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Relationship Between Plasma Testosterone and Suicidal Behavior in Patients with Antisocial Personality Disorder

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WHAT IS ALREADY KNOWN ON THIS TOPIC?

- *People with ASPD have a high risk of suicide, especially due to impulsive and aggressive behaviors. Hormonal imbalances, including elevated testosterone, have been suggested as possible contributing factors.*

WHAT THIS STUDY ADDS ON THIS TOPIC?

- *This study found that ASPD patients with a history of suicide attempts had significantly higher free testosterone levels than healthy controls, while total testosterone did not differ.*
- *A positive correlation between free testosterone and HDL cholesterol levels was observed, suggesting a possible biological mechanism linking hormonal and metabolic factors to suicide risk.*

ABSTRACT

Objective: Antisocial personality disorder (ASPD) is associated with a heightened risk of suicide, particularly among male patients, where chosen suicide methods tend to be more lethal. The link between suicidal behavior and plasma testosterone levels remains a key area of investigation. This study investigates whether plasma testosterone levels differ between ASPD patients with a history of suicide attempts, aiming to explore the hormone's potential role as a biomarker for suicide risk. This study aimed to explore the association between plasma testosterone levels and suicidal behavior in individuals with ASPD who attempted suicide.

Methods: A total of 44 patients with ASPD and 24 healthy controls were enrolled, matched by age, education, and gender. Biochemical evaluations included total and free testosterone, thyroid function tests, blood lipids, folate, ferritin, and vitamin B12 levels. Psychopathological assessments were conducted using the Hamilton Depression (HAM-D) and Anxiety (HAM-A) Scales.

Results: The mean ages of the patient and control groups were 22.26 (±3.04) and 24.36 (±2.5) years, respectively. Free testosterone levels were significantly elevated in the patient group compared to controls (P = .02). Hamilton Anxiety (HAM-A) and HAM-D scores were also notably higher in the patient group. A positive correlation was identified between free testosterone levels and high-density lipoprotein in patients with ASPD (R = 0.520; $P < .05$).

Conclusion: These preliminary findings suggest that elevated free testosterone may contribute to increased suicide risk in men with ASPD, potentially through its impact on impulsivity and aggression. While the effect size was modest, identifying hormonal patterns associated with suicidal behavior may help guide future risk assessment strategies. Further research with larger and more diverse samples is warranted.

Keywords: Plasma testosterone, antisocial personality disorder, suicidal behavior

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INTRODUCTION

Antisocial personality disorder (ASPD) is characterized by a long-term pattern of disregard for the rights of others, often resulting in significant societal consequences and serious personal destruction for the individual. Individuals with ASPD are frequently in conflict with societal norms from a young age, often leading to legal issues and engagement in criminal behavior.[1,2] Impulsivity and aggression, hallmark features of ASPD, further heighten the risk for engaging in suicidal behaviors, a risk notably higher compared to the general population.[3,4] The underlying pathophysiological mechanisms contributing to this heightened suicide risk, including impulsivity, impaired decision-making, and hormonal dysregulation, remain areas of active investigation.[5] Recent studies have shifted focus to explore how ASPD may be influenced by broader neurobiological mechanisms, particularly hormonal disregulation, which may exacerbate impulsivity and aggression and contribute to suicidal behaviors.[6] Epidemiological data indicate a steady increase in suicide rates over recent decades, underscoring its emergence as a significant public health concern.[7]

Suicidal behavior is often viewed as an expression of internalizing psychopathology, typically manifesting as severe dysphoria, emotional distress, and social isolation. One key factor contributing to the elevated prevalence of suicidal behaviors in ASPD patients is the inadequate assessment of suicide risk. Furthermore, research shows that individuals with ASPD often score higher on neuropsychological measures of risk-taking behavior, correlating with an increased likelihood of suicide attempts. The high prevalence of substance use disorders in individuals with ASPD is another crucial factor linked to suicidal behavior, highlighting the complex interplay between impulsivity, addiction, and self-harm tendencies.[8] Studies suggests that the likelihood of a suicide attempt in individuals with ASPD is approximately 3.7 times higher than in those without the disorder.[9-11]

