

Inflammatory Biomarkers, Lipid Profile, Neuroendocrine Markers, and Impulsivity in Major Depressive Disorder with and Without Suicidality: A Comparative Cross-Sectional Study

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Abstract

Background: Suicidality in Major Depressive Disorder (MDD) represents a major public health concern and is associated with significant morbidity and mortality. Increasing evidence suggests that inflammatory dysregulation, altered lipid metabolism, neuroendocrine abnormalities, and impulsivity may contribute to suicidal behaviour in depressive disorders. The present study aimed to compare inflammatory biomarkers, lipid profile parameters, neuroendocrine markers, and impulsivity among patients with MDD with and without suicidality, and to evaluate correlations between impulsivity and biochemical biomarkers.

Methods: This hospital-based cross-sectional comparative study included 150 patients diagnosed with MDD according to ICD-10 criteria. Participants were divided into two groups: MDD with suicidality (n=75) and MDD without suicidality (n=75). Depression severity, suicidal intent, impulsivity, and suicide severity were assessed using the Montgomery-Åsberg Depression Rating Scale (MADRS), Beck Suicide Intent Scale (SIS), Barratt Impulsiveness Scale-11 (BIS-11), and Columbia Suicide Severity Rating Scale (C-SSRS), respectively. Biochemical assessment included CRP, ESR, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), lipid profile parameters, ACTH, and DHEA.

Results: Patients with suicidality demonstrated significantly higher MADRS, SIS, BIS-11, and C-SSRS scores compared with non-suicidal patients ($p < 0.001$). CRP, ESR, NLR, PLR, and ACTH levels were significantly elevated in the suicidality group, whereas total cholesterol, HDL, LDL, VLDL, and DHEA levels were significantly lower ($p < 0.05$). Correlation analysis revealed significant associations between impulsivity and selected biochemical parameters.

Conclusion: Suicidality in MDD is associated with severe depressive symptoms, increased impulsivity, systemic inflammation, altered lipid metabolism, and HPA-axis dysregulation. Integration of biochemical biomarkers with psychological assessment may improve identification of high-risk suicidal patients.

Keywords: Major Depressive Disorder; Suicidality; Impulsivity; Inflammatory Biomarkers; Lipid Profile; Neuroendocrine Markers.

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Introduction

Major Depressive Disorder (MDD) is among the most prevalent and disabling psychiatric disorders worldwide and represents a major contributor to global morbidity, disability, and mortality.

Depression affects nearly 280 million people globally and is recognized as one of the leading causes of years lived with disability [1]. Beyond emotional suffering and impaired psychosocial

functioning, MDD carries a profound risk of suicidality, including suicidal ideation, suicide attempts, and completed suicide [2]. Suicide remains a major public health concern, accounting for nearly 700,000 deaths annually worldwide, with depressive disorders contributing substantially to this burden [3]. Individuals with MDD exhibit markedly higher rates of suicidal thoughts and behaviours than the general population, making suicide prevention a critical priority in psychiatric research and clinical practice [4].

Suicidality in MDD is a complex and multifactorial phenomenon involving interactions among psychological, neurobiological, genetic, inflammatory, and environmental factors [5]. While traditional psychiatric evaluation relies primarily on symptom-based assessment, growing evidence suggests that objective biological markers may help identify individuals at increased risk for suicidal behaviour [6]. Over the past two decades, increasing attention has been directed toward understanding the biological mechanisms underlying suicidality in depression, particularly the role of inflammatory dysregulation, altered lipid metabolism, hypothalamic–pituitary–adrenal (HPA) axis abnormalities, and behavioural traits such as impulsivity [7].

The inflammatory hypothesis of depression proposes that activation of immune-inflammatory pathways contributes significantly to depressive symptomatology and suicidal vulnerability [8]. Elevated levels of inflammatory markers such as C-reactive protein (CRP), interleukin-6 (IL-6), tumour necrosis factor- α (TNF- α), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR) have been reported in patients with MDD, particularly among those exhibiting suicidal ideation or suicide attempts [9–11]. Neuroinflammation may alter monoaminergic neurotransmission, impair neuroplasticity, and influence fronto-limbic circuitry involved in emotional regulation and behavioural inhibition [12]. Meta-analytic evidence has demonstrated significantly higher CRP and IL-6 levels in individuals with suicidal behaviour compared with non-suicidal psychiatric patients and healthy controls [11].

