

Epidemiological characteristics and laboratory correlates of psychiatric disorders in mountainous regions

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ABSTRACT

Objective: To assess the prevalence and pattern of psychiatric disorders in individuals presenting to the psychiatry department and to examine their relationship with routine laboratory measurements, age, marital status and educational level.

Materials and Methods: This cross sectional study was conducted in Skardu from September 2021 to February 2022. A total of 100 adults aged 21–40 years who provided written informed consent were enrolled. Participants underwent clinical evaluation by a consultant psychiatrist, medical specialist and gynecologist and diagnoses were made according to ICD-10 criteria. Blood samples were analyzed for complete blood counts and liver and renal function tests using standard methods. Statistical analysis assessed associations between demographic characteristics, laboratory findings and psychiatric diagnoses.

Results: Among the 100 participants 81% were married and 19% single, with a mean age of 26.94 ± 4.35 years. Depressive episodes were most common (44%), followed by adjustment disorder (30%), anxiety disorder (12%), dissociative disorder (9%) and mood disorder (5%). All participants had mild anemia (mean hemoglobin 12.37 ± 1.35 g/dL) and mildly elevated ALT levels (mean 42.30 ± 15.25 U/L). No significant differences in laboratory parameters were found across diagnostic groups ($p > 0.05$).

Conclusion: Depressive disorders 44% and adjustment disorders 30% were the leading psychiatric conditions at high altitude. Apart from mild anemia and marginal elevation in alanine aminotransferase levels baseline hematological and biochemical findings were largely comparable across diagnostic categories.

Keywords: Adjustment disorder, Depression, High altitude ICD 10, Psychiatric disorders.

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INTRODUCTION

Psychiatric illnesses contribute substantially to the global burden of disease and are responsible for nearly one third of productivity loss and functional impairment worldwide [1]. Current epidemiological estimates indicate that one in every eight individuals, approximately 12% of the global population lives with a diagnosable mental disorder with depressive and anxiety disorders accounting for the majority of cases reported in recent burden analyses [2]. Evidence also shows that nearly 50% to 75% of psychiatric disorders begin during childhood or adolescence [3]. In low and middle income countries the documented prevalence of psychiatric disorders in early life ranges between 10% and 20%, reflecting considerable unmet mental health needs [4]. Multiple population based studies have identified age, gender

and socioeconomic status as strong determinants of psychiatric morbidity. Disruptive behavior disorders and attention deficit/hyperactivity disorder are more common in boys, whereas anxiety disorders occur more frequently among post pubertal girls [5]. Living and working at high altitude introduces environmental and physiological stressors that can trigger or intensify psychiatric symptoms. Factors such as persistent cold exposure, reduced oxygen availability, social isolation, reduced mobility and prolonged separation from family are recognized contributors to emotional distress in high altitude settings [6]. Patients residing in such environments are also exposed to severe weather variability, high ultraviolet radiation, unpredictable blizzards, avalanches and rockslides, all of which compound occupational and psychological strain. Accommodation at high altitude often consists of compact fiberglass shelters with suboptimal ventilation. Heating methods commonly involve wood fires or kerosene stoves, leading to prolonged exposure to smoke and airborne particulate matter. These conditions heighten stress when combined with limited physical activity, monotony of daily tasks and extended work hours in cold temperatures. Additionally, physiological adaptations to high altitude such as changes in

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hemoglobin concentration, red cell mass and hepatic enzyme activity may influence hematological and biochemical values, complicating clinical interpretation. Although published literature remains limited some studies have noted differences in laboratory findings, including mild anemia in depressive states and biochemical alterations in schizophrenia. The purpose of the present study was to determine the prevalence and spectrum of psychiatric disorders among patients residing at high elevation and to explore potential associations with demographic characteristics and baseline laboratory measurements.

MATERIAL AND METHODS

This cross sectional study was carried out in the Psychiatry/ Medicine Department from September 2021 to February 2022 after obtaining ethical approval from the institutional review board vide letter number ERB/Psy/02 dated 07 August 2021. Using a presumed prevalence of 25%, a 95% confidence interval, and a 5% margin of error, the WHO sample size calculator determined that a minimum of 73 participants was required. A total of 100 patients aged 21 to 41 years were enrolled through non probability sampling. Each participant was assessed by a consultant psychiatrist following referral from the general outpatient or medical/Gynae departments and written informed consent was obtained. Individuals with cerebral palsy, autoimmune diseases, brain tumors, neurological disorders or chronic systemic illnesses such as diabetes, asthma, nephrotic syndrome, hypothyroidism and epilepsy were excluded. Demographic details were collected using a structured questionnaire. Psychiatric diagnoses were made in accordance with the International Classification of Diseases, 10th Revision (ICD-10) and categorized into five main groups: adjustment disorders, dissociative disorders, mood disorders, anxiety disorders and depressive episodes. Participants were stratified into two age categories (21–28 years and 29–40 years) and three educational levels (middle—8 years, matric—10 years and intermediate—12 years) to assess demographic trends.