Numerous studies have examined the relationship between hormonal changes, aggression, and impulsivity in individuals with ASPD. The hormonal regulation of behavior is influenced by developmental factors, early life experiences, and social conditions.[12] Notably, Book et al[13] reported a stronger correlation between testosterone levels and aggression in males. This has led to the hypothesis that testosterone may contribute to increased antisocial behaviors and aggression, or conversely, that antisocial tendencies may influence testosterone levels. However, if a direct correlation between testosterone and impulsivity were to exist, individuals with lower testosterone levels would be expected to display opposing behavioral patterns, a finding not consistently observed in the literature. Rather than acting as a universal predictor of aggression, testosterone has been more consistently linked to social dominance and status-seeking behaviors.[14]

Nonetheless, individuals predisposed to aggression and impulsivity remain at a higher risk for suicidal behaviors, irrespective of whether these tendencies are directly modulated by testosterone. The use of anabolic-androgenic steroids, which increase testosterone levels, has been associated with violent behavior, further supporting the hypothesis that hormonal dysregulation may play a role in aggression and impulsivity.[15] Although the relationship between testosterone and suicidal behavior in ASPD remains underexplored, research suggests that elevated testosterone levels may be linked to increased impulsivity and aggression, potentially contributing to the higher suicide risk observed in this population.[16]

While some studies suggest that individuals with ASPD and a history of suicide attempts may have lower testosterone levels, others propose that elevated free testosterone may be linked to increased impulsivity and risk-taking behaviors. Given the conflicting findings in the literature, the primary aim of this study is to clarify the relationship between plasma testosterone levels and suicidal behavior in individuals with ASPD. In doing so, the authors seek to better understand the biochemical and neuropsychological factors that contribute to the increased risk of suicidal behavior in this population.[17,18]

Moreover, this study aims to investigate the contribution of additional biochemical markers, including thyroid function, folate, ferritin, and vitamin B12 levels, to suicidal behavior in ASPD. Thyroid dysfunction has been associated with mood disturbances, and imbalances in thyroid hormones may contribute to increased impulsivity and suicidal behavior. Folate and vitamin B12 play important roles in neurotransmitter synthesis and brain health; deficiencies in these vitamins have been linked to depression, cognitive dysfunction, and a heightened risk of suicide. Ferritin, which reflects iron stores in the body, has been shown to impact mood regulation, and low levels of ferritin may contribute to depressive symptoms and suicidal tendencies. The authors' hypothesis posits that individuals with ASPD will exhibit elevated free testosterone levels, which may be linked to increased impulsivity and suicidal behavior, and that abnormalities in thyroid function, folate, ferritin, and vitamin B12 may interact with these factors to further increase suicide risk.

The study will contribute to the existing literature by providing new insights into the complex biochemical mechanisms underlying suicidal behaviors in individuals with ASPD. By examining both hormonal and biochemical parameters, as well as psychometric assessments, the authors aim to identify potential biomarkers for early detection and intervention, ultimately improving clinical approaches to preventing suicide in individuals with ASPD.

MATERIALS AND METHODS

Participants and Procedure

This study included 44 patients diagnosed with ASPD and 24 healthy controls. The diagnosis of ASPD was established using the Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II), administered by a trained psychiatrist at the Gülhane School of Medicine, Department of Pyschiatry between December 2013 and August 2014. All participants in the patient group had a history of suicide attempts and were under clinical follow-up. The healthy control group consisted of individuals with no history of psychiatric disorders or suicide attempts. Exclusion criteria included a history of organic brain disorders (e.g., infections, inflammation, cancer, trauma), intellectual disability, psychotic or mood disorders, or endocrine-related diseases. Written informed consent was obtained from all participants, and the study protocol was approved by the Ethical Committee of Gülhane Military Academy (Approval no: 21; Date: June 5 , 2013).

Blood Sample Collection

Blood samples were collected from all participants between 08:00 and 10:00 a.m. to minimize the effects of diurnal variation on testosterone levels. Testosterone levels exhibit diurnal variation, with higher levels observed in the morning. Blood samples were obtained using standard venipuncture techniques and collected into serum-separating tubes. All samples were processed immediately to obtain plasma and serum fractions, which were stored at −80°C until analysis. Conditions that could affect testosterone levels, such as recent use of anabolic steroids, chronic illness, or acute stress, were specifically excluded in this study.

Biochemical and Psychopathological Assessments

Biochemical analyses were performed on blood samples from all participants to measure plasma cholesterol, total testosterone, free testosterone, thyroid function tests, folate, ferritin, and vitamin B12 levels. Testosterone levels were specifically measured using immunoassay techniques, and levels of other biochemical markers were assessed using standard clinical laboratory procedures. Psychopathological assessments were conducted using the HAM-A and the HAM-D to evaluate symptoms of anxiety and depression, respectively. Additionally, sociodemographic data, including age, gender, and educational background, were collected to ensure appropriate group matching.

