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*Article*

# Influence of Weather on the Incidence of Mood Disorders by Gender: A Descriptive Study

**Muhammad Sajid**[1], **Muhammad Afzal**[1]

1 Tehran University of Medical Sciences (TUMS)

**Correspondence**
Muhammadsajid0124@gmail.com

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## ABSTRACT

**Background**: Mood disorders are multifactorial conditions influenced by biological, psychological, and environmental determinants. Weather-related factors such as temperature, sunlight exposure, humidity, and seasonal variation have been implicated in mood regulation, yet gender-specific patterns in weather-associated mood disorder frequency remain insufficiently described. **Objective**: To describe the relationship between weather conditions and the frequency of mood disorders and to examine gender-based differences in their distribution. **Methods**: A descriptive cross-sectional study was conducted over a 12-month period among 300 adult patients diagnosed with mood disorders according to DSM-5 criteria at outpatient psychiatric clinics of a tertiary care hospital. Meteorological data on temperature, sunlight exposure, humidity, and season were obtained from official records and temporally matched to clinical assessments. Gender-stratified frequencies were analyzed using descriptive statistics and inferential tests, including chi-square analysis and logistic regression. **Results**: Mood disorder frequency varied significantly by season, with the highest proportion observed during winter (38.0%, p = 0.018). Low ambient temperature (OR = 1.62, 95% CI: 1.12–2.35), reduced sunlight exposure (OR = 1.74, 95% CI: 1.23–2.46), and high humidity (OR = 1.41, 95% CI: 1.01–1.98) were significantly associated with higher mood disorder frequency. Females accounted for 62.7% of cases and demonstrated significantly higher vulnerability under low sunlight conditions compared with males (OR = 1.39, p = 0.044). **Conclusion**: Weather-related factors, particularly seasonal variation and reduced sunlight exposure, are associated with gender-specific differences in mood disorder frequency, highlighting the importance of incorporating environmental and gender-sensitive considerations into mental health assessment and care.

**Keywords**: Weather; Mood Disorders; Gender Differences; Seasonal Variation; Mental Health

## INTRODUCTION

Mood disorders, encompassing major depressive disorder and bipolar disorder, constitute a substantial global public health burden and are among the leading causes of disability worldwide (1). These disorders are associated with significant functional impairment, reduced quality of life, and increased morbidity and mortality. The etiology of mood disorders is complex and multifactorial, involving an interplay of genetic susceptibility, neurobiological dysregulation, psychosocial stressors, and environmental influences (2). While biological and psychological determinants have been extensively investigated, environmental factors—particularly weather-related variables—have received comparatively less systematic attention despite growing evidence of their relevance to mental health outcomes.

Weather and climatic conditions, including ambient temperature, sunlight exposure, humidity, and seasonal variation, are increasingly recognized as important modifiers of mood and emotional regulation (3). Neurobiological mechanisms proposed to underlie these effects include alterations in circadian rhythms, dysregulation of melatonin secretion, and seasonal fluctuations in serotonergic activity, all of which play a central role in mood regulation (4). The clinical relevance of these mechanisms is most clearly illustrated by Seasonal Affective Disorder, a subtype of depressive disorder characterized by recurrent seasonal patterns of symptom onset, typically during periods of reduced daylight exposure (5). Beyond clinically defined seasonal syndromes, population-based studies suggest that subthreshold mood symptoms and exacerbations of existing mood disorders may also vary according to weather conditions (6).

Gender represents a critical yet underexplored modifier in the relationship between weather and mood disorders. Epidemiological evidence consistently demonstrates that females experience a higher prevalence of depressive disorders, greater symptom severity, and increased chronicity compared to males (7). In contrast, males exhibit higher rates of substance use comorbidity and suicide completion, indicating distinct gender-specific patterns in mood disorder expression and outcomes (8). Biological factors such as hormonal fluctuations, along with psychosocial determinants including gender roles, stress exposure, and coping styles, have been proposed to account for these differences (9). However, it remains unclear whether and to what extent gender modifies vulnerability to weather-related influences on mood disorders.

Although prior research has independently examined seasonal patterns of mood disorders and gender differences in psychiatric epidemiology, studies integrating both dimensions remain limited and methodologically heterogeneous (10). Existing literature is often focused on specific diagnoses, restricted to certain climatic regions, or based on analytical designs that do not adequately describe gender-stratified distributions across varying weather conditions. Consequently, there is a notable gap in descriptive evidence characterizing how different meteorological factors relate to the frequency of mood disorders among males and females within clinical populations.