For laboratory evaluation, 3 mL of venous blood was drawn aseptically and placed in gel and EDTA tubes. Hematological hepatic, and renal function tests were analyzed by a consultant pathologist using Sysmex XP-100 and Microlab 300 analyzers (Sysmex Corporation, Kobe, Japan; Merck KGaA, Darmstadt,

Germany). Data were analyzed using SPSS version 23. Continuous variables, including age and laboratory values, were expressed as mean $\pm$ standard deviation (SD), while categorical variables such as education, marital status and psychiatric diagnosis were presented as frequencies and percentages. Group means were compared using one way ANOVA and relationships between categorical variables were examined using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The average age of study participants was 26.94 ± 4.35 years. Of them, 77 (77%) were under the age of 29 and 23 (23%) were between the ages of 29 and 41. According to a marital status analysis, 81 (81%) were married and 19 (19%) were single. Educational attainment varied with 30% educated up to middle level, 38% up to matric and 32% up to intermediate level. Based on ICD-10 diagnostic criteria, the most prevalent psychiatric condition was *depressive episode* in 44% ($n=44$), followed by *adjustment disorder* in 30% ($n=30$). Other diagnoses included anxiety disorder in 12% ($n=12$), dissociative disorder in 9% ($n=9$) and mood disorder in 5% ($n=5$). Mild anemia (mean Hb 12.37 ± 1.35 g/dL) and slightly elevated alanine aminotransferase levels (mean ALT 42.30 ± 15.25 U/L) were observed across diagnostic groups, though no statistically significant differences were detected between psychiatric categories ($p > 0.05$) (Figure-I). Age was a confounding variable for Depressive Episode and Adjustment Disorder with high propensity for younger age for former and low for latter (Table-I). Marital status was a confounding factor for Mood Disorder having more propensity for unmarried individuals (Table-II). The educational status of children was a confounding variable for Depressive Episode and Adjustment Disorder with higher predilection of former with low education. Adjustment disorder was seen more in individuals with higher educational qualifications (Table-III). Slightly raised ALT was observed in patients of depression and adjustment disorder (44.4 ± 15.01 and 43.9 ± 14.56 respectively) with slightly low hemoglobin levels as per reference range of study population. However, no significant difference was found between groups for any of the metrics (Table-IV).

Table-I: Age as an effect modifier in psychiatric diseases at high altitude.

Age groups	Depressive Episode n=44 44%		Anxiety Disorder n=12 12%		Dissociative disorder n=09 9%		Mood Disorder n=05 5%		Adjustment Disorder n=30 30%	
	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value
21-28 yrs n=53	40	0.016	0	0.731	3	0.065	1	0.745	9	0.019
29-41 yrs n=47	4		12		6		4		21	

Table-II: Marital status as an Effect modifier of psychiatric disorders at high altitude

