

Cognitive Functioning with Ascent to Altitude: Analysis by Mixed Methodology

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Abstract: ***Introduction:** Oxygen insufficiency at high altitude leads to cause adverse effects on cognitive functioning. Combatants get deployed to high altitude as part of their job. Hence this study was conducted to assess the cognitive impairment in among combatants and to explore their perception towards it along with the helping strategies. **Materials & Methods:** A mixed methodology was adopted for this study. Structured questionnaire (modified cognitive questionnaire) is used to assess the cognitive impairment. An in depth interview with open ended questions were used to explore their perception towards the cognitive impairment and the remedial measures. **Results:** The assessment of cognitive impairment revealed that the existence of cognitive impairment was evident in sample. Lack of concentration was the most evident symptom as reported by 64% sample. Forgetfulness was reported by 52% whereas mood deviation by 21% and slow reaction time by 48%. Qualitative analysis revealed that there exists a moderate level of impairment in cognition in terms of sluggish performance, lack of concentration and forgetfulness. Samples reported that remedial measures such as Slow acclimatization, Indulgence in diversional activities, Practice of yoga and Early recognition of changes and seeking help are found to be beneficial. **Conclusion:** Present study has identified that majority of the sample deployed at high altitude had one or other type of cognitive impairment to a considerable extend. The perception analysis revealed that samples were able to recognize the changes on time and were able to adopt apt coping skills to limit further deterioration. Hence the experience and suggestions can be utilized for preparation of combatants before deployment in high altitude*

Keywords: High altitude, Cognitive impairment, Combatants, Acclimatization, Hypoxia

1. Introduction

Life exists in all geographical areas of world. Struggle for each habitats differs. Life at altitude is very challenging as it has its impact on physical, physiological and psychosocial wellbeing.

Oxygen is vital for maintaining human life at optimal way. The fatal effect of altitude is hypoxia. Exposure to high altitude leads to cognitive impairment such as attention, memory and executive functions. In a review by Petrassi et al noted that there is considerable individual variability in the extend of cognitive functions at altitude.

High - altitude environments can be debilitating to unacclimatized individuals exposed to elevations above 3, 000 m (9, 843 ft) for periods ranging from several hours to days. Moderate hypoxia induces substantial alterations in physiological and psychological parameters within a few hours. Immediately upon ascent to high altitude, there is decreased blood oxygenation, which reduces the oxygen supply throughout the periphery and in the brain. With time the body compensates, at least in part, for the lack of oxygen with a variety of physiological responses and adjustments. In aggregate, this is termed *acclimatization*

High - altitude exposure negatively impacts cognitive performance and mood. High - altitude migrants report increased anxiety, anger, and fatigue, and lower rates of positive mood and vigor than sea - level cohorts matched for age, sex, and education level. Depression and suicide rates are also higher in high - altitude populations, even when accounting for socioeconomic factors. This depressive

mood, and additional cognitive impairment at high altitudes, may result from low oxygen availability and/or poor sleep quality

But even the fittest among us suffer in thin air. Combatants of defence service are posted to high altitude in their early years of service. They are physically fit, medically and emotionally stable individuals. All combatants need the highest level of physical and cognitive functioning. They move to high altitude only after completion of the mandatory acclimatization period

The present study aim to assess the cognitive impairment in combatants after their de induction and also their perception regarding cognitive impairment and the helpful remedial measures so as to incorporate the same in preparation of those who are waiting to be posted soon.

2. Materials and Methods

Keeping the scope in mind a mixed methodology was used for this study. It was conducted at a training college for various levels of combatants during the period of Sep - Nov 2022. The study conducted with the aim to assess the level and perception on cognitive impairment of those who have recently returned from high altitude so as to prepare those who will be deployed to higher altitude in coming months.

The tool comprised of three parts. Section 1 contains demographic variables - age, duration of tenure at high altitude. Section 2 comprised of the cognitive impairment questionnaire with modifications. A total of 20 questions used on Likert scale. Section 3 consists of the qualitative

part with open ended questions on their perception regarding cognitive impairment as well as the possible remedial measures.

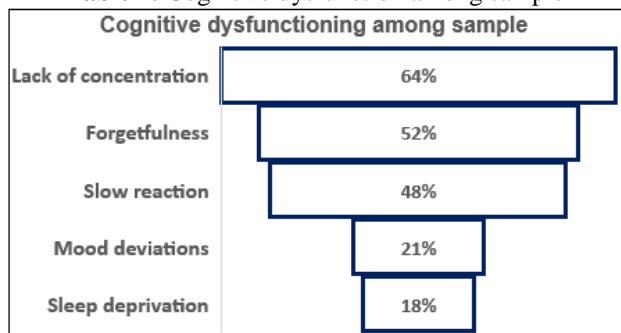
Eligible participants were explained regarding the purpose of the study based on inclusion criteria. Combatants with age more than 40 years and those with any comorbidities were excluded from study. Confidentiality ensured. Willingness from the participants obtained. A total of 60 sample participated in this study.

