RESEARCH PAPER

Serum Ferritin and Vitamin B12 as Indicators of Mood Symptom Severity in Adult Women: Findings from a Cross-Sectional Study

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ABSTRACT

Depressive mood disorders are highly prevalent among adult women and are influenced by nutritional, inflammatory, and neuroendocrine factors. Biomarkers including ferritin, vitamin B12, serotonin, cortisol, C-reactive protein (CRP), and malondialdehyde (MDA) are important for neurotransmitter production, stress regulation, and brain function. This study investigated the relationship between micronutrient levels, oxidative stress markers, and severity of depressive symptoms in adult females. A cross-sectional study was conducted during the period between January 2022 and December 2024 on 125 women aged 18–45 years attending an outpatient clinic. Depression severity was assessed using the Beck Depression Inventory-II (BDI-II) and Hamilton Depression Rating Scale (HAM-D). Fasting blood samples were analyzed for serum ferritin, vitamin B12, total iron-binding capacity (TIBC), serotonin, cortisol, CRP, and MDA using immunoassay methods. Participants were grouped according to symptom severity. Statistical analyses included ANOVA, Pearson correlation, and logistic regression. Severe depressive symptoms were associated with significantly reduced ferritin, vitamin B12, and serotonin levels, along with elevated TIBC, cortisol, CRP, and MDA levels ($p < 0.05$). Ferritin and vitamin B12 showed negative correlations with depression scores, whereas cortisol and inflammatory markers showed positive correlations. Logistic regression identified ferritin, vitamin B12, TIBC, and cortisol as significant predictors of depression severity. Depression severity is closely linked to micronutrient imbalance, oxidative stress, and neuroendocrine dysfunction. Combined biomarker evaluation may aid diagnosis and therapeutic monitoring in women with depressive disorders.

Keywords: Ferritin; Serotonin; CRP; MDA; Mood disorders; Vitamin B12.

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1. INTRODUCTION

Mood disorders constitute a major public health issue and contribute to mental health problems globally. According to the WHO (2023), further than 280 million individuals international suffer in depression related disorders that lower their daily living standards, impede productivity, and increase healthcare costs. Due to various hormonal, biological, and psychosocial factors, women of reproductive age are especially susceptible to mood disorders. Shortages of essential micronutrients may affect neuronal networks responsible for mood regulation, thereby heightening the emphasis on dietary and biochemical factors in mental well-being (Granero, 2022; Soriano-Gonzalez *et al*., 2025 and Iglesias-Vázquez *et al*., 2018).

Iron is crucial for transport of O2, mitochondrial metabolism of energy and the synthesis of neurotransmitters. Iron performances as a cofactor for enzymes that play a role in the construction of monoamine neurotransmitters like serotonin, norepinephrine, dopamine, whichever regulate mental and

emotional functions in the CNS (Kumar *et al*., 2022). Serum ferritin is a widely used pointer of the iron reserves in body and systemic availability of iron (WHO, 2025). Due to factors such as menstrual bleeding, dietary insufficiency, and biological requirements related to gender, iron deficiency is one of the maximum shared nutritious imbalances internationally, especially among women (Camaschella, 2019; DeLoughery, 2017 and Rajkumar, 2026). Ferritin indicates iron deficiency affecting neurotransmitter synthesis (Hassan, *et al*., 2025) and vitamin B12 linked to impaired myelination and cognitive decline. The depression of mood severity diseases shows more in severe than in other psychological and biochemicals parameters which interprets the nutritional-neurochemical deficiency (Leung and Kyung, 2024).

A current research suggests that a deficiency of iron can negatively affect mental capacity, even in the absence of anemia. (Deepthi *et al*., 2025) A multitude of studies has linked low ferritin levels to depressive symptoms, fatigue, and memory issues. Observational studies have indicated that there is a correlation amongst inferior ferritin levels and augmented assessments of severity in depression (Rajkumar, 2026). Clinical studies suggest that there is a negative correlation among iron shortage anemia ((Hassan, *et al*., 2025) and depression severity, indicating that a reduced iron supply may subsidize to disposition dysregulation ((Leung and Kyung, 2024). The results suggest that altered iron metabolism may disrupt neurotransmitter networks and brain energy metabolism, thereby affecting mental and social functioning.

Vitamin B12 (Cobalamin) entertains an energetic performance in synthesis of DNA, the RBCs formation and one-carbon metabolism related to methylation processes in the CNS. For the preservation of the myelin scabbard and manufacture of monoamine neurotransmitters that disturb mood, Vitamin B12 is crucial Leung and Kyung, 2024). Insufficient levels of B12 Vitamin can result in cognitive impairment, depression, irritability, and neuropathy. Indicators of mental illness can result in blood-related problems, underscoring the need for quick identification (Green *et al*., 2017). Recent demographic and medical studies have shown the connection between mental health and vitamin B12.

