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Occupational Health Hazards

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Department of Forestry and Environmental Science
School of Earth and Environmental Science

Uttarakhand Open University
Haldwani, Nainital (U.K.)

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Unit 1: Introduction to Occupational Health

Unit Structure

1.0 Learning Objectives

After completion of this unit, you will be able to:

- understand about occupational health;
- understand the history and scope of occupational health;
- understand the concept of health hazards;
- understand the factors causing health hazards;

1.1 Introduction

Occupational health is a multidisciplinary approach that protect and promote the worker's health by preventing and controlling occupational diseases and accidents at work. It focuses to develop healthy and safe environment to enhance the physical, mental and social well-being of workers. This unit aims at providing learners a basic background information about occupational health and safety. Occupational health is a multidisciplinary and comprehensive approach that has evolved from a mono-disciplinary stage and is a basic element that follows the principle of Sustainable development.

1.2 Occupational health and Safety

Occupational health and safety encompass the social, mental and physical well-being of workers, that is the "whole person" in all occupation. Occupational safety helps to prevent direct hazard while occupational health focuses on all the activities perform in the workplace. However, occupational health issues are given less attention as compared with occupational safety issues. Occupational health is applied by different occupational health professionals such as engineers, chemists, toxicologists, doctors, nurses, safety professionals and environmental health practitioners.

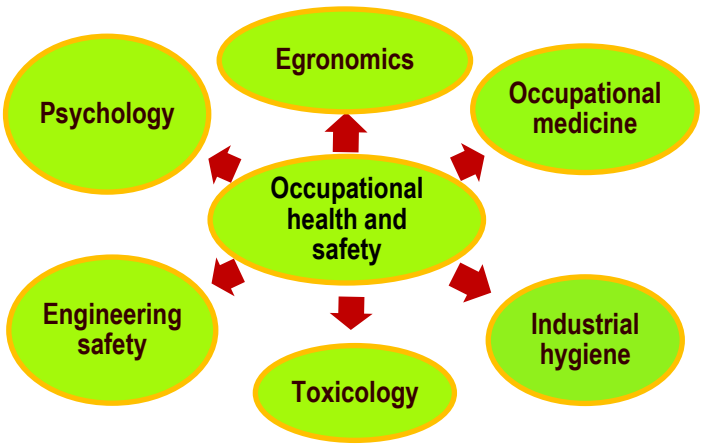

Fig. 1. Different fields related to Occupational health and

1.3 Principles of Occupational health and safety

The basic principles for the development of occupational health and safety services are as follows:

a) The service must optimally be preventive oriented and multidisciplinary.

b) The service provided should integrate and complement the existing public health service.

c) The service should address environmental considerations.

d) The service should involve, participation of social partners and other stakeholders.

e) The service should be delivered on panned approach.

f) The service should base up to date information, education, training, consultancy, advisory services and research findings.

g) The service should be considered as an investment contributing positively towards ensuring productivity and profitability.

1.4 Scope of occupational health and safety

The scope of occupational health and safety is three-fold. It begins with the anticipation and recognition of workers' health problems in an industrial atmosphere. The causes of these problems may be chemical, physical, biological, psychological, and ergonomical environments. The second scope includes evaluation of the recognized problem, which encompasses mainly data collection, analysis, interpretation, and recommendations. Finally, the third scope involves the development of corrective actions to eliminate or limit the problem. Generally, the work frame of occupational health and safety is wide and needs multidisciplinary approach. It requires the knowledge of physics, biology, chemistry, ergonomics, medicine, engineering, and related sciences. It also requires public health management skills for proper communication and decision making.

1.5 History of occupational health and safety

The origins of occupational health and safety concerns started from 18th to 19th century or late industrial revolution. This century saw the rise of iron industries, cotton mills, and semi-automated factories, which became the main industries and laid the groundwork for the industrial revolution. Moreover, the industrial revolution has increased the economy, but causes a negative impact on the health and safety of different workers working in these industries and factories. These workers were exposed to harmful gases, acids, toxins, temperature, light and sound that causes physical, social and psychological health disorders. Scholars and decision-makers of the time realized that industrial health and hygiene was a critical issue because of the injuries, illnesses, and health risks that workers faced as a result of the industrial revolution.

Annie Hamilton was an American toxicologist who studied the human health impacts of industrial metals and chemical compounds. She became a pioneer in the field of industrial illnesses and hygiene by making important contributions through her publications. Although the need to address occupational (industrial) health and safety issues was there during the Industrial Revolution, the vast worldwide city expansion that has resulted in extensive industrialization and population increase has made the matter even more serious. Acts, laws, and policies have been developed all over the world with the aim of safeguarding

everyone's health and safe working conditions. Every nation has its own laws and regulations pertaining to workplace safety and health.

Every nation has passed legislation to safeguard employees at work, such as the Occupational Health and Safety Act of 1970 in the United States. In order to protect employees in workplaces, the Canadian Center for Occupational Health and Safety (CCOHS) was established by an Act of Parliament in 1978. The department of occupational health and safety was established in Malaysia to address health and safety concerns. This department has its own health and safety policy and audits both hazardous and non-hazardous equipment at workplaces.

Check your progress

1. The occupational health and safety act of U.S.A was made on which year?
   - **a.** 1989
   - **b.** 1992
   - **c.** 1996
   - **d.** 1970
2. What do you understand by Occupational health and safety?
3. Explain the principle of Occupational health and safety?
4. Explain the scope of Occupational health and safety?

Answers:

1. d
2. See section 1.2
3. See section 1.3
4. See section 1.4

1.6 Objectives of occupational health and safety

The main goal of OHS is to guarantee that every worker, regardless of industry, has access to health and safety. World Health Organization (WHO) has incorporated occupational health into its policies and in important WHO texts, the necessity of safeguarding employees from occupational health risks and promoting everyone's safety at work has been underlined. OHS concerns at work must be addressed immediately for every employee due to shifting work-life patterns and the increasing need for increased productivity from employees. The

Global Strategy on Occupational Health for All paper emphasizes the importance of primary prevention and calls on nations to develop national occupational health policies and programs along with the necessary resources and infrastructure. In order to fulfill OHS needs at work, the text places a strong emphasis on developing policies, structures, procedures, and activities. It draws attention to the necessity of sufficient human resources and support services for putting the new plan into action. The WHO places a high value on cooperation between international organizations, non-governmental organizations, and the several fields related to occupational health issues at both the national and local levels.

1.7 Occupational Diseases

Occupational diseases are unfavorable health disorders that affect people and are linked to exposure to certain substances at work or in the workplace. Such factors could be physical like heat, cold, noise and different radiations and vibrations, chemical such as solvents, pesticide dust and heavy metals, biological means infective agents like HIV, ergonomics, mechanical and psychosocial stressors that causes psychosocial and psychosomatic effects. There are different types of Occupational Health effects like Occupation Specific diseases, chemical specific health effects and Occupational cancers.

1.8 Characteristics of occupational diseases

Health care professionals frequently fail to consider the occupational origin of occupational sickness. This is due to a variety of distinctive characteristics of occupational disorders that might make it challenging to pinpoint their occupational origin. The clinical and pathological features of asthma and other non-occupational disorders are similar to those of most occupational diseases. Occupational sickness may occur after exposure has ended. Both non-occupational and occupational factors can contribute to the development of diseases. The timing and dosage of exposure have an impact on the clinical signs of occupational illness.

1.9 Prevention of occupational diseases

Occupational diseases can be prevented by three ways: Primary, Secondary and Tertiary prevention.

1. **Primary prevention**

a. Primary prevention is achieved by lowering the risk of illness, the level of exposure to dangerous substances and the amount of dosage.

b. Industrial hygiene professionals carry out these kinds of reductions by utilizing prot ective
gear while working and distributing doses to each employee in a proper rotation.

2. **Secondary prevention**

Secondary prevention is done before the identification of any health problem or disease, means before workers get ill to limit the adverse effects of the disease.

3. **Tertiary prevention**

Tertiary prevention includes reduction of clinical effects on the health of a diseased person. The main aim of tertiary prevention includes reduction in the symptoms of disease, minimizing the injury and increasing the capacity of the body organs to function properly.

1.10 Health hazards

Health hazard means developing a disease in a person, basically “hazard” means the capacity to cause harm to an exposed body. Occupational hazard is of 2 types: safety hazard and health hazard. The harm or problem caused by the hazards totally depends on various circumstances such as time duration and degree of exposure.

1.11 Factors causing health hazards

There are several factors or agents that causes health hazards, diseases and disabilities or sometimes death in the job or in the work place. Such factors are classified as: Physical Hazards, Mechanical Hazards, Chemical Hazards, Biological Hazards, Ergonomic Hazards, and Psychosocial Hazards.

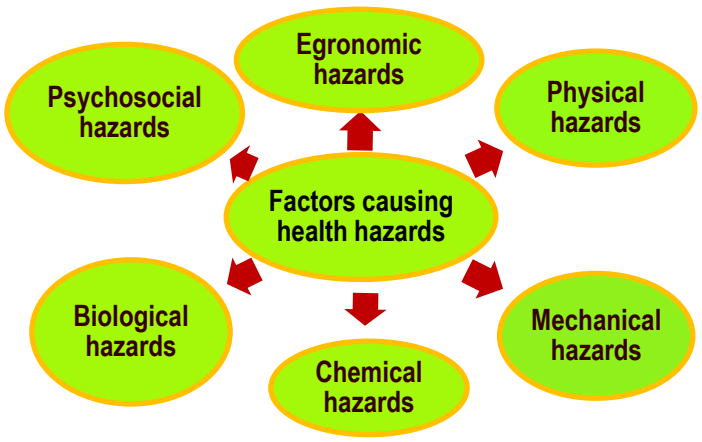

Fig. 2. Factors causing health hazards

1. Physical hazards

Physical hazards include thermal stress (hot and cold stress), noise, vibration, radiation (ionizing, non-ionizing), and other unhealthy microclimatic conditions. Physical hazards cause immediate health impact on the workers like extreme hot and cold environment reduces the metabolic activities of a person.

2. Mechanical hazards

Mechanical hazards include dangerous unprotected tools, unshielded machines and unsafe or improper structures present in the work environment. It causes great injuries or diseases to the health of workers.

3. Chemical hazards

Chemical hazards occur due to the release of chemicals (irritant gases and vapours) in the workplace, or prolonged exposure of such chemicals in the workplace. Organic solvents like alcohols, hydrocarbon, ether, ketone is volatile and causes health problems.

4. Biological hazards

It includes the diseases that are caused by microbial agents that are exposed in the work place. Microbial agents include bacteria, viruses, fungi and parasites. These types of diseases mainly occurred to the health workers that are working in sewage treatment plants, leather industry, hospitals, and laboratories.

5. Egronomic hazards

Egronomic hazard means the diseases that are caused due to the exposure of workers to heat, light, noise, environmental contaminants and all the tools and instruments used in the workplace. In developed countries, around 10-30% of workers are exposed to heavy instruments used in industries while in developing countries the number increases to 50-70%.

6. Psychosocial hazards

Psychosocial stress is caused due to pressure of work and time, hectic work and the tension of being unemployment. There are also other factors that causes psychosocial hazards like heavy responsibility on a particular worker, monotonous work and many isolated works.

Check your progress

1. What is the full form of WHO?

a. World Health Organization

b. World Human Organization

c. World Health Organ

d. None of the above

2. What is the full form of OHS?

   a. Organized Health and Safety

   b. Occupational Health and Safety

   c. Open Health System

   d. Open Human System

3. Briefly describe the characteristics of occupational disease.
4. Write a short note on health hazards.
5. Write a short note on prevention of disease.

Summary

This unit describes the concept and scope of occupational health and safety, it is a multidisciplinary approach that protect and promote the worker's health by preventing and controlling occupational diseases and accidents at work. Occupational health is a multidisciplinary and comprehensive approach that has evolved from a mono-disciplinary stage and is a basic element that follows the principle of Sustainable development. The

scope of occupational health and safety is three-fold. It begins with the anticipation and recognition of workers' health problems in an industrial atmosphere. The causes of these problems may be chemical, physical, biological, psychological, and ergonomical environments. Occupational diseases are unfavorable health disorders that affect people and are linked to exposure to certain substances at work or in the workplace. Health hazard means developing a disease in a person, basically "hazard" means the capacity to cause harm to an exposed body. Occupational hazard is of 2 types: safety hazard and health hazard. There are several factors or agents that causes health hazards, diseases and disabilities or sometimes death in the job or in the work place.

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Unit 2: The Occupational Environment

Unit Structure

2.0 Learning Objectives

After completion of this unit, you will be able to:

- understand about occupational environment;
- understand the criteria of occupational environment;
- understand the concept of occupational exposure limits;
- understand the threshold limits of pollutants

2.1 Introduction

Occupational environment means all the physical, social and psychological conditions or environment in which workers perform their work for the development of the organization. The environment or the condition of the workplace decides the efficiency of the work done by the employees. Occupational environment totally depends upon different factors including physical, social and organizational environment.

1. Physical environment

In the workplace, physical factors play a key role in the functioning of the employee. Suitable layout of the workplace, light, noise level, temperature, ventilation and exposure to different hazards like chemical, radiation and heavy machine are the main physical factors that should be in control for proper work environment.

2. Social environment

Social environment of the workplace is one of the key factors that improves the environment of any industry, office and consultancy. Relationship with coworkers, team work, culture of the workplace and proper management and communication among each other are the main social factors of any industry.

3. Organizational environment

Organizational environment includes different work policies, values of the company, job demands and various safety regulations.

An appropriately arranged occupational environment promotes employee health, efficiency and safety.

2.2 Principles of Occupational Environment

The workplace environment is directed by essential principles that promote safety, effectiveness, and the well-being of employees. These principles assist organizations in fostering a productive and sustainable work atmosphere. The essential principles include:

- **a.** Giving priority to the physical and mental health of employees and establishing workplace safety protocols and hazard mitigation strategies.
- **b.** Conducting regular risk evaluations and adhering to safety regulations (e.g., OSHA, ISO standards) and creating workstations to minimize physical strain and exhaustion.
- **c.** Offering adequate lighting, ventilation, and noise management and confirming that all the tools and equipment are user-friendly and secure.
- **d.** Encouraging sensible working hours, rest periods and supporting adaptable work arrangements like remote work and hybrid models. Promoting health initiatives, including mental health assistance.
- **e.** Encouraging collaboration, communication, and inclusivity and minimizing workplace stress and fostering psychological safety. Tackling problems such as workplace harassment and discrimination.
- **f.** Adhering to National and International labor regulations concerning worker rights, as well as ensuring equitable wages, job security, and ethical employment practices. Offering regular safety training and skill enhancement.

g. Encouraging employee feedback to enhance the work environment and adjusting to new technologies and innovations in the workplace.

h. Minimizing waste, pollution, and carbon emissions in the workplace and encouraging sustainable practices like energy conservation. Guaranteeing the secure disposal of hazardous substances.