Statistical Analysis

Statistical analyses were performed using SPSS version17.0 (SPSS Inc.; Chicago, IL, USA) and GraphPad Prism version 5.01 (GraphPad Software Inc., San Diego, California, USA) software. Descriptive statistics were presented as means ± standard errors of the mean (SEM). To compare biochemical parameters between groups, non-parametric tests were employed due to the small sample size of the control group and the non-normal distribution of variables, as confirmed by Kolmogorov-Smirnov tests. Specifically, the Mann–Whitney *U*-test was used to compare continuous variables between the ASPD and healthy control groups.

Correlations between biochemical parameters and psychopathological scores were analyzed using Spearman's rank correlation test. The correlations were generally weak, with low Spearman's rho values, indicating that the relationships were modest. These weak correlations suggest that other factors might be contributing to the observed relationships. Statistical significance was set at $P < .05$ for all analyses.

RESULTS

The mean age of participants in the patient and control groups was 22.26 (±3.04) and 24.36 (±2.5) years, respectively. Group matching ensured no statistically significant differences in age, gender, or educational background. Biochemical analysis revealed that free testosterone levels were significantly elevated in the ASPD group compared to the control group ($P = .02$) (Figure 1). Similarly, HAM-A and HAM-D scores were significantly higher in the ASPD group ($P < .05$; HAM-D: $R = -0.14$). A significant positive correlation was observed between free testosterone levels and high-density lipoproteins (HDL) in the patient group ($R = 0.520$, $P < .05$) (Figure 2).

However, no significant differences were found between the groups in terms of total testosterone levels, suggesting that free testosterone rather than total testosterone may be more relevant in understanding the hormonal dynamics in ASPD patients ($P > .05$). Additionally, no significant differences were found in cholesterol, thyroid function tests, cortisol, folate, ferritin, or vitamin B12 levels between the groups ($P > .05$). The correlation matrix indicated that, apart from the significant association between free testosterone and HDL levels, no other meaningful correlations were observed among the biochemical parameters and psychopathological scores.

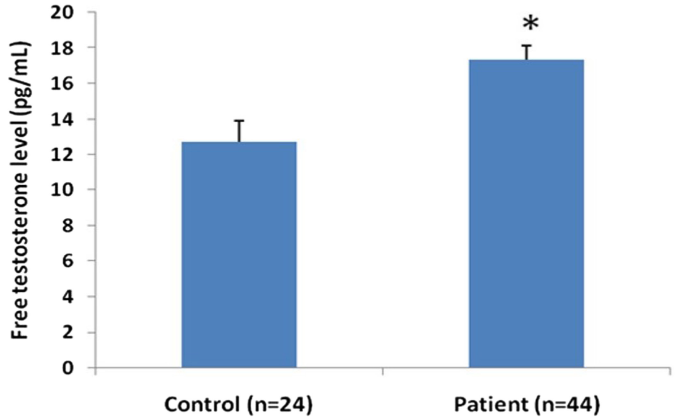

Figure 1. Free testosterone levels found in control and patient group.

DISCUSSION

This study provides biochemical evidence indicating that individuals with ASPD who attempted suicide exhibit significantly higher free testosterone levels compared to healthy controls. A positive correlation was identified between free testosterone and HDL levels in ASPD patients, suggesting a possible metabolic and hormonal interaction that may influence suicidal behavior. However, it is important to note that statistical significance alone is not sufficient to draw definitive conclusions. While statistical significance was observed, the effect size and statistical power must also be considered. The weak effect size observed in this study warrants caution in interpreting these results as clinically relevant or robust. The conclusion about a correlation between free testosterone and HDL is based on weak statistical associations, and further investigation with more statistically powered studies is needed to better understand these relationships.