Not getting enough vitamin B12 may intensification the danger of depression and mood disorders (Anmella *et al*.,2025). Studies conducted on populations show that the consumption of vitamin B12 lowers the frequency of depression and improves cognitive performance (Marx *et al*., 2017). Additionally, research in the field of mental health nutrition has indicated that insufficiencies of iron and vitamin B12 can affect inflammatory and neuroendocrine systems linked to mood disorders (Granero, 2022 and Stetler and Miller, 2017). Alongside micronutrient deficiencies, neuroendocrine mechanisms such as HPA axis dysregulation have been associated with mood disorders. The stress hormone cortisol influences emotional behavior and brain development. Chronic stimulation of the HPA axis may lead to amplified levels of cortisol, which could result in feelings of sadness and worry, as well as cognitive decline (Bertollo *et al*., 2025). Dysregulation of cortisol, a key stress-responsive hormone, is strongly associated with the severity of depressive symptoms through its effects on hypothalamic–pituitary–adrenal (HPA) axis activity (Nguyen *et al*., 2025 and Mina *et al*., 2025). Elevated or altered cortisol secretion patterns have been linked to increased symptom burden, disrupted emotional regulation, and structural as well as functional changes in brain regions involved in mood control (Baik, 2024).

The disorders of mood such as main depressive disorder (MDD) and nervousness disorders are associated with dysregulation of systems of neurobiological, it includes the hypothalamic pituitary adrenal (HPA) axis, serotonergic alleyways, and inflammatory cascades (Pariante and Lightman, 2008). Elevated cortisol levels indicate chronic stress activation, while reduced serotonin is linked to depressive symptoms. Inflammatory markers like CRP (Mazereeuw *et al*., 2015) and oxidative stress (Miller and Raison, 2016; Maes *et al*., 2011) markers such as MDA further contribute to neuronal dysfunction (Liu *et al*., 2015). As a result, biochemical indicators of iron metabolism, vitamin levels, and stress hormones could clarify mood issues. Despite the growing acknowledgment of the link between micronutrient deficiency and psychological well-being, there are only a handful of studies investigating serum ferritin (Worwood, 1990), serotonin (Anderson *et al*., 1987), MDA, cortisol (Wood *et al*., 1997); C-Reactive protein (Pepys and Hirschfield, 2003; Rifai *et al*, 1999) and vitamin B12 levels in connection with psychological manifestations in adult women (Osuna *et al*., 2024). Since these micronutrients are essential for neurotransmitter synthesis and brain metabolism, exploring their link to mood disorders could reveal modifiable biological risk factors. The study examined how blood ferritin and vitamin B12 levels correlate with the severity of mood disorders in adult women.

2. METHODS AND METHODS

2.1. Study Design and Data of Demographic

Design of the Study and Demographic Data

This observational cross-sectional study was conducted during the period between January 2022 and December 2024 involved women attending an outpatient facility. To investigate the connection between serum ferritin and B12 vitamin levels and the degree of depressive indications, a group of 125 women aged 18 to 45 was selected. People were selected based on predefined

acceptance criteria. Prior to their enrollment, all members were delivered with comprehensive details approximately the study's procedures and objectives.

2.2. Criteria for Inclusion and Exclusion

Our research included women aged 18–45 years, who had not been previously diagnosed with psychiatric disorders and were not receiving iron or B12 treatment during the enrollment period. People were excepted from the investigation if they are pregnant, had a antiquity of chronic inflammation, thyroid-related issues, or previous diagnoses of mental health problems that could have affected their psychological assessment or biochemical characteristics.

2.3. Ethical Consent

The current proposed research received approval from the Institutional Ethical Committee of Saveetha College of Nursing (SCON), part of Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University. Preceding to their presence in the study, all contributors providing informed consent in writing (Approval No: 001/11/2023/IEC/SMCH dated 21/11/2023). All measures were achieved in agreement with principled standards for medical investigations involving human subjects.

2.4. Assessment of Emotional Symptoms

Two validated tests were used to evaluate the mood symptoms severity: Hamilton Depression Rating Scale (HAM-D)29 and Beck Depression Inventory-II (BDI-II)30. Participants were categorized into four groups based on standard evaluation criteria: 0–7 early/normal, 8–16mild, 17–23moderate, and ≥24 severe for the HAM-D; and minimal 0–13, mild 14–19, moderate 20–28, and severe 29–63 for the BDI-II. The assessments were done following standard protocols to guarantee consistency and precision in the assessment of mood-related symptoms.

2.5. Procedures for Blood Collection and Serum Preparation

Under sterile conditions, around 5 mL of venous blood was harvested from each contributor afterward an overnight fast lasting 8 to 10 hours. To mitigate the effects of daily variations in cortisol levels, blood samples were gathered in the morning, specifically amongst 8:00, 10:00 AM. Blood samples were collected using sterile vacutainer tubes deprived of anticoagulant. These samples were permitted to accumulation at room temperature for approximately 20–30 minutes. To aid in serum separation, the samples at 3000 rpm were centrifuged for 10 minutes at a temperature of 4°C. The clear serum was carefully moved to microcentrifuge tubes with the correct labels and stored at −80°C until biochemical analysis was performed. In instruction to preserve the integrity of the samples, multiple freeze–thaw cycles were carefully avoided.

