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Research on the Effects of Hormone Changes on Long-Term Prognosis and Intervention Strategies in Adolescent Depression

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Abstract. This review aims to investigate the impact of hormonal changes on the long-term outcomes and intervention strategies in adolescent depression. In recent years, the incidence of adolescent depression has risen significantly. Its pathological mechanisms are not only related to family and social factors but also closely tied to dynamic hormonal changes during adolescence. Fluctuations in hormone levels, including adrenaline, thyroid hormones, and cortisol, significantly affect adolescents' emotional and cognitive functions, and have been shown to be closely associated with the clinical severity and long-term prognosis of depression. Several key hormones can serve as biomarkers to monitor patients' conditions, providing a scientific basis for the timely evaluation of disease progression and the effectiveness of interventions. Hormonal-based interventions have been shown to improve symptoms and outcomes to some extent, but their long-term efficacy and safety have not been validated in large-scale, long-term studies. As research deepens on hormonal changes and their interactions with other biological factors, more precise and personalized intervention strategies are expected to emerge, fostering a healthier and more stable growth environment for adolescents and promoting their overall mental health.

Keywords: Adolescent depression; Hormone changes; Intervention strategies.

1. Introduction

With the increasing incidence of adolescent depression, research has been intensifying, revealing that its pathological mechanisms are not only linked to family and social factors but also closely related to the dynamic changes in adolescent hormone levels. Consequently, this research provides an important biological foundation for early diagnosis and precise intervention.

1.1. Depression in Adolescents

Adolescent depression has become a critical global public health issue. In recent years, the prevalence of depression among adolescents has been steadily rising. About 10% to 20% of adolescents have experienced or are experiencing symptoms of depression. The development of adolescent depression is closely linked to social pressures, family issues, and academic stress. Depression profoundly affects adolescents' emotional and cognitive functions, potentially leading to behavioral problems such as self-harm and suicide, which can severely impair their long-term social adaptation and quality of life. Therefore, early identification and intervention for adolescent depression are crucial.

1.2. Effects of hormone level changes on mood regulation

Adolescent mood swings are closely associated with changes in the body's hormone levels. With the onset of puberty, levels of sex hormones, thyroid hormones, and cortisol fluctuate, which, to some extent, influences emotional and mental health. Prolonged abnormal hormone levels can contribute to the onset of adolescent depression. For example, elevated cortisol levels have been linked to the development of depression and offer valuable clues for the early diagnosis and intervention of the disorder [1].

1.3. Intervention strategies for adolescent depression at present

Currently, various intervention strategies exist for treating adolescent depression, including pharmacological treatment, psychotherapy, and lifestyle interventions. Medication that modulates neurotransmitter and hormone levels, cognitive-behavioral therapy (CBT), and family and school support all play critical roles in adolescent depression management. Despite the variety of interventions, these approaches often fail to address the unique needs of each individual. For instance, adolescents with depression exhibit significant differences in coping styles and social support. Depressed adolescents with obsessive-compulsive disorder tend to use more negative coping mechanisms and receive less social support, resulting in varying responses to the same intervention.

2. Biological Mechanisms of Major Hormonal Actions and Their Prognostic Implications

The pathogenesis of adolescent depression is multifaceted, with particular attention paid to the biological effects of various hormones and their influence on prognosis.

2.1. Epinephrine

As a central hormone in the stress response, adrenaline plays a pivotal role in the pathological process of adolescent depression. Studies have shown that adolescent depression is often associated with hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, leading to elevated levels of adrenaline and other stress hormones [2]. This constant overactivation not only heightens the body's sensitivity to acute stress but also adversely affects the central nervous system. Prolonged high levels of adrenaline damage and cause atrophy in hippocampal neurons, leading to cognitive dysfunction [3]. These symptoms are considered early manifestations of depression and hinder adolescents' developmental progress.

2.2. Thyroid Hormones

Abnormal thyroid hormone levels can disrupt mood regulation in the central nervous system by affecting the synthesis and metabolism of neurotransmitters like serotonin [4]. This critical factor, which maintains metabolic balance and neural function, also plays a role in the onset and prognosis of adolescent depression.

Adolescence is a crucial period for growth and development, and even slight fluctuations in thyroid hormone levels can negatively impact nerve cells, increasing the risk of mood disorders. One study assessed adolescent patients for depression upon admission using the Hamilton Depression Scale (HAMD-24), after which blood samples were taken to measure thyroid hormones and other relevant biomarkers. Results indicated a significant correlation between thyroid dysfunction and cognitive impairment in depressed adolescents [5].

Further clinical data support thyroid hormone levels as important biomarkers for assessing long-term prognosis and intervention strategies for depression in adolescents, suggesting that monitoring can help identify disease risk early [6]. At the same time, intervention measures through regulating thyroid hormone-related pathways also provide new therapeutic ideas for improving clinical symptoms and cognitive function of depression patients.

These studies not only deepen understanding of adolescent depression but also provide a theoretical basis for formulating more precise, independent and personalized intervention strategies. In order to further promote the prevention and treatment of juvenile depression, it is necessary to further explore the interaction between thyroid hormones and neurotransmitters and cognitive function.

2.3. Cortisol

Cortisol, another key hormone, plays a significant role in both the treatment and prognosis of adolescent depression by regulating endocrine balance and immune response. Abnormal cortisol

levels are commonly seen in adolescent depression, reflecting the individual's stress response and correlating with the clinical severity and long-term prognosis of the disorder.

