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Mini Review

COVID-19 and Female Infertility: Investigating a Hypothetical Link Between Heavy Metal-Induced Viral Mutation and Reproductive Dysfunction

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Abstract

The potential effects of COVID-19 on female fertility have become a subject of growing concern, with emerging evidence suggesting disruptions in ovarian reserve and hormonal balance. This paper explores the relationship between female infertility and the etiology of SARS-CoV-2, with a focus on a controversial hypothesis that the virus may have originated from an influenza virus mutated by environmental exposure to cadmium and lead. We analyze current literature linking COVID-19 to decreased Anti-Müllerian Hormone (AMH) levels, reduced antral follicle count (AFC), and increased levels of follicle-stimulating hormone (FSH) and luteinizing hormone (LH)-all markers of impaired fertility. Additionally, we examine the independent toxic effects of cadmium and lead on female reproductive health, emphasizing their roles in disrupting folliculogenesis and hormone regulation. By integrating virological, toxicological, and reproductive health perspectives, this paper highlights the potential dual threat of viral infection and heavy metal exposure to female fertility and calls for further interdisciplinary research into environmental factors contributing to pandemic emergence and reproductive dysfunction.

Keywords: *COVID-19; Female Infertility; Heavy Metals Toxicity; Viral Mutation; Oxidative Stress*

Introduction

The global outbreak of COVID-19 has prompted widespread investigation into its origin, pathology, and long-term effects, including those on reproductive health. Emerging studies have explored the virus's potential impact on female fertility, focusing on ovarian reserve markers and hormonal balance. Simultaneously, alternative hypotheses suggest environmental factors such as heavy metals-specifically cadmium and lead-may have played a role in mutating influenza viruses, possibly contributing to the emergence of SARS-CoV-2 [1]. This paper discusses the interconnected effects of cadmium and lead exposure, influenza virus mutation, and COVID-19 on female reproductive health, with a particular emphasis on hormone regulation and ovarian reserve.

Discussion

COVID-19 and female fertility

Although research is ongoing, preliminary findings indicate that COVID-19 may influence female fertility by affecting ovarian function. Some studies report a decrease in Anti-Müllerian Hormone (AMH) and antral follicle count (AFC), both key indicators of ovarian reserve, while also noting an increase in Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH) [2,3]. These hormonal imbalances can lead to reduced egg quality and quantity, negatively impacting fertility potential and assisted reproductive technology outcomes.

Cadmium and lead as environmental stressors

Heavy metals like cadmium and lead are known endocrine disruptors with established links to reproductive toxicity. Cadmium exposure, in particular, has been associated with lower AMH levels [4], reduced antral follicle count, and premature ovarian aging [5]. Mechanistically, cadmium interferes with folliculogenesis, leading to follicular atresia and impairing estrogen production, which disrupts FSH and LH regulation [6].

Similarly, lead exposure, while not consistently linked to AMH levels [7], has been shown to disrupt antral follicle development and elevate FSH and LH, likely through oxidative stress and interference with the pituitary-ovarian axis [8,9].

Mutation hypothesis: Influenza to SARS-CoV-2

An alternative etiology for COVID-19 posits that SARS-CoV-2 may have evolved from an influenza virus mutated by environmental exposure to cadmium and lead [3]. While this theory remains controversial and not widely accepted in mainstream virology, it raises the possibility that heavy metal-induced mutations could create novel viral strains with enhanced pathogenicity. If this hypothesis holds any validity, the intersection of viral mutation and heavy metal exposure could present a dual threat to female reproductive health: direct viral effects on ovarian function, and indirect effects via environmental toxicants.

Influenza, viral infection, and fertility

Even prior to the emergence of COVID-19, influenza was known to adversely affect reproductive outcomes, particularly among women undergoing fertility treatments [9]. Viral infections can compromise immune and endocrine function, disturb hormonal balance, and interfere with implantation and placental development. The synergistic effects of viral infection and toxic environmental exposure could therefore amplify the risk of fertility disorders in women.

Conclusion

The intersection of viral infection, environmental toxicants, and female reproductive health presents a complex and multifaceted challenge. While current evidence confirms that COVID-19 may negatively impact ovarian reserve and hormonal balance [2,3], the role of cadmium and lead in this context-either as independent endocrine disruptors or as potential mutagenic agents of influenza viruses-warrants deeper investigation [1,4-9]. Understanding these interactions is critical not only for reproductive health management during and after pandemics but also for addressing broader public health risks posed by environmental contamination. Further interdisciplinary research is needed to validate the hypothesis of a metal-induced viral mutation and its implications for fertility, as well as to clarify the long-term reproductive effects of COVID-19 in women.

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