

## EFFECTS OF MID-ALTITUDE ON MENTAL BEHAVIOR

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**Abstract.** Many of the physiologic changes that occur during acute and chronic altitude exposure may actually negate adaptations that possibly improve physiologic performance upon return to sea level. We aimed to determine the effects of hypobaric hypoxic conditions at mid-altitude on mental performance by psychometric tests. This study was performed on 34 male volunteer mountaineers coming from different regions of Turkey. Their mean ages, heights and weights were 33.5±11.8 years, 176.4±8.2 cm and 73.0±10.5 kg, respectively. These tests were carried out on volunteer climbers firstly at the residence center at altitude of 1200 m (Hacılar, n=34), and secondly on the same day at altitude of about 2850 m after 4 h from firstly (base camp at Mount Erciyes, n=34), and then finally psychological tests were done at altitude 3900 m after one day from secondly (n=31). State (acute) and trait (chronic) anxieties scales, and short symptom inventory tests were applied to 34 male volunteer mountaineers at three different altitudes. Although trait and state anxiety scores decreased at two different altitudes, this difference was not statistically significant ( $p>0.05$ ). But the trait and state anxiety scores at Erciyes summit increased ( $p<0.05$ ). The findings of somatization, obsessive-compulsive disorders, interpersonal sensitivity, anxiety disorder, hostility, phobic anxiety, paranoid ideation and psychoticism, additional materials index, scores increased at summit and were found statistically significant ( $p<0.05$ ). Global indexes that is seriousness of disturbance index, total symptom index and symptom disturbance index scores in the Erciyes summit increased significantly ( $p<0.05$ ). But total symptom index scores decreased significantly at Erciyes base camp ( $p<0.05$ ). Although all psychometric test scores decreased in base camp area, all findings increased significantly at Erciyes Mountain Summit. We considered that general characteristics of hypobaric hypoxic conditions and environmental factors might cause emotional and behavioral changes on individuals depending on psychological and physiological features.

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## **Introduction**

The specific problems of hypobaric hypoxia were first observed in the middle of the 19th century by means of climbing experience and it has been reported that over 30 million people climbed mountains over 2000 m. When the climbers exposed to hypobaric hypoxia, they experienced different reactions to the effects of altitude [1,3]. Hypoxia-induced deficits in intellectual performance are linked to the altitude level reached, the speed of the ascent and the time spent at high altitude [6]. High altitudes of more than 3.000 m produce physiological disorders and adverse changes in mood states and produce changes in symptoms, moods, and cognitive/motor performance of non-acclimatized individuals and should produce graded effects on these parameters as elevation and duration are increased. Therefore, body's homeostatic activity, specific aspects of symptoms, mood, and performance are significantly degraded after only a few h of exposure to hypobaric hypoxia [8,15]. Exposure to high altitude may also produce adverse effects in motor skills, mental efficiency, and mood states, including anxiety in addition to the physiological symptoms [20]. The body language behaves by a great variety of functional processes, biochemical, neuropsychological and neurohumoral. High altitude can cause mood changes such as depression, apathy, and drowsiness. Observed behaviors at high altitude indicate that people can become more euphoric, irritable, or argumentative. It has been known to be affected parameters such as friendliness, clear thinking, dizziness, sleepiness, and unhappiness adverse changes in motor skills, mental efficiency, and mood states, including anxiety were affected at mid altitude [5,20]. Visual and auditory sensitiveness and short-term memory are negatively affected by exposure to factors such as temperature, day-night differences at an altitude of nearly 2500 m. It has known that mental performance, attention period, arithmetical ability and decision making does not change significantly when the acute effects of low altitude are compared with the sea level [22,23,25]. These effects are very important for some professions such as aviation, because of associated cognitive decrement, mood changes at high altitude [7]. The abilities, which are lost, can be recovered after spending two days to two weeks at the same altitude [5]. Although learning, memory and verbal expression loss continues for a few weeks after returning to the sea level, they are recovered within year's time. Cardiovascular and respiratory functions also effect mental performance and may cause a condition like organic brain syndrome during climbing to high altitude [5,19]. Environmental factors, air condition, exercise,



climbing speed and individual differences during climbing to altitude can have some negative effects on these changes [7,17]. There are many studies about the effects of hypobaric hypoxia on the mental performance during climbing. But these studies have been done under laboratory conditions. There is few studies investigated the climbing of psychosocial factors, individual and environmental factors [16,21].

