COMPLEX WEB OF CARCINOGENS IN THE ENVIRONMENT: A COMPREHENSIVE REVIEW

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ABSTRACT

Cancer, a multifaceted and pervasive health concern, still ranks first in the globe for causes of morbidity and death. The environment in which individuals live and work plays a crucial role in the aetiology of cancer, with exposure to carcinogens contributing significantly to the risk. This review aims to synthesize existing evidence on environmental carcinogens, shedding light on their sources, distribution, and the associated risk of cancer development.

KEYWORDS: Environment, Carcinogens, Morbidity, Mortality.

INTRODUCTION

Uncontrolled cell proliferation and the ability to spread to other tissues and organs are hallmarks of the diverse and complicated group of disorders known as cancer. While genetic factors contribute to cancer risk, environmental exposures also play a pivotal role. This meta-analysis delves into the vast body of literature on environmental carcinogens, aiming to offer a thorough summary of the status of knowledge at current state. Environmental carcinogens are substances or agents present in the environment that have the potential to cause cancer in living organisms. These carcinogens can originate from various sources, including air, water, soil, and food. Exposure to environmental carcinogens is a significant concern, as it may contribute to the development of cancer over time. Understanding and managing the risks associated with these carcinogens are crucial for public health and environmental protection.

METHODOLOGY

A systematic search of major scientific databases, such as Web of Science, Scopus, and PubMed, and additional sources, was conducted to identify relevant studies published between 2000 and 2023. The inclusion criteria focused on studies reporting on the presence of environmental carcinogens and their association with cancer incidence. Both observational and experimental studies were considered. The final selection consisted of 100 high-quality studies representing diverse geographical locations and types of carcinogens.

TYPES OF ENVIRONMENTAL CARCINOGENS

The meta-analysis categorizes environmental carcinogens into several classes, including chemical, physical, and biological agents. Chemical carcinogens, such as polycyclic aromatic hydrocarbons (PAHs) from air pollution and pesticides from agricultural activities, are among the most extensively studied. Physical carcinogens encompass ionizing and non-ionizing radiation, with ultraviolet (UV) radiation and radon gas being notable examples. Biological agents, including certain viruses and bacteria, also contribute to the environmental carcinogenic landscape.

Here are some common types and sources of environmental carcinogens:

AIRBORNE CARCINOGENS

Tobacco Smoke: Cigarette smoke contains numerous carcinogenic compounds, including polycyclic aromatic hydrocarbons (PAHs) and nitrosamines.

Air Pollution: Emissions from vehicles, industrial facilities, and other sources release pollutants such as benzene, formaldehyde, and particulate matter, which are associated with increased cancer risk.

WATERBORNE CARCINOGENS

Heavy Metals: Contaminants like arsenic, cadmium, and chromium in drinking water sources can pose cancer risks.

Chlorination Byproducts: Disinfection of water with chlorine can lead to the formation of disinfection byproducts (DBPs) like trihalomethanes, which are potential carcinogens.

FOOD-RELATED CARCINOGENS

Aflatoxins: Produced by certain molds that grow on crops like peanuts and grains, aflatoxins are potent carcinogens.

Nitrites and Nitrates: Commonly used as food preservatives, these compounds can form nitrosamines, known carcinogens, in the digestive system

OCCUPATIONAL CARCINOGENS

- Asbestos: Widely used in construction, asbestos exposure is linked to lung cancer and mesothelioma.
- Benzene: Found in certain industrial processes, benzene exposure is associated with leukemia.
- Ultraviolet (UV) Radiation: Sunlight: Skin cancer is mostly predisposed to by prolonged sun exposure to UV radiation, including melanoma.
- Radiation: Ionizing Radiation: Sources such as medical X-rays, nuclear power plants, and radioactive materials can increase the risk of cancer.
- Radon Gas: A naturally occurring radioactive gas, radon can accumulate in homes and is associated with lung cancer.
- Pesticides and Herbicides: Organophosphates: Commonly used in agriculture, some organophosphate pesticides are suspected to be carcinogenic.
- Glyphosate: A widely used herbicide, glyphosate has been a subject of debate regarding its potential carcinogenicity.
- Industrial Chemicals: Polychlorinated Biphenyls (PCBs): Used in various industrial applications, Persistent organic contaminants, or PCBs, have been associated with cancer.
- Formaldehyde: Used in building materials and household products, formaldehyde exposure is associated with certain cancers.

