each studied IAF unit (Fig 1-2). Hypertension contributed to the majority of these unfit individuals (Fig 3). Age, BMI and WHR of the unfit individual are depicted in Table 1.

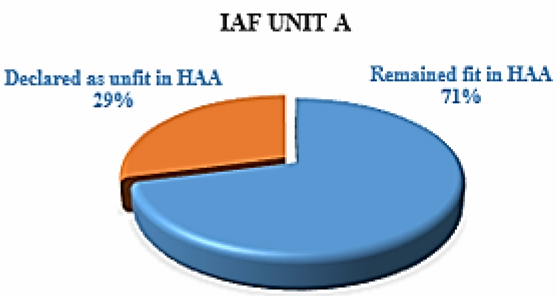

Fig 1: Unfitness percentage in IAF Unit A

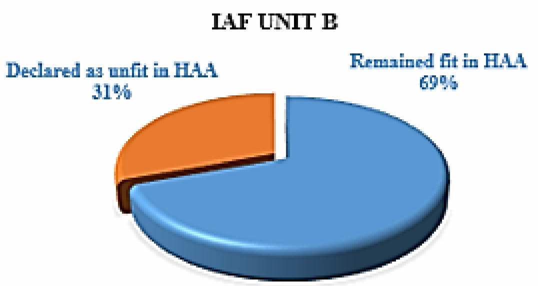

Fig 2: Unfitness percentage in IAF Unit B

Table 1: Body parameters of the studied unfit population (n=25)

Sl No	Parameters	Min	Max	Mean ± SD
1.	Age	23	36	29.2 ± 3.32
2.	BMI	20.96	29.16	24.4 ± 1.72
3.	WHR	0.84	0.90	0.88 ± 0.02

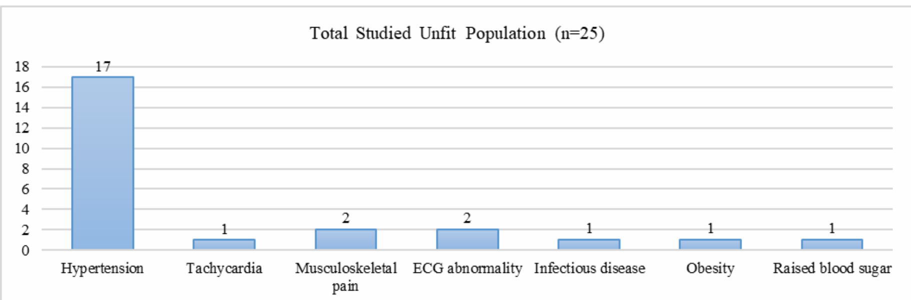

Fig 3: Detected disabilities at HAA

Amongst 85 HAMT fit deployed IAF personnel, 20% developed HASH. Amongst those HASH cases, 82% gave family history of HTN to 1st degree relative, 12% were active regular smoker, 71% were moderate alcohol consumer (Fig 4), 94% had previous HAA deployment history, all of the HASH cases developed HTN during their previous HAA deployment, 94% used to carry out adequate physical exercises and 29% were continued with antihypertensive medication (ARBs) post de-induction.

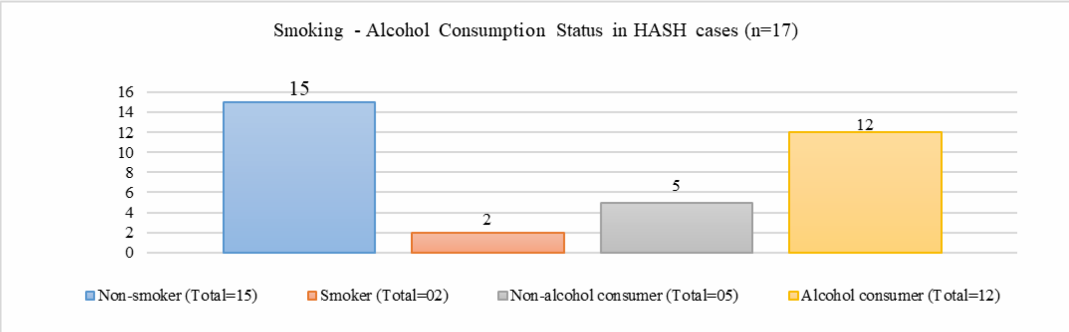

Fig 4: Smoking, Alcohol consumption status

Table 2: Chi square test report of the dependent variable nominal data (n=25)

