



Toxicity of cobalt, nickel and manganese: interactions with lipids and biomembranes - a narrative review

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ABSTRACT

Introduction: Cobalt, nickel, and manganese are essential trace metals involved in key physiological processes, including enzymatic activity, cellular signaling, energy metabolism, and oxidative stress response. However, disturbances in their homeostasis, particularly due to chronic exposure, are associated with significant adverse health effects, such as cardiotoxicity, carcinogenicity, allergic reactions, and neurotoxicity.

Objectives: This work aimed to provide an integrated analysis of the toxicity of cobalt, nickel, and manganese, with particular emphasis on their interactions with lipids and biological membranes as critical targets of metal-induced toxicity.

Methodology: A narrative review of the scientific literature was conducted, with searches performed in the PubMed and Google Scholar databases using combinations of Portuguese and English keywords related to metal toxicity, homeostasis, lipids, and biomembranes. Articles published predominantly within the last 5 to 10 years were included, selected based on their relevance to the study topic.

Results: The analyzed studies demonstrate that excessive exposure to these metals compromises the structural and functional integrity of biomembranes, promoting alterations in membrane

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fluidity and permeability, dysregulation of lipid metabolism, and induction of lipid peroxidation. These effects contribute to mitochondrial dysfunction, induction of oxidative stress, and activation of inflammatory pathways, being implicated in the pathophysiology of cardiovascular, neurodegenerative, and oncological diseases.

Conclusion: Metal-membrane interactions represent a central mechanism underlying the toxicity of cobalt, nickel, and manganese. A deeper understanding of these processes is essential for the development of more effective preventive and therapeutic strategies in human health.