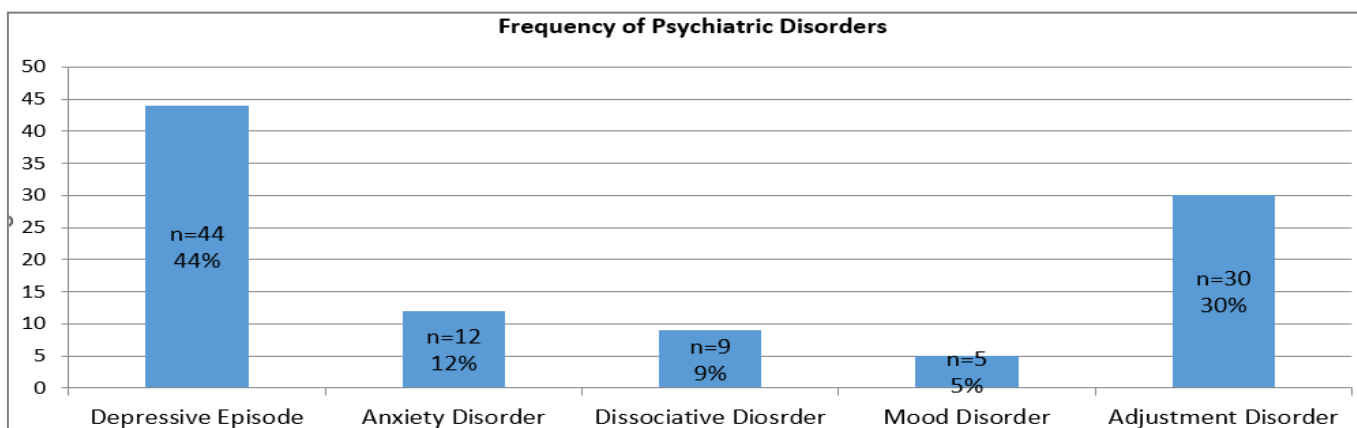
Marital status	Depressive Episode n=44		Anxiety Disorder n=12		Dissociative disorder n=09		Mood Disorder n=05		Adjustment Disorder n=30	
	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value
Married n=66	28	0.622	09	0.282	07	0.615	02	0.020	20	0.411
Un married n=34	16		03		02		03		10	

Table-III: Educational status as a modifier of psychiatric disorders at high altitude.

Educational status	Depressive Episode n=44		Anxiety Disorder n=12		Dissociative disorder n=09		Mood Disorder n=05		Adjustment Disorder n=30	
	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value	No of pts	P value
Middle n=30	23		03		1		-		03	
Matric n=38	18	<0.01	03	0.357	4	0.422	01	0.055	12	0.006
Intermediate n=32	03		06		4		04		15	

Table-IV: Baseline blood parameters (Mean±SD) in psychiatric disorders at high altitude

Parameters	Depressive Episode n=44	Anxiety Disorder n=12	Dissociative disorder n=09	Mood Disorder n=05	Adjustment Disorder n=30	Overall n=100	P value
TLC (x10 ⁹)	5.81±1.25	5.75±1.31	5.92±1.36	5.78±0.85	5.82±1.17	5.82±1.21	0.99
Hemoglobin (g/dL)	12.2±1.27	12.3±1.49	12.4±1.62	12.7±1.17	12.5±1.38	12.37±1.35	0.81
Platelets (x10 ⁶)	246±79	252±84	232±66	269±90	260±66	250.90±74.94	0.83
Urea (mmol/L)	5.72±1.17	5.80±1.25	5.65±1.13	5.90±0.98	5.89±1.17	5.78±1.15	0.96
Creatinine (umol/L)	80.8±14.23	82.17±11.32	82.88±10.37	87.60±10.14	86.93±9.86	81.57±12.08	0.81
Bilirubin (U/L)	10.31±3.02	10.9±2.32	10.5±3.10	11.3±2.37	10.7±2.39	10.60±2.71	0.90
ALT (U/L)	44.4±15.01	39.5±18.14	36.1±15.83	32.2±9.20	43.9±14.56	42.30±15.25	0.27
ALP (U/L)	194.2±42.84	200.3±49.18	208.0±43.02	202.0±27.73	200.8±45.65	198.56±43.31	0.91

**Figure-I: Pattern of psychiatric disorders at high altitude.**

DISCUSSION

This study examined the pattern of psychiatric disorders among individuals residing at high altitude who presented to the Psychiatry/Medicine Outpatient Department. The predominant diagnosis was Depressive Episode (44%), followed by adjustment disorder (30%). Other psychiatric conditions included anxiety disorder (12%), Dissociative Disorder (9%), and *Mood Disorder* (5%). These findings suggest that depressive and stress related conditions constitute the major mental health burden among residents at high altitude. Previous studies have consistently reported an increased risk of depression and suicide with rising altitude. A study found that depression occurs in about 17% of acclimatized individuals [5,6]. Similarly, Zhou Q, Dai Z, Hou L, *et al.* discovered that a significant portion of volunteers suffered from mild to moderate depression and anxiety at high altitude [7]. A study on seasonal variations found that six out of 76 international patients had an anxiety related diagnosis, and Sracic *et al.* found that seven out of 1,036 people had anxiety symptoms within days of arriving at high altitude [8]. The biological mechanism behind these associations has been proposed to be hypoxia induced inflammatory activation, which may contribute to mood dysregulation and suicidal thoughts [10].