2.6. Biochemical Investigation

Serum levels of ferritin31, vitamin B12, total iron-binding capacity (TIBC) and cortisol35 were restrained using economically obtainable ELISA kits, subsequent the manufacturer's instructions. Prior to commencing the evaluation, all chemical and serum samples were permitted to equilibrate to room temperature. Standards, controls, and serum samples (usually 50–100 µL) were added in duplicate to 96-well microplates that had been pre-coated with particular antibodies. After being at 37°C incubated for the specified duration, the plates were washed multiple times with wash buffer to remove any unbound compounds. A secondary antibody linked to an enzyme was then added and allowed to incubate. After this, tetramethylbenzidine (TMB) substrate was introduced to promote color development. The procedure was stopped using a stop solution, which is usually 2N sulfuric acid. The optical density was then at 450 nm measured with an accurate microplate reader. The analytes' concentrations were established using standard calibration curves made with known standards.

Malondialdehyde (MDA)

MDA is measured using the TBARS (Thiobarbituric Acid Reactive Substances) assay, MDA reacts with thiobarbituric acid (TBA) to arrangement a pink chromogen measurable spectrophotometrically the absorbance detected as 532 nm unit expressed as nmol/L (Ohkawa H *et al.* (1979).

C-Reactive Protein (CRP)

CRP is estimated using **high-sensitivity immunoturbidimetric assay (hs-CRP)** or by ELISA method followed by Rifai N *et al*. (1999).

Serotonin Assay done by Anderson GM *et al.* (1987). Platelet and plasma serotonin in depression. *Psychiatry Research*. consuming economically obtainable ELISA.

2.7. Reference Ranges and Cut-off Values

The reference ranges used for biochemical interpretation are as follows. For adult females, normal serum ferritin levels are between 15 and 150 ng/mL. Values under 20 ng/mL indicate reduced iron stores. B12Vitamin levels are cataloged as follows: below 200 pg/mL is considered deficient, 200 to 300 pg/mL is borderline, and above 300 pg/mL is normal. The total iron-binding capacity (TIBC) reference range that has been set is 250–400 µg/dL. Morning serum cortisol levels were assessed according to established clinical ranges, with normal values ranging from 5 to 25 µg/dL. Values above 25 µg/dL were considered elevated, while those below 5 µg/dL were regarded as low.

2.8. Examination of Logit Regression

Within the framework of regression analysis, the selected variables were separated into two separate groups based on clinically significant thresholds. Ferritin levels below 30 ng/mL were classified as low, TIBC values over 400

µg/dL were considered elevated, B12vitamin levels under 200 pg/mL were identified as deficient, and cortisol levels exceeding 25 µg/dL were acknowledged as elevated.

2.9. Statistical Analysis

The statistical analysis was accomplished using the suitable statistical software, constant variable quantity were presented as mean ± standard deviation, although definite variables were shown as incidences and %. Group differences were evaluated using ANOVA (one-way analysis of variance), surveyed by Tukey's post hoc assessment for numerous comparisons. Pearson correlation investigation was used to assess the association between biochemical variables and mood scores. To identify specific indicators of moderate-to-severe mood symptoms, a binary logistic regression analysis was performed, considering possible bewildering factors such as age and body mass index. A p-value of less than 0.05 was measured statistically important.

3. RESULTS AND DISCUSSION

3.1. Calculation of Mood Severity Employing HAM-D and BDI-II

Two validated tools, the Hamilton Depression Rating Scale (HAM-D) and the Beck Depression Inventory-II (BDI-II), were used to assess the frequency of mood symptoms in the individuals. The main medical examination tool was the HAM-D, carried out by a qualified clinician. The BDI-II served as an individual measure to supplement the examination of depressive symptoms.

Using standard threshold levels of the 17-item HAM-D scale, participants were categorized into four distinct severity groups: early/normal mild 0–7, 8–16, moderate 17–23 and ≥24 severe. The research included 125 women, categorized as follows: 25 (20%) were classified as early/normal (7.9 ± 2.4), 32 (25%) as mild (16.7 ± 2.9), 38 (30%) as moderate (18.4 ± 2.4), and 30 (25%) as severe (28.5 ± 3.7). With an average HAM-D score of 18.5 ± 7.8 for the study group, it was evident that a important number of patients displayed restrained to unembellished depressive symptoms. The distribution of participants according to mood intensity is shown in **Fig. 1**.