The assessment of cognitive impairment is done with descriptive statistics. The response of the qualitative data is thematically analysed into each phenomenon of interest. Analysis of data was facilitated by categorization of themes.

Table 1: Descriptive data of sample, n=60

Variable	Distribution of sample	Percentage
Age	20 - 25 yrs	0
	25 - 30yrs	54 (90%)
	30 - 35yrs	06 (10%)
	35 - 40yrs	0
Duration of Deployment	<6 months	23 (39%)
	6 - 12 months	34 (57%)
	12 - 18 months	03 (4%)
Height of deployment	Upto 9000 ft	13 (22%)
	9000 - 12500 ft	33 (55%)
	12500 - 15500 ft	11 (19%)
	Above15500 ft	03 (4%)

Table 2: Cognitive dysfunction among sample



Analysis of qualitative session

Coding and categorizing the data was carried out. Transcripts were thematically coded according to the research themes that emerged from the analysis as given in table 3

Phenomenon of Interest	Themes
Impairment in cognitive functioning	<ul style="list-style-type: none"> • Slow in performance • Lack of concentration compared to before • Forgetfulness
Coping measures	<ul style="list-style-type: none"> • Slow acclimatization • Indulgence in diversional activities • Practice of yoga • Early recognition of changes and seeking help

Analysis revealed that there existed a moderate level of impairment in cognition in terms of sluggish performance, lack of concentration and forgetfulness. Samples reported

that remedial measures such as Slow acclimatization, Indulgence in diversional activities, Practice of yoga and Early recognition of changes and seeking help are found to be beneficial.

3. Discussion

The present study aimed to assess the level and perception on cognitive impairment of those who have recently returned from high altitude so as to prepare their course mates who will be deployed to higher altitude in coming months. Description of demographic variables revealed that majority of sample were in the age group of 25 - 30 yrs (90%) with a service bracket of up to 5 yrs (69%). This data is sufficient enough to describe the level of physical strength and fitness. Majority of sample (55%) were deployed at a height of 9000 - 12000ft.

The assessment of cognitive impairment revealed that the existence of cognitive impairment was evident in majority of sample. Lack of concentration was the most evident symptom as reported by 64% sample. Forgetfulness was reported by 52% whereas mood deviation by 21% and slow reaction time by 48%.

When the question asked “what changes do you feel in cognitive functioning regular activities after deployment in high altitude”, the sample responded in different ways. One answered “I felt I m becoming incapable to perform activities as I used to be” Another. Sample stated “ I was wondering what was happening as I take more time to perform regular activities, somewhat a lethargic state. Another statement was “I was forgetting things which are on the tip of my tongue”

From these responses it is evident that slow reaction time and forgetfulness have contributed to their feeling of low self.

When asked regarding remedial measures, almost every sample said adherence to slow acclimatization protocol which is in vogue in organization is the first and the best method. Other answers varied from “keeping mind occupied” to indulgence in diversional activities”. Practice of yoga was suggested by majority. They also were keen to state that ”not to ignore symptoms: accept and seeking help will be beneficial to limit the dysfunctioning. Present study is congruent with the findings of many other studies.

4. Conclusion

This study aimed to assess the level and perception on cognitive impairment of those who have recently returned from high altitude so as to prepare their course mates who will be deployed to higher altitude in coming months. A mixed methodology was adopted to get an in depth view of this. Present study has identified that majority of the sample had one or other type of cognitive impairment to a considerable extend. The perception analysis revealed that samples were able to realise the changes on time and were able to adopt apt coping skills to limit the further deterioration. Hence the experience and suggestions can be utilized for preparation of combatants before deployment in

high altitude. This study also recommends prospective evaluation of combatants who will be deployed in high altitude after this preparation.

Competing interests

The authors declare that they have no competing interests.