By adhering to these guidelines, organizations can develop a work environment that boosts productivity, guarantees safety, and fosters overall employee satisfaction.

2.3 Scope of Occupational Environment

The scope of the workplace environment is extensive, covering various aspects that impact workers' health, safety, and efficiency. It consists of the physical factors, social and psychological elements, organizational policies and practices, as well as technological impacts. The modern workplace or occupational environment is ongoing in its development, emphasizing sustainability, inclusiveness, and the well-being of employees to establish safer and more efficient workplaces.

2.4 History of Occupational Environment

The idea of the occupational environment has changed considerably throughout history, and was influenced by industrialization, labor movements, scientific progress, and workplace regulations. In the pre-industrial period, the main form of work was agriculture, and numerous other artisans and craftsmen operated in small workshops with few safety hazards. In the 18th and 19th centuries, the industrialization revolution emerged, bringing along numerous factory-oriented jobs that involved mass production and mechanization. In this time period, the working conditions were harsh and included extended hours, child labor, contact with dangerous substances, and the use of unsafe machinery.

In the early 20th century, industrial accidents and health problems prompted reforms and the creation of labor unions promoting the workers' rights. The establishment of workplace safety regulations in various nations, such as the UK's Factory Acts and the US's Occupational Safety and Health Act (OSHA) in 1970, was formed. In the middle of the 20th century, a modern occupational environment emerged that promotes ergonomics and emphasizes in the creation of workplaces that alleviate physical strain. Numerous

governments and organizations implement strict health and safety protocols, and consideration for workplace stress, mental health, and employee well-being is also prioritized.

Check your progress

5. The US's Occupational Safety and Health Act (OSHA) was made on which year?
   - **e.** 1989
   - **f.** 1992
   - **g.** 1996
   - **h.** 1970
6. What do you understand by Occupational environment?
7. Explain the principle of Occupational environment?
8. Explain the scope of Occupational environment?
9. Explain the history of Occupational environment?
10. Occupational environment depends upon how many factors?
    - **a.** 1
    - **b.** 2
    - **c.** 6
    - **d.** 3

Answers:

5. d
6. See section 2.1
7. See section 2.2
8. See section 2.3
9. See section 2.4
10. d

2.5 Criteria of Occupational Environment

The work environment is assessed according to key criteria that ascertain workplace safety, employee health, and general productivity. All of these factors ensure that the workplace is in compliance with health and safety standards, promotes effectiveness, and contributes to employee satisfaction. These criteria include:

1. **Workplace Safety and Health Standards**

Adherence to workplace safety regulations like OSHA and ISO 45001 and accessibility of personal protective equipment (PPE). Existence of emergency procedures like fire safety, first aid, and proper evacuation plans and routine risk evaluations and hazard management in the workplace.

2. **Physical Work Condition**

Physical work condition consists of adequate lighting, airflow, and sound management. Proper temperature and air conditions suitable for employment and secure and ergonomic workstation layout to minimize strain and exhaustion.

3. **Psychological and Social Environment**

Creating an environment that is both courteous and supportive to employees and implementing policies to prevent harassment and discrimination in the workplace. Fostering effective communication and teamwork and providing stress management and mental health support services in the workplace.

Other criteria include organizational policies and work ethics, technological and digital work environment, work-life balance and employee well-being, sustainability and environmental responsibility. By fulfilling these criteria, an occupational environment can guarantee safety, efficiency, employee satisfaction, and long-term sustainability in the workplace.

2.6 Occupational Exposure Limits (OELs)

Occupational Exposure Limits (OEL) are crucial for safeguarding workers from health and safety hazards arising from exposure to airborne toxic substances. An OEL represents a maximum allowable concentration of a hazardous substance in the air of a workplace for a specific substance or category of substances to which employees may be exposed during their working lifetime for example 8 hours daily, 5 days a week, or for 40 years without experiencing negative health impacts. Generally, the Occupational Exposure Limit (OEL) signifies the permissible level of exposure, for a duration of time typically 8 hours, to a chemical or physical hazard without causing adverse effects on a worker's health. Repeated exposure to levels beneath these concentrations throughout a complete working life does not result in any notable negative effects on the health of those exposed and to their offspring. These OEL limits are established by numerous professional associations globally,

including the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH) in the U.S. The OELs for physical hazards derive from industrial experience and experimental studies conducted on humans and animals. The OELs for chemical substances are set according to the substance's chemical characteristics, experimental research involving animals and humans, as well as toxicological and epidemiological information. Various organizations might use distinct terminology for the OEL. For instance, the term for OEL as defined by ACGIH is "Threshold Limit Value" (TLV)®, whereas NIOSH refers to it as "recommended exposure limits" (REL).

2.7 Characteristics of occupational exposure limits

A. Occupational exposure limits (OELs) refer to the highest allowable air concentrations that serve as reference standards to safeguard workers from excessive exposure to chemical substances through inhalation.

B. OELs serve as a valuable foundation for creating procedures that ensure the safe management of substances in the workplace.

C. There are established protocols for determining OELs. The quantity of toxicological data accessible for a chemical substance differs greatly, but typically the OEL is founded on the no observed or lowest observed adverse effect level (NOAEL or LOAEL) for the most significant effect observed in one or more repeated dose animal experiments.

D. The objective of creating an OEL is to safeguard employees from possible harmful impacts of chemicals in usual workplace exposure situations.

2.8 Types of exposure limits

There are different types of exposure limits based on the type of chemicals or substances used. For **chemical** substances, ACGIH (2021) classifies four types of threshold limit values: Threshold Limit Value – Time-Weighted Average (TLV-TWA), Threshold Limit Value – Short-term exposure (TLV-STEL), Threshold Limit Value – Ceiling (TLV-C) and Threshold Limit Value – Surface Limit (TLV-SL).

Threshold Limit Value – Time-Weighted Average (TLV-TWA): The time-weighted average level of a harmful substance in the air calculated over an 8-hour shift and a 40-hour workweek to which it is thought that employees could be continually exposed, day in and day out, for an entire working life without negative effects.

Threshold Limit Value – Short-term exposure (TLV-STEL): A 15-minute time-weighted average exposure that must not be surpassed at any moment during a workday, even if the total 8-hour TLV-TWA is below the TLV-TWA. Employees should not face more than four exposures daily to concentrations exceeding TLV-TWA up to TLV-STEL. There must be a minimum of a 60-minute gap between exposures. The short-term exposure limit has been established to consider the immediate impacts of substances that mainly have long-term effects.

Threshold Limit Value – Ceiling (TLV-C): The level that must not be surpassed at any moment during the working exposure.

Threshold Limit Value – Surface Limit (TLV-SL): The permissible level of a material on a surface that is unlikely to lead to negative health impacts if an individual comes into contact with that surface. It complements the inhalation TLVs for materials for which the exposure pathway is via the skin and those labeled as skin and respiratory allergens.

The unit of measurement of all these limits are ppm and mg/m^3. Aerosols are usually expressed in mg/m^3 while gases and vapours are expressed in ppm or mg/m^3.

For **physical hazards**, ACGIH defines Threshold Limit Value – Time-Weighted Average (TLV-TWA) and Threshold Limit Value-Ceiling (TLV-C).

Threshold Limit Value – Time-Weighted Average (TLV-TWA): The average exposure weighted by time for a workday of 8 hours and a workweek of 40 hours. **Threshold Limit Value-Ceiling (TLV-C):** The limit of exposure that must not be surpassed at any moment.

Check your progress

6. What are the criteria of Occupational Environment?
7. What is the full form of OEL?
    - **e.** Occupational Exposure Limits
    - **f.** Occupational Extreme Limitation

g. Open External Limits

h. Open Exposure Limits

8. Briefly describe the characteristics of Occupational Exposure Limits.

9. Write a short note on Occupational Exposure Limits.

10. Describe different types of exposure limits.

11. What is the full form of PPE?

a. Personal Protective Equipment

b. Public Protection Element

c. Personal Passport Element

d. None of the above

12. What is the full form of ACGIH?

a. American Conference of Governmental Industrial Hygienists

b. American Context on Government Industrial Hygiene

c. Australian Conference of Governmental Industrial Hygienists

d. None of the above

13. What is the full form of NIOSH?

a. National Institution of Occupational Safe and healthy

b. National Institute for Occupational Safety and Health

c. National International Occupational Safety and Health

d. None of the above

14. What is the full form of TLV?

a. Threshold Limit Value

b. Threshold Limited Value

c. Thousand Limit Valuation

d. None of the above

15. Explain different types of threshold limit values.

Answers:

1. See section 2.5

2. a

3. See section 2.7

4. See section 2.6

5. See section 2.8
6. a
7. a
8. b
9. a
10. See section 2.8

Summary

This unit describes the concept and scope of occupational environment and different types of exposure limits. Occupational environment means all the physical, social and psychological conditions or environment in which workers perform their work for the development of the organization. Occupational environment totally depends upon different factors including physical, social and organizational environment. The workplace environment is directed by essential principles that promote safety, effectiveness, and the well-being of employees. The scope of the workplace environment is extensive, covering various aspects that impact workers' health, safety, and efficiency. It consists of the physical factors, social and psychological elements, organizational policies and practices, as well as technological impacts. The work environment is assessed according to key criterias that ascertain workplace safety, employee health, and general productivity. These criteria include Workplace Safety and Health Standards, Physical Work Condition and Psychological and Social Environment.

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Unit 3: The Categories of Health Hazards

Unit Structure

3.0 Learning Objectives

After going through this unit, you will be able to:

- Understand the general impact and health consequences of Industrialization.
- Identify and classify Occupational Hazards.
- Examine specific workplace hazards and their health consequences.

3.1 Introduction

The modern world has been greatly influenced by industrialization. It created modern towns, boosted economic expansion, and fundamentally changed how we live and work. However, as with many significant changes, there has been a cost, particularly in terms of our health.

Although it brought about advancements, it also brought about a number of health problems that continue to impact millions of people worldwide. And these are actual issues that affect actual lives, not just figures in a paper. Understanding the human side of industrialization's effects—not only the statistics, but the people behind them—is essential as we assume our roles as professionals, leaders, and global citizens.

We frequently see factories, technology, and expansion when we think about industrialization, but we hardly ever consider the invisible costs. One of the most evident, yet commonly ignored effects is pollution, particularly the type we inhale and consume on a daily basis.

3.1 The Impact of Industrialization on Human Health

Hazardous materials are released into the atmosphere hourly by power plants, automobiles, and industry. These contaminants enter our bodies rather than merely existing in the atmosphere. They enter our circulation and lungs, where they gradually and silently impact our health. This is a real concern for residents in highly industrialized areas. It's just part of everyday life. Communities close to factories or major highways have higher rates of conditions like bronchitis, asthma, and even cancer and heart disease.

New employment opportunities developed as a result of industrialization, yet many of these positions carried significant hazards. Workers frequently find themselves in difficult and occasionally dangerous situations in mines, factories, and construction sites. They are exposed to dangerous chemicals, dust that can choke them, loud noises, and heavy machinery that doesn't necessarily have the right safety precautions.

The risks aren't always present instantly. Long-term exposure to specific dust and fibers can cause diseases like silicosis and asbestosis, which can take years for symptoms to appear and sometimes only become serious after the task is completed and the harm is irreparable.

Unfortunately, this still happens today. People continue to risk their health—and even their lives—just to put food on the table in many low- and middle-income nations because safety laws are lacking or poorly implemented. These are matters of justice and dignity, not merely those of the job. Nobody should have to decide between maintaining their health and making a living.

People are drawn to industries as they expand. Rapid urbanization results from cities becoming attractive to employment seekers. However, cities frequently expand more quickly than their infrastructure can support. The outcome? Slums, crowded areas, inadequate sanitation, and a shortage of waste disposal and water for drinking. Infectious diseases spread readily under such circumstances. In heavily populated

metropolitan areas where industrialization has overtaken growth, outbreaks of cholera, dengue, and tuberculosis are nevertheless frequent.

We frequently consider industrialization's impact on physical health, but its impacts on mental health are equally significant. It can be quite hard to move from a rural, community-based lifestyle to a fast-paced, competitive urban one.

Burnout, anxiety, and depression can result from long work hours, job uncertainty, and the ongoing need to keep up. We need to discuss more about the invisible but very real toll that industrialization has on many people's mental health, especially as it continues to rise in current society.

3.2 Occupational Hazard

Any circumstance that puts our health and safety at risk might be categorized as a hazard. This could be anything as visible as an exposed hole in the floor, or it could be a dangerous substance kept in a lab, even if it isn't being used right now. These are frequently referred to as occupational risks in the context of the workplace, particularly in industries. The hazards that workers encounter have increased along with the growth and evolution of industries as a result of industrialization.

According to estimates from the International Labor Organization (ILO), there are about 200,000 work-related deaths globally each year. Many workers also experience accidents and illnesses at work. In order to provide a scientific basis for decisions aimed at safeguarding human health from the detrimental consequences of exposure in the workplace, it is imperative to maintain continuous monitoring through an occupational health program.

Workplace accidents and diseases are more common in developing countries. It is estimated that there are over 120 million workplace accidents each year, with over 200,000 of those fatalities taking place in developing countries. Lower worker competence and poor occupational health can cost a country anywhere from 10% to 20% of its gross national product (GNP), according to the World Health Organization (WHO). Occupational illnesses, fatalities, and diseases are thought to cost the world's economy 4% of its entire production. The ILO estimates that 6300 people die every day from occupational accidents, and that 2.3 million people die each year from work-related illnesses.

An industry typically has some kind of occupational danger, regardless of how long it has been in operation. If these risks are not adequately controlled, persons who are exposed may become ill, get hurt, or experience long-term health issues. For this reason, workplace safety and employee protection depend heavily on preventive and management.

There are several types of occupational hazards (shown in figure-1):

- Physical (such as heat, loudness, or dangerous equipment),
- Chemical (such being around poisonous materials),
- biological (like germs, viruses, or molds), and
- psycho-social (like stress, harassment, or lengthy workdays).