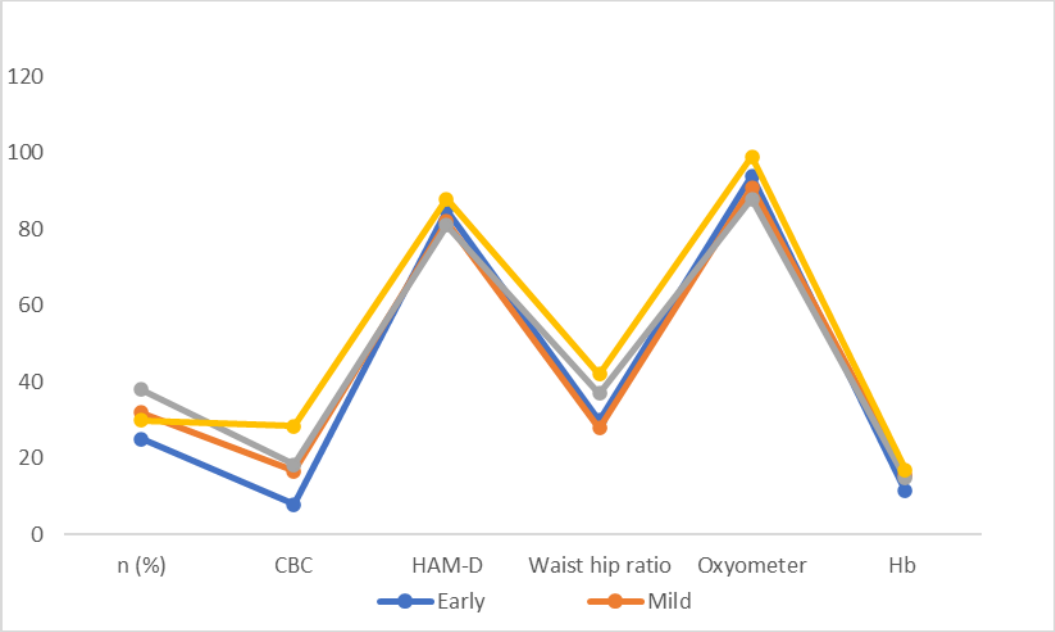


Fig. 1. Distribution of Participants According to Mood Severity

The findings derived from the BDI-II scale showed a similar distribution of depression symptoms. In line with the BDI-II severity categorization (minimal 0–13, mild 14–19, moderate 20–28, severe 29–63), contributors who were classified as moderate or severe on the HAM-D scale had elevated BDI-II scores. This study's categorization of mood severity is bolstered in its accuracy and consistency by the correlation between clinicians' evaluations and personal assessments. The intensity of depressed symptoms among the subjects increased in a comparable manner for both measures.

3.2. Participants Categorized According to Severity of Mood

The Fig. 1 depicted the distribution of participants into groups based on the severity of their mood. The chart shows that intermediate mood symptoms were the most common component of the research group, followed by mild and severe categories. The early or normal group made up the smallest percentage of participants. This distribution suggests that a considerable number of women attending the outpatient clinic exhibited clinically relevant levels of mood disorder.

3.3. Biochemical Parameters in Relation to Mood Severity

The biochemical profiles of the subjects were evaluated by measuring total iron binding capacity (TIBC), blood ferritin, vitamin B12, and cortisol concentrations, as illustrated in Fig. 2. TIBC levels increased gradually as mood severity worsened. In the early group, the average TIBC level was 310 ± 40 µg/dL. This increased to 330 ± 45 µg/dL in the minor group, 355 ± 50 µg/dL in the reasonable group, and 390 ± 60 µg/dL in the severe group. The variation was statistically significant ($p = 0.002$), representative that increased TIBC levels were connected with more severe mood symptoms.