Environmental stressors are also important. Isolation, severe weather, limited family communication and the physically taxing and remote nature of high-altitude deployment all contribute to the accumulation of psychological stress [11]. According to Young *et al.*, the higher rates of depression and suicide seen at higher elevations might be caused by hypoxia induced suppression of serotonin synthesis [12]. Compared to reports from individuals/ mountaineers who had acclimated to the environment the current study found a greater prevalence of anxiety and depression disorders [5–8]. This discrepancy most likely results from the fact that our study population consists of patients who are already seeking psychiatric evaluation as opposed to asymptomatic high-altitude residents. Socioeconomic stressors, subpar living conditions, poor nutrition and restricted access to specialized psychiatric care in remote areas are possible additional contributing factors.

According to Nock *et al.*, altitude plays a significant role in chronic hypoxia, which exacerbates underlying affective disorders and mood instability [13]. By showing that mood disorders frequently remained after oxygen therapy improved pulmonary function in hypoxic individuals, Yu *et al.* brought attention to the intricate relationship between hypoxia and mental

health [14]. Hypoxia may worsen panic symptoms and physiological stress when coupled with anxiety-driven autonomic reactions [15].

After a brief exposure to high altitude, dopamine can be released, which may initially cause euphoria. However, prolonged hypoxia lowers serotonin availability, which can lead to depression and anxiety [16]. Long-term exposure to hypoxic environments has also been linked to neurotic and psychotic disorders [17]. Reduced sunlight exposure, altered melatonin secretion at high altitude and disrupted circadian rhythms also contribute to mood disorders, poor concentration, and cognitive impairment [18]. Nutritional deficiencies, dehydration and chronic stress can prolong neurotic symptoms and worsen these effects [19].

High altitude residents frequently experience somatic complaints like headaches, palpitations, dizziness, and dyspnea which can resemble or trigger anxiety or dissociation symptoms [20]. High altitude may physiologically trigger dissociation, characterized by disruptions in identity, perception, memory, and consciousness [21]. Mania and mood elevation following high altitude ascent have also albeit infrequently occurred in people with pre-existing bipolar disorder [22]. Although the data are mostly anecdotal and susceptible to reporting bias, psychotic features have also been documented among mountaineers at elevations above 7,000 feet.

Compared to reference values, patients with adjustment and depressive disorders in the current study had slightly lower hemoglobin concentrations and slightly higher mean alanine aminotransferase (ALT) levels (43.9 ± 14.56 U/L and 44.4 ± 15.01 U/L, respectively). However, these differences were not statistically significant. Rather than being directly linked to mental health issues, mild anemia and a slight elevation of ALT could be caused by physiological adaptation to hypoxia or subclinical nutritional factors.

This study is important because it suggests that all of the cohort members had mental health problems because it only included patients who visited a psychiatric clinic. As a result, rather than community prevalence the results show clinical distribution. Underreporting and delayed presentation, which are probably brought on by the cultural stigma associated with mental health, may further skew actual prevalence estimates in Pakistan.

The study's single center design, small sample size and lack of a control group composed of healthy individuals at similar elevations are some of its drawbacks. More multicentric research with bigger,

community based cohorts is required to validate these results and look into potential biological links between hypoxia, inflammation and neurotransmitter imbalance in psychiatric morbidity at high altitude.

CONCLUSION

The most prevalent mental illnesses among people who lived at high elevations were adjustment disorders and depression. They appear to arise from exposure to environmental stressors, social isolation and hypoxia. Our findings highlight the need for focused mental health programs and timely psychological evaluation for individuals residing or working at high altitudes. The current body of evidence on the psychological effects of high altitude exposure remains limited. Comprehensive, multicenter investigations are essential to clarify the link between psychiatric disorders and altitude related physiological adaptations.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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Declared none

AUTHORS CONTRIBUTION

Mustajab Alam: Drafting the manuscript, acquisition, analysis, and interpretation of data. critical review, statistical review, critical review and discussion, final approval, accountable for all aspects of publication

Malik Awais Amin: Conception, data collection, formal analysis, investigation, and resources, result analysis, review, final approval, accountable for all aspects of publication

Syed Ali Ghawas: Data collection, critical review, Patient evaluation and referral, accountable for all aspects of publication

Anam Manzoor Alam: Critical review and discussion, data collection, formal analysis, accountable for all aspects of publication

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