International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

A Study of Common Human Exposure Pathways to Dangerous Chemicals

Dr. Y. G. Thakre

Assistant professor, Department of Home Science (Faculty of Chemistry), Yeshwant Mahavidyalaya, Wardha, Maharashtra, India

***Abstract*-- Harmful chemical exposure is still a major public health issue. It comes from many sources in our environment, workplaces, and homes. This investigation looks at the common ways people come into contact with dangerous chemicals and the factors that lead to these exposures. Workplaces like agriculture, manufacturing, construction, and healthcare account for a large part of high-intensity exposure because of regular contact with pesticides, solvents, heavy metals, and industrial waste. At home, using or storing cleaning products, personal care items, and appliances improperly creates additional risks. Environmental pollution in air, water, and soil also adds to ongoing, low-level exposure from pollutants like particulate matter, lead, and agricultural runoff. Consumer items such as plastics, electronics, cosmetics, and food packaging expose people to chemicals through swallowing or skin contact. Accidental spills and releases, while not common, can lead to serious health problems. This investigation shows that chemical exposure often happens due to poor safety practices, weak regulations or enforcement, lack of public awareness, and leftover pollution. Understanding these common causes is vital for creating effective prevention strategies and lowering the risks linked to chemical exposure.**

***Keywords*-- Chemical, Health issues, Harmful, Exposure, Public Health, Exposure**

I. INTRODUCTION

Some of the most typical scenarios where people get exposed to chemicals that are harmful to their health are as follows: they breathe in air that has been polluted by pollution, cleaning products, or fumes in the workplace; they eat food that has been contaminated or drink polluted water, or they may even put their hands to their mouths after having made contact with lead dust; and their skin or eyes may come into contact with chemicals that are found in products used at home, cosmetics, or during the performance of certain tasks at their jobs. These exposures may occur in any way, such as through things that are normally found in the household or through industrial and environmental sources. Exposure to hazardous chemicals is a global concern with significant and diverse impact on human populations.

Hazardous chemicals can come from many sources, including environmental pollution (air, water, soil), occupational hazards, products we use at home and in the community, and lifestyle and behavior patterns. There are numerous routes into the human body for these hazardous chemicals, including breathing them in, swallowing them, or touching them (dermal contact), as well as from the mother's womb to a developing fetus. These exposures often occur over long periods of time and at low doses and have cumulative effects on an individual's health. They can lead to a variety of health-related issues, such as respiratory and cardiovascular diseases, neurological disorders, developmental disorders, cancer, reproductive harm, and organ damage. Due to how commonly chemical mixtures are used and the availability of new and emerging contaminants, the total impact of chemical exposure on human health is likely underestimated. In order to effectively prevent exposure to hazardous chemicals, we need to develop integrated strategies involving stronger regulations and controls on the environment and the workplace, increased consumer awareness, safe design of products, and ongoing research. Only through coordinated efforts at the societal, governmental, industrial, and individual levels will we be able to reduce the risk to public health from harmful chemical exposures for both current and future generations [1].

II. COMMON SOURCES OF HARMFUL CHEMICAL EXPOSURE

PAHs (polycyclic aromatic hydrocarbons), petroleum related compounds, PBDE (Polybrominated biphenyl ethers) flame retardants, Phthalates e.g. DEHP (Di ethyl hexyl phthalate), Nonylphenol (found in detergent) are some of the chemicals which cause changes in metabolism of the living species thereby suppressing the immune system. Reproduction and development processes of living organisms are highly targeted and affected. Though Bleaching powder is a useful household cleaning agent but it produces toxic fumes of chlorine gas on reaction with sodium hypochlorite and acids.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

Inhale of small amounts results in difficulty in breathing and becomes the cause of permanent respiratory impairment. Significant exposure results in death. Chloramines, household bleach reacts with ammonia, common in many cleaning agents through solution, to produce a series of toxic gases. It is highly caustic, exposure produces respiratory-, skin problem and eye burns. Moderate doses can result Blood poisoning, bluing of the skin caused by lack of oxygen in the blood, and death [2].

These dangerous substances cause specific types of hazards. They are known as chemical hazards and typically result from poor handling of chemical substances. When these chemicals interact with air and water, they can produce harmful effects. Hazardous substances can have multiple unsafe properties. The main properties include: Explosive: This type can cause explosions, Oxidizing: These can exist as gases, liquids, or solids and can lead to fires and explosions, Flammable: These ignite easily, catch fire quickly, and burn intensely. Corrosive: These can severely damage eyes and skin, leading to burns and blindness, Toxic: These can cause harmful effects when ingested or inhaled, which may be mild or life-threatening, Harmful chemical exposure in humans mainly comes from three key sources: the environment, workplaces, and the products we use every day. The main ways we come into contact with these chemicals are through breathing them in, swallowing them, or having them touch our skin [3].