Previous research on the relationship between testosterone levels and suicidality has yielded mixed results. Some studies have reported elevated testosterone levels in suicide attempters, while others have found lower levels. The authors' findings are consistent with those that suggest elevated free testosterone may contribute to impulsivity and aggression, which are core characteristics of ASPD. However, the absence of significant differences in total testosterone levels in this study points to the complexity of this relationship, with potential factors like testosterone-binding proteins and free testosterone bioavailability playing a more important role than total testosterone levels.[19-21]

Elevated testosterone levels have been consistently associated with impulsivity and aggression, behaviors that are core to the diagnostic criteria of ASPD. These behaviors, when combined with other risk factors, could elevate the likelihood of suicidal behavior. High testosterone may contribute to increased irritability, poor emotional regulation, and risk-taking behavior, all of which are associated with an increased likelihood of suicide attempts in vulnerable individuals.[4]

Testosterone acts on several brain regions, including the prefrontal cortex and limbic system, areas involved in emotion regulation, aggression, and decision-making. The prefrontal cortex plays a key role in controlling impulsive behavior, and dysfunction in this area could contribute to the increased risk of suicidality in individuals with high testosterone levels. The limbic system, particularly structures

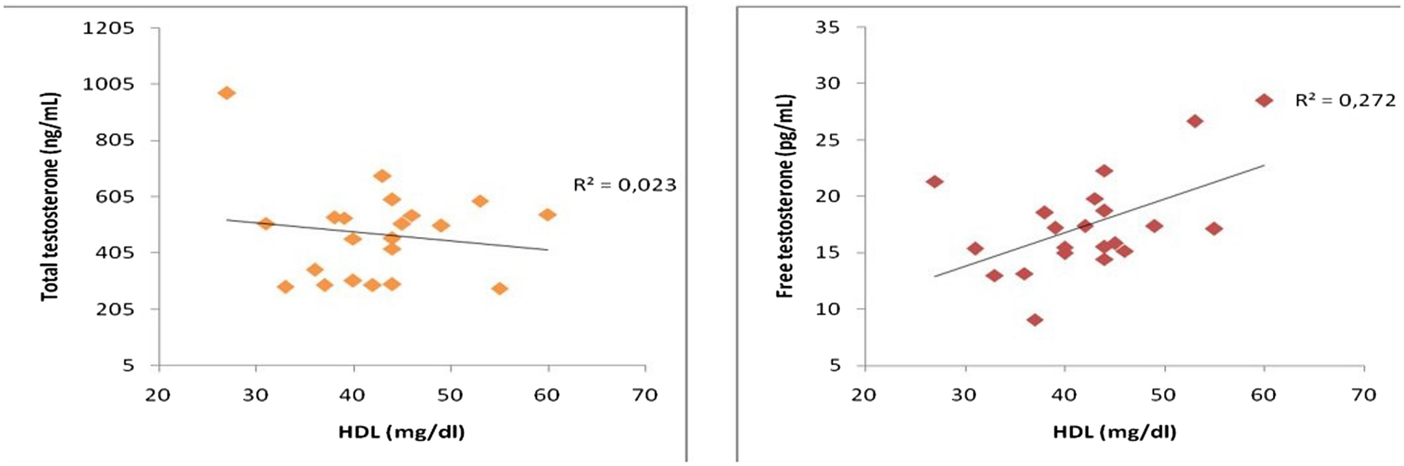

Figure 2. Correlation between high-density lipoprotein and testosterone levels in the patient group.

like the amygdala, regulates emotional responses and has been implicated in aggression. Dysregulation of these brain regions due to elevated testosterone levels may lead to increased vulnerability to suicidal behavior in individuals with ASPD.[22-28]

The study did not observe significant differences in total testosterone levels, which suggests that free testosterone, or the bioavailable form of the hormone, may play a more important role in modulating impulsivity and aggression than total testosterone. The presence of testosterone-binding proteins could alter the bioavailability of free testosterone, affecting its interaction with target tissues in the brain. This subtle balance may contribute to the behavioral dysregulation observed in ASPD patients at risk for suicide.

The correlation between free testosterone and HDL levels suggests a possible interplay between metabolic processes and hormonal regulation. Elevated testosterone levels may influence lipid metabolism, and alterations in lipid profiles could be a biomarker for heightened suicidal risk. These interactions could represent an important area for future research to explore how hormonal fluctuations impact both behavioral regulation and cardiovascular health, with implications for suicide risk.

The positive correlation between free testosterone and HDL could also indicate an underlying pathophysiological condition in the patient group that affects both testosterone production and lipid metabolism. For instance, in conditions like insulin resistance or obesity, elevated testosterone levels and altered lipid profiles often coexist. In ASPD patients who attempt suicide, the relationship between testosterone and lipid profiles might reflect a multisystem dysfunction that contributes to both the neurobiological mechanisms underlying aggressive behavior and the metabolic alterations associated with increased suicidality.