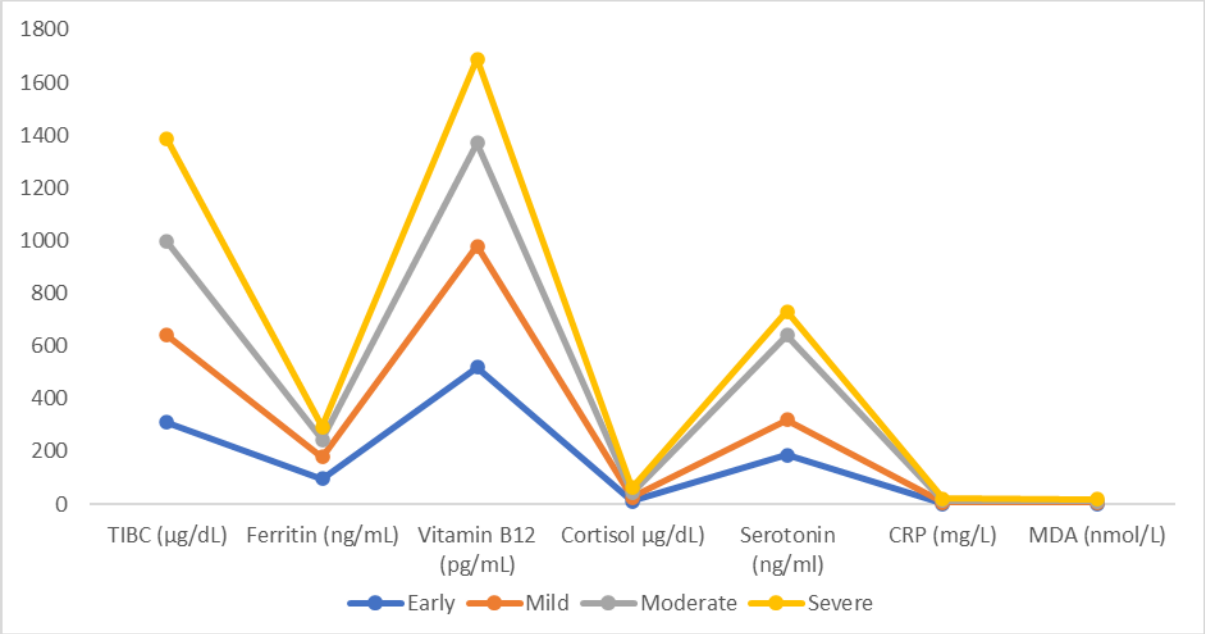


Fig. 2. Biochemical profile of Mood severity in adult women

On the other hand, serum ferritin levels decreased significantly while mood severity intensified. Ferritin levels were highest in the early category (95.4 ± 18.2 ng/mL), followed by the mild (82.6 ± 20.1 ng/mL) and moderate groups (65.3 ± 17.5 ng/mL). The severe group exhibited the lowest levels (48.9 ± 15.7 ng/mL). The statistically significant decline observed ($p < 0.001$) suggests a potential correlation between reduced iron reserves and more severe mood disorders. At the same time, vitamin B12 levels showed a consistent decline with increasing mood severity. The average concentrations of vitamin B12 were as follows: 520 ± 110 pg/mL for the early group, 460 ± 105 pg/mL for the mild group, 390 ± 95 pg/mL for the moderate group, and 320 ± 88 pg/mL for the severe group. The variations observed were deemed statistically significant ($p < 0.001$), indicating a correlation between reduced vitamin B12 levels and increased mood severity.

Serum cortisol levels, by contrast, increased steadily in line with the worsening of mood severity, suggesting a connection to the emotional response. The levels of cortisol rose from 11.2 ± 2.1 µg/dL in the early group to 13.5 ± 2.8 µg/dL in the mild group, then to 16.8 ± 3.4 µg/dL in the reasonable group, and finally to 19.4 ± 4.2 µg/dL in the severe group ($p < 0.001$). The one-way ANOVA showed a important cumulative effect of mood severity on ferritin levels. The post hoc Tukey analysis revealed important alterations among the unembellished and early groups ($p < 0.001$), the severe and mild groups ($p = 0.002$), and the moderate and early groups ($p = 0.01$).

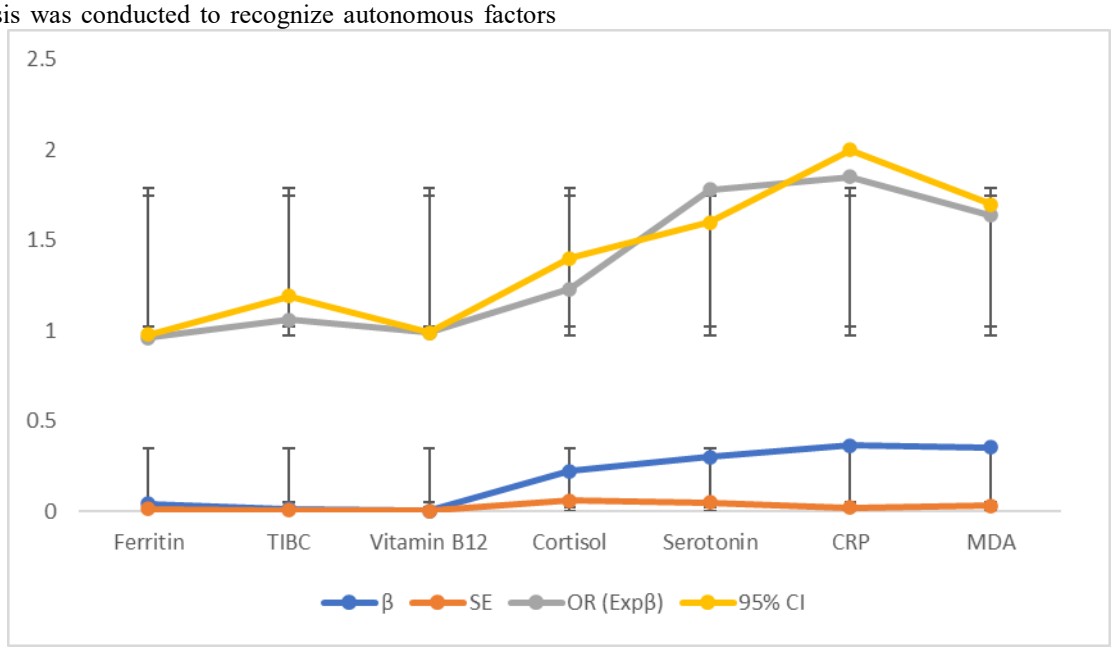
3.4. Relationship Between Biochemical Parameters and Mood Intensity