Alongside inflammatory processes, abnormalities in lipid metabolism have also been implicated in suicidal behaviour. Several studies have reported significantly lower serum total cholesterol (TC), low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels among suicidal patients with depression [13].

Cholesterol plays a crucial role in neuronal membrane stability, serotonergic receptor functioning, and synaptic transmission. Reduced cholesterol levels may therefore contribute to

impaired serotonergic neurotransmission, impulsive behaviour, and emotional dysregulation associated with suicide risk [14]. Shaker et al. observed significantly lower TC and LDL levels among suicidal MDD patients, supporting the role of altered lipid metabolism as a potential biological marker of suicidality [15]. Neuroendocrine dysregulation, particularly involving the HPA axis, represents another important biological mechanism associated with depression and suicidality [16]. Chronic stress exposure may result in persistent activation of the HPA axis, leading to elevated adrenocorticotrophic hormone (ACTH) and cortisol secretion, impaired glucocorticoid receptor sensitivity, and neurotoxic effects on limbic brain structures [17]. Studies have demonstrated associations between HPA-axis abnormalities and suicidal ideation independent of depression severity [18]. In contrast, dehydroepiandrosterone (DHEA), which possesses neuroprotective and antiglucocorticoid properties, has been found to be reduced among individuals with severe depression and suicidality [19].

Impulsivity has also emerged as an important psychological and neurobehavioural factor contributing to suicidal behaviour in MDD [20]. Defined as a tendency toward rapid, poorly planned reactions without adequate consideration of consequences, impulsivity may facilitate the transition from suicidal ideation to suicidal action [21]. High impulsivity has been associated with increased suicide attempts, greater lethality of attempts, and shorter intervals between suicidal thoughts and self-harm behaviour [22]. Neurobiologically, impulsivity is linked to serotonergic dysfunction and impaired prefrontal inhibitory control mechanisms [23]. Kim et al. demonstrated that MDD patients with suicidal ideation exhibited significantly greater impulsivity along with reduced Nogo P3 amplitudes, suggesting impaired cognitive inhibition in suicidal depression [24].

Despite substantial advances, existing literature remains fragmented, with many studies examining inflammatory markers, neuroendocrine abnormalities, lipid alterations, or impulsivity independently rather than simultaneously. Furthermore, there is limited research integrating these biological and behavioural dimensions in Indian populations with MDD. The identification of combined biological and psychological correlates of suicidality may contribute toward improved suicide risk stratification and development of targeted preventive interventions. Therefore, the present study was undertaken to compare inflammatory biomarkers, lipid profile parameters, neuroendocrine markers, and impulsivity among patients with Major Depressive Disorder with and without suicidality attending a

tertiary care psychiatric centre in North India. The study also aimed to examine associations between impulsivity and biochemical markers in order to better understand the neurobiological and behavioural mechanisms underlying suicidality in depression.

Methods

Study Design and Setting: The present study was a hospital-based cross-sectional comparative study conducted in the Department of Psychiatry at a tertiary care teaching hospital in North India.

The study aimed to compare inflammatory biomarkers, lipid profile parameters, neuroendocrine markers, and impulsivity among patients with MDD with and without suicidality.

Study Duration: The study was conducted over a period of 18 months after obtaining approval from the Institutional Ethics Committee.

Participants: A total of 150 participants diagnosed with Major Depressive Disorder according to the International Classification of Diseases, 10th Revision (ICD-10) diagnostic criteria were included in the study. Participants were divided into two groups:

- Group I: 75 patients with MDD and suicidality
- Group II: 75 patients with MDD without suicidality

Patients were recruited consecutively from the outpatient and inpatient services of the Department of Psychiatry after obtaining written informed consent.

Inclusion Criteria: The following participants were included in the study:

1. Patients aged between 18 and 65 years.
2. Patients diagnosed with Major Depressive Disorder according to ICD-10 criteria.
3. Patients willing to provide written informed consent.
4. Patients able to understand and respond to assessment tools.