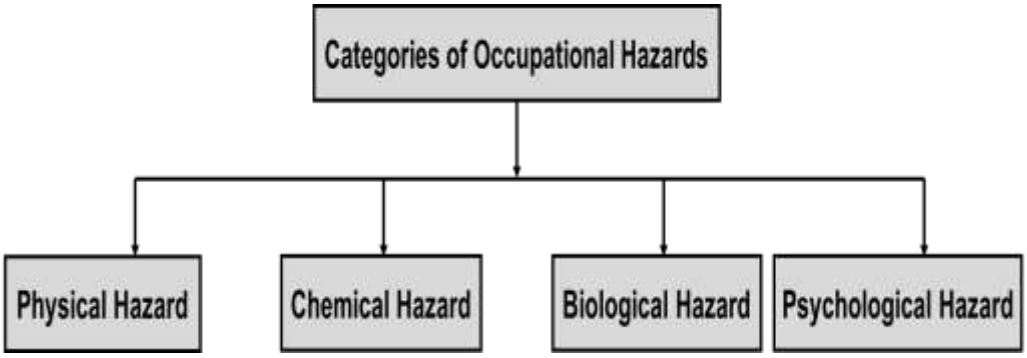

Figure-1: Categories of Occupational Hazards

Each of these risks has the potential to cause occupational or work-related illnesses in a variety of ways. One of the most important steps in making workplaces safer and healthier for everyone is identifying and addressing these risks.

Question for Practice

Q1. Which of the following is NOT mentioned as a type of occupational hazard?

A) Physical

B) Psychological

C) Economic

D) Chemical

Q2. What is one major reason for the spread of infectious diseases in rapidly urbanized areas?

A) Improved infrastructure

B) Access to technology

C) Overcrowding and poor sanitation

D) Decreased pollution

Q3. Industrialization has led to both economic expansion and increased health risks.

Q4. All occupational hazards have immediate effects on workers' health.

Q5. Long-term exposure to specific dust and fibers can cause diseases like _____ and _____.

Q6. According to the WHO, occupational illnesses and accidents may cost a country up to _____ of its GNP.

Q7. Assertion (A): People living near highways and factories face higher risks of bronchitis and asthma.

Reason (R): Industrial and vehicular emissions release harmful pollutants into the air.

A) Both A and R are true, and R is the correct explanation of A.

B) Both A and R are true, but R is not the correct explanation of A.

C) A is true, but R is false.

D) A is false, but R is true.

Q8. Match the type of occupational hazard with the appropriate example:

Type of Occupational Hazard	**Example**
A. Physical	**1.** Toxic chemicals
B. Chemical	**2.** Viruses and bacteria
C. Biological	**3.** Excessive noise
D. Psycho-social	**4.** Workplace harassment

3.2.1 Physical Hazard

A circumstance that poses a risk or harm to one's health and safety is referred to as a hazard. According to OSH, physical hazards are potential risks that could result in workers suffering physical harm or injury as a result of physical agents, circumstances, or conditions present in the workplace. Physical hazards are defined as physical agents that have the potential to alter human health conditions and biological processes, such as noise, vibration, radiation, electricity, and extremely high or low

temperatures. This category also includes the ergonomic and mechanical risks that are present during work.

3.2.1.1 Noise

Noise is a type of vibration that occurs through solids, liquids, or gases and is typically described as an ear-unpleasing sound that the listener does not want to hear. The human response is the only thing that can tell a sound from a noise. One person may find pop music to be enjoyable, while another may find it annoying. Noise is created by mechanical vibration as a result of industrialization and growing mechanization in practically every industry and trade. Noise hazards are caused by high and continuous noise levels both inside and outside the work area. Workers' hearing may be harmed by loud noises at work. Long-term exposure to loud noises frequently causes this to happen over longer lengths of time. Short-term exposure to noise may only cause transient hearing loss, but prolonged exposure to high noise levels can cause permanent hearing loss or other conditions like tinnitus in workers. Sudden, very loud noises can potentially cause immediate, permanent damage. Noise-Induced Hearing Loss (NIHL), which starts in the 4 kHz frequency range and worsens with prolonged exposure, can be brought on by exposure to extreme noise levels (over 90 dB). According to audiometry, NIHL is a permanent and incurable illness that is both reportable and compensable in India.

Non-auditory impacts of noise include migraines, tinnitus (ear ringing), annoyance, poor focus, decreased work performance, and even raised blood pressure, in addition to hearing impairment. In addition to increasing worker tiredness, tension, irritation, and sleep difficulties, high noise levels can hinder communication and make warnings harder to hear, all of which can lower performance.

Therefore, it is crucial to reduce noise by implementing suitable preventive and control methods. Early planning during the workplace's design phase is the most effective way to manage noise. Once operations start, noise control becomes more challenging but still feasible. Control measures should address the following:

a) the source of the noise,

b) the path it takes, and

c) the receiver (the employee).

Employees should be given and encouraged to wear hearing protection such as earmuffs and earplugs, and every industry that produces a lot of noise should put in place a program for at-risk employees to conserve their hearing.

3.2.1.2 Vibration

Vibration is an oscillatory motion that occurs in various occupations such as vehicle (truck, tractor, dumber, dozer) operators, workers in ships and shipyards, construction workers (tunnel, bridge making), miners (drillers, blasters, crushers, chipping hammer, etc.), and airplane and helicopter maintenance engineers.

There are two main types of vibrations:

i. Hand-transmitted Vibration: Vibrations of 1000 Hz or higher enter the body through the hands due to various processes in which vibrating tools or work pieces are grasped or pushed by the hands or fingers. This causes disorders of the hands and fingers.

ii. Whole-body Vibration: Whole-body vibration enters the body in various directions when the body is supported on a vibrating surface, such as a vibrating platform or floor. This vibration typically has a low frequency range (0.5 Hz to 100 Hz). Blood circulation, bones, joints, muscles, and nerves are all impacted by prolonged and frequent vibration exposure of the fingers or hand. The prevalent conditions include hand-arm vibration syndrome and vibration-induced white finger.

While brief exposure to hand-arm vibration or whole-body vibration may cause acute impairment, repeated or sustained exposure causes irreversible harm. Isolating the individual from vibration, modifying the duration of exposure, maintaining vibrating equipment properly, and avoiding cold exposure to hands and fingers while using vibrating tools are all ways to prevent vibration disorders. Vibration diseases do not occur very frequently in our nation.

3.2.1.3 Radiation

X-rays, gamma rays, radio and television waves, light, and infrared radiation are the most frequent types of radiation energy generated by electromagnetic phenomena. Radiation dangers include both ionizing and non-ionizing radiation exposure, which can cause tissue damage, burns, and even cancer. Numerous industries use radiation

energy in various forms. Their frequencies determine their unique usage, ranging from satellite communication and microwaves to electro-power systems.

A dose of radiation over six Sieverts (sv) is lethal. Cosmic rays, X-rays, and radiation from radioactive materials are examples of ionizing radiation. There are numerous industrial applications for ionizing radiation, including manufacturing, research, medicine, and energy production. It is crucial to appropriately regulate exposures to protect workers because ionizing radiation damages the body's cells by causing chemical alterations in the DNA of the cells, which results in aberrant cell growth.

Ionizing radiation poses the following health risks:

- Skin discoloration and peeling, as well as skin burn.
- Acute radiation sickness, which manifests as weakness, nausea, and vomiting 2-4 days after exposure.
- Leukemia, sterility, blood abnormalities, and cancer of other vulnerable organs.
- Genetic alterations in bodily cells; harm to the intestines and central nervous system.

Radiant heat, radio waves, microwaves, terahertz radiation, infrared light, visible light, and ultraviolet light are examples of non-ionizing radiation. Employees who undertake tasks that expose them to non-ionizing radiation should be properly protected, particularly by wearing eye and face shields. The health effects of non-ionizing radiation are limited to the skin and eyes and can be either acute from direct exposure or chronic from extended exposure. There may be immediate skin alterations, including pigmentation, epidermal damage, squamous cell carcinoma, or eye abnormalities.

3.2.1.4 Electricity

People can be killed or seriously injured by electricity, and it can also harm property. Electric shock and burns from contact with live parts, injuries from arcing, fire from malfunctioning electrical equipment or installations, explosions from inappropriate electrical equipment, or static electricity igniting flammable dusts or fumes, such as in a spray paint booth, are the main risks associated with working with electricity. Other kinds of injuries can also result from electric shocks, such as falls from scaffolds or ladders.

3.2.1.5 Heat/Cold

The health and safety of employees are at risk from extreme temperatures, whether they are extremely hot or extremely cold. Most people only work well in a relatively small range of body temperatures, such as 37°C to 1°C, and they operate worse in temperature extremes. Heat stress may be a problem for employees who operate in hot, muggy conditions or are exposed to intense heat. Heat stroke, heat exhaustion, heat syncope, cramps, heat rashes, and death are among the occupational disorders brought on by exposure to excessive heat and high humidity. Heat and humidity can also make people more likely to get hurt since they can cause dizziness, sweaty palms, and fogged safety glasses. Contact with hot surfaces, steam, or fire can result in additional heat-related ailments, such burns. Sweating is the body's attempt to release heat when the core temperature rises as a result of work, metabolism, or environmental heat load. This keeps the body's temperature balanced. Sweating therefore happens when working in a heated atmosphere. The body can receive or lose heat through radiation, convection, metabolism, or conduction. Evaporation is the only way that heat is lost. Consequently, sweating-induced heat evaporation is a protective feature when working in hot conditions surroundings. The body's heat balance equation can be represented as follows:

$$\boldsymbol{M \pm Cv \pm Cd \pm R - E = 0}$$

where,

M = metabolic heat,

CV = convection,

Cd = conduction,

R = Radiation,

E = Evaporation.

In other words, heat gain equals heat loss to keep the body's heat balance. When exposed to excessive heat at work, especially during the summer, an industrial worker may get heat-related illnesses. Steel mills, cement mills, metal processing businesses, paper mills, textile mills, and construction projects can all provide heat hazards. Heat stroke, heat exhaustion, heat cramps, or heat rash are examples of acute heat diseases that can range in severity from mild fainting to unconsciousness. Long-term skin cancer may result from direct exposure to radiant heat.

Cold: In our nation, cold-related hazards are uncommon, with the exception of places where winter temperatures drop significantly. Workers in certain industries are exposed to extreme cold, including freezer plants, ice factories, meat processing and packaging facilities, cold storage facilities, etc. Workers in these types of environments should be adequately protected by warm clothing to prevent their bodies from being exposed to extreme cold. Cold first affects the skin, thus it needs to be properly protected. Cold diseases can be either localized (chilblain or frostbite) or generalized (hypothermia).

Cold disorders can be exacerbated or precipitated by exposure to cold winds, contact with wet surfaces or cold metal, wearing inadequate clothing, being too young or old, having poor health, and having skin diseases. Common illnesses include trench foot, chilblain, frostbite, and cold stress. Extremely cold conditions can make workers more susceptible to a number of illnesses, such as frostbite, a build-up of musculoskeletal conditions, tissue damage, and even hypothermia.

Hypothermia: It is a widespread ailment brought on by exposure to chilly environments. The signs of hypothermia include uncontrollably shivering, a sharp drop in body temperature, a weak pulse, a low heart rate, and a drop in blood pressure when the air temperature drops below 10°C. As the illness progresses, symptoms include cold skin, drowsiness, irregular breathing, memory loss, speech disturbance, fatigue, and exhaustion.

Some neurological and vascular conditions can be brought on by exposure to cold, such as burning and itching sensations over the tips of fingers and toes because of abnormal blood circulation, blue hands or feet because of a decrease in hemoglobin in the blood, and vascular blockage, especially in diabetics, tobacco users, and the elderly. Exposure to cold causes emergency situations.

Questions for Practice

Q9. Which of the following types of vibrations primarily affects bones, muscles, and nerves through body support surfaces?

A) Air-transmitted vibration

B) Whole-body vibration

C) Surface-conducted vibration

D) Hand-transmitted vibration

Q10. What is the minimum dose of ionizing radiation considered lethal?

A) 1 Sievert

B) 2.5 Sieverts

C) 6 Sieverts

D) 10 Sieverts

Q11. Noise-Induced Hearing Loss (NIHL) is a temporary condition that can be reversed with medication.

Q12. Exposure to extreme heat can result in occupational conditions such as heat stroke, heat exhaustion, and even death.

Q13. _____ is an oscillatory motion that can cause hand-arm vibration syndrome or vibration-induced white finger in workers.

Q14. Hypothermia is a condition caused by exposure to cold environments where the body temperature drops below _____.

Q15. Assertion (A): Workers in steel and cement mills are at high risk of heat-related illnesses.
Reason (R): These industries involve high environmental temperatures and exposure to radiant heat.

A) Both A and R are true, and R is the correct explanation of A.

B) Both A and R are true, but R is not the correct explanation of A.

C) A is true, but R is false.

D) A is false, but R is true.

Q16. Match the physical hazard with its health effect:

Physical Hazards	**Health Effect**
A. Noise	1. Frostbite and trench foot
B. Vibration	2. Hand-arm vibration syndrome
C. Ionizing Radiation	3. Permanent hearing loss
D. Extreme Cold	4. Genetic mutations and cancer

3.2.2 Chemical Hazard

Chemicals are now a necessary part of human existence, they support development and activities, prevent and treat a wide range of illnesses, and increase agricultural production. Despite their benefits, chemicals can be harmful to human health and the environment, particularly if used carelessly. With the widespread usage of pharmaceuticals worldwide, the possibility of adverse effects increases. It is anticipated that the chemical sector will expand in both developed and emerging countries. In this regard, it is recognized that evaluating and reducing the risks associated with chemical exposure is one of the main goals in accomplishing the principles of sustainable development.

The measurement of a substance's quantity and frequency of contact with a person or the environment is known as "chemical exposure." Three methods of chemical and pollutant exposure were ingestion (eating or drinking), absorption (skin and eye contact), and inhalation (breathing in). We are exposed to pollutants and chemicals when we inhale or breathe them in. We take more than 20,000 breaths every day. This number could be significantly greater for newborns and young children. Breathing in pollutants and poisons can expose the bloodstream and lungs.

We can occasionally, but not always, taste or smell harmful chemicals. Certain chemicals, like carbon monoxide or radon, are invisible and tasteless. Absorption (skin and eye contact) is another method of exposure. By exposing your skin and eyes, chemicals and contaminants can enter your body. Because the skin and eyes are more chemically sensitive and may react to pollutants faster than the rest of the body.

Ingesting is an additional exposure method. We are exposed to pollutants and chemicals when we eat and drink. Chemicals and pollutants are present in both the food we consume and the water we drink.

The presence of high concentrations of dusts, fumes, vapors, mists, and solid particulate matter in the workplace creates chemical risks. Exposure to cleaning agents, solvents, machine oils, and other organic or inorganic compounds used in industrial operations can have detrimental effects on one's health.

3.2.2.1 Particulate Matter

The two types of particulate matter are dusts and fumes. Dusts are particles that range in size from 0.1 to 30 meters or more and are produced by mechanical processes such as crushing, grinding, pulverizing, sandblasting, and shake-out operations in mines and industries. Fumes are made up of extremely fine particles and are produced by the combustion, condensation, and sublimation of material. When inhaled, these particles cross the respiratory barrier and end up in the lungs' alveoli, where they cause damage to the alveolar walls and fine opacities.