III. Route Of Chemical Entry Or Exposure Pathway

The following are the Route of Chemical Entry or Exposure Pathway

Inhalation: If we can smell it, we can inhale it. Inhalation is the primary entry route of hazardous chemicals; all airborne particles can be inhaled. This is mainly in the process of breathing.

Ingestion: The toxic materials enter the gastrointestinal tract through eating, drinking or smoking. This causes harmful chemical ingestion.

Absorption: This is mainly through the absorption of harmful substances. Absorption is the common exposure site for liquids and airborne particles where absorption occurs rapidly.

Injection: The sharp puncture on the skin allows infectious agents to enter the body.

Exposure can occur through the water. When people drink contaminated groundwater or surface water by swimming or showering—exposure to the soil and dust when they ingest or breathe them. Children are more susceptible due to activities and hand-mouth contact. Exposure through food people who consume food containing hazardous substances [4]

IV. Common Types Of Workplace Exposure

Chemical exposure: Workers in industries like agriculture, manufacturing, and healthcare may encounter toxic substances that can result in both acute and chronic health issues. Exposure can come from inhalation, skin contact, or ingestion, leading to a range of problems, including respiratory issues, skin disorders, and even cancers.

Physical hazards: These can include exposure to extreme temperatures, loud noises, or machinery that can cause injury or long-term health problems. For example, prolonged exposure to high noise levels can lead to irreversible hearing loss, while extreme temperatures can result in conditions like heatstroke or hypothermia.

Biological hazards: Workers in healthcare, waste management or research may face exposure to viruses, bacteria, and other infectious agents. This type of exposure can be particularly concerning, as it can lead to outbreaks of disease and long-lasting health impacts.

Psychological hazards: Stress and workplace bullying can lead to mental health issues, which, while less visible, can be just as damaging. Mental health conditions can affect overall well-being, job performance, and even physical health, highlighting the importance of addressing these issues in the workplace [5].

V. Identifying Hazard Control Options

Method of identifying and ranking safeguards to protect workers from hazards. They are arranged from the most to least effective and include elimination, substitution, engineering controls, administrative controls and personal protective equipment.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

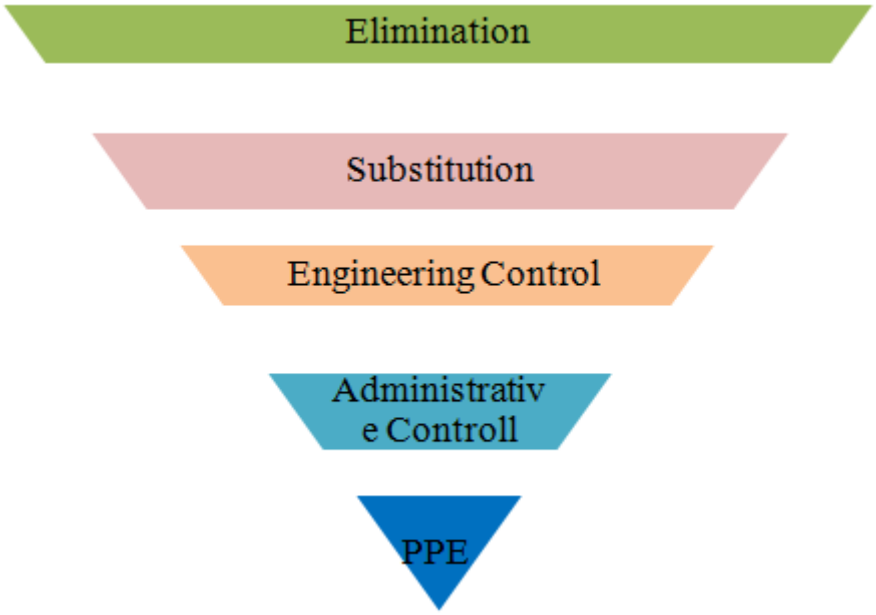

Figure 1-Hazard control options

Elimination and substitution -Elimination and Substitution makes sure the hazard no longer exists in following

1. Ending the use of a hazardous material
2. Doing work at ground level rather than at heights
3. Stopping the use of noisy processes

Substitution means changing out a material or process to reduce the hazard- Examples:

1. Switching to a less hazardous material
2. Switching to a process that uses less force, speed, temperature, or electrical current[6]

Controlling Chemical exposure -The main reason for these hazardous chemicals that are found in blood and urine samples of a large share of the European and the U.S. population is the prevalence of these chemicals in consumer products such as toys, electronics, clothes, and cosmetics. The same chemicals can be found in different environmental compartments. Although the exposure dose to hazardous chemicals in each individual product may be within safe limits, the combined exposure to a mixture of these chemicals can lead to increased health and environmental risks. Establishing a chemical management system that goes beyond simply complying with OSHA standards and strives to reduce or eliminate chemical hazards at the source through informed substitution best to protect workers [7].

Engineering controls -By using engineering controls, you can completely eliminate a worker's exposure to hazards by helping isolate them from that hazard source. Engineering controls also allow workers to perform their efforts in a manner that is safe for themselves and others. Examples of engineering controls include:- Enclosures for noise, Localized exhaust ventilation systems, Guardrail systems that raise up off the ground, Guards for machinery, Interlocks, Lifting device or lift systems[8].

Administrative controls and safe work practices - Administrative controls are work practices designed to reduce the direction, frequency, and severity of chemical exposure. They are always used in conjunction with other controls to improve the effectiveness. Administrative controls often involve-Chemical safety policies and standard operating procedures, Rules prohibiting certain behaviors in the workplace, modified work scheduling, Restricting access to parts of the workplace, Decontamination procedures ,Health and workplace monitoring ,Alarms systems training[9]

Personal protective equipment (PPE) -- Protecting ourselves so that we can continue to help others is a priority for health care providers around the world.

This includes being conscious and up to date with infection prevention and control measures and the appropriate implementation of personal protective equipment (PPE), hand hygiene and waste management of potentially harmful materials [10]. Personal Protective Equipment (PPE) refers to the specialized clothing or gear worn by individuals to protect themselves from hazards that can cause injury or illness.

VI. Conclusion

Human exposure to hazardous chemicals is a complex issue, influenced by multiple pathways that often operate simultaneously. Recognizing how inhalation, ingestion, dermal contact, and other routes contribute to overall risk is essential for protecting public health. By understanding these exposure mechanisms, individuals can adopt safer habits, workplaces can strengthen protective standards, and policymakers can develop more effective regulations. Although hazardous chemicals are an unavoidable part of modern life, informed awareness, rigorous safety practices, and strong environmental protections together play a crucial role in minimizing harm and ensuring a safer, healthier environment for all. Effective control measures—such as proper ventilation, use of personal protective equipment, safe chemical storage, adherence to regulatory standards, and public education—play a critical role in reducing exposure.

Ultimately, while hazardous chemicals remain an inevitable component of modern society, comprehensive awareness, responsible management, and proactive prevention strategies can significantly minimize health risks and safeguard both individuals and communities.

REFERENCES

[1] Pruss-Ustin A.,et al. "Knowns and unknowns on burden of disease due to chemicals: a systematic review." Environmental Health, 2011;10:9

[2] Bajpai Sangeeta and Kamboj Monika Harmful Chemicals: Impact on Environment International Journal of Advanced Research (2016), Volume 4, Issue 5, 1800-1806.

[3] Ajeet Jaiswal, Archana S. Human Health and Exposure to Hazardous Substances. *J. Microb. Res.* Vol, Iss 1. (2023). DOI: 10.58489/2836-2187/011

[4] Missouri Dept of Health and Senior Service, (2020). Health Effect of Chemical Exposure, November 2020.

[5] Workplace Health and Safety Queensland, (2020). Managing Hazchem, November, 2020.

[6] "Hierarchy of Controls | Environmental Health & Safety (EHS)"Ehs.utexas.edu.Retrrived 2024-04-07.

[7] Dodson, Robin E., et al. "Consumer behavior and exposure to parabens, bisphenols, triclosan, dichlorophenols, and benzophenone-3: Results from a crowd sourced biomonitoring study." International Journal of Hygiene and Environmental Health 230 (2020): 113624.

[8] R. Silva, M. Cruz, Impact of chemical safety training on incident rates, Safety and Health in Industry, 60(5) (2022) 332-339.

[9] C. Weschler, J. Sundell, T. Salthammer, Chemical exposure risks in industrial workplaces: A cross-sectoral analysis, Environmental Science & Technology, 54(6) (2020) 1124-1132

[10] Protective Personal Equipment. World Health Organization. Https. Retrieved on: 13 March 2020.