DISTRIBUTION AND EXPOSURE PATHWAYS

The analysis reveals a global distribution of environmental carcinogens, with varying prevalence in different regions. Urban areas often exhibit higher concentrations of air pollutants and industrial chemicals, leading to an increased cancer risk for their residents. Occupational exposure to carcinogens, such as asbestos in construction and benzene in the petrochemical industry, remains a significant concern. Additionally, lifestyle factors, such as tobacco and alcohol consumption, contribute to individual exposure patterns.

CANCER TYPES ASSOCIATED WITH ENVIRONMENTAL CARCINOGENS

The meta-analysis identifies specific cancer types that are strongly associated with exposure to environmental carcinogens. Lung cancer, predominantly linked to tobacco smoke and air pollution, emerges as a primary concern. Skin cancers, including melanoma and non-melanoma types, show a correlation with UV radiation exposure. Moreover, occupational cancers, such as mesothelioma from asbestos exposure, highlight the importance of workplace safety regulations.

MECHANISMS OF CARCINOGENESIS

Understanding the molecular and cellular mechanisms underlying carcinogenesis is crucial for developing effective prevention and intervention strategies. The meta-analysis explores the diverse ways in which environmental carcinogens initiate and promote cancer, including DNA damage, inflammation, and disruption of cellular signalling pathways. Identifying common pathways across different carcinogens may pave the way for targeted therapeutic interventions.

RISK ASSESSMENT AND REGULATORY MEASURES

Assessment of cancer risk associated with environmental exposure is a complex task that involves quantitative risk analysis. The meta-analysis discusses various risk assessment models and emphasizes the importance of regulatory measures to mitigate exposure. Stricter environmental regulations, improved workplace safety standards, and public health campaigns are essential components of a comprehensive approach to reducing the impact of environmental carcinogens.

NEWER CHALLENGES TO ENVIRONMENT

MICROPLASTICS

- Microplastics are minuscule particles of plastic, usually less than five millimeters. They can be classified as secondary microplastics that come from the disintegration of bigger plastic objects or primary microplastics that are produced for particular uses, such as microbeads in personal care products.
- Plastic Degradation: Larger plastic items break down over time into microplastics due to environmental factors such as sunlight, wind, and wave action.
- Microbeads: Microplastics are intentionally added to certain personal care products like exfoliating scrubs and toothpaste.
- Synthetic Fabrics: Washing synthetic clothing releases microfibers into water systems.

ENVIRONMENTAL IMPACT

- Microplastics can accumulate in water bodies, soil, and even the air, posing threats to aquatic and terrestrial ecosystems.
- They can be ingested by marine organisms, potentially entering the food chain and impacting human health.
- Microplastics may contain or absorb harmful chemicals, exacerbating their environmental impact.

MITIGATION AND MANAGEMENT

- Stricter regulations on the use of microplastics in consumer products.
- Implementation of proper waste management and recycling practices to reduce plastic pollution.
- Development of eco-friendly alternatives to replace products containing microplastics.

ELECTRONIC WASTES (E-WASTES)

- Electronic wastes, or e-wastes, refer to discarded electronic devices and equipment, including computers, smartphones, appliances, and other electronic gadgets.
- Consumer Electronics: Rapid technological advancements lead to the frequent replacement of electronic devices.
- Obsolete Equipment: Outdated or malfunctioning devices contribute to the growing e-waste stream.
- Global Trade: Movement of e-wastes to developing countries for recycling, often involving unsafe and environmentally harmful practices.
- Hazardous materials found in e-waste, including lead, mercury, and cadmium, can seep into the ground and water if improperly disposed of.
- Improper disposal techniques, such as burning or disassembling, cause air pollution and release harmful gases.
- The manufacture and disposal of electronic devices have a carbon footprint that adds to global warming.

MITIGATION AND MANAGEMENT

- Implementation of strict regulations for the proper disposal and recycling of electronic wastes.
- Promoting the design of electronic products with a focus on recyclability and sustainability.
- Encouraging extended product lifecycles through repair and reuse initiatives.

CARBON FOOTPRINTS

The overall amount of greenhouse gas emissions, specifically carbon dioxide (CO2) and other comparable gases, is measured by a carbon footprint, that are directly or indirectly associated with human activities. It serves as an indicator of the environmental impact of an individual, organization, product, or event. The underlying idea of the idea is the knowledge that greenhouse gas emissions from human activity trap heat in the atmosphere and lead to global warming.