The opacities are radio-opaque and can get larger or combine to form larger opacities. "Dusty lungs" or "pneumoconiosis" are the names given to this lung illness. Breathlessness, chest pain, fever, weakness, and compromised lung function are the disease's telltale signs and symptoms. A lung function test, a chest X-ray (big film or at least 70 mm film, not odelca film), and extended exposure to respirable dust (0.5 m to 5 m) or fumes can all be used to diagnose pneumoconiosis. As a broad word, pneumoconiosis is defined by the dust that causes it, such as silicosis (silica), anthrocosis (coal dust), asbestosis (asbestos fiber), bylsinosis (cotton fiber), siderosis (iron dust), bagossosis (cane sugar fiber), baritosis (barium), or stannosis (tin).

Certain harmful dusts, such as lead, manganese, mercury, arsenic, antimony, or cadmium, can cause disorders of the target organs when they reach the bloodstream through ingestion, inhalation, or direct skin absorption. There is ample evidence of manganese (which affects the central nervous system), mercury poisoning, which can cause mental disease and tremor, lead colic, lead palsy, chrome ulceration, arsenic poisoning, and asbestos-induced mesothelioma of the pleura. Among the occupational illnesses brought on by particulate matter are metal fume fever, occupational asthma, toxic jaundice, and allergic alveolitis.

3.2.2.2 Toxic Gases and Vapours

Depending on how they affect the human body, the harmful gases and vapors might be categorized as irritants, asphyxiants, narcotics, or anesthetics. The concentration of these harmful materials in the workplace and the length of exposure determines their physiological reaction. Most of these gases although generate acute effects and even death in high concentration, chronic effect owing to low concentration may also be produced. Irritant gases can irritate the bronchioles and alveoli (nitrogen dioxide,

phosgene) or have an acute effect on the upper respiratory tract (ammonia, sulfur dioxide, formaldehyde, and acrolein). Suffocation results from simple asphyxiant gasses that prevent the tissues from receiving enough oxygen. Common examples arc: carbon dioxide, ethane, methane, hydrogen, nitrogen and helium.

Because of their chemical effects on the blood or brain's respiratory center, chemical asphyxiants such as carbon monoxide, hydrogen cyanide, and hydrogen sulfide, among others, cause asphyxia. They may induce sudden collapse, unconsciousness or death when ingested in high concentration. Because the gas leaks, carbon monoxide poisoning frequently occurs in coke ovens and steel mills. Anaesthetic and narcotic gases, such as ethers, hydrocarbons, acetone, acetylene, ethyl and prophylactic alcohol, and others, cause anesthesia, unconsciousness, and unintentional death at high concentrations. Additionally, there is neurotoxicity from solvents, mercury, and manganese fumes, cardiac sensitization from volatile hydrocarbons, and cancer from carcinogenic chemicals.

3.2.2.3 Solvents and other Toxic Chemicals

Especially in chemical facilities, businesses utilize high-quality solvents. A large number of these solvents are poisonous. Solvents are absorbed when they come into touch with the skin, resulting in complicated and varied effects. During handling, some organic materials are breathed and have an impact on the central nervous system. The effects of the solvents range from drowsiness to death, depending on the level of exposure. We are exposed to solvents on a daily basis in addition to at work. When handling them, one should be aware of their effects and take the appropriate safety measures. When handling, storing, and transporting these chemicals, safety precautions ought to be taken. If employed in chemical plants and other businesses, the possible harm of the toxic solvents may be thoroughly investigated. Care should be used when handling solvents that have a high potential for explosion or fire. To avoid unintentional chemical exposure, each chemical's Material Safety Data Sheet should be reviewed.

Questions for Practice

Q17. Which of the following is **NOT** a common route of chemical exposure in humans?

A) Inhalation

B) Absorption

C) Injection

D) Ingestion

Q18. Pneumoconiosis caused by **coal dust** is referred to as:

A) Silicosis

B) Anthracosis

C) Asbestosis

D) Siderosis

Q19. Exposure to solvents can affect the central nervous system and may lead to unconsciousness or even death.

Q20. Carbon monoxide is a harmless gas and does not cause asphyxiation.

Q21. _____ are produced through combustion or sublimation and consist of extremely fine particles that can damage the lungs when inhaled.

Q22. A high dose of _____ radiation may cause mental illness, tremors, or even death due to its toxic effects on the nervous system.

Q23. Assertion (A): Chemical hazards are a serious concern in the workplace.

Reason (R): Exposure to toxic chemicals and gases can cause occupational diseases like mesothelioma, metal fume fever, and toxic jaundice.

A) Both A and R are true, and R is the correct explanation of A.

B) Both A and R are true, but R is not the correct explanation of A.

C) A is true, but R is false.

D) A is false, but R is true.

Q24. Match the chemical hazard with its corresponding illness or effect:

Chemical Hazard	**Corresponding illness or effect**
A. Silica dust	**1.** Lead colic and lead palsy
B. Lead exposure	**2.** Pneumoconiosis (Silicosis)
C. Carbon monoxide	**3.** Asphyxiation
D. Solvent inhalation	**4.** CNS depression and drowsiness

3.2.3 Biological Hazards

Biological hazards are agents (pathogens) that cause disease and can spread to people through different exposure pathways (modes of transmission).

According to the Technical guidelines on biological hazards in the working environment, any living organisms or substances derived from plants, animals, or humans—including genetically modified ones—that have the potential to endanger human health are referred to as biological hazards. Numerous industries, particularly those that handle plant or animal products, provide biological risks. These include bacteria, viruses, fungi, parasites, prions, DNA materials, bodily fluids, and other microorganisms, that are present at work. Because they frequently work with raw materials of plant or animal origin, industries like paper mills, textile mills, wool processing plants, tanneries, dairies, sugar mills, food processing facilities, and seed processing units are especially vulnerable to biological hazards.

Humans can contact a number of occupational diseases from animals. Particularly at danger are those who work directly with animals, such as zoo employees, butchers, veterinary surgeons, and employees at pet stores. Depending on the organism and type of exposure, these illnesses can be either acute or chronic, lasting a short time or a long time.

To safeguard people, property, the environment, and transportation networks, a number of international regulations govern dangerous products, including biological agents and chemicals. These rules address the transportation, storage, workplace usage, consumer sale, and disposal of such items. The United Nations developed a set of guidelines to harmonize the classification and communication of dangers in order to maintain these systems across the globe.

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is one of the most important instruments created. Following the Chemicals Convention of 1990, the UN and the International Labour Organization (ILO) established this system, which superseded the numerous labeling and categorization schemes that were previously used in various nations. GHS makes it simpler for people worldwide to comprehend the dangers and handle hazardous products safely by using standardized warning symbols and comprehensive safety data sheets.

Three distinct warning pictograms are used (shown in figure-2) in various contexts to clearly represent the risks associated with biological materials that present significant health risks.

Figure-2: Bio-Hazard Labelling

Source: United Nations, Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

The presence of chemical or physical pollution in the workplace may exacerbate the impact of biological agents. For instance, exposure to nitrogen oxide may raise the risk of pneumonia in humans, irritating gases and fumes increase the incidence and severity of respiratory illnesses, and working in a dusty environment might spread tuberculosis through dust. Adopting biosafety measures is necessary to lessen or completely eradicate these risks.

3.2.4 Psycho-social Hazards

A worker may experience stress, pressure, or interpersonal issues as a result of psychosocial risks in the workplace. Some job risks are less obvious but just as dangerous as physical ones. Any aspect of how work is planned, structured, or handled that raises the possibility of stress at work is referred to as a psychosocial hazard. While experiencing pressure at work is common, excessive or unmanageable stress turns into a problem.

The human element of work has been severely stretched as a result of the economy's globalization and fierce competition in all fields. Workers are under a lot of stress due to the introduction of new technology, automation, computerization, a focus on product quality, competitive pricing, and a changing work environment. Older employees must be retrained or rehabilitated to deal with the new circumstances, while new hires must be ready for a more difficult task. This causes stress at work, and if a healthy coping

mechanism is not used, employees and managers may experience psychosomatic illnesses like depression, hypertension, mental illness, and insomnia.

Although many workers today enjoy greater economic prosperity, they still have to deal with the dangers of industrialization, especially in large cities, where issues with housing, transportation, healthcare, and other amenities remain unresolved. Employee behavioral changes including anxiety, sadness, hostility, aggression, and drunkenness are brought on by this, and they are the source of subpar work output and aberrant mental health.

Psycho-social health problems, such as exhaustion, headaches, peptic ulcers, high blood pressure, and accelerated aging, have been observed quite frequently. Among the issues that impact a person's and their family members' physical, mental, and social well-being include boredom, repetitive work, sedentary jobs, and monotonous daily routines. In the future, this will be a significant issue. To keep employees happy, healthy, and stress-free, these concerns should be addressed by all industries. Psychosocial risks can take many different shapes and have varying effects on individuals based on their particular circumstances, role, and environment. In table 1, there are few typical instances:

Table 1:

Cause	Description
Tasks and Job Design	Repetitive or boring labor, failing to apply one's abilities, or being asked to perform duties for which one is not prepared.
Hours and Workload	Stress and exhaustion might result from working long hours, working shifts, or having rigid schedules.
Authority Over Work	Being excluded from decisions that impact your role or having little influence over how or when work is completed.
Workplace	Uncomfortable workplaces, hazardous equipment, poor lighting, and noisy surroundings can all make tasks more difficult.

Culture of the Organization	unclear objectives, inadequate communication, or work environments that tolerate abuse or discrimination without taking appropriate action.
Workplace Relationships	lack of assistance from coworkers or superiors, bullying, harassment, or isolation.
Role Clarity	having competing obligations or not knowing what is expected of you at work.
Professional Growth	worries about harsh performance reviews, a lack of possibilities for promotion, or job stability.
Balance Between Work and Life	struggles to balance personal obligations because of work obligations or frequent absences from home.

The first step in preventing work-related stress is to identify the dangers and take preventative action. In table 2, there are some ways that organizations can assist:

Table 2:

Prevention Action	Description
Evaluate the dangers	Psychosocial risks should be recognized and evaluated on a regular basis, much like physical hazards.
Encourage employee control	Employees should have more control over their work and tasks.
Boost Interaction	Confusion and anxiety can be decreased via courteous, honest, and open communication.
Encourage involvement	Engage employees in decision-making, particularly when it comes to their duties or working circumstances.
Construct Support Systems	Encourage bosses and coworkers to have supportive connections.

Equilibrium Life and Work	Acknowledge that employees have obligations outside of work, and make every effort to provide flexibility.
Encourage a Culture of Positivity	Make well-being, safety, and health the organization's guiding principles.

Businesses contribute to the creation of safer, healthier, and more productive workplaces for everybody when they take psychosocial hazards seriously and implement effective management techniques.

Questions for Practice

Q25. Which industry is **most likely** to expose workers to biological hazards?

A) Software development

B) Textile mill

C) Banking

D) Automobile showroom

Q26. Which of the following is a **psychosocial hazard** in the workplace?

A) Loud machinery

B) Chemical spills

C) Job insecurity and workplace harassment

D) Exposure to dust

Q27. Bacteria, fungi, and bodily fluids are examples of biological hazards.

Q28. Globally Harmonized System (GHS) was created to make it easier to apply different national chemical labeling systems independently.

Q29. The _____ is an international system developed by the UN and ILO for classifying and labeling hazardous chemicals.

Q30. One common result of prolonged psychosocial stress in the workplace is _____, which may include symptoms such as fatigue and sleep disturbances.

Q31. Assertion (A): Psycho-social hazards can cause serious health effects like hypertension and depression.

Reason (R): Long working hours, lack of job control, and poor workplace relationships are common sources of psycho-social stress.

A) Both A and R are true, and R is the correct explanation of A.

B) Both A and R are true, but R is not the correct explanation of A.

C) A is true, but R is false.

D) A is false, but R is true.

Q32. Match the hazard with its associated risk or illness:

Hazard	Associated Risk or Illness
A. Prions	**1.** Psychosomatic illnesses like insomnia and anxiety
B. Nitrogen oxide + dust	**2.** Spread of tuberculosis and pneumonia
C. Work-life imbalance	**3.** Can cause degenerative brain conditions
D. Workplace bullying	**4.** Chronic stress and decreased productivity

Summary

1. The modern world has been changed by industrialization, which has produced cities, jobs, and economic expansion. However, in addition to its advantages, it has brought about significant health dangers, many of which continue to impact millions of people today. We hardly discuss the hidden costs to people's physical and mental health, even though we frequently witness the outward manifestations of progress—roads, factories, and technology.
2. Impact on Environmental Health: Every day, we breathe in contaminants released into the atmosphere by industrial operations. Particularly in highly industrialized regions, these chemicals not only remain in the environment but also reach our bloodstream and lungs, where they can cause heart problems, cancer, bronchitis, and asthma.
3. Occupational Health Risks: Working in an industrial setting can provide many risks. Employees are subjected to radiation, dust, chemicals, noise, vibration, electricity, and extremely high or low temperatures. These hazards can cause short-term injuries or lead to long-term diseases like silicosis, asbestosis, and

noise-induced hearing loss. Workers in many underdeveloped nations continue to face these risks on a daily basis, frequently with no protection, due to lax safety standards.

4. Types of Workplace Hazards:

   Physical Hazards - Loud noise might cause lasting hearing loss. The hands and spine are impacted by vibration. Radiation exposure can cause tissue damage and cancer. Extremes in temperature can result in frostbite, heatstroke, and hypothermia.

   Chemical Hazards: Dust, fumes, toxic gasses, and solvents are among the dangerous materials that employees may breathe in or absorb. These may harm the brain system, the lungs, or other organs. Long-term exposure can even lead to cancer or neurological diseases.

   Biological Hazards: Workers in industries that handle raw plant or animal materials, such as textile mills or dairy farms, are more likely to contract diseases due to exposure to bacteria, viruses, and other pathogens. Psychosocial Risks: Anxiety, sadness, and burnout are among the mental health conditions that are exacerbated by long hours, high pressure, job insecurity, harassment, and inadequate management. Even repetitious or solitary job can lead to considerable emotional strain.

5. Urbanization and Living Conditions: People relocate to cities in search of employment as industries expand. Rapid urbanization, however, frequently results in crowded slums, inadequate sanitation, and a shortage of clean water, which makes it easier for diseases like cholera, dengue, and tuberculosis to flourish.