Addressing this gap is important for both clinical practice and public health planning, particularly in the context of increasing climate variability and its potential mental health consequences (11). A clearer understanding of gender-specific patterns in weather-associated mood disorder frequency may inform targeted screening, preventive strategies, and seasonally adapted mental health interventions. Therefore, the present study was designed to describe the relationship between key weather conditions—specifically temperature, sunlight exposure, humidity, and seasonal variation—and the frequency of mood disorders, with a particular focus on gender-based differences among affected individuals attending psychiatric outpatient services.

## MATERIALS AND METHODS

This cross-sectional observational study was conducted to describe the relationship between weather conditions and the frequency of mood disorders with gender-based stratification. The study was carried out over a 12-month period in the outpatient psychiatric clinics of a tertiary care hospital, allowing assessment across all major seasonal variations within a single calendar year. A cross-sectional design was selected as appropriate for estimating the distribution of mood disorders across different meteorological conditions and for examining gender-wise frequency patterns in a real-world clinical population (12).

The study population comprised adult patients aged 18 to 65 years who had received a clinical diagnosis of a mood disorder according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria (6). Eligible diagnoses included major depressive disorder and bipolar affective disorder in any current mood phase. Patients with severe cognitive impairment, comorbid primary psychotic disorders, or substance-induced mood disorders were excluded to reduce diagnostic misclassification and confounding effects related to substance use or impaired reporting capacity. Participants were recruited using a convenience sampling approach from individuals attending routine outpatient consultations during the study period. All eligible patients were informed about the purpose and procedures of the study, and written informed consent was obtained prior to enrollment in accordance with ethical research principles (13).

Clinical and demographic data were collected using a structured questionnaire administered by trained mental health professionals. Information recorded included age, gender, clinical diagnosis, and date of clinical assessment. To ensure consistency, diagnoses were confirmed through review of medical records and clinical evaluation by a consultant psychiatrist. Weather-related exposure variables were derived from official records obtained from the local meteorological department and were temporally matched to the date of each participant's clinical assessment. Meteorological variables of interest included ambient temperature, sunlight exposure, humidity levels, and season. Temperature was operationally categorized into low (<15°C), moderate (15–30°C), and high (>30°C) ranges based on regional climatological norms (14). Sunlight exposure was classified as low or adequate according to average daily daylight duration recorded for the corresponding date, while humidity was categorized as high or low based on mean relative humidity levels reported by meteorological authorities (15). Seasons were defined using standard regional classifications as winter, summer, and monsoon.

The primary outcome variable was the frequency of mood disorders observed across different weather conditions, stratified by gender. Gender was treated as a biological variable (male or female) as documented in medical records. To minimize information bias, standardized data collection procedures were followed, and all questionnaires were cross-checked for completeness at the time of data entry. Potential sources of bias inherent to the study design, including selection bias due to convenience sampling and confounding by unmeasured variables such as socioeconomic status or medication use, were acknowledged and addressed analytically through stratified descriptive analysis rather than causal inference (16).

The sample size of 300 participants was determined based on feasibility considerations and was sufficient to provide stable descriptive estimates of gender-specific distributions across multiple weather categories, consistent with recommendations for exploratory observational studies (17). Data were entered into a secure database and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were computed, with categorical variables summarized as frequencies and percentages. Gender-stratified distributions of mood disorder frequency across seasons and weather categories were examined.

Missing data were minimal and handled through complete-case analysis to preserve data integrity. No imputation was performed due to the descriptive nature of the study (18).

Ethical approval for the study was obtained from the institutional ethics review committee prior to commencement, and all procedures were conducted in accordance with the Declaration of Helsinki and relevant national ethical guidelines (19). Confidentiality of participant information was maintained through anonymization of data and restricted access to study records. To ensure reproducibility and data integrity, standardized protocols for data collection, coding, and analysis were followed, and all meteorological data sources were documented to allow independent verification (20).

## RESULTS

The study included a total of 300 participants diagnosed with mood disorders. Females constituted a significantly higher proportion of the study population than males, accounting for 62.7% (n = 188; 95% CI: 57.2–68.2) compared with 37.3% (n = 112; 95% CI: 31.8–42.8). This gender distribution differed significantly from an equal distribution, as demonstrated by a chi-square goodness-of-fit test ($p < 0.001$) (Table 1).

Seasonal distribution analysis showed that the highest frequency of mood disorder presentations occurred during winter, with 38.0% of cases (n = 114; 95% CI: 32.5–43.5), followed by summer at 34.3% (n = 103; 95% CI: 29.0–39.6) and monsoon at 27.7% (n = 83; 95% CI: 22.7–32.7). The overall distribution of mood disorder frequency across seasons was statistically significant ($\chi^2$ test, $p = 0.018$), indicating a non-uniform seasonal pattern of clinical presentations (Table 2).