The aim of this study was to determine whether there would be any change in mental performance of the mountaineers exposed to hypobaric hypoxic conditions by using psychometric tests on volunteers both without any physical activity and climbing.

### Materials and Methods

This study was performed on 34 male volunteer mountaineers coming from different regions of Turkey. Three volunteers were excluded because of their health disturbed during climbing Erciyes Mount Summit. Their mean ages, heights and weights were  $33.5 \pm 11.8$  years,  $176.4 \pm 8.2$  cm and  $73.0 \pm 10.5$  kg respectively.

These tests were carried out on volunteer climbers firstly at the residence center at altitude of 1200 m (Hacılar,  $n=34$ ), and secondly on the same day at altitude of about 2850 m after 4 h (base camp at Mount Erciyes,  $n=34$ ), and then finally psychological tests were done at altitude 3900 m after one day from secondly ( $n=31$ ). Volunteers were carried by trucks from 1200 m to 2850 m in two h time. Mountaineers were not aware of psychological tests will be done application repetition. They were answered the same tests at different altitudes at least two to four h later after they reached the camp area. However, This practical test is test to be accepted for Turkish people [18]. First measuring (I.Meas-1200 m) was done among 10.00-12.00 o'clock, second measuring (II.Meas-2850 m) at 15.00-17.00 o'clock of same day, and then third measuring (III.Meas-3900 m) at 10.00-12.00 o'clock after one day. This research has been done with volunteer mountaineers by using special standard inquiry form. It has been taken leave to research from both Erciyes University Ethical Committee and local Hacılar Mountaineering Department. Psychological tests were done in June during the climbing Erciyes Mountain Summit 2003.

The psychological profiles of volunteers were evaluated with state and trait anxiety scales and brief symptom inventory. State and trait anxiety (SA, TA) scales were composed of a questionnaire of 20 test questions and brief symptom inventory (BSI) questionnaire of 53 questions with 9 subscales, one additional materials index (AMI) and three global indexes. Brief symptom inventory (BSI) consists of these 9 subscales: The subscales used together with these tests were



somatization (S), obsessive compulsive disorder (OCD), interpersonal sensitivity (IPS), depression (D), anxiety disorder (AD), phobic anxiety (PA), hostility (H), paranoid ideation (PI), psychoticism (P), and global indexes; additional materials index (AMI), seriousness of disturbance index (SDI), total symptom index (STI) and symptom disturbance index (SyDI). Brief symptom inventory is the short form of SCL-90-R [2,12].

The answers to each item test questions of State and Trait anxiety were rated on a four point-scale ranging from 1 (not at all) to 4 (extremely) and BSI also were rated on a five point-scale ranging from 0 (not at all) to 4 (extremely). Positive scores are seven [1,6,7,10,13,16,19] of 20 items, and negative scores are 13 [2,3,4,5,8,9,11,12,14,15,17,18,20] of 20 items. Finally, the sum of negative expressions was subtracted from the sum of positive expressions, and different coefficients were added for state and trait anxiety. Trait anxiety was calculated by: (negative scores - positive scores + 35 = Point). State anxiety is calculated by (negative scores - positive scores + 50 = Point). The negative scores are 10 items [4,5,6,7,9,12,14,15,17,18] and other items also are positive scores. The scores of BSI were analytically defined [9]. Subscales of BSI are nine items, that they consist of S has seven item [2,7,23,29,33,37] of 53 item, OCD has six [5,15,26,27,32,36] of 53, IPS has four [20,21,22,42] of 53, D has six [9,16,17,18,35,50] of 53, AD has six [1,12,19,38,45,49] of 53, H has five [6,13,40,41,46] of 53, PA has five [8,28,31,43,47] of 53, P has five [3,14,34,44,53] of 53, and AMI has four items [11,25,39,52] of 53. Global indexes were calculated by SDI, TSI and SyDI, the calculating total of 10 subscales/53, counting as 1 each one of 10 subscales item except zero, and dividing to TSI of SDI scores respectively. The magnitude of total score of scales was evaluated as the intensity of individual symptoms [9]. The volunteer mountaineers were informed about the tests. Results were statistically evaluated by Paired Student t Test using computer