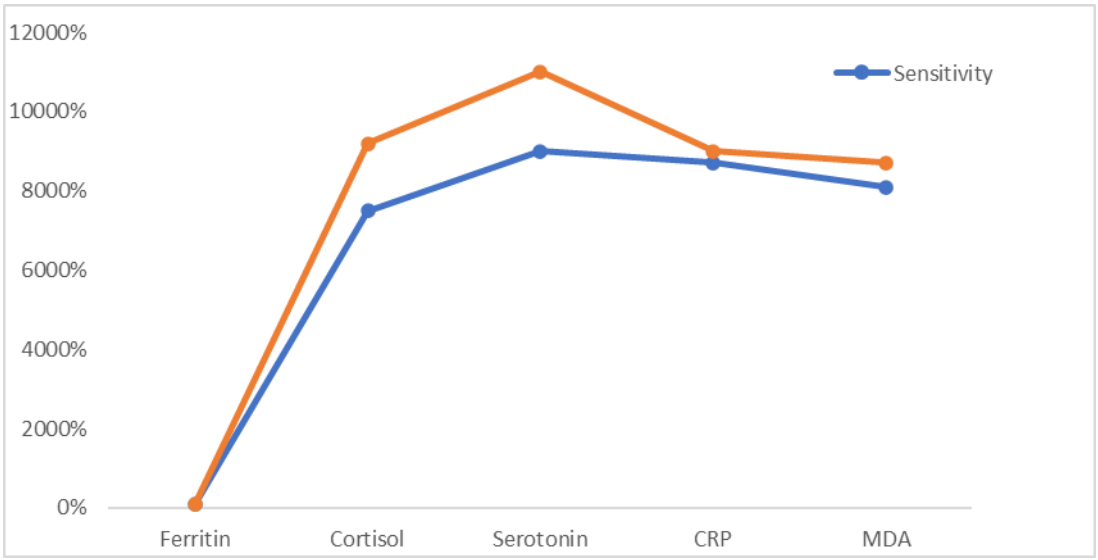
A Pearson association examination was achieved to evaluate the association amongst biochemical markers and levels of mood severity. The results showed a considerable -ve association between serum ferritin levels and mood severity ($r = −0.65$, $p < 0.001$), suggesting that lower ferritin concentrations were connected with higher ratings of depression symptoms. The total iron binding capacity (TIBC) showed a moderate positive correlation with mood severity ($r = 0.52$, $p = 0.002$), suggesting that uppermost TIBC levels were linked with worsened mood symptoms. The levels of vitamin B12 showed a reasonable -ve association with the severity of mood ($r = −0.60$, $p < 0.001$), which suggests that reduced amounts of vitamin B12 were associated with heightened mood severity. Serum cortisol exhibited the strongest positive correlation with mood severity among all the biochemical indicators analyzed ($r = 0.72$, $p < 0.001$), signifying a notable association between increased cortisol levels and worsened depressive symptoms.

Serotonin elevated progressively which confirms the neurotransmitter in stability 90±1.2 ng/ml; Blood levels of CRP show 7.0±2.4 mg/L and MDA also elevated drastically 6.0±0.36 nmol/L determines metabolic, anti-inflammatory and oxidative stress effects in mood severity diseases (Ahmed *et al*., 2023). Neuroendocrine signals which influences the cortisol shows significantly high with severity with mood depression (Gupta *et al*., 2025).

3.5. Logistic Regression to Predict Moderate to Severe Mood Symptoms

As illustrated in Fig. 2 and 3, a binary logistic regression analysis was conducted to recognize autonomous factors connected with moderate-to-severe mood symptoms (Bottiglieri, 2005). A robust correlation was instigated amongst lowered blood ferritin levels and increased likelihood of moderate-to-severe mood symptoms (β = −0.042, OR = 0.96, 95% CI: 0.95–0.98, p = 0.001). This suggests that for each unit increase in ferritin, the probability of severe mood disorders decreases by approximately 4%. There was a +ve correlation amongst total iron binding capacity and mood severity (β = 0.015, OR = 1.06, p = 0.024), signifying that increased TIBC levels slightly raised the likelihood of clinically significant mood disorders.





Here was an important -ve correlation between vitamin B12 levels and mood severity (β = −0.004, OR = 0.99, p = 0.006), indicating that lower vitamin B12 levels were connected with a advanced likelihood of moderate-to-severe depression symptoms. The strongest independent predictor identified was serum cortisol (β = 0.224, OR = 1.23, 95% CI: 1.09–1.40, p < 0.001), which means that increased levels of cortisol significantly elevated the likelihood of moderate-to-severe mood disorders (Ring, 2025). Stress marker such as serum cortisol showed 20% higher risk of severe mood symptoms which indicates HPA axis dysregulation (Lei *et al*., 2025; Menke, 2024)).

Vitamin B12 plays a vital role in preserving neuronal function by supporting methylation processes and cellular metabolism, and its deficiency may contribute to neurochemical disturbances associated with depression (Sălcudean *et al*., 2025). At the same time, increased levels of malondialdehyde (MDA) indicate enhanced lipid peroxidation and oxidative damage to neuronal membranes (George *et al*., 1987). Elevated concentrations of C-reactive protein (CRP) reflect underlying systemic inflammation, which has been widely recognized as a contributing factor in the development and progression of mood disorders. The results show that low ferritin and vitamin B12 levels, along with high TIBC and cortisol levels, are important biochemical indicators of the severity of mood symptoms in adult women. This suggests that deficiencies ((Warner and Kamran, 2023) in micronutrients and stress-related hormonal changes might distress the progression and development of mood severity.