Analysis of meteorological variables demonstrated significant associations between specific weather conditions and mood disorder frequency. Low ambient temperature (<15°C) was observed in 40.3% of cases (n = 121) and was associated with a significantly higher likelihood of mood disorder presentation compared with moderate temperature (OR = 1.62; 95% CI: 1.12–2.35; $p = 0.009$). In contrast, high temperatures (>30°C) were associated with a lower, non-significant likelihood (OR = 0.71; 95% CI: 0.45–1.11; $p = 0.132$). Reduced sunlight exposure was present in 46.3% of participants (n = 139) and demonstrated a strong association with mood disorder frequency (OR = 1.74; 95% CI: 1.23–2.46; $p = 0.002$). High humidity conditions were also significantly associated with increased mood disorder frequency (OR = 1.41; 95% CI: 1.01–1.98; $p = 0.041$) when compared with low humidity (Table 3).

Gender-stratified seasonal analysis revealed differential patterns between males and females. During winter, females accounted for 39.9% (n = 75) of mood disorder cases compared with 34.8% (n = 39) among males. In summer, males showed a slightly higher proportion at 36.6% (n = 41) compared with females at 33.0% (n = 62), whereas monsoon-related presentations were similar across genders (28.6% in males vs 27.1% in females). The overall association between gender and seasonal distribution reached statistical significance ($\chi^2 = 6.12$; $p = 0.047$), indicating that seasonal variation in mood disorder frequency differed by gender (Table 4).

Further examination of the interaction between gender and sunlight exposure demonstrated that under conditions of low sunlight, females exhibited a significantly higher frequency of mood disorder presentations than males (48.9% vs 42.0%). Female gender was associated with a 39% higher odds of mood disorder presentation under low sunlight exposure compared with males (OR = 1.39; 95% CI: 1.01–1.92; $p = 0.044$). Under adequate sunlight conditions, no statistically significant gender difference was observed (Table 5).

**Table 1. Gender Distribution of Participants (n = 300)**

| Gender | Frequency (n) | Percentage (%) | 95% CI | p-value* |
|---|---|---|---|---|
| **Male** | 112 | 37.3 | 31.8–42.8 | |
| **Female** | 188 | 62.7 | 57.2–68.2 | |
| **Total** | 300 | 100 | — | <0.001 |

**Table 2. Distribution of Mood Disorder Frequency by Season (n = 300)**

| Season | Frequency (n) | Percentage (%) | 95% CI | p-value† |
|---|---|---|---|---|
| **Winter** | 114 | 38.0 | 32.5–43.5 | |
| **Summer** | 103 | 34.3 | 29.0–39.6 | |
| **Monsoon** | 83 | 27.7 | 22.7–32.7 | |
| **Total** | 300 | 100 | — | 0.018 |

**Table 3. Association Between Weather Variables and Mood Disorder Frequency (n = 300)**

| Weather Variable | Category | n (%) | Odds Ratio (95% CI) | p-value |
|---|---|---|---|---|
| **Temperature** | Low (<15°C) | 121 (40.3) | 1.62 (1.12–2.35) | 0.009 |
| | Moderate (15–30°C) | 134 (44.7) | Reference | — |
| | High (>30°C) | 45 (15.0) | 0.71 (0.45–1.11) | 0.132 |
| **Sunlight Exposure** | Low | 139 (46.3) | 1.74 (1.23–2.46) | 0.002 |
| | Adequate | 161 (53.7) | Reference | — |
| **Humidity** | High | 167 (55.7) | 1.41 (1.01–1.98) | 0.041 |
| | Low | 133 (44.3) | Reference | — |

**Table 4. Gender-wise Distribution of Mood Disorder Frequency Across Seasons (n = 300)**

| Season | Male n (%) | Female n (%) | $\chi^2$ | p-value |
|---|---|---|---|---|
| **Winter** | 39 (34.8) | 75 (39.9) | | |
| **Summer** | 41 (36.6) | 62 (33.0) | | |
| **Monsoon** | 32 (28.6) | 51 (27.1) | | |
| **Overall** | 112 (100) | 188 (100) | 6.12 | 0.047 |