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1. Biological hazards in the working environment, International Labour Conference 112th Session, 2024
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3. International Labour Organization

Answers

1. C)

2. C)

3. True

4. False

5. silicosis; asbestosis

6. 20%

7. A)

8. A-3, B-1, C-2, D-4

9. B)

10. C)

11. False

12. True

13. Vibration

14. 10°C

15. A)

16. A-3, B-2, C-4, D-1

17. C)

18. B)

19. True

20. False

21. Fumes

22. Mercury

23. A)

24. A-2, B-1, C-3, D-4

26. B)

27. C)

28. True

29. False

30. Globally Harmonized System (GHS)

31. burnout

32. A)

33. A-3, B-2, C-4, D-1

Unit 4: Physical Environmental Factors and Occupational Disorders

Unit Structure

4.0 Learning Objectives

After reading this unit students should be able to:

- Identify factors affecting health of workers;
- Understand the workplace/occupational environment and hazards
- Discuss about the occupational disorders
- Understand the occupational hazards of agriculture workers
- List the preventive measures to combat occupational hazards/disorder

4.1 Introduction

In the previous unit, you have studied various categories of health hazards. You have also studied about their prevention and control. Many non-communicable diseases have multiple causes. One of the causes of these diseases/disorders is Occupational physical environmental factors which is discussed in the present unit.

Physical environmental factors, such as climate, noise levels, and air quality, are elements of the built and natural environments that can have an impact on health. Conversely, occupational disorders are health problems brought on by work risks, such as exposure to physical dangers including vibration, noise, and extremely high or low temperatures.

The physical surroundings of a workplace can significantly affect workers' productivity, safety, and well-being. The dangers and stressors that exist in the workplace and have the potential to expose employees to physical harm, discomfort, or sickness are referred to as occupational physical environment concerns. The way workplaces, resources, and machines are designed, as well as the physical demands of the task itself, can all contribute to these issues.

4.1.1 Types of Occupational Physical Environment Problems

The following are some typical categories of issues with the physical environment at work:

- **Ergonomic hazards:** Inadequately constructed work areas or equipment that can result in injuries to the muscles like tendinitis, syndrome of the carpal tunnel, and back pain.
- **Noise pollution:** Exposure to high decibel levels might result in tinnitus or hearing loss.
- **Extremes in temperature:** Working in conditions which are either too hot or too cold might result in hypothermia or other heat-related ailments.

- **Illumination problems:** insufficient and too much light might lead to discomfort in the eyes, headaches, or mishaps.
- **Vibration:** Being near vibrating machinery or equipment can lead to injuries to the muscles, including hand-arm vibration syndrome.

According to the WHO, there are 100 million occupational injuries worldwide that result in 0.1 million fatalities. According to estimates, 45,000 fatal injuries and 17 million non-fatal occupational injuries—or 17% of the global burden—occur in India annually. The study and prevention of environmental issues among employees in the workplace is known as occupational health. Three factors—the workplace (working environment), the home, and social security and welfare programs—have an impact on an employee's health.

4.1.2 The Workplace/Occupational Environment

There are three different ways that the workplace environment might affect an employee's health.

1. Man and Machine: Power drives the machines in practically every industry; accidents are caused by inappropriate machine installation, unprotected moving parts, inadequate maintenance, etc. Long workdays cause exhaustion, annoyance, and a decline in productivity.

2. Man and Environment: Man's health is impacted by his actions and how he interacts with his surroundings.

3. Man towards Man: A worker's relationship with his employer, fellow employees, and colleagues. Their safety, security, and mental health are influenced by a variety of psychosocial elements, including motivation, as well as welfare circumstances, job satisfaction, and reward.

4.1.3 Hazards

The workers are at risk from five different kinds of hazards: mechanical, chemical, biological, psychological, and physical. There are some other hazards include skin,

lung, and prostate cancers as well as diseases that form blood, such as leukemia, Allergic reactions, urticarial irritation, folliculitis, and eczema.

4.2 Environmental Factors and Occupational Disorders

Occupational disorders are those that develop during or as a result of working at workplace. Here is how they can be categorized: (Table 4.1):

Table 4.1 Factors causes of occupational disorders.

S.No.	Causative Factors	Disorders Condition
1.	Diseases due to Physical Factors a) Heat b) Cold c) Light d) Pressure e) Noise f) Radiation g) Mechanical Factors h) Electricity	Heat hyperpyrexia, heat exhaustion, heat syncope, heat cramp, burns and local effects Trench foot, frost bite, chilblains Occupational Cataract, Miner's nystagmus Caisson disease, air embolism, blast. Occupational deafness, Cancer, leukemia, aplastic anemic, Pancytopenia Injuries and accidents Burns
2.	Diseases due to Chemical Factors a) Gases b) Inorganic dusts c) Organic dust d) Metal their compounds e) Acids, Alkalis, Pesticides	Gas Poisoning Pneumoconiosis Bagassosis Byssinosis, Tobocosis and farmers' lung Lead Mercury, Cadmium Poisoning Burns
3.	Biological Agent	Brucellosis, leptospirosis, anthrax actinomycosis, tetanus, encephalitis etc.
4.	Occupational Cancers	Cancer of skin, bladder, lungs
5.	Occupation Dermatitis	Dermatitis, eczema
6.	Diseases of Psychological Origin	Industrial neurosis, hypertension, ulcer etc.

7.	Occupational diseases of Agriculture Worker	Anthrax, leptospirosis, tetanus, tuberculosis and Q fever Accidents due to machinery used for farming, insect and snake bite, solar radiation and respiratory diseases.
8.	Occupational diseases to the Health Care Workers	Infections like HIV, hepatitis, TB, backache, mental stress, varicose vein, sleep deprivation
9.	Occupational diseases to the Computer Professionals	Carpal turner syndrome, dry eyes, cervical spondylitis, insomnia, backache.

4.2.1 Pneumoconiosis and Prevention Strategies

Dust illness is an alternative name for pneumoconiosis. A variety of lung parenchymal illnesses are brought on by a particular occupation and are brought on by long-term inhalation of insoluble dust.

Since there is no known cure for pneumoconiosis, preventive measures is limited to interventions. The disease's course can be slowed and the patient's quality of life enhanced by managing its symptoms. Reducing symptoms, stopping more damage, and enhancing lung function are the main goals of treatment.

Clinical symptoms include a chronic cough and increasing breathing difficulties, which gradually impairs a person's ability to work by decreasing lung fibrosis. Complications include pulmonary illness and, in certain situations, cancer. The following are some of the factors that affect pneumoconiosis:

- The health risks increase with dust concentration. 200 mcg per cubic meter of air is the maximum amount that is allowed.
- Another crucial element is the dust's structure; the more complex the composition, the higher the health hazard.
- The dust's size is still a further vital factor. The tissue reactivity increases with the size of the dust particle.

- The length of exposure also affects the state of the disease. The health risk increases with the length of exposure.
- Individual response plays a crucial role in determining the disease state. There is a lower risk of pneumoconiosis if a person is healthier and more nourished.

Table 4.2 The causes, occupations, and common kinds of pneumoconiosis

Dust Type	Disease/Disorders	occupations
Silica	Silicosis	Sand stone industry, stone quarrying and dressing, granite industry, pottery ceramics, gold, silver and mica industry
Asbestos	Asbestosis	Asbestos cement factory, fireproof textiles
Iron	Siderosis	Iron one and mines, iron and steel industries
Coal dust	Anthracosis	Coal Mines
Aluminum	Aluminosis	Aluminum Industry
Barium	Baitosis	Photography, Printing, barium diagnostic works
Berryllium Stone	Berylliosis Lithosis	Beryllium mining, manufacture of alloy. Stone Industry
Organic dusts	Cotton dust	Byssnosis Textile Industry
Sugar cane dust	Bagassosis	Cane sugar factory, paper and cardboard factories
Tobacco dust	Tobaccosis	Tobacco factories (Beedi, cigar, cigarette)
Mouldy hay Grain dust	Farmer's lung	Agriculture Industry

4.2.2 Lead poisoning and its preventing strategies

Occupational and non-occupational are two different sources of lead poisoning

1) The plumbism is a prevalent occupational type in the plumbing, glass paint, lead mining, and printed pottery industries.

2) Automobile exhaust, lead-containing water pipes, lead-containing insecticide-sprayed food (Fruits), and kids who eat lead-containing mud are examples of non-occupational sources.

Lead poisoning can be diagnosed through blood and urine testing. Additional laboratory tests are required, such as a reduction in hemoglobin, a loss of red blood cells, and a measurement of the lead levels in your blood and urine. As we all know, prevention is key to minimizing occupational diseases, which include the following:

- **The pre-placement screening:** Preplacement screening include a comprehensive assessment of the candidate prior to employment. A physical examination and standard tests, such as a chest x-ray, are part of it. The right task should be assigned based on the worker's physical and mental capabilities.
- **Education/Awareness on Health:** Workers who are susceptible to pneumoconiosis receive ongoing education regarding the dangers of breathing in dust. They obtain education regarding the risks associated with smoking as a contributing factor.
- The prevention of disorder also involves providing a healthy physical environment. In factories, proper housekeeping and enough ventilation are essential.
- Water sprays are used to prevent dust from forming at its source.
- It's also critical to prevent dust from escaping into the environment. At the very least, the escape in the atmosphere should be stopped if the dust production cannot be controlled.
- Bagassosis is controlled by spraying 2% propionic acid and limiting the moisture level to less than 20%. Special ventilator setups can also be used to eliminate dust. Particular protection; Masks and other safety gear can be used by employees.

- **Early detection and treatment:** In order to identify issues early on, employees should undergo routine medical exams, such as chest x-rays.
- **Limitations for disabilities:** Handicap limitation is the process of preventing a worker from becoming even more disabled by identifying their handicap at the smallest level and promptly moving them to another position. Rehabilitation is necessary for employees who have developed fibrosis and become disabled.

It is necessary to change jobs and further manage healthcare facilities in order to prevent more lead exposure.

4.2.3 Occupational Cancers

The most frequent malignancies brought on by work-related risks include those of the skin, lungs, blood-forming organs including bone marrow, bladder, etc.

- On the areas where carcinogens operate continuously, intensely, and for an extended period of time, cancer develops.
- After ten to fifteen years of continuous exposure, they become visible.
- They may also appear following the end of exposure.
- Males are more likely to have it than females.
- The tumor's location remains impressively consistent across all occupations.
- Occupation-related cancers occur far more frequently than cancers in general.
- The prevention of cancer greatly depends on maintaining good standards of personal hygiene.

4.3 Occupational Dermatitis

Dermatitis, eczema, folliculitis, urticarial, ulcers, and even skin cancer are among them. The following are the agent factors for occupational dermatomes:

- Physical agents: Radiation and heat
- Chemical agents: minerals such as arsenic, acids, alkalis, colours, solvents, grease, tar, and pitch

- Biological agents include bacteria, fungus, viruses, and some parasites.
- Plant products: Vegetables, fruits, leaves, flowers, and more.
- Sensitizing agents: These include formalin, pesticides, photo-developing chemicals, and others that cause allergies.

4.4 Industrial Accidents

The majority of industries frequently experience accidents. Indeed, several sectors of the economy—such as construction and the coal and other mining industries—are notorious for their mishaps. Numerous factors, including physiological, psychological, and physical ones, might contribute to accidents.

Industry accidents are also frequently caused by environmental conditions, such as dangerous machinery, noise pollution, bright lighting, and high temperatures.

4.5 Agricultural Workers' Occupational Hazards

As you are aware, almost 70% of our population reside in rural areas and work primarily in agriculture. The idea of occupational health in the agricultural sector is unique. The idea of occupational health in the agricultural sector is new. If you live in a remote region, you may have witnessed numerous accidents and health issues that are completely forgotten. Because of the assumption that occupational health is primarily a concern of industry, it is frequently forgotten that agricultural workers face a wide range of health issues. The majority of people in India live in rural regions and work in agriculture, thus they face challenges in this sector. Therefore, in addition to other occupational diseases, here you will also learn about the occupational diseases of agricultural workers.

Workers in agriculture are vulnerable to the following health hazards:

- **Zoonotic disorders:** Workers in agriculture frequently experience this because they interact with animals. Diseases including anthrax, brucellosis, leptospirosis, tetanus, and bovine tuberculosis are common among them.

- **Accidents:** Due to increased usage of agricultural machinery, accidents in the agricultural sector are occurring more frequently than in the past. In India, snake and insect bites are also an issue.
- **Toxic Hazards:** The use of chemicals as insecticides and fertilizers in agriculture is growing. These chemicals expose workers in agriculture to harmful risks.
- **Physical Hazards:** The health of agricultural laborers may suffer as a result of their exposure to extremes in temperature, humidity, and sun radiation.
- **Respiratory Diseases:** Lung ailments, particularly farmer's lung, are caused by exposure to dust from corn, husks, coconut fibers, tea, tobacco, cotton and other materials.

4.6 Prevention Strategies Occupational Hazards/Disorders

4.6.1 Primary Preventive Care

Pre-placement screening are part of primary prevention and are given to each employee before to their employment.

- A good physical environment is essential for a healthy workforce.
- The workspace should be constructed to be stress- and machine-stain-resistant. Appropriate ventilation and lighting are necessary. Workplace temperatures should be between 25°C and 27°C. Exhaust, the wet or oiling procedure, and other measures should be used to control the dust.
- Workplace cleanliness is crucial, and employees require a suitable water supply. Having clean drinking water is just as crucial. There should be one lavatory and urinal for every 50 employees, for every 25 employees.
- The provision of welfare services, such as a lunchroom, recreational facilities, family welfare services, childcare for working moms' children, and insurance facilities.

- Protecting against occupational dangers requires specific protection, such as personal protective equipment. Helmets, goggles, earplugs, respirators, and vaccinations against a variety of infectious diseases are examples of personal protective measures.

4.6.2 Secondary Preventive Care

Periodic testing, which include radiological and laboratory tests, are used to make early diagnoses.

As soon as the diagnosis is made, prompt therapy begins. When such a hazard is present, personal monitoring is crucial.

4.6.3 Tertiary Preventive Care

This involves the rehabilitation and limiting of impairments. Those who suffer an injury or accident that leaves them physically disabled while working receive special consideration. These individuals receive rehabilitation and an appropriate career to help them overcome their psychological trauma and become valuable members of their families, the nation, and themselves.

4.6.4 Legislative Measures

There are several laws were created in India to address the wellbeing of industrial workers i.e., Indian factories Act-1948, Family Pension and Deposit Linked Insurance Fund Act-1952, Mines Act-1952, Tea Plantation Act-1953, Minimum age Act, 1948, Maternity Benefit Act-1961, Laborer's Act, Industrial Dispute Act-1947, Employees Provident Fund Act, 1952, Employees State Insurance Act, 1923.

Employers are required to abide by these rules in order to protect the standards and safety of their employees. The Act gives the management of the Employee State Insurance program to an independent organization known as the ESI Corporation, which is chaired by the union minister for labour and directly under the labour ministry. There several benefits to the employees such as; Medical benefit, Sickness benefit, Maternity benefit, Disability benefit, Dependent's benefit, Funeral expenses and Rehabilitation Allowance etc.