Sl No	Parameters	Score	df	p value
1.	Age	1.382	1	*0.240*
2.	BMI	0.379	1	*0.538*
3.	WHR	0.067	1	*0.796*
4.	Family h/o HTN	11.060	1	*0.001**
5.	Smoking history	1.023	1	*0.312*
6.	Alcohol intake history	2.482	1	*0.115*
7.	Previous HAA exposure	12.891	1	*<0.001**
8.	HTN in Previous HAA exposure	25.000	1	*<0.001**
9.	Physical exercise	0.324	1	*0.569*
10.	Antihypertensive drug requirement	2.941	1	*0.086*

*p value < 0.05

Family history of HTN, previous history of HAA deployment and previous detection of HTN during HAA deployment suggest significant correlation with HASH ($p<0.05$).

Table 3: Binary Logistic Regression to assess probability to develop HASH

Sl No	Parameters	SE	Wald	df	Sig	Exp (B)
1.	Age	4969.787	<0.001	1	1.000	9.338
2.	BMI	7444.635	<0.001	1	0.999	0.000
3.	WHR	972434.527	<0.001	1	1.000	2.062E+185
4.	Family h/o HTN	31912.950	<0.001	1	0.999	0.000
5.	Smoking history	86372.132	<0.001	1	1.000	2904.019
6.	Alcohol intake history	18526.350	<0.001	1	0.998	0.000
7.	Previous HAA exposure	63182.906	<0.001	1	0.999	0.000
8.	Physical exercise	47766.877	<0.001	1	0.999	2.336E+16
9.	Antihypertensive drug requirement	64181.369	<0.001	1	0.999	0.000

Binary logistic regression was performed to assess impact of the discussed factors on the probability of development of HTN in HAA. All the said factors significantly contributed to the model (Wald<0.001). In addition, if an individual had smoking history, the odds of HASH are 2904 times higher. Analysis of 03 years database of 03 units of IA (Fig 5), deployed in HAA revealed that 18-25% of the HAMT fit personnel developed HASH during deployment. 60-83.44% of the HASH cases became normotensive after returning back from HAA. Whereas 16.56-40% of them continued to be hypertensive requiring pharmacological intervention.

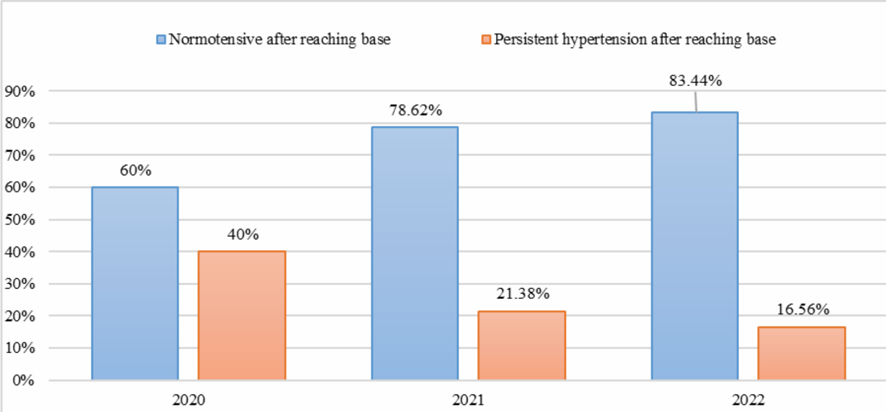

Fig 5: Hypertensive Status of Rejected Individual (Indian Army data: 2020-22)

IV. Discussion

Hypertension can be defined as that level of blood pressure above which an excess morbidity and mortality is observed compared with a control population [4]. Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-8) offers background information as well as recommendations for classification, risk stratification and therapy.