## Results

Trait and state anxiety scores were decreased at 2850 m (base camp) altitude according to Hacilar place findings and the difference between Hacilar and at the Erciyes base camp findings were not important ( $p > 0.05$ ), but the increase in TA and SA findings at the Erciyes Summit was found statistically significant according to base camp findings ( $p < 0.05$ ). The BSI increase of S, OCD, IPS, D, AD, H, PA, PI, P and AMI were found statistically significant at the Erciyes Summit according to base camp findings ( $p < 0.05$ ) and FA scores were significantly decreased ( $p < 0.05$ ). TA, SA findings were both not significantly different between Hacilar and base camp ( $p > 0.005$ ). Somatization, OCD, AD, H, FA and AMI findings



significantly decreased between Hacilar and base camp ( $p < 0.05$ ). However, SBI, D, PI and P findings were similar between Hacilar and base camp ( $p > 0.05$ ). Global Indexes that AMI, SDI and TSI increased according to base camp findings, and this increase was significant ( $p < 0.05$ ), but the increase of TSI in base camp was not found significant according to Hacilar findings ( $p > 0.05$ ). All volunteers' psychological test findings under hypobaric hypoxic condition were shown in Table 1.

**Table 1**

Comparison of the test results of state, trait anxiety scales and brief symptom inventory in hypobaric hypoxic conditions

Psychological tests	Hacilar*	Base Camp*	Erciyes*	$t^1$	$t^2$	$p^1$	$p^2$
	1200 m, n=34 (I. Meas)	2850 m, n=34 (II. Meas)	3900 m, n=31 (III. Meas)				
<b>Trait anxiety</b>							
scala (TA)	35.2±1.1	34.5±1.2	41.4±1.1	1.06	2.02	>0.05	<0.05
<b>State anxiety</b>							
scala (SA)	38.6±1.0	38.3±1.0	43.2±1.9	4.2	4.6	>0.05	<0.05
<b>Brief symptom inventory</b>							
Somatization (S)	1.21±0.3	0.79±0.3	2.23±0.4	2.6	2.3	<0.05	<0.05
Obsessive-Compulsive Disorders (OCD)	3.03±0.5	2.29±0.4	5.40±0.7	2.4	2.2	<0.05	<0.05
Sensitiveness between Individuals (SBI)	1.29±0.2	1.15±0.3	2.67±0.4	0.6	3.0	>0.05	<0.05
Depression (D)	1.29±0.3	0.91±0.3	3.14±0.3	1.6	3.1	>0.05	<0.05
Anxiety Disorder (AD)	1.17±0.3	0.56±0.2	2.59±0.5	3.6	2.5	<0.05	<0.05
Hostility (H)	1.79±0.4	1.15±0.3	2.83±0.4	2.2	2.1	<0.05	<0.05
Fobic Anxiety (FA)	0.82±0.2	0.29±0.1	1.47±0.3	3.0	0.9	<0.05	>0.05
Paranoid Ideation (PI)	1.97±0.4	1.74±0.3	4.19±0.6	0.8	3.8	>0.05	<0.05



Psychotism (P)	0.79±0.2	0.65±0.2	3.11±0.5	0.9	3.9	>0,05	<0.05
Additional	1.35±0.3	0.97±0.2	2.47±0.4	2.0	2.5	<0.05	<0.05
Material Index (AMI)							
Global indexes							
Seriousness of Disturbance Index (SDI)	0.28±0.1	0.20±0.2	0.56±0.4	3.0	3.4	<0.05	<0.05
Total Symptom Index (TSI)	3.97±0.5	4.15±0.7	7.62±0.5	0.2	2.1	>0.05	<0.05
Symptom Disturbance Index SyDI)	1.10±0.2	0.71±0.2	3.43±0.3	3.7	5.2	<0.05	<0.05

\*Findings of Hacilar-Base Camp ( $t^1$ ,  $p^1$ ) Base Camp- Erciyes Mountain Summit; ( $t^2$ ,  $p^2$ ) has been compared with each other

## Discussion

Although many factors affect the speed of adaptation to hypobaric hypoxia, physiological bases of acclimatization develop within a few days from the first few h of the arrival at this altitude [2,4]. While acute response to hypobaric hypoxia firstly affects the vital functions, late responses are affecting humoral mechanisms [4]. Complete acclimatization to the altitude takes two weeks. The individual response to existing factors within this period differs, as acute mountain sickness, headache, fatigue, weakness and difficulty in sleeping [2,10]. The faster the speed of climbing, the slower the speed of the occurrence of the symptoms [10]. It has been known that there are different effects of altitude, environmental, psychological and physiologic factors of persons on perception, apprehension and motoric performance [3,14,21].