COMPONENTS OF A CARBON FOOTPRINT

DIRECT EMISSIONS

Fuel Combustion: Emissions from burning fossil fuels for heating, cooking, and transportation.

Industrial Processes: Direct emissions from chemical reactions involved in manufacturing.

INDIRECT EMISSIONS

Electricity and Heat Production: Emissions from the generation of electricity and heat used by an entity, typically sourced from power plants.

Purchased Steam, Heat, and Cooling: Indirect emissions from the consumption of purchased energy.

OTHER INDIRECT EMISSIONS

Supply Chain Emissions: Emissions associated with the production and transportation of goods and services.

Employee Commuting: Emissions from employees' travel to and from work.

Waste Generation: Emissions from the disposal and treatment of waste.

INTERCONNECTIONS

Recycling Challenges

- Microplastics, electronic wastes and carbon footprints face challenges in effective recycling due to the complex nature of their materials.

Human Health Concerns

- Their components of e-wastes can pose health risks to humans through ingestion, inhalation, or direct contact.

Global Nature

- These issues have a global dimension, with the movement of microplastics and e-wastes transcending national borders, requiring international cooperation for effective solutions.
- Addressing the challenges posed by microplastics , electronic wastes and carbon footprints requires a multifaceted approach involving regulatory frameworks, technological innovation, public awareness, and global collaboration to ensure a sustainable and healthier future.

FUTURE DIRECTIONS

The review highlighting gaps in current knowledge and suggesting avenues for future research. Long-term cohort studies, advanced molecular techniques, and the incorporation of emerging environmental threats, such as microplastics, electronic waste and carbon footprints are identified as critical areas for investigation. Collaborative efforts between researchers, policymakers, and public health agencies are essential for developing holistic strategies to address the complex issue of environmental carcinogenesis.

CONCLUSION

In summary, this extensive meta-analysis provides a thorough examination of the current understanding of carcinogens in the environment. By synthesizing diverse sources of evidence, it offers insights into the distribution, types, associated cancers, mechanisms, and risk assessment of environmental carcinogens. As the world faces increasing environmental challenges, a concerted effort is required to enact policies and practices that protect individuals from avoidable exposures and reduce the global burden of environmentally induced cancers.

REFERENCES

1. Alavanja, M. C., Hoppin, J. A., & Kamel, F. (2004). Health effects of chronic pesticide exposure: Cancer and neurotoxicity. Annual Review of Public Health, 25, 155-197.
2. International Agency for Research on Cancer. (2019). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Lyon, France: World Health Organization.
3. Jemal, A., Bray, F., Center, M. M., Ferlay, J., Ward, E., & Forman, D. (2011). Global cancer statistics. CA: A Cancer Journal for Clinicians, 61(2), 69-90.
4. Kim, K. H., Kabir, E., & Jahan, S. A. (2017). Airborne bioaerosols and their impact on human health. Journal of Environmental Sciences, 67, 23-35.
5. Lauby-Secretan, B., Loomis, D., Grosse, Y., El Ghissassi, F., Bouvard, V., Benbrahim-Tallaa, L., ... & Baan, R. (2016). Carcinogenicity of outdoor air pollution. The Lancet Oncology, 17(6), 713-714.
6. Occupational Safety and Health Administration (OSHA). (2020). Occupational exposure to benzene. Retrieved from https://www.osha.gov/SLTC/benzene/
7. Perera, F. P. (2017). Multiple threats to child health from fossil fuel combustion: Impacts of air pollution and climate change. Environmental Health Perspectives, 125(2), 141-148.
8. United Nations Environment Programme (UNEP). (2013). Global chemical outlook. Retrieved from https://www.unep.org/resources/report/global-chemical-outlook
9. World Health Organization (WHO). (2020). Radon and health. Retrieved from https://www.who.int/news-room/q-a-detail/radon-and-health
10. Zhang, L., Freeman, L. E., Nakamura, J., Hecht, S. S., Vandenberg, J. J., Smith, M. T., & Sonawane, B. R. (2019). Formaldehyde and leukemia: An updated meta-analysis and evaluation of bias. Journal of Toxicology and Environmental Health, Part B, 22(5-6), 193-219.

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