Under high altitude exposure, systemic BP undergoes significant changes as a net result of a number of physiological responses. The pattern of these changes seems to have three distinct phases. Over the first minutes or hours of hypoxia exposure, BP remains largely unchanged because of direct vasodilator effect of hypoxia counteracting chemo reflex- induced sympathetic activation [5]. Subsequently pressor mechanisms begin to dominate, leading to increase in BP [6]. Finally, after a longer period of high altitude permanence, these mechanisms may be partly inhibited when blood oxygen concentration increases through ventilatory and alveolar diffusion, acclimatization as well as increased haematocrit (The later due to erythropoiesis and reduction in plasma volume). This may explain lower BP values observed in highlanders when compared to lowlanders exposed to altitude hypoxia (Grocott et al., 2007). In the initial response, the prevailing mechanism is a direct vasodilator effect of hypoxia, relying on local regulatory mechanisms aimed at assuring adequate oxygen supply to peripheral tissues. These mechanisms include production and generation of nitric oxide, ATP release from red blood cells and changes mediated by Hypoxia Inducible Factor-1 (HIF-1). If the exposure to high altitude lasts for a few hours or more, pressor mechanisms dominate, the most important one being sympathetic activation. Hypoxia is a potent sympathetic activator via stimulation of the peripheral chemoreceptors, as demonstrated by the increase in heart rate and plasma norepinephrine observed in this condition [6].

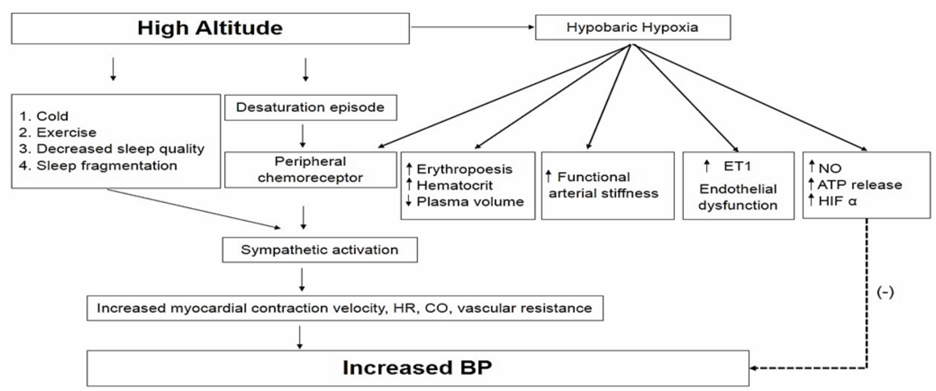

Fig 6: Effect of altitude in BP regulation

Effect of altitude exposure has been described in the above diagram (Fig 6). Studies of the effects of climate, altitude, and BP are marked by the variability of individual responses and a multitude of interacting variables. In addition, the factors which are responsible for raised BP are sodium intake, diet, exercise, body mass index (BMI) and age. Increased altitude introduces the additional factors of hypoxia, cold, wind, altitude sickness, dehydration and physiological stress [7]. Interrelationships between these variables include the positive association between cold climate and increased BMI [8]. A higher BMI was believed to be responsible for elevated BP in high-altitude (Above 3150 meters) [9].

Rejection rate due to HASH in IAF personnel (20%) is similar to IA personnel (18-25%). Requirement of antihypertensive medication post-deinduction in IAF personnel (29%) was similar to IA personnel (16.56-40%). Statistically significant correlation of family history of HTN, previous history of HAA deployment and previous detection of HTN during HAA deployment ($p<0.05$) in respect of HASH suggests positive correlation of HASH with the ibid variables. Amongst the HASH cases, there was no statistically significant correlation found in respect of age, BMI, WHR, smoking, alcohol consumption and lack of physical exercise. In Binary logistic regression analysis, all the said parameters significantly contributed to the model. Nevertheless, clinical decision making remains main stay in screening during HAMT. Development of hypertension in high altitude deployment is attributable to service. If detected, it will increase the financial burden as well as adversely affect the availability of trained personnel during HAA deployment. The goal during HAMT should be to declare a person fit only if he can sustain the impending physiological stressors of HAA. In this way, preventable cause for development of HTN can be mitigated.

In this study, ethnicity, dietary habit, psychosocial history were not incorporated. Study was done only on male participants. More number of participants involving more IAF units and IA units who get deployed at HAA would have enhance the quality of the study.

V. Conclusion

Scientific literature survey supports the fact that high altitude exposure is a well-known cause of systemic hypertension. From the organizational perspective, it is highly recommended to obtain meticulous history of the individual with additional emphasis on family history and previous HAA deployment history. Pre-hypertensive cases should be evaluated with 24 hours ABPM invariably. Rational decision should be taken by the medical officer at parent unit level, keeping physiological stressors of HAA into consideration, before declaring a person fit for HAA. Troops should be sensitized about the modifiable risk factors of hypertension. Further study on HASH with larger sample size including various HAA associated cardio-pulmonary disabilities viz. CVT, HAPO, HACO etc may be envisaged.

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