This study investigated how blood ferritin, vitamin B12, total iron binding capacity (TIBC), and cortisol levels correlate with the severity of mood symptoms in adult women (George, *et al*., 2025; Warner and Kamran, 2023). Two validated instruments, Hamilton Depression Rating Scale (HAM-D) and Beck Depression Inventory-II (BDI-II), were used to evaluate the intensity of mood (Khiroya *et al*., 2023). The results showed that a considerable proportion of people experienced symptoms of moderate to severe depression. The relationship between HAM-D and BDI-II categories shows a reliable assessment of the severity of depression symptoms in the study group. Women of reproductive age have been shown by earlier studies to exhibit a significant prevalence of depressive symptoms, linked to biological, hormonal, and psychological factors.

The research demonstrated a correlation between the substantial decrease in serum ferritin levels and increased mood severity. Those exhibiting pronounced depressive symptoms showed markedly lower ferritin levels compared to individuals in the early or moderate groups. Iron is important for the construction of neurotransmitters, particularly dopamine, serotonin, and norepinephrine, whichever are critical for regulating mood. Thus, a reduction in iron availability may impede brain metabolism and neurotransmitter function, resulting in symptoms for depressive (Stoyanovsky *et al.,* 2019). Current studies have similarly indicated that individuals with iron deficiency or reduced ferritin levels are additional expected to exhibit depressive symptoms and psychological discomfort (Deepthi *et al*., 2025). Clinical studies have demonstrated an important connection amongst iron deficiency anaemia and levels of depression, suggesting that iron status may influence emotional and cognitive functioning. In addition, systematic investigate has underscored that individuals with mental illnesses frequently exhibit iron shortage, which might act as a modifiable biological danger factor for depression (Bertollo, 2025)

The current study uncovered a important drop in B12 vitamin levels and an increase in mood severity, as well as changes in iron status. People classified as having moderate or severe mood symptoms had considerably reduced vitamin B12 levels compared to those categorized as early or mild. Because of its involvement in DNA synthesis, methylation (Manikandan *et al.,* 2026 and 2025), and myelin integrity maintenance, vitamin B12 is essential for neurological function44. Several neuropsychiatric symptoms, including depression, irritability, and cognitive decline, have been associated with a deficiency in vitamin B12. According to previous research, individuals whose vitamin B12 levels are low exhibit an increased risk of mood disorders and depressive symptoms. Research based on longitudinal studies has shown that adequate intake of vitamin B12 may reduce the risk of developing depressive symptoms over time, highlighting the importance of keeping micronutrient levels optimal for mental health. Alterations in cortisol, ferritin, vitamin B12, MDA, and CRP highlight the interconnected roles of stress response, micronutrient imbalance, oxidative damage, and inflammation in determining the severity of mood disorders (Gao *et al*., 2023).

Results of the present investigation showed that TIBC levels rose gradually in line with increased mood severity. Elevated TIBC usually indicates reduced iron availability and is commonly observed in individuals with iron deficiency. The robust link found in this study between TIBC and mood severity emphasizes the idea that disturbances in iron metabolism might contribute to the development of depressive symptoms (Deepthi *et al*., 2025). Research conducted previously has demonstrated similar findings, indicating that individuals with low iron levels frequently exhibit elevated TIBC levels and increased symptoms of depression.

A significant discovery in the present study was the considerable increase in cortisol levels that accompanied

an intensification of mood severity. Among the biochemical measures examined, cortisol exhibited the strongest positive correlation with depression symptom ratings. Cortisol, a vital hormone, is instrumental in the body's physiological reaction to stress and is regulated by the hypothalamic–pituitary–adrenal (HPA) axis. The HPA axis dysregulation is closely linked to depression's pathophysiology. Chronic stress can result in the ongoing activation of the HPA axis, which leads to prolonged increases in cortisol levels and neurobiological changes that may contribute to mood disorders. Cortisol levels that are too high can negatively affect brain regions that play a role in managing emotions, like the hippocampus and prefrontal cortex. This may lead to a greater vulnerability to symptoms of depression.

This study's logistic regression analysis identified serum ferritin, TIBC, vitamin B12, and cortisol as independent predictors of moderate to severe mood disorders. Cortisol was recognized as the primary predictor, with ferritin and vitamin B12 levels following. The findings suggest that both deficiencies in micronutrients and hormone dysregulation caused by stress play a role in the development and intensity of mood disorders ((Khalil *et al*., 2025). Earlier research has underscored that depression is a complex condition marked by the interaction of nutritional deficiencies, metabolic issues, and neuroendocrine disruptions (Ring, 2025). Thus, assessing numerous biochemical markers at the same time could yield a more comprehensive understanding of the molecular mechanisms behind mood disorders. The present study demonstrates a strong association between biochemical alterations and mood symptom severity. Elevated cortisol levels reflect chronic stress exposure and HPA axis dysregulation, which is a hallmark of depressive disorders. Reduced serotonin levels support traditional monoamine deficiency concepts (Menke, 2024).

In women, the severity of mood disorders such as major depression and anxiety is closely associated with disruptions in iron handling, oxidative balance, and micronutrient availability, particularly involving ferritin, C-reactive protein (CRP), lipid oxidation markers (Gopalakrishnan *et al*., 2025), and vitamin B12 status. Ferritin acts as a protective intracellular reservoir that binds excess iron, thereby restricting the pool of free ferrous ions (Fe^{2+}) and limiting redox-driven cellular damage. When ferritin regulation is impaired or ferritin degradation is enhanced, intracellular free iron increases, facilitating oxidative reactions that promote lipid damage (Gopalakrishnan *et al*, 2026).