4.6.5 Engineering Interventions or Measures

- It is important for building design to consider worker safety. The flooring, door and window heights, roof, and wall and ceiling heights should all be considered.
- An additional precaution in order to ensure health and safety is good housekeeping.
- **Enclosure:** Dust and fumes cannot escape into the manufacturing atmosphere if the hazardous material and process are enclosed.
- **Isolation:** To keep employees from coming into direct contact with dangerous materials, the offensive process is isolated in a different facility.
- **Local ventilation for exhaust:** Before escaping into the factory atmosphere, dust, fumes, and other harmful elements can be captured and removed at their source.
- **Safety apparatus:** Occupational dangers can be decreased by the use of protective gear, such as respirators, gas masks, earplugs, helmets, safety shoes, aprons, gloves, gum boots, barrier creams and goggles.
- **Environmental monitoring**: One crucial component of occupational health is environmental monitoring. Periodic environmental review is its primary goal.

4.7 Midlevel Healthcare Professionals Contribution to the Avoidance of Occupational Hazards

The initial point of contact for employees is the community health officer. They will not hesitate to consult a friendly, evaluable health care provider. The following is a summary of your role:

- The community health nurse, in coordination with other safety office team members, conducts workplace monitoring and identifies health risks. Determining whether a group of employees is experiencing a real or possible work-related illness or injury is helpful.

- Comprehensive programs or initiatives aimed at educating and controlling employees about possible health risks and preventative measures.
- Community health officers conduct environmental surveys and assess worker health risks as part of occupational health surveillance. Immunization for workers exposed to infectious biological agents is part of medical surveillance.
- A decrease in occupational disorders and injuries as a result of early workplace hazard identification. Create statistics to find noteworthy patterns in workplace injuries or disorders.
- Occupational health nurses also have a significant duty in order to encourage and protect health by changing the behavior of individuals and groups and motivating them to take ownership of issues that impact their health and are under their control.
- Improved well-being of employees by education on workplace risk factors. Knowledge of and proficiency with local resources are also important.
- In order to prevent complications, encourage healing, and ease rehabilitation for both occupational and non-occupational disorders and injuries, primary care refers to the collection of nursing interventions used to manage disease or functional difficulties in the workplace.
- Adequate care, referrals, and follow-up to enable a prompt return to work. It is necessary to document and report on every step.
- Offering constructive criticism while assisting staff members in resolving issues and making well-informed decisions is known as counselling. It is helpful in handling emergency situations. Maintaining confidentiality is important. One should be mindful of their legal commitments.
- Case management and rehabilitation: These can be related to or unrelated to the workplace. In the workplace and workplace culture, occupational health

nurses apply the knowledge they have learnt from research and epidemiological studies.

Summary

The modern era is moving towards the industrial revolution. Health issues are anticipated due to the industry's scale and complexity.

In the upcoming years, occupational health must become a higher priority. In India, we require comprehensive occupational health care.

In spite of the fact that there are numerous organizations working in the subject of occupational health, we also need to provide more comprehensive occupational health services to the scattered sector, which includes laborers, domestic helpers, and agricultural workers.

Terminal Questions

1. Enumerate occupational disorders.
2. List the health issues that affect agricultural workers.
3. List the steps taken to prevent pneumoconiosis.
4. Discuss the prevention strategies occupational hazards/disorders
5. What safety measures are in place against occupational dangers?
6. What is the Contribution of Midlevel Healthcare Professionals to the Avoidance of Occupational Hazards?

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Unit 5: Air-borne Bio-allergens

Unit Structure

5.0 Objectives

After reading this unit students should be able to:

- Elaborate allergy and airborne allergens
- Understand allergic reaction and symptoms
- Describe the causes of airborne allergies
- Understand the diagnosis and prevention of airborne allergies.

5.1 Introduction

In the previous unit of this block, we discussed about the conditions related to altitude illnesses and its management. In this unit, we will be discussing about allergy, Air-borne Bio-allergens, their types, distribution factors governing their availability, disorders, its intensity and Prevention of disorders

5.2 Allergy and Airborne Allergens

Therefore you must first know about the allergies. An allergy is a particular immunological response to a generally neutral substance that most people don't find irritating. Not every sneezing is a sign of a cold. An allergic reaction to something in the air can cause it at times. According to medical professionals, the majority of people experience symptoms of allergic reactions to airborne allergens, which are substances that cause allergic reactions, in the upper respiratory tract, which is the part of the body that refers to the mouth, throat, and nasal passages.

In some countries, pollen allergy, is one of the most common cause of chronic diseases. Airborne allergens are the leading cause of problems for allergy sufferers worldwide, and they frequently trigger the respiratory symptoms of asthma. People with allergies frequently have multiple substance sensitivities, and this unit outlines the causes, symptoms, diagnosis, treatment, and research efforts for those who suffer from these allergies. Pollens, microbes, fungal spores, food, latex rubber, insect venom, medications, and other substances are examples of allergens that can trigger allergic reactions.

5.3 Allergy-Sensitive Individuals

According to scientists, some people transmit one or both of their parents' tendency for allergies. This indicates that allergies are more probably to affect them. They most likely do not inherit a genetic tendency to be allergic towards a particular allergen, though. Allergies in one or both parents increase the probability that a child may develop allergies. Allergy development also appears to be influenced by exposure to allergens during periods when the immune system's capabilities are compromised, such as during pregnancy or following a viral infection.

5.4 Allergic Reaction

The immune system's primary role is to protect the body from infectious agents like viruses and bacteria. But in the majority of allergy reactions, the immune system's responses are reacting to a false signal. An allergic person's immune system starts for battle against the allergen when they first come into contact with it because they sense it as an enemy.

The immune system does this by generating large amounts of a type of antibody called immunoglobulin E, or IgE. Each IgE antibody is specific for one particular substance. In the case of pollen allergy, each antibody is specific for one type of pollen. For example, the immune system may produce one type of antibody to react against oak pollen and another against ragweed pollen.

The IgE molecules are unique because they are the only kind of antibody that strongly interacts to the body's basophils, lymph which are blood cells, and cells called mast cells, which are tissue cells. The allergen binds to the antibody like a key does to a lock when it next comes into contact with its particular IgE. Histamine and other powerful substances that promote inflammatory are released (and sometimes produced) by the cell to which the IgE is bound as a result of this activity. These substances create allergy symptoms by interacting with tissues in different body areas, including the respiratory system.

5.5 Allergy Symptoms

Many people are aware with the distinctive symptoms and indications of airborne allergies.

- Sneezing, frequently accompanied by a runny or blocked nose
- Coughing and postnasal flow
- Irritation in the throat, nose, and eyes
- Watering eyes
- **Conjunctivitis:** redness, itching, burning, and a feeling of something being in the eye.

- **Allergic Shiners:** A sign of eye allergies, allergic shiners appear as dark circles or discoloration behind the eyes and are sometimes accompanied by other allergy-related symptoms such as swelling, redness, and itching.
- **Allergic Salute:** A common sign of allergic rhinitis is the "allergic salute", which involves repeatedly wiping the tip of the nose with an upward palm motion to reduce itching. Children with allergies often show this act of affection.

Mucus in the nasal passages merely transports foreign particles to the throat, as well as where they are coughed or swallowed by non-allergic individuals. However, the individual who is highly reactive to airborne allergens, has a different situation.

In sensitive individuals, mast cells that exist in these tissues secrete histamine along with other substances as soon as the allergen hits the lining of the nose, initiating a series of events. Some cells that line some tiny blood arteries in the nose are contracted by the strong substances. The nasal passageways enlarge as a result of the fluids escaping, leading to nasal congestion. Additional symptoms of histamine include sneezing, irritation, itching, and excessive mucus production, all of which can lead to rhinitis caused by allergies.

Other chemicals released by mast cells, including cytokines and leukotrienes, also contribute to allergic symptoms. Some people with allergy develop asthma, which can be a very serious condition. The symptoms of asthma include Allergy symptoms are further aggravated by other substances that mast cells release, such as leukotrienes and cytokines. Some allergy sufferers get Asthma which is a potentially fatal illness. Shortness of breath, wheezing, and coughing are some of the warning symptoms of asthma. Excess mucus production, inflammation, and an enlargement of the lungs' airways are the causes of shortness of breath. In addition to being incapacitating, asthma can be dangerous. The airways are also becoming affected if allergy symptoms are accompanied by coughing and feeling short of breath.

5.6 Allergies due to Pollen

Trees, weeds, and grasses release microscopic pollen grains every spring, summer, and autumn. The air currents carry these tiny particles. Pollen is supposed to fertilize

sections of other plants, however many never make it to their destinations. Rather, pollen gets into people's throats and nostrils, causing pollen allergy, a form of allergic rhinitis that occurs during the year. This is commonly referred to as allergy symptoms.

Pollen is one of the most frequent environmental triggers for allergies. There are a lot of foods, medications, and animals that might cause allergies that can be avoided. Even dust inside the home and insects can be avoided. However, the only possible strategy to prevent airborne pollen is to stay indoors during high pollen counts, with windows closed, though even this may not be helpful.

In order to reproduce, plants create microscopic pollen grains that are too small to be seen with the naked eye. In certain species, the plant fertilizes itself with pollen from its own blossoms. It is necessary to cross-pollinate other kinds. Cross-pollination is the process by which pollen must move from one plant's flower to another of the same species in order for fertilization to occur and seeds to form. Some flowering plants are transported by insects, whereas other plants depend on the wind.

Plants without ostentatious blooms, such as trees, grasses, and weeds, produce the pollen kinds that most frequently trigger allergy reactions. Small, light, dry pollen grains that are specifically designed for wind transportation are produced by these plants. People frequently report having an allergy to aromatic or colorful flowers, such as roses. Actually, the only people who are likely to be sensitive to pollen from these plants are florists, gardeners, and others who deal with flowers on a regular basis. Since insects like bees and butterflies carry this kind of pollen rather than the wind, most people rarely come into contact with the big, heavy, waxy pollen grains of these flowering plants.

According to several research, a number of grasses in India, such as *Parthenium* (also called Congress grass or carrot grass) and *Cynodon dactylon* (Bermuda grass), are known to cause pollen allergies. According to Doubtnut, parthenium is especially well-known for being an invasive weed that generates a lot of pollen. *Eragrostis tenella, Pennisetum,* and *Cynodon dactylon* are more grasses that may cause allergies. Similarly birch, oak, cedar, gulmohar, and radhachura trees are among those that are known to cause pollen allergies in India. In addition, mesquite (vilayati bavad, Pahadi

Kikar), neem, peepal, and even some fruit trees including fig, plum, and apricot can trigger allergic reactions.

5.7 Mold Allergy

When allergic rhinitis can be brought on by inhaling small fungus spores or occasionally fragments of fungi. Mold spores can potentially enter the lungs because they are so small. For some people, consuming specific foods, such cheeses that have been treated with fungi, might trigger or exacerbate symptoms of mold allergies. Dried fruits, mushrooms, and meals that contain vinegar, soya sauce, or yeast might occasionally cause allergy symptoms. The family of fungi includes thousands of different kinds of molds and yeasts. Single cells called yeasts can divide to form clusters. The many cells that make up molds develop into branching threads known as hyphae. While both are likely to trigger allergic reactions, only a few molds are commonly known to be the culprits. Spores are the reproductive organs or seeds of fungi. The size, shape, and colour of spores vary depending on the type of mold. Millions of spores can be produced by the new mold growth that each spore that germinates can create.

5.7.1 Molds growth

Molds can grow anywhere there is oxygen, moisture, and a supply of the few additional substances they require. They thrive on decaying logs and fallen leaves in the autumn, particularly in damp, shaded spots. In gardens, they can be found on some grasses and weeds as well as in compost piles. Farms, grain bins, and silos are likely to have mold because certain molds cling to grains like wheat, oats, barley, and maize. Mold growth is most common in wet basements and closets, bathrooms (particularly shower stalls), fresh food storage areas, refrigerator drip trays, indoor plants, air conditioners, humidifiers, trash cans, mattresses, leather furniture, and old foam rubber pillows. In addition, molds enjoy greenhouses, barns, dairy facilities, breweries, and bakeries. Workers in moldy surroundings include loggers, mill workers, carpenters, furniture repairers, and upholsterers.

5.7.2 Molds that cause allergies

Mold spores, like pollens, are only significant airborne allergens if they are plentiful, move freely with air currents, and have an allergic chemical composition. In some

places, mold spores are so common that they frequently surpass pollens in the atmosphere. But luckily, there are just a few varieties that are serious allergies.

In general, the most common molds in the US, both indoors and outdoors, are *Alternaria* and *Cladosporium (Hormodendrum*). Additional common species include *Aspergillus, Penicillium, Helminthosporium, Epicoccum, Fusarium, Mucor, Rhizopus,* and *Aureobasidium (Pullularia).* However, an allergy to the mold-derived medication penicillin has nothing to do with a respiratory allergy to the mold Penicillium.

According to the Centers for Disease Control and Prevention (CDC), *Cladosporium, Penicillium,* and *Aspergillus* are among the most prevalent molds found inside in India. Additionally, these molds are regarded as allergenic, which means that certain people may experience allergic reactions to them. *Alternaria, Curvularia*, and Fusarium are other frequent molds that are especially common in Delhi.

5.7.3 Additional Mold-Related Disorders

Similar to allergic illnesses, fungi or organisms that interact with them can cause additional health issues. Certain Aspergillus species can result in a variety of ailments, such as allergies and infections. These fungi can grow into a compact spherical called a "fungus ball" after getting trapped in the airways or a remote area of the lung. Aspergillus can grab the chance to spread throughout the body or infect the lungs of individuals who have severe underlying diseases or lung injury.

Exposure to these fungi can also cause asthma in a few people or allergic bronchopulmonary aspergillosis, a lung condition that resembles severe chronic asthma. A low-grade fever, difficulty breathing, and the coughing up of mucus plugs or brown-flecked masses are the symptoms of this latter disease, which only affects a small percentage of asthmatics. Diagnosis can be established with the use of X-rays, skin tests, blood tests, and fungal sputum investigation. Typically, prescription steroids are beneficial in treating this reaction. Immunotherapies, such as allergy injections, are inefficient.

5.8 Allergy due to Dust Mites

All homes and workplaces contain dust, and dust mites are microscopic organisms that cause allergies. Microscopic mites are found in house dust and some furniture.

Perhaps the most frequent cause of chronic allergic rhinitis is dust mites. A house dust mite allergy can cause asthma symptoms in addition to symptoms that are typically comparable to those of a pollen allergy.

House dust mites grow in the summer and disappear in the winter. They reside in carpets, upholstered furniture, and bedrooms. However, they survive the coldest months when kept in a warm, humid home. Particles such as dead dust mites and their waste byproducts can be observed floating in a beam of sunshine.