Contribution of Authors

Both the authors significantly contributed to the design and analysis of the manuscript. JG conceptualized the project, contributed in analyzing the data, designing writing and the final draft of the article. AK has interviewed the samples, collected data and contributed in data coding and analysis

References

- [1] Asmaro, D., Mayall, J., and Ferguson, S. (2013). Cognition at altitude: impairment in executive and memory processes under hypoxic conditions. *Aviat. Space Environ. Med.*84, 1159–1165. doi: 10.3357/ASEM.3661.2013
- [2] Davranche, K., Casini, L., Arnal, P. J., Rupp, T., Perrey, S., and Verges, S. Cognitive functions and cerebral oxygenation changes during acute and prolonged hypoxic exposure. *Physiol. Behav.*, 2016, 164, 189–197. doi: 10.1016/j.physbeh.2016.06.001.
- [3] Bao, H.; Chen, Z.; Wang, D. Cognitive function of male recruits exposed to 3700 maltitude for different periods: a comparison between 3 months and 15 months. *Acad. J. Second. Mil. Med. Univ.*2015, 36, 455–458.
- [4] Hornbein, T. The high - altitude brain. *J. Exp. Biol.*2001, 204, 3129–3132. Available online at: <http://jeb.biologists.org/content/204/18/3129>
- [5] John E Davis1*, Dale R Wagner2, Nathan Garvin1, David Moilanen1, Jessica Thorington1 and Cory Schall1 xCognitive and psychomotor responses to high - altitude exposure in sea level and high - altitude residents of Ecuador *Journal of Physiological Anthropology*, 2015, 34: 2
- [6] Li, Y.; Wang, Y. Effects of Long - Term Exposure to High Altitude Hypoxia on Cognitive Function and Its Mechanism: A Narrative Review. *Brain Sci.*2022, 12, 808. <https://doi.org/10.3390/brainsci120608089>
- [7] Ma, H., Wang, Y., Wu, J., Luo, P., & Han, B. Long - term exposure to high altitude affects response inhibition in the conflict monitoring stage. *Scientific Reports*, 2015, 5 (1). <https://doi.org/10.1038/srep1370>
- [8] Matiram Pun, Veronica Guadagni, Kaitlyn M. Bettauer, Lauren L. Drogos, Julie Aitken, Sara E. Hartmann, Effects on Cognitive Functioning of Acute, Subacute and Repeated Exposures to High Altitude, 01131Frontiers in Physiology | www.frontiersin.org 1 August 2018 | Volume 9 |
- [9] Matiram Pun, Veronica Guadagni Lauren L. Drogos Charlotte PonSara E. HartmannMichael Furian, Mona Lichtblau, Lara Muralt, Cognitive Effects of Repeated Acute Exposure to Very High Altitude Among Altitude - Experienced Workers at 5050 m *Journal of high altitude medicine and biology* vol 20, n0: 4
- [10] McMorris, T., Hale, B. J., Barwood, M., Costello, J., and Corbett, J. Effect of acute hypoxia on cognition: a systematic review and meta - regression analysis. *Neurosci. Biobehav. Rev.*74, 225–232. doi: 10.1016/j.neubiorev.2017.01.010th
- [11] Pun M, Guadagni V, Bettauer KM, Drogos LL, Aitken J, Hartmann SE, Furian M, Muralt L, Lichtblau M, Bader PR, Rawling JM, Protzner AB, Ulrich S, Bloch KE, Giesbrecht B, Effects on Cognitive Functioning of Acute, Subacute and Repeated Exposures to High Altitude. *Front. Physiol.*9: 1131. doi: 10.3389/fphys.2018.01131
- [12] Roach, Emma B. Bleiberg, Joseph Lathan, Corinna E. Wolpert, Lawrence Tsao, Jack W. Roach, Robert C. Decreased reaction time after high altitude cognitive testing is a sensitive metric of hypoxic impairment, *NeuroReport: August 6, 2014 - Volume 25 - Issue 11 - p 814 - 818* doi: 10.1097/WNR.000000000000169
- [13] Wang, Hailin Ma, Shimin Fu, Shichun Guo, Xiaofang Yang, Ping Luo& Buxin Han, Long - Term Exposure to High Altitude Affects Voluntary Spatial Attention Early and Late Processing Stages
- [14] Wilson, M. H., Newman, S., and Imray, C. H. The cerebral effects of ascent to high altitudes. *Lancet Neurol.*8, 175–191, 2009. doi: 10.1016/S1474 - 4422 (09) 70014 - 6
- [15] Yan, X.; Zhang, J.; Shi, J.; Gong, Q.; Weng, X. Cerebral and functional adaptation with chronic hypoxia exposure: A multi - modal MRI study. *Brain Res.*2010, 1348, 21–29.
- [16] Yan, X.; Zhang, J.; Gong, Q.; Weng, X. Adaptive influence of long term high altitude residence on spatial working memory: An fMRI study. *Brain Cogn.*2011, 77, 53–59.