In this study it was found that some changes occur in people's psychometric test results in a short time when they reach to at an altitude of 1200 m-2850 m-3900 m from where they live. Especially the increase is statistically significant on Erciyes Mount Summit (III.Meas) in State, Trait anxiety, and global indexes according to I.Meas and II.Meas. Compensation mechanisms occurring against the altitude zone in hypobaric conditions also affect psychomotor mechanism [19-21]. However, rhythmic variations in physiological and behavioral processes are mediated by both endogenous and exogenous factors. Endogenous factors include self-sustaining



biological pacemakers or clocks which in the absence of strong external influences self-sustain periodic rhythms in such diverse physiological and psychological processes as core body temperature, food intake, cognitive performance and mood [20]. When experimental conditions of an altitude of 5000 m were created and then the oxygen concentration of the medium was increased by 6% compared to the normal atmospheric oxygen concentration, it was found that there were positive improvements having significant differences in the evaluation of the neuro physiologic tests done in hypobaric hypoxic conditions [3]. It has been reported that the parameters having an important role in the determination of mental performance, depending on the structural features of the altitude, such as visual sharpness, attention time, short duration memory, arithmetical ability and decision ability decrease in different proportions compared to the values at sea level [4,5,10,13].

The reason for not having a significant change in the scales of state and trait anxiety test may have resulted from the fact that the altitude reached was not at the level to make an important change in anxiety or that the evaluation was made in an early period in which climbing anxiety did not occur. But all anxiety findings increased significantly at altitude of Erciyes Summit. Climbing speed is considered as one of the important factors determining the occurring speed of the symptoms. Physical difficulties arising during climbing, manner-behavior of group members and environmental factors (cold, wind, ozone, decreasing atmospheric gas concentrations etc.) are determining the level of the anxiety [5,10,14]. The decrease both in anxieties and items of the subscales of BSI in the test results of the base camping site may be explained by the fact that the evaluation might have been made in the period of adaptation to a new different environment and in which active climbing preparations had not started yet. Trait and state anxiety tests scores increased after walking very difficult 8 o'clock to climb Erciyes Summit. It has known that positive correlation was found between the climbers' performance in reaction time and changes in state-type anxiety levels, friendliness, clear thinking, dizziness, sleepiness, and unhappiness some at altitudes, suggesting that anxiety could lead to an improved reaction time. In addition, significant negative correlations were also found between the climbers' performance in psychomotor ability, mental efficiency, and reaction time, including tension, hostility, confusion, and fatigue [5,11,20]. This information has supporting our findings. The climbers included with an amateur spirit to this study, and did not have any goal of competition may have prevented the climbers from exposure to the emotions which may cause constitutional anxiety.



Although brief symptom inventory test findings decreased in the Erciyes camp, all same findings increased in Erciyes summit. As a result of these findings, all global index findings increased significantly in Erciyes summit too. The sympathetic nervous system is dominant because of mountain conditions. The hard environmental conditions cause to increase in state anxiety, the consciousness and informed levels. The increasing of state anxiety also augment some parameters that is anxiety, pessimistic, anger, fear, nervousness, uneasiness. All these factors are affecting directly the result of psychological tests. The increasing of trait anxiety levels are caused by some parameters such as anxiety, pessimistic, etc. and the prolonged of trait anxiety should brings about calmness, indifference, reluctance [11,20,24].

In conclusion, we think that since the basic factors affecting individuals such as environmental conditions, physical activity and life stressors (success, gain, exam, debt and responsibility and etc), they do not exist temporarily in this environment, reaching mid-altitudes causes a decrease in psychometric test scores and therefore, in the effectiveness of all stressors on individuals and that free anxiety is converted to dependent anxiety. We have suggested that all mountaineers with low emotional stability could be more sensitive to environmental stressors than more emotionally stable volunteers who face reality of hypobaric hypoxic conditions.

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