The observed positive correlation between free testosterone and HDL levels in this study offers remarkable insights into the potential interplay between hormones and lipid metabolism in individuals with ASPD and suicidal behavior. However, the exact mechanisms remain unclear, and further research is needed to investigate how testosterone modulates lipid profiles and whether these interactions have broader implications for the management of metabolic and psychiatric comorbidities. By exploring the physiological and pathophysiological mechanisms behind this relationship, future studies could provide valuable information on how hormonal and metabolic factors contribute to suicidality in high-risk populations like those with ASPD.

One of the main limitations of this study is the small sample size. A limited sample reduces the power of statistical tests, which may result in the inability to detect true relationships between variables or may yield misleading conclusions due to variability. This limitation must be addressed in future studies with larger sample sizes to improve the generalizability and reliability of the findings. Additionally, the study's design did not account for all possible confounders, such as the effects of medications or other medical conditions, which may have influenced testosterone levels and contributed to the results observed.

In terms of implications for future research, further investigation is needed to explore the underlying neurobiological mechanisms by which free testosterone influences aggression and impulsivity in individuals with ASPD. While elevated testosterone levels may be linked to these behaviors, the exact pathways through which testosterone interacts with brain structures, such as the prefrontal cortex and limbic system, remain unclear. Future studies should focus on these mechanisms to provide a clearer understanding of how hormonal influences contribute to suicidal behavior in ASPD patients.

Additionally, the role of comorbid psychiatric conditions, such as major depressive disorder (MDD), should be more thoroughly explored. This study found that higher HAM-D scores in suicide-attempted ASPD patients suggest the potential confounding influence of depression on the relationship between testosterone and suicidality. Future research should investigate whether the relationship between testosterone and suicidal behavior is moderated by comorbid psychiatric conditions, and if depression itself contributes to hormonal fluctuations.

Furthermore, the limitations of this study highlight the need for more robust, well-powered studies that can evaluate the complex interplay between free testosterone, impulsivity, aggression, and psychiatric symptoms. Future research should also explore the role of other potential biomarkers for suicidality in ASPD patients, as a single marker may not fully explain the complexity of suicidal behavior in this population.

In conclusion, while this study suggests that free testosterone may play a role in modulating impulsivity and aggression, which are associated with suicidal behavior in ASPD, the findings are not conclusive. The complexity of hormonal influences on suicidality, along with the confounding effects of psychiatric comorbidities, warrants further investigation. Larger studies, employing a more comprehensive approach, are essential to better understand the intricate relationship between testosterone and suicidality and to identify potential biomarkers for suicide risk in this high-risk population.

Limitations

This study has several limitations. First, the small sample size of the control group limits statistical power, and larger studies are needed to strengthen the findings. Second, the absence of a comparison group of ASPD patients without suicide attempts limits generalizability. Including this group would help determine whether the observed differences are linked to suicidal behavior or ASPD in general.

Third, the study did not assess the severity or frequency of suicide attempts, which should be considered in future research. Fourth, sociodemographic factors, such as education and employment status, were not analyzed comprehensively, limiting exploration of their impact on ASPD and suicidal behavior.

Fifth, the study did not include BMI or metabolic markers like glucose and lipid profiles, which could interact with testosterone. Future research should include these factors. Sixth, the sample was predominantly male, so gender differences in hormonal regulation and psychopathology warrant further investigation.

Seventh, the study focused on young adults, and broader age ranges in future research could enhance understanding. Finally, the reliance on correlation analyses limits the ability to infer causality, so future studies should use regression models.

Despite these limitations, the study offers valuable insights into the hormonal and metabolic mechanisms underlying suicidal behaviors in ASPD, emphasizing the importance of timely intervention following suicide attempts.

This study provides preliminary evidence that elevated free testosterone levels may be associated with increased suicidal behavior in individuals with ASPD. The significant correlation between free testosterone and HDL levels suggests a possible interaction between hormonal and metabolic pathways in this high-risk population. Although the effect sizes were modest and the findings require validation in larger, more diverse samples, the results highlight the potential of free testosterone as a biomarker for suicide risk. Future research should explore the neurobiological mechanisms underlying these associations to better inform risk assessment and intervention strategies in ASPD.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval was received for this study from the ethics committee of Gülhane Military Academy (Approval no: 21; Date: June 5, 2013).

Informed Consent: Written informed consent was obtained from the participants who agreed to take part in the study.

Peer-review: Externally peer reviewed.

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