Vitamin B12 supports cellular metabolic stability through its role in one-carbon metabolism, indirectly maintaining redox equilibrium and reducing oxidative stress–mediated injury (Tan *et al*., 2023). A deficiency in this vitamin can therefore exacerbate oxidative imbalance and contribute to neuronal dysfunction. Lipid peroxidation, driven by iron-catalysed reactions and enzymatic activity such as lipoxygenases, represents a major pathway of cellular injury in ferroptosis (Gopalakrishnan *et al*., 2025). This process begins with the interaction of Fe^{2+} and lipid hydroperoxides, leading to the formation of reactive radical species that propagate a continuous oxidative chain reaction, ultimately compromising membrane integrity and cell viability. Elevated CRP concentrations reflect an underlying inflammatory response that has been increasingly linked to psychiatric conditions, reinforcing the concept of inflammation-associated depression. Concurrently, increased levels of malondialdehyde (MDA), a byproduct of lipid oxidation, indicate heightened oxidative stress and are associated with neuronal damage and altered neurotransmission (Anderson *et al*., 1987). The combined evaluation of these biochemical markers provides a more robust diagnostic approach and enables improved classification of disease severity.

Ferritin functions as a critical intracellular buffer for iron homeostasis by sequestering excess iron and thereby minimizing the availability of reactive ferrous ions (Fe^{2+}), which are known to drive oxidative injury. Disruption in ferritin dynamics, including enhanced degradation or impaired storage capacity, leads to an expansion of the labile iron pool, subsequently intensifying iron-mediated oxidative processes and lipid damage (Gopalakrishnan, 2025 and 2026).Vitamin B12 contributes to cellular integrity through its involvement in one-carbon metabolic pathways, which are essential for maintaining redox balance40. Insufficient levels of this micronutrient may aggravate oxidative stress and are often associated with impaired neuronal function. In addition, elevated levels of C-reactive protein (CRP) serve as indicators of systemic inflammation and have been increasingly implicated in the pathophysiology of psychiatric disorders, supporting the framework of inflammation-related depression. Similarly, higher concentrations of malondialdehyde (MDA), a secondary product of lipid peroxidation, reflect enhanced oxidative stress and are linked to neuronal injury and disruptions in neurotransmission. The evaluation of micronutrient deficiencies, particularly of iron and vitamin B12, in individuals showing depressive symptoms could assist in pinpointing potentially reversible biological factors that contribute to mood disorders. Identifying and correcting these flaws in a timely manner may improve therapy outcomes and overall psychological health. Moreover, the evaluation of cortisol levels could yield important information regarding physiological changes caused by stress that are associated with mood disorders. This research has specific limitations that should be recognized when assessing the results. The cross-sectional design inhibits

the identification of causal relationships between micronutrient intake and the severity of mood symptoms.

Secondly, the small sample size was limited to women attending one outpatient facility, affecting the scope of the findings. Third, potential complicating factors such as nutritional habits, socioeconomic status, behavioural patterns, and accompanying circumstances were not thoroughly examined (Lassale *et al*., 2019). The absence of variability measurements, such as standard deviation, for certain biochemical data weakens the reliability of statistical interpretation. Utilizing self-reported measures (like the BDI-II) alongside clinician-designed assessments may lead to reporting bias (WHO, 2023). In adult women, reduced levels of ferritin, serotonin, C-reactive protein, and malondialdehyde are significantly linked to greater severity of mood symptoms. Evaluating micronutrient status could provide a straightforward and economical method for identifying modifiable biological factors associated with mood disorders.

5. CONCLUSION

The present study demonstrated a marked connection between biochemical markers and the intensity of mood symptoms in adult females. A strong correlation was observed between diminished blood concentrations of ferritin and vitamin B12 and increased severity of depression symptoms. In contrast, levels of TIBC and cortisol rose progressively as mood symptoms worsened. Logistic regression and correlation analysis identified ferritin, vitamin B12, TIBC, and cortisol as independent predictors of moderate to severe mood disorders. Serotonin is directly correlated with depression severity mood disorder with neurotransmitter disparity. Malonialdehyde in serum levels determined neuronal injury and also promote oxidative stress. C-reactive protein supports severe inflammatory hypothesis of depression, which is also act as a marker for diagnostic depression based mood disorders. The findings suggest that alterations in micronutrient levels and the hormonal control of stress might contribute to the fundamental causes of mood disorders. As a result, checking Ferritin, iron status, vitamin B12 levels, and cortisol concentrations on a regular basis might be an accurate method to identify regulating risk factors and improve the treatment of mood disorders in women which possesses impair and synthesis of neurotransmitter, chronic stress functioning. Biochemical markers such as cortisol, serotonin, CRP, and MDA can also serve as reliable indicators of mood severity disorder which indicates anti-inflammatory and oxidative stress effects. The metabolic, physiologic and biochemical evaluation of these markers provide a robust, clinical stereotype o may improves early diagnosis, behavior monitoring, and custom-made therapeutic approaches.

Declaration

Conflict of interest
None

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No

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