Exclusion Criteria

Participants with the following conditions were excluded:

1. Presence of psychotic disorders, bipolar affective disorder, substance use disorders (except nicotine and caffeine), or organic psychiatric conditions.
2. Presence of acute or chronic inflammatory disorders, autoimmune diseases, malignancy, severe systemic illness, or active infection.
3. Patients receiving corticosteroids, immunomodulatory agents, or lipid-lowering medications.
4. Pregnant or lactating females.

5. Patients with intellectual disability or severe cognitive impairment interfering with assessment.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants after explaining the purpose and procedures of the study. Confidentiality and anonymity of participant information were maintained throughout the study.

Study Tools and Assessments: The following instruments were used for assessment:

1. Semi-Structured Proforma - A specially designed semi-structured proforma was used to collect socio-demographic details, clinical history, family history, medical history, and psychosocial variables.
2. MINI International Neuropsychiatric Interview Plus (MINI-PLUS) - The MINI-PLUS was used to confirm the diagnosis of Major Depressive Disorder and assess suicidality.
3. Montgomery-Åsberg Depression Rating Scale (MADRS) -The severity of depressive symptoms was assessed using the MADRS. Higher scores indicated greater severity of depression.
4. Beck Suicide Intent Scale (SIS) - The SIS was used to assess the severity of suicidal intent among participants.
5. Barratt Impulsiveness Scale-11 (BIS-11) - Impulsivity was evaluated using the BIS-11, a standardized self-report measure assessing attentional, motor, and non-planning impulsivity.
6. Columbia Suicide Severity Rating Scale (C-SSRS) - The C-SSRS was used to assess the intensity and severity of suicidal ideation and suicidal behaviour.

Biochemical Assessment - Venous blood samples were collected from all participants under aseptic precautions. The following biochemical parameters were assessed:

Inflammatory Biomarkers

- C-reactive protein (CRP)
- Erythrocyte sedimentation rate (ESR)
- Neutrophil-to-lymphocyte ratio (NLR)
- Platelet-to-lymphocyte ratio (PLR)

Lipid Profile Parameters

- Total cholesterol (TC)
- High-density lipoprotein (HDL)
- Low-density lipoprotein (LDL)
- Very low-density lipoprotein (VLDL)

Neuroendocrine Markers

- Adrenocorticotrophic hormone (ACTH)

- Dehydroepiandrosterone (DHEA)

Routine laboratory procedures and standardized assay methods were used for biochemical estimation in the institutional central laboratory.

Statistical Analysis: Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were expressed as frequency and percentage. The independent sample t-test was used to compare continuous variables between groups, while the chi-square test or Fisher's exact test was applied for categorical variables. Pearson's correlation coefficient was used to assess relationships between impulsivity and biochemical biomarkers.

A p-value of less than 0.05 was considered statistically significant.

Results

A total of 150 patients diagnosed with Major Depressive Disorder (MDD) were included in the study, comprising 75 patients with suicidality and 75 patients without suicidality. The mean age of participants in the suicidality group was 37.98 ± 12.12 years, whereas the mean age in the non-suicidality group was 40.01 ± 12.97 years. No statistically significant differences were observed between the two groups with respect to socio-demographic variables including age, gender, marital status, occupation, family type, and place of residence (Table 1).

Table 1: Socio-demographic characteristics of the study participants

Variable	MDD with Suicidality (n=75)	MDD without Suicidality (n=75)	p-value
Age (years), Mean $\pm$ SD	37.98 ± 12.12	40.01 ± 12.97	0.325
Female Gender, n (%)	38 (50.7%)	40 (53.3%)	0.744
Married, n (%)	44 (58.7%)	42 (56.0%)	0.945
Unemployed, n (%)	26 (34.7%)	22 (29.3%)	0.119
Nuclear Family, n (%)	39 (52.0%)	40 (53.3%)	0.870
Rural Residence, n (%)	36 (48.0%)	41 (54.7%)	0.599

Clinical comparison revealed that the mean age of onset and duration of illness were comparable between the two groups. However, patients with suicidality demonstrated significantly greater depression severity. The mean MADRS score was significantly higher among suicidal patients (33.09 ± 6.11) compared with non-suicidal patients (27.37 ± 6.11) ($p < 0.001$). Severe depression was also significantly more common in the suicidality group (Table 2).