Studies have shown that cortisol levels are significantly correlated with early-life trauma and depression status, making it a sensitive biomarker for predicting the onset and progression of depression [7]. Dynamic monitoring of cortisol levels is crucial for evaluating disease changes and intervention effects, providing a scientific basis for accurate prevention and treatment strategies.

2.4. Other Hormones

Prolactin levels are significantly higher in adolescents with depression, which disrupts neurotransmitter balance and thus affects emotional control in the brain, which is closely related to cognitive impairment, sleep problems and increased feelings of despair [8].

Adolescence is a critical period for individuals to transition from childhood to adulthood. Significant fluctuations in sex hormone levels have an important impact on adolescents' mental health. This violent fluctuation of sex hormone levels often leads to long-term emotional instability in adolescents, affecting their mental health and resulting in extreme emotions. These extreme emotions are all triggers of adolescent depression and, in some cases, are highly likely to cause non-suicidal self-injury [4].

3. Intervention Strategy

Hormonal-based interventions offer new approaches for treating adolescent depression. Dynamic monitoring and regulation of hormone levels are key components of precise interventions.

3.1. Pharmacological Intervention

Pharmacological treatment is a significant approach for regulating hormone levels.

Some drugs can also improve depressive symptoms by regulating thyroid hormone levels. For example, magnesium valproate in combination with sertraline improves Non-Suicidal Self-Injury (NSSI) behavior in adolescents with depression and is associated with functional modulation of the hypothalamic-pituitary-thyroid (HPT) axis. In one study, researchers investigated the effects of magnesium valproate combined with sertraline on NSSI behavior and hormone levels in adolescents with depression. The subjects were 242 adolescents who met the diagnostic criteria for persistent depressive disorder in Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), hospitalized in Shandong Province Mental Health Center from January to December 2021. Among them, 156 had NSSI behavior and 86 did not have NSSI behavior. The experimental group received magnesium valproate combined with sertraline, while the control group received sertraline only. The results showed that the depression score of NSSI group was significantly higher than that of non-NSSI group, and the hormone levels of NSSI patients also showed significant differences, especially the serum FT4, testosterone and prolactin levels were significantly higher than those of non-NSSI group. There were significant sex differences between thyroid hormones and NSSI behavior, and low Thyroid Stimulating Hormone (TSH) level was an independent risk factor for NSSI behavior. Magnesium valproate combination therapy significantly improved thyroid hormone levels in patients with NSSI, especially in women, and changes in FT4 and TSH levels correlated with reduced self-injury behavior. This study suggests that functional changes in the HPT axis may play an important role in the development of adolescent depression and non-suicidal self-injurious behaviors [9]. However, since the experiment was not set up to receive placebo treatment as a control group, it may affect its accuracy, so it needs to be analyzed according to specific conditions in subsequent studies.

Similar hormone-modulating drug interventions include the selective serotonin reuptake inhibitors (SSRIs) class of antidepressants that modulate serotonin levels, thereby improving mood and cognitive function [10, 11].

3.2. Mental Intervention

Psychological intervention also plays a crucial role in the treatment of adolescent depression. Cognitive behavioral therapy (CBT) is a commonly used psychotherapy that helps patients identify and change negative thinking patterns and behavioral habits. Studies have shown that CBT combined with selective serotonin reuptake inhibitor drug therapy can significantly improve symptoms and prognosis in adolescent depression patients [12]. Mindfulness therapy, which enhances mental flexibility and stress coping abilities, is also effective in reducing depressive symptoms by activating the serotonin system [13].

3.3. Lifestyle Intervention

A supportive living environment and healthy lifestyle habits are beneficial in preventing and managing adolescent depression. A stable and nurturing home environment can help alleviate depressive symptoms, while optimizing the school environment can reduce academic and social pressures. Additionally, regular sleep, a balanced diet, and physical exercise contribute positively to the prognosis of adolescent depression.

4. Conclusion

4.1. Main Progress of Current Studies

The pathogenesis of adolescent depression is closely related to hormonal changes and their effects on prognosis. Fluctuations in hormones such as adrenaline, thyroid hormones, and cortisol affect adolescents' emotional and cognitive functions and influence the clinical severity and long-term prognosis of depression. Monitoring thyroid hormone levels serves as an important biomarker for assessing prognosis and intervention strategies, while dynamic cortisol monitoring can provide insights into the individual's stress response state. These hormones offer valuable biological markers for timely disease evaluation and intervention.

4.2. Limitations and Future Directions

While existing studies have highlighted the important role of hormonal changes in adolescent depression, several limitations remain. Most studies have focused on individual hormones, with fewer addressing the interactions between multiple hormones or their combined effects with other biological factors. Furthermore, hormonal changes as biomarkers for adolescent depression have yet to be validated in large-scale, long-term studies.

Nevertheless, investigating hormonal changes in adolescent depression remains an innovative field. Future research should integrate multi-omics technologies to analyze the complex relationships between hormonal changes and gene expression, neurotransmitter metabolism, and other factors, providing a more comprehensive theoretical foundation for precise interventions.

4.3. Future Prospects

Hormonal-based interventions offer new strategies for treating adolescent depression. A combination of pharmacological treatment, psychological therapy, and lifestyle changes has improved symptoms and outcomes for many adolescents. As research on hormonal changes and their interactions with other biological factors progresses, more precise and personalized interventions are expected to be developed. In the future, early diagnosis and targeted treatments for adolescent depression may be achieved through dynamic hormone monitoring, coupled with genetic testing and neuroimaging techniques. Together with optimized family and school environments and lifestyle adjustments, these efforts can provide a healthier, more stable growth environment for adolescents and foster their overall mental health development.

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