Instead of being a single item, so-called house dust is a diverse blend of substances that may cause allergies. It could include fibers from several materials and fabric types, including: stuffing materials such as feathers and cotton lint; food particles; mold and fungal spores (particularly in moist spaces); dander from dogs, cats, and other pets; bacteria; plant and insect bites; and other allergens associated with a particular home or structure

In densely populated cities, cockroaches are frequently found. House dust also contains some of the same substances found in cockroach saliva and dung. Some people, particularly youngsters, may experience allergic responses or asthma symptoms as a result of these substances. For many people living in inner cities, cockroach allergens are probably a major contributing factor to asthma.

5.9 Animal Allergy

The most frequent cause of allergic reactions with animals is household pets. Many people believe that the fur of dogs and cats triggers pet allergies. However, scientists have discovered that saliva's antigens are the main allergens. When the animal eats its own fur, protein molecules stick to it. Enzymes that cause allergies can also be found in urine and skin. The proteins may float into the air once the material containing them dries. Although they spend more time indoors, near people, and lick themselves more than dogs, cats may be more vulnerable to allergic reactions.

As home pets, several rodents—like gerbils and guinea pigs—have grown in popularity. Like mice and rats, they can also trigger allergic reactions in certain individuals. The main source of these animals' allergies is their urine.

Animal allergies can develop over a period of two years and may not go away for at least six months after the animal contact has ended. It can take four to six weeks for pet allergens to stay in carpet and furnishings. After the animal has been eliminated. These allergies may continue to linger in the air of the home for months. Thus, it is advisable for those who are allergic to animals to enquire with the landlord or previous owner about the presence of furry creatures on the property.

5.10 Sensitivity to Chemicals

A wide range of synthetic and natural substances appear to cause these allergy-like reactions, according to some individuals who report reacting to chemicals in their surroundings. These compounds may consist of those that are found in: Paints, carpets, materials for plastics, cigarette smoke, fragrances, and plants Aroma. A true allergic reaction including IgE and the production of histamine or other chemicals is not represented by chemical sensitivity, even though the symptoms might look like those of allergies. It is a reaction to a chemical irritation rather than an allergen, and it may be more common in allergy sufferers.

5.11 Diagnosis of Allergy

When someone has allergy symptoms, like the nasal congestion of allergic rhinitis, they may initially think they have a cold, but the "cold" continues. The easiest approach to determine whether someone is allergic is to get them tested.

5.11.1 Skin Tests

To find out if a patient has IgE antibodies in their skin that react to a particular allergen, allergists—physicians who specialise in allergic diseases—use skin tests. Damaged samples from allergens like dust mites, pollens, or molds that are frequently present in the surrounding will be used by the allergist. Each allergen's extract is given to a tiny incision or scrape on the back or arm, or it is injected inside the skin.

One method of determining a person's IgE antibody level is by skin testing. If the reaction is positive, the test site will show a swelling, which is a small, increased, bright red spot, with a flare, which is a surrounding flush. A positive reaction does not always mean that a specific allergen is the source of symptoms, but the size of the swelling can provide the physician with an essential diagnostic hint. While such a reaction

suggests the presence of an IgE antibody to a particular allergen, it does not always lead to respiratory symptoms.

5.11.2 Blood Tests

The most accurate and affordable method of diagnosing allergies is through skin testing. However, this method should not be used to screen people with common skin problems like eczema. Other diagnostic procedures measure the amount of IgE antibodies to a specific allergen using a blood sample. The radio-allergosorbent test (RAST) is one such blood test that can be used when eczema is present or if a patient has taken medications that affect skin testing.

5.12 Prevention

5.12.1 Staying away from mold and pollen

To completely avoid allergic mold or pollen, one needs to go to an area where the harmful substance cannot establish itself and where the air does not contain it. A person who is sensitive to a particular mold or pollen may become allergic to new allergens after many exposures, so even this strong measure might only provide short-term comfort. People with ragweed allergies, for instance, to can move to places where ragweed is not found and then develop allergies to other weeds or even grasses or trees in their new environment. This strategy is discouraged by allergy specialists because moving is not a dependable cure. There are additional approaches for reducing exposure to pollens that cause problems.

- When the amount of pollen outside is at its peak, such as in the morning, stay indoors with the windows closed. In particular, sunny, windy days might be problematic.
- If working outdoors, wear a face mask that filters pollen from the air and prevents it from getting to your nasal passages.
- Plan your trip for when pollination is most likely to occur and pick a place where exposure to such factors is low.

5.12.2 Prevention from House Dust

There are following steps to prevent from the house dust:

- Make sure your bedroom is dust-proof if you have a dust mite allergy. Having these items in the bedroom is the worst.
- If you can, install washable area carpets over linoleum, tiles, or wooden floors instead of wall-to-wall carpets. Make sure to wash the rug covers routinely.
- Changing furniture to get remove of dust collectors and using new cleaning methods might contribute to decreasing the number of dust mites in your house. The key to efficient dust removal is frequently water.
- Frequently use water that is hotter than 130^{o} F to clean washable objects, such as throw carpets. Dust mites are not killed by lower temperatures.
- If you are not able or willing to set the water temperature in your home at 130^{o} F, wash washable items at a commercial facility that employs high water temperatures. (If the water temperature is higher than 120^{o} F, you run the risk of getting burned.)
- Use an oiled duster or a moist towel to dust frequently.

There are approaches for removing cockroaches from your house if they are an issue:

- Don't leave waste or food out.
- Food should be kept in sealed containers.
- Immediately clean up any food particles or liquid spills.
- Prior to applying pesticide sprays, try using poison baits, traps, or boric acid (for cockroaches). If you use sprays, avoid using them in places where food is prepared or stored.
- Avoid spraying in places where kids sleep or play.
- Just the infected region should receive the spray.
- Pay close attention to the label's instructions.
- When you spray, make sure there is an adequate supply of fresh air.
- When spraying, keep the individual who has asthma or allergies out of the room.

5.12.3 Prevention from Pets Allergens

Finding them a new home is the most effective way to prevent allergic reactions if you or your child are sensitive to furry pets, particularly cats. That can usually be not a desirable choice if you are like the majority of individuals who have strong attachments to their dogs. However, there are strategies to help minimize airborne animal allergen levels, which might minimize allergy reactions.

- Give your pet a weekly bath and brush it more often (a non-allergic person is supposed to do this)
- Pets should not be allowed in your bedroom.
- Get away of carpets and soft furnishings that gather allergies from animals.
- Make use of HEPA-filtered room air purifiers and vacuuming.
- Put on a face mask when cleaning the house and your pets.

5.12.4 Prevention from Chemicals Allergens

You should stay away from allergens like chemicals as much as possible because they might exacerbate the symptoms of airborne allergies. If you have a pollen allergy, stay away from excessive exposure to allergens like fresh paint or tar, smoking, pesticide sprays, and airborne pollutants when pollen levels are high.

5.12.5 Prevention through Air Conditioners and Filters

To help keep mold and pollen allergies out of your car or house, turn on air conditioners whenever you can. There are a number of fiberglass or electrically charged plate-based air-filtering systems that can help lower indoor allergies. Reduced exposure to animal allergies is also made possible by portable devices that can be utilized in separate rooms. There should be enough airflow to modify the room's air five or six times every hour. As a result, the size of the room should influence the filtration device's size and effectiveness. However, the flu, respiratory infections, and tuberculosis are examples of bacterial or viral illnesses that no air filter is able to prevent.

5.13 Treatment of Air-borne Allergies

- **Medications:** Your doctor may prescribe antihistamines and topical nasal steroids if you are unable to prevent airborne allergens to a sufficient degree. You can purchase over-the-counter medications that can alleviate allergy symptoms, but if they are ineffective or result in undesirable side effects like drowsiness, your doctor may prescribe both medications.
- **Antihistamines:** Antihistamines, as their name suggests, attempt to mitigate the effects of histamine that gets released by mast cells in the tissues of your body and plays a part in the symptoms of allergies. Antihistamines have long been effective in lowering nasal swelling and discharge, sneezing, and eye and nose itching. Sleepiness and a loss of attention along with coordination are among the adverse reactions that many antihistamine users experience. Children's reactions like these could be interpreted by adults as behavioral issues.

  There are prescription and over-the-counter antihistamines that have fewer of these adverse effects. While most of these non-sedating antihistamines do not make you sleepy, they are just as effective as other antihistamines at preventing histamine-induced symptoms.
- **Topical Nasal Steroids:** Anti-inflammatory medications that prevent allergic reactions are topical nasal steroids. They also lower nasal fluid accumulation and mucus output, as well as the number of mast cells in the nose, among other beneficial effects. For moderate or severe cases of a condition called allergic a combination of antihistamines and nasal steroids is a very effective treatment. When taken as prescribed, topical nasal steroids are safe, despite the possibility of side effects.
- **Nasal Spray:** Some people find that the nasal spray cromolyn sodium helps stop the development of allergic rhinitis in the nose. It can safely prevent the production of substances such as histamine from mast cells when used as a spray for the nose It significantly improves some people in managing their allergies and, when taken as prescribed, has minimal adverse effects.

Summary

Substances that trigger allergic reactions when inhaled are referred to as aeroallergens or airborne allergens. These allergens can cause symptoms like rhinitis, conjunctivitis, and asthma. They are usually proteins or glycoproteins that are released into the atmosphere. Dust mites, pollen, pet dander, fungus spores, and some industrial materials are common sources of airborne allergies.

Any airborne chemical that has the potential to cause an allergic reaction in vulnerable people is considered an airborne allergen. Usually, they are tiny enough proteins or glycoproteins to reach the respiratory system through inhalation.

Common sources of allergies in the air include: Plant pollen, particularly from grass, trees, and weeds, is a key contributor to seasonal allergies. Molds release spores of fungi that can trigger allergic reactions, particularly in people who are sensitive to mold. House dust mites are microscopic organisms that are often responsible for indoor allergies and grow in carpets, upholstery, and bedding. Airborne animal allergens, such cat dander, can cause allergic responses. Certain industrial materials, such as wood chip or cement dust, can also cause airborne allergies, particularly in work environments.

Allergens in the air can cause the immune system to create antibodies, which react with the allergen when inhaled. Inflammation of the respiratory tract brought on by this reaction may result in symptoms including runny nose, itchy eyes, sneezing, and trouble breathing.

A variety of allergic diseases, such as asthma, conjunctivitis, and allergic rhinitis (hay fever), can be brought on by airborne allergens. In addition to lowering quality of life, these illnesses might raise medical expenses.

The key to treating allergies is minimizing exposure to airborne allergens. This may entail taking precautions like utilizing air purifiers, cleaning bedding regularly, avoiding carpets and thick curtains, and keeping windows closed during periods of high pollen.

Terminal Questions

1. What do you understand from allergy?
2. Discuss about the airborne allergens.

3. What is allergic reaction?
4. Describe about the allergy symptoms.
5. Explain the different causes of airborne allergens.
6. Discuss the diagnosis and prevention of airborne allergies.

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Unit 06: Climate change and human disorders

Unit Structure

6.0 Learning Objectives

After the study of this unit, a learner would be able to:

- Know about the phenomena of climate change.
- Understand the various disorders caused by climate change to humans in tropical region.
- Understand the various disorders caused by climate change to humans in temperate and high-altitude region.
- Explain the different types of control measures to decrease the effectiveness of human disorders due to climate change.

6.1 Introduction

Climate change is a long-term shift in the temperature and average weather patterns of the earth's local, regional, and global climates, particularly due to the burning of fossil fuels, greenhouse effect, global warming, urbanization, and deforestation. Climate change is responsible for increase in CO_2 concentration, melting glaciers, rising sea levels, more severe droughts and hurricanes. In the year 1992, United Nation Conference on Environment and Development (UNCED) also known as 'Earth Summit' was held at Rio de Janeiro, Brazil, from June 3-14. The main aim of the conference

was to address the urgent issues related to environmental protection. It resulted in significant agreements, where countries agreed on official binding on the GHG emissions. United Nations Framework Convention on Climate Change (UNFCCC) is aimed at preventing global climate change and came into force on 21 March 1994. "The ultimate outcome is the stabilization of greenhouse gas concentrations in the atmosphere at a level within a time-frame sufficient to allow ecosystems to adapt naturally to climate change.

It is estimated that over the last 50 years, anthropogenic activities like burning of fossil fuels have released enough amount of carbon dioxide along with other greenhouse gases in order to trap additional heat in the lower atmosphere and influence the global climate. Reports ravels that in the last 100 years, the world has warmed by approximately 0.75 °C. Extreme weather events are more intense like high air temperatures directly increases risk of deaths from cardiovascular and respiratory disease. For instance, more than 70 000 deaths were recorded from excessive heat wave of summer 2003 in Europe. A high temperature ultimately increases the levels of ozone, pollutants and other aeroallergen in the air that intensify cardiovascular and respiratory disease. The ongoing temperature increases can also trigger asthma.

6.2 Climate change phenomenon

Climate change is a considerable global phenomenon determined by both natural (Changes in Earth's Orbit, Volcanic Activity, Sun's Activity) as well as human-induced factors. It is observed that from 1951 to 2010, the increase in global average surface temperature was mainly caused by the anthropogenic increase in Greenhouse gases (GHGs) emission. The atmospheric gases (GHGs) behave like glass walls of a greenhouse i.e., greenhouse is made up of glass walls, plants are grown in it under controlled climatic conditions. The glass walls are transparent to solar radiation and allowed to go into the greenhouse and do not allow the infrared radiation go out to space). Likewise, atmosphere is transparent to solar radiation, that reaches the earth surface and heat it but infrared radiation reflected or emitted by earth are not allowed by greenhouse gases to go out, thus trapped the heat, resulting in the warming of the atmosphere. This is called greenhouse effect. This increased heat leads to a warming of the Earth's surface. However, naturally earth has a greenhouse effect, where certain

already existing gases in the atmosphere trap some of the sun's heat, to keep the planet warm enough to support life.

Do you know, what are the sources of GHGs?

In recent time every sector of economy is responsible for these GHGs emissions. Four major GHGs are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O) and Fluorinated gases (mostly HFCs). Let us now discuss about their major sources of emission: Around 75% CO_2 originated from burning fossil fuels like coal, oil, and gas and about 20% from deforestation and decomposition of organic materials, peat lands, crop residues etc. The major sources of Methane (CH_4) emission are livestock, particularly cattle and sheep (25%), rice cultivation (12%), coal production (10%), and decomposition of organic waste in waste water treatment (9%) etc. Nitrous Oxide (N_2O) mainly comes from fertilized grasslands and croplands. Fluorinated Gases mostly Hydrofluorocarbons (HFCs) emitted from air conditioners in cars and refrigerators.

Self-Assessment 1

1. Which of the following statement best explains why climate change poses a multifaceted threat to global health and stability?