Table 2: Clinical characteristics of the study participants

Variable	MDD with Suicidality (n=75)	MDD without Suicidality (n=75)	p-value
Age of Onset (years), Mean $\pm$ SD	33.42 ± 12.26	35.16 ± 13.08	0.404
Duration of Illness (years), Mean $\pm$ SD	4.93 ± 2.72	5.68 ± 2.60	0.089
MADRS Score, Mean $\pm$ SD	33.09 ± 6.11	27.37 ± 6.11	$<0.001^*$
Severe Depression, n (%)	28 (37.3%)	8 (10.7%)	$<0.001^*$

Assessment of suicide-related variables demonstrated significantly higher suicidal intent, suicide severity, and impulsivity among patients with suicidality. The mean Beck Suicide Intent Scale (SIS) score in the suicidality group was 15.93 ± 3.55 compared with 5.13 ± 2.06 in the non-suicidality group ($p < 0.001$). Severe impulsivity was observed more frequently among suicidal patients, and moderate-to-high suicide severity assessed using the Columbia Suicide Severity Rating Scale (C-SSRS) was also significantly greater in this group (Table 3).

Table 3. Suicide intent, suicide severity, and impulsivity

Variable	MDD with Suicidality (n=75)	MDD without Suicidality (n=75)	p-value
SIS Score, Mean $\pm$ SD	15.93 ± 3.55	5.13 ± 2.06	$<0.001^*$
Medium/High Suicide Intent, n (%)	73 (97.3%)	1 (1.3%)	$<0.001^*$
BIS-11 Score, Mean $\pm$ SD	Significantly Higher	Lower	$<0.001^*$
Severe Impulsivity, n (%)	28 (37.3%)	3 (4.0%)	$<0.001^*$
Moderate/High C-SSRS Severity, n (%)	53 (70.7%)	19 (25.3%)	$<0.001^*$

Biochemical analysis revealed significant differences between the groups across inflammatory, lipid, and neuroendocrine biomarkers. Patients with suicidality demonstrated significantly higher CRP, ESR, NLR, PLR, and ACTH levels compared with patients without suicidality. Conversely, total cholesterol, HDL, LDL, VLDL, and DHEA levels were significantly lower in the suicidality group. The mean ESR level was 27.50 ± 9.46 mm/hr in suicidal patients compared with 18.35 ± 5.01 mm/hr in non-suicidal patients, while mean DHEA levels were 201.28 ± 41.60 pg/mL and 248.24 ± 29.94 pg/mL, respectively (Table 4).

Table 4: Comparison of biochemical biomarkers between the study groups

Biomarker	MDD with Suicidality (n=75)	MDD without Suicidality (n=75)	p-value
CRP (mg/L)	8.94 ± 2.31	4.76 ± 1.84	<0.001*
ESR (mm/hr)	27.50 ± 9.46	18.35 ± 5.01	<0.001*
NLR	2.80 ± 0.72	1.98 ± 0.69	<0.001*
PLR	156.42 ± 28.17	121.38 ± 21.44	<0.001*
Total Cholesterol (mg/dL)	148.62 ± 24.16	182.37 ± 28.41	<0.001*
HDL (mg/dL)	36.21 ± 6.12	45.74 ± 7.03	<0.001*
LDL (mg/dL)	79.56 ± 18.42	108.63 ± 22.51	<0.001*
VLDL (mg/dL)	28.41 ± 7.25	34.16 ± 8.11	0.012*
ACTH (pg/mL)	48.62 ± 11.34	34.81 ± 9.17	<0.001*
DHEA (pg/mL)	201.28 ± 41.60	248.24 ± 29.94	<0.001*

Correlation analysis between impulsivity and biochemical markers demonstrated variable associations in both groups. In the suicidality group, impulsivity showed a significant positive correlation with LDL levels ($r = 0.228$, $p = 0.049$). In the non-suicidality group, significant positive correlations were observed between impulsivity and total cholesterol ($r = 0.238$, $p = 0.040$) as well as DHEA levels ($r = 0.247$, $p = 0.033$). Correlations with CRP, ESR, NLR, PLR, VLDL, HDL, and ACTH were statistically non-significant in both groups (Table 5).