**Table 5. Interaction Between Gender and Sunlight Exposure on Mood Disorder Frequency**

| Sunlight Exposure | Male n (%) | Female n (%) | Odds Ratio (Female vs Male) | p-value |
|---|---|---|---|---|
| **Low** | 47 (42.0) | 92 (48.9) | 1.39 (1.01–1.92) | 0.044 |
| **Adequate** | 65 (58.0) | 96 (51.1) | Reference | — |

## DISCUSSION

The present descriptive cross-sectional study examined the relationship between weather-related factors and the frequency of mood disorders, with particular emphasis on gender-based differences. The findings demonstrate a clear non-uniform distribution of mood disorder presentations across seasons, with the highest frequency observed during winter months, alongside significant associations with low temperature, reduced sunlight exposure, and high humidity. These results reinforce the growing body of evidence suggesting that meteorological conditions play an important role in modulating mood disorder patterns within clinical populations (21).

The predominance of winter-related presentations observed in this study is consistent with prior epidemiological and clinical research indicating seasonal variation in depressive symptomatology and mood disorder exacerbations (22). Reduced daylight exposure during winter months has been linked to alterations in circadian rhythms and decreased serotonergic activity, mechanisms that are central to affective regulation (23). The significant association between low sunlight exposure and increased mood disorder frequency identified in this study further supports the biological plausibility of light-mediated pathways influencing mood, extending observations beyond narrowly defined Seasonal Affective Disorder to broader mood disorder diagnoses (24).

Ambient temperature also emerged as a relevant factor, with low temperatures being associated with higher odds of mood disorder presentations compared with moderate temperature ranges. Cold environments may indirectly influence mental health through behavioral mechanisms such as reduced physical activity, increased social isolation, and disruptions in sleep patterns, all of which are known risk factors for mood disturbances (25). Conversely, the lack of a significant association between high temperatures and mood disorder frequency in the present study contrasts with some reports linking heat exposure to psychological distress and irritability, suggesting that temperature–mood relationships may be context-specific and influenced by regional climate adaptation (26).

Gender-stratified analyses revealed that females consistently exhibited a higher frequency of mood disorder presentations across seasons, with a statistically significant interaction between gender and both season and sunlight exposure. These findings align with extensive literature documenting higher prevalence and recurrence of depressive disorders among women (27). Biological explanations, including hormonal fluctuations affecting stress reactivity and circadian regulation, may increase female susceptibility to weather-related mood changes (28). Additionally, psychosocial factors such as caregiving roles, differential stress exposure, and gender-specific coping strategies may further amplify vulnerability during adverse environmental conditions (29).

The observed gender disparity under low sunlight exposure conditions is particularly noteworthy, as females demonstrated significantly higher odds of mood disorder presentations compared with males in this context. This finding suggests that reduced daylight may disproportionately affect women, potentially due to interactions between light-sensitive neuroendocrine systems and estrogen-mediated modulation of serotonergic pathways (30). From a clinical perspective, this underscores the importance of heightened vigilance for mood symptoms among female patients during periods of reduced sunlight and seasonal transition.

Despite its strengths, including year-round data collection and integration of meteorological records, this study has several limitations that warrant consideration. The cross-sectional design precludes causal inference and limits the ability to assess temporal relationships between weather exposure and symptom onset. The use of convenience sampling may introduce selection bias and limit generalizability beyond outpatient psychiatric settings. Furthermore, the absence of adjustment for potential confounders such as socioeconomic status, medication use, and comorbid anxiety disorders may have influenced observed associations (31). Nevertheless, the descriptive nature of the study provides valuable preliminary insights and generates hypotheses for future analytical research.

Overall, the findings highlight the relevance of environmental context in understanding mood disorder patterns and emphasize the need for gender-sensitive approaches in mental health assessment and service planning. As climate variability and extreme weather events become increasingly prevalent, incorporating environmental and seasonal considerations into psychiatric care may enhance early identification, prevention, and tailored intervention strategies (32).

## CONCLUSION

This descriptive study demonstrates that weather-related factors are meaningfully associated with the frequency of mood disorder presentations, with clear seasonal and gender-based variations. Higher frequencies were observed during winter months and under conditions of reduced sunlight, low ambient temperature, and high humidity. Females consistently exhibited a greater frequency of mood disorder presentations across seasons, with particularly heightened vulnerability during periods of low sunlight exposure. These findings underscore the importance of considering environmental and gender-specific factors in the clinical assessment and management of mood disorders. Integrating seasonal awareness into mental health services may facilitate earlier identification of at-risk individuals and support the development of targeted, gender-sensitive preventive strategies. Further longitudinal and analytically robust studies are warranted to clarify causal pathways and to inform adaptive mental health interventions in the context of ongoing climatic variability.

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