

OXIDATIVE STRESS: THE SILENT CULPRIT BEHIND MODERN DISEASES

NAVEED SHUJA¹

¹Dean, Professor Department of Bio-Chemistry, Lahore Medical & Dental College, Lahore
Correspondence to: Naveed Shuja, Email: rananaveedshuja@gmail.com, Cell: +92334205687

This article may be cited as: Shuja N: Oxidative Stress: The Silent Culprit Behind Modern Diseases. Pak Med & Allied, 2025; 01(5): 1-2.

Received: 10-05-2025

Revised: 15-07-2025

Accepted: 15-08-2025

Published: 30-08-2025

© The Author(s) 2025. This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International License \(CC BY 4.0\)](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.



The extra production of the reactive oxygen species (ROS) and the lack of suitable antioxidants to counteract their impact has become the key to the pathogenesis of a broad spectrum of diseases. Finally, being perceived as a biochemical quainter, oxidative stress is currently being viewed as one of the key processes affecting aging, prolonged inflammation, metabolic illnesses, cardiovascular diseases, neurodegenerative diseases, and even cancer¹. It is also important to the clinician and researchers to understand its implications to come up with preventive and therapeutic approaches. At the cellular level, ROS are very unstable molecules that are mainly produced after the respiration process of the mitochondria, enzyme reactions, and environmental exposures like pollution, radiations, and toxins. Whereas ROS physiological concentrations play a significant role in signaling, immune protection, and cellular homeostasis, their intrusion results into lipid peroxidation, DNA damage, and protein modification. Such molecular dysfunctions add up to tissue malfunction and organ injury, which is a frequently shared feature among disease processes².

The clinical potential of oxidative stress is enormous. Through endothelial dysfunction and inflammation, ROS promotes atherosclerosis facilitating hypertension, myocardial infarction and stroke in cardiovascular diseases³. Insulin resistance and pancreatic β -cell dysfunction are aggravated by oxidative stress in diabetes. Alzheimer and Parkinson neurodegenerative diseases have been closely associated with neuronal damage and protein aggregation, which have been associated with ROS¹⁰. Oxidative stress has also been a stimulant and a two-sided weapon of DNA mutation and tumor suppression in cancer, respectively, depending on the context of the cell. There are challenges and opportunities associated with dealing with oxidative stress. Antioxidant treatments, nutritional interventions and lifestyle changes have demonstrated mixed success in the clinical studies. Vitamins C and E, polyphenols, and coenzyme Q10 are some of the nutrients that provide

protective effect but there has been inconsistency in translating these effects into a clinical result. New strategies, such as specific antioxidants, mitochondrial protective agents and gene therapy have provided promise of more specific interventions⁶. Notably, oxidative stress is not to be considered as a circumstance but as a complex interaction with inflammation, metabolic dysfunction, and genetic predisposition, which needs to be addressed holistically⁴.

Public health-wise, the contemporary lifestyle, which constitutes poor diet, sedentary habits, chronic stress, and environmental pollution have enhanced the occurrence of oxidative stress and this is the reason preventive approaches should be taken⁷. Oxidative biomarker screening, promoting diets that are high in antioxidants and physical exercise might aid in the reduction of the chances of developing the disease at a population level⁵. Moreover, the development of new therapeutic targets by promoting studies about oxidative stress pathways can be used to discover new therapeutic opportunities and personalized medicine treatment. To sum up, oxidative stress is an invisible but an important cause of modern health issues⁸. Its universal implication in the pathogenesis of diseases emphasizes the severity of its monitoring that is required among clinicians and researchers. Through the combination of understanding oxidative processes into clinical care and community prevention and control, we will be better able to prevent, diagnose, and treat diseases that are influenced by this biochemical imbalance, and the resultant patient outcomes and longevity⁹.

REFERENCES

- Forman HJ, Zhang H. Targeting oxidative stress in disease: promise and limitations of antioxidant therapy. *Nat Rev Drug Discov.* 2021;20(9):689-709. doi:10.1038/s41573-021-00233-1.
- Jomova K, Raptova R, Alomar SY, Alwasel SH, Nepovimova E, Kuca K, Valko M. Reactive oxygen species, toxicity, oxidative stress, and antioxidants: chronic

- diseases and aging. *Arch Toxicol.* 2023;97(10):2499-2574. doi:10.1007/s00204-023-03562-9.
3. Pizzino G, Irrera N, Cucinotta M, et al. Oxidative stress: harms and benefits for human health. *Oxid Med Cell Longev.* 2017;2017:8416763. doi:10.1155/2017/8416763.
4. Dumbrell C, et al. Oxidative stress: concept and some practical aspects. *Clin Chim Acta.* 2020. doi:10.1016/j.cca.2019.11.066.
5. Vassalle C, et al. Targeting oxidative stress for disease prevention and therapy: current understanding and perspectives. *Molecules.* 2020;25(11):2653. doi:10.3390/molecules25112653.
6. Tumilaar SG, Hardianto A, Dohi H, Kurnia D. A comprehensive review of free radicals, oxidative stress, and antioxidants: overview, clinical applications, global perspectives, future directions. *J Chem.* 2024;2024:5594386. doi:10.1155/2024/5594386.
7. Afzal S, et al. The central role of reactive oxygen species in oxidative stress, neuroinflammation and neurodegenerative diseases. *Front Pharmacol.* 2023;14:1269581. doi:10.3389/fphar.2023.1269581.
8. Frontiers review: Oxidative stress: fundamentals and advances in quantification and biomarkers. *Front Chem.* 2024;12:1470458. doi:10.3389/fchem.2024.1470458.
9. Progress in understanding oxidative stress, aging, and antioxidant strategies. *Antioxidants (Basel).* 2024;13(4):394. doi:10.3390/antiox13040394.
10. RONS and oxidative stress: an overview of basic concepts. *Occup Med Environ Health.* 2022;2(4):30. doi:10.26735/9801/2/4/30.

Publisher's Note:

Annals of Pakistan Medical & Allied Professionals (Pak Med & Allied) remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.