Table 5: Correlation of impulsivity (bis-11) with biochemical biomarkers in both groups

Biomarker	MDD with Suicidality		MDD without Suicidality	
	r	p-value	r	p-value
CRP (mg/L)	0.101	0.387	0.116	0.323
ESR (mm/hr)	-0.004	0.970	0.044	0.705
NLR	0.118	0.313	0.172	0.140
PLR	0.088	0.453	0.028	0.815
Total Cholesterol (mg/dL)	-0.035	0.769	0.238	0.040*
HDL (mg/dL)	-0.012	0.917	-0.150	0.198
LDL (mg/dL)	0.228	0.049*	0.128	0.275
VLDL (mg/dL)	0.068	0.564	0.002	0.990
ACTH (pg/mL)	-0.054	0.648	-0.098	0.402
DHEA (pg/mL)	-0.078	0.503	0.247	0.033*

Discussion

The present study compared socio-demographic characteristics, clinical variables, impulsivity, suicidal severity, inflammatory biomarkers, lipid profile parameters, and neuroendocrine markers among patients with Major Depressive Disorder (MDD) with and without suicidality. The findings demonstrated significant associations between suicidality and greater depression severity, increased impulsivity, elevated inflammatory markers, altered lipid profile, and neuroendocrine dysregulation.

Socio-demographic variables including age, gender, marital status, occupation, family type, and residence did not differ significantly between the two groups. These findings are consistent with previous studies reporting that suicidality in MDD may not be solely determined by demographic characteristics but rather by clinical and biological

vulnerability factors [15,25]. Although some earlier studies observed greater suicidal behaviour among younger individuals and females, the present findings suggest that suicidality may occur across a broad socio-demographic spectrum [26,27]. The present study demonstrated significantly greater depression severity among suicidal patients, with markedly higher MADRS scores in the suicidality group. Severe depression was substantially more common among suicidal patients than non-suicidal patients. These findings are in accordance with previous studies demonstrating a strong association between depressive severity and suicidality [24,28]. Chen et al. reported that depressive severity significantly mediated the relationship between impulsivity and suicidal ideation [29]. Similarly, Peng et al. found that adolescents with MDD and suicide attempts exhibited significantly greater depressive symptoms and psychological distress compared with non-attempters [30]. Severe

depressive symptoms may contribute to hopelessness, emotional dysregulation, impaired problem-solving abilities, and increased psychological pain, thereby increasing suicidal vulnerability.

Suicidal intent and suicide severity were also significantly greater among suicidal patients in the present study. The mean Beck Suicide Intent Scale (SIS) score was substantially elevated in the suicidality group, indicating greater seriousness and determination toward self-harm behaviour. These findings are supported by earlier literature demonstrating that high suicide intent scores are associated with increased risk of future suicide attempts and completed suicide [31]. Menon et al. also reported significant associations between suicidal intent, impulsivity, and hostility traits among suicide attempters [32]. The significantly greater suicide severity observed using the Columbia Suicide Severity Rating Scale (C-SSRS) further supports the clinical validity of the suicidality grouping in the present study.

Impulsivity emerged as an important psychological correlate of suicidality in the present study. Patients with suicidality demonstrated significantly higher impulsivity scores and a greater proportion of severe impulsivity compared with non-suicidal patients. Similar findings have been consistently reported in previous studies [20,24]. Kim et al. demonstrated that suicidal MDD patients exhibited significantly higher impulsivity scores together with impaired inhibitory control reflected by reduced Nogo P3 amplitudes [24]. Impulsivity may facilitate the transition from suicidal ideation to suicidal action by impairing behavioural inhibition, increasing emotional reactivity, and reducing cognitive control over self-destructive impulses [21]. The findings of the present study therefore reinforce the importance of impulsivity assessment during suicide risk evaluation in MDD patients.

The present study also demonstrated significantly elevated inflammatory biomarkers including CRP, ESR, NLR, and PLR among suicidal patients. These findings support the growing evidence implicating systemic inflammation in the neurobiology of depression and suicidality [8,11]. Black and Miller, in a meta-analysis, reported significantly increased inflammatory cytokines and CRP levels among suicidal individuals compared with non-suicidal psychiatric patients [11]. Elevated inflammatory markers may influence suicidal behaviour through cytokine-induced alterations in serotonergic neurotransmission, glutamatergic excitotoxicity, impaired neuroplasticity, and dysregulation of fronto-limbic circuits [12]. Neupane et al. similarly observed elevated CRP and IL-6 levels among suicidal depressed patients [33]. Increased NLR and PLR observed in the present study further support the

hypothesis that chronic low-grade inflammation contributes to suicidal vulnerability in MDD.

Significant alterations in lipid profile parameters were also observed among suicidal patients. Total cholesterol, HDL, LDL, and VLDL levels were significantly lower in the suicidality group compared with the non-suicidality group. These findings are consistent with previous literature suggesting an association between hypocholesterolemia and suicidal behaviour [13,14]. Wu et al., in a meta-analysis of 65 epidemiological studies, demonstrated significantly lower total cholesterol and LDL levels among suicidal individuals [34]. Cholesterol plays a vital role in neuronal membrane integrity and serotonergic receptor functioning; therefore, reduced cholesterol levels may impair serotonin transmission and contribute to impulsive and aggressive behaviour associated with suicidality [14]. Lower HDL levels may additionally reflect increased inflammatory and oxidative stress activity in suicidal depression.

Neuroendocrine abnormalities involving the HPA axis were also evident in the present study. ACTH levels were significantly elevated, whereas DHEA levels were significantly reduced among suicidal patients. Similar findings have been reported in earlier studies investigating stress-axis dysregulation in depression and suicide [16,18]. Jokinen and Nordström demonstrated HPA-axis hyperactivity among suicide attempters with mood disorders [35]. Persistent stress exposure may result in chronic activation of the HPA axis, excessive cortisol secretion, impaired glucocorticoid feedback regulation, and neurotoxic effects on limbic brain structures involved in emotional regulation [17]. DHEA, which possesses neuroprotective and anti-inflammatory properties, was significantly lower among suicidal patients in the present study. Reduced DHEA levels may impair stress resilience and increase vulnerability to depressive symptoms and suicidal behaviour [19].

Correlation analysis demonstrated significant associations between impulsivity and certain biochemical parameters. Impulsivity showed positive correlations with LDL levels in suicidal patients and with total cholesterol and DHEA levels among non-suicidal patients. Although correlations with inflammatory markers were statistically non-significant, the observed trends suggest possible interactions between behavioural dysregulation and biological abnormalities in MDD. Previous studies have also suggested that inflammatory activation, lipid abnormalities, and neuroendocrine dysfunction may influence impulsive traits and suicidal behaviour through shared neurobiological pathways involving serotonin dysfunction, neuroinflammation, and impaired prefrontal inhibitory control [12,20].

A limitation of the present study is that it employed a cross-sectional design, which limits the ability to establish causal relationships between biochemical biomarkers, impulsivity, and suicidality. The study was conducted at a single tertiary care centre with a relatively modest sample size, which may restrict the generalizability of the findings to the broader population. In addition, various confounding factors such as dietary habits, sleep disturbances, physical activity, psychosocial stressors, and subclinical inflammatory conditions could have influenced the biochemical parameters despite the exclusion criteria applied. The study also did not include longitudinal follow-up; therefore, the predictive value of the investigated biomarkers for future suicidal behaviour could not be determined. Further large-scale multicentric longitudinal studies are therefore required to validate and expand upon the present findings.

Conclusion

The present study demonstrated that patients with Major Depressive Disorder (MDD) and suicidality exhibited significantly greater depression severity, suicidal intent, suicide severity, and impulsivity compared with non-suicidal patients. Suicidal patients also showed significantly elevated inflammatory biomarkers including CRP, ESR, NLR, and PLR, along with altered lipid profile parameters characterized by lower total cholesterol, HDL, LDL, and VLDL levels. Neuroendocrine dysregulation was evident through increased ACTH and reduced DHEA levels among suicidal individuals. These findings support the growing evidence that suicidality in MDD is associated with complex interactions between psychological factors, systemic inflammation, altered lipid metabolism, and HPA-axis dysfunction. The study highlights the importance of integrating biochemical markers with clinical and psychological assessment for early identification of high-risk individuals. Such an integrated approach may improve suicide risk prediction and contribute to the development of targeted preventive and therapeutic strategies in patients with Major Depressive Disorder.

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