A) It leads to an increase in natural disasters like earthquakes and volcanic eruptions.

B) It only disrupts weather cycles, without significantly affecting human health.

C) It causes a rise in sea levels, droughts, and extreme temperatures, which in turn intensify health risks like cardiovascular and respiratory diseases.

D) It primarily affects wildlife and has minimal direct impact on human society.

2. What underlying principle makes greenhouse gases responsible for the Earth's warming, as per the greenhouse effect?

A) Greenhouse gases directly emit heat into the atmosphere.

B) Greenhouse gases allow sunlight to pass through but prevent the escape of infrared radiation.

C) Greenhouse gases cool the Earth’s surface by reflecting solar radiation.

D) Greenhouse gases work like insulation, absorbing and blocking all forms of radiation.

3. The 1992 Earth Summit in Rio de Janeiro marked a fundamental moment in global environmental governance primarily because:

A) It led to the immediate ban of all fossil fuel usage worldwide.

B) It emphasized that climate change was a hoax created by industrialized countries.

C) It resulted in formal international agreements on binding limits for greenhouse gas emissions.

D) It declared climate change solely a problem of future generations.

4. Which of the following accurately captures the relationship between urbanization and climate change?

A) Urbanization reduces GHG emissions through technological innovations.

B) Urbanization is a direct cause of the depletion of the ozone layer.

C) Urbanization contributes to climate change through increased energy consumption and deforestation.

D) Urbanization helps cool the atmosphere by promoting green infrastructure.

6.3 Impacts of climate change on human health

Since last hundred years, human activity made several far-reaching changes in the structure and functions of natural systems of the Earth. Climate change unexpectedly harming human health especially true in tropical and subtropical regions that are mostly facing direct intensity, frequency, along with extreme weather conditions such as drought, hurricanes etc. Almost, all countries situated in the tropical region have fewer resources to acclimatize to the impacts of climate change.

Severe changes in world climate directly influence the functioning of many ecosystems as well as the biological health of plants, animals and other creatures. Similarly, there would be serious health impacts on human populations. Societal development and economic growth increase sequential series of environmental hazards.

The extent of environmental health problems due to climate change has expanded from indoor air pollution of a household to urban air pollution of a community, after that to regional acid rain up to global level. The adverse impacts on human health would greatly vary geographically due to both environment, topographical and susceptibility of the local community. However, impacts may be positive and negative, but scientists

mostly predict negative impacts. Climatic changes defiantly disrupt or alter a verity of natural, ecological and physical systems of Earth.

Climate change is considered as a serious threat to human health. Along with physical and biological environment including both natural and human systems, it also influences the social and economic conditions as well as the functioning of health systems. As climatic conditions change, more frequent weather and climate events are observed including exposure to extreme weather conditions like heat waves, very cold winter, droughts, floods, wildfires, cyclones. These all events impose direct impacts on health. These extreme weather and climate hazards directly or indirectly, raising the risk of non-communicable diseases, health emergencies, the emergence and spread of infectious diseases and untimely deaths.

The increasing stresses such as changing precipitation patterns and temperature degrade the environmental as well as the physical and mental health. Even all aspects of health are influenced by climate change, from the food we eat, the water we drink, the clean air we breathe, the weather we experience and soil to food systems and livelihoods. Further postponement in tackling climate change will increase health risks and disregard our joint commitments to make certain human right to health for all.

According to the 6th Assessment Report of the Intergovernmental Panel on Climate Change's (IPCC), the climate risks are increasing faster and soon will become more severe than previously estimated, and it will be harder to adjust with increased global heating. It further explains that around 3.6 billion people already living in highly susceptible areas to climate change. Instead of contributing less to global emissions, the low-income countries and small island developing states (SIDS) tolerate the harshest health impacts. In susceptible regions, the extreme weather conditions impose fifteen times higher death rate than in less susceptible ones.

Climate change is impacting health in a variety of ways comprising heat waves, storms and floods, the disturbance in food systems, increases food, water and vector-borne disease. These health risks are excessively most vulnerable to women, children, poor communities, migrants, ethnic minorities, displaced persons and older populations.

Self-Assessment 2

1. What key reason explains why low-income countries and Small Island Developing States (SIDS) suffer more from climate change impacts?

A) They have fewer resources to adapt and are geographically more exposed.

B) They lack biodiversity and natural ecosystems.

C) They contribute the most to global emissions.

D) They refuse to implement climate policies.

2. According to the 6th IPCC Assessment Report, what alarming trend is highlighted about climate risks?

A) Climate risks are stabilizing in most parts of the world.

B) Climate risks are becoming less harmful with new technologies.

C) Climate risks are accelerating and becoming more severe than earlier predicted.

D) Climate risks only impact physical infrastructure, not health.

3. How does climate change affect human health, as outlined in the passage?

A) Only through increased radiation from the sun.

B) Through political instability and financial losses.

C) By promoting healthier lifestyles in vulnerable areas.

D) By causing extreme weather, disrupting food systems, and increasing disease spread.

4. What factor does *not* directly contribute to geographic variation in climate-related health impacts?

A) Soil acidity

B) Local community's susceptibility

C) Topography

D) Environmental conditions

6.3.1 Disorders caused by climate change to humans in tropical and sub-tropical regions

Human populations in tropical and subtropical climates are constantly exposed to high temperatures. Climate change adversely impacts human health in tropical and subtropical regions via increased risks of waterborne diarrheal diseases, vector-borne diseases like malaria and dengue, heat stress, heatstroke, mental health and malnutrition. Specifically, changing temperatures and rainfall patterns is responsible for

the spread of diseases like dengue, malaria, and chikungunya. Specific health issues due to climate change are given below:

1. **Heatstroke and heat-related illnesses**

Human body temperature is maintained between 36.5–37.5°C at normal physiological conditions. Increasing body temperature activates the autonomic nervous system causing increased sweating to allow dissipation of heat. A warmer temperature is responsible for more frequent, intense, and longer heat waves. This will ultimately lead to an increase in heat-related deaths especially during summer months. Extreme heat can lead to heat stroke and dehydration, as well as other cardiovascular and respiratory disease. Outdoor workers, athletes, and people without home tend to be more exposed to extreme heat. Even heat exhaustion is a prolonged exposure to heat can lead to nausea, dizziness and muscle cramps.

Global climate change is the most difficult natural disaster causing extreme heat waves events. According to the Economic Survey of Asia, it is expected that the world temperature is climb up to 1.5°C until 2050, which is now increasing at a speed of 2°C per century. Heat exhaustion and heat stroke are the most frequent weather-related deaths. When, our body temperature reached as high as 40 °C, caused by a breakdown in thermoregulation, ultimately results in neurological dysfunction ranging from gentle cognitive injury to coma. The main causes of heat stroke including destruction of the green belt mainly due to infrastructure, deforestation, greenhouse gasses, pollution etc. (Islam and Hamit, 2023). Various impacts of climate change are shown in figure 1.

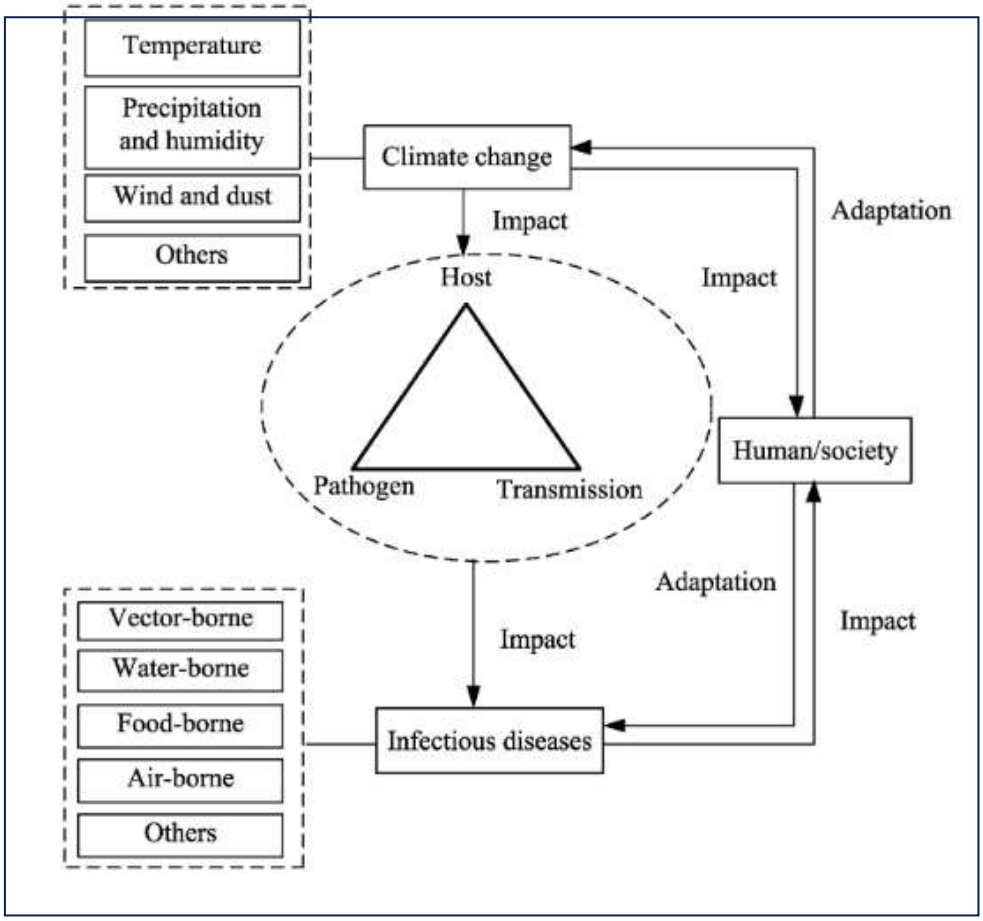

Figure 1. Impact of climate change on human society (Source: Wu et al., 2016)

2. Respiratory diseases

Climate changes badly affected the Indoors and outdoors quality, which can lead to serious health issues in humans like asthma attacks and other respiratory and cardiovascular problems. Wildfires also increase the temperature, unhealthy air pollutants and create smoke and other. Warmer temperatures also accelerate ozone at ground level, which are a harmful air pollutant and a component in smog also. A higher level of ozone at ground level increases the risk of premature dying, respiratory problems, reduce lung function, asthma and other chronic lung diseases. Smog decreases visibility and can be harmful to human health. Particulate matters are extremely fine particles and liquid droplets in the atmosphere. Some particulate matter such as dust, wildfire smoke is created by anthropogenic activities including burning of fossil fuels. These fine particles can lead to adverse health effects, including lung cancer and cardiovascular disease. Climate changes also affect allergies for example the spring pollen season occurring earlier and the length of the season has increased for some plants with. In addition to this, rising carbon dioxide concentrations and

temperatures may also lead to earlier flowering and increased pollen levels in some plants. It is observed that elevated carbon dioxide concentrations cause earlier start of the pollen season, enhanced photosynthesis and reproductive effects and produce more pollen, increases plant leaf biomass increased fungal spore production. Pollen and fungal spores are potential asthma trigger and causes other allergic respiratory diseases. Evan, Extreme heat and high humidity trigger asthma symptoms (Amato et al., 2014).

Climate change imposes a direct threat to respiratory health similarly; it affects air, weather and water quality at local, national and international level. In the year 2003, around 40,000 deaths happen across Europe as a result of rapid rise in the number of hot days, mostly due to cardiopulmonary causes. As an effect of a deterioration of the polar ice packs, the sea levels also started to rise. Heat waves and melting ice together have led to water deficiency in many areas. However, extreme climatic variations also responsible for more severe winters that is also a potential danger for respiratory health.

3. Vector-borne diseases

The temperatures in tropical regions are creeping nearer to the thermal limits of many organisms. Warming and climate change, changes precipitation with increased flooding in some areas and drought in others, while developing best suitable background for vector-borne diseases by effecting the pathogens, vectors, and hosts, as well as ability to prevent and treat these diseases. Warming temperatures affect the behavior, abundance, life history and physiologic characteristics of vectors and pathogens.

Climate changes increases the geographic range of diseases and vectors. Vector-borne diseases are transmitted by disease vectors including mosquitoes, ticks, and fleas. Vectors carry infectious viruses, bacteria, and protozoa, from animals to humans. Malaria, Dengue, Chikungunya are the primary diseases of tropical and subtropical regions. Recent scenario of climate change increases the cases of dengue and chikungunya due to extension of the geographic range and transmission seasons. Warm temperatures build more favorable breeding environment for vectors and also increased the risk of transmission. Mosquitoes thrives best in certain climate conditions for example too cold, hot, wet, or dry weather influence the location and number of mosquitoes. Climate change can also lead to the spread of diseases into areas where

they were previously uncommon, as in case of dengue and chikungunya. Climate changes also affect the spread of other vector-borne diseases, like leishmaniasis, lymphatic filariasis, zika fever, and tick-borne diseases. Some vector-borne diseases are explained below:

i. Dengue

In recent decades, the most common mosquito-borne viral disease worldwide has stretched considerably as a reaction of declining vector-control programs and growing rate of global trade and travel. Dengue virus are transmitted to humans by infected female mosquitoes, the primary reservoir host most commonly *Aedes aegypti*. Water-storage and rainwater-filled containers are the most favorable mosquito breeding sites. The major cause of expansion of these vectors is predicted to be climate change and differential ability of *A. aegypti* to survive normally lethal temperatures.

ii. Malaria

Malaria caused by plasmodium species and transmitted between humans by infected female anopheles, is one of the deadliest and climate-sensitive vectors-borne disease. Malaria is a seasonal epidemic in response to changes in temperature, rainfall and humidity of a region. However, the effects of climate change on local livelihoods and food security, may increase population susceptibility to the disease and weaken the effectiveness of control strategies. Due to global warming, the United States experienced malaria outbreaks. Countries like Azerbaijan, Tajikistan and Turkey are prone to mosquito-borne malaria.

iii. West Nile

West Nile virus causes a fatal neuro-invasive disease in humans and animals worldwide. West Nile virus was first identified in in 1999 in the New York City of the United States. It is the leading cause of mosquito-borne disease. Nearly 7 million persons were infected during the period from 1999 to 2016. Humans and horses, can be incidentally infected, human infections can cause life-threatening illness in rare cases, mostly in older adults and in immune-compromised persons.

iv. Lyme Disease

Lyme disease is the most common tick-borne illness worldwide, mice, squirrels, lizards, and birds are part of this disease; however, humans play no role in ongoing spread. The life cycle strongly influenced by the ambient air temperature and

abundance of reservoir hosts. During the period, 2010 to 2018, around 470,000 cases of Lyme disease were diagnosed and treated in the United States as compared with the period from 2005 to 2010 with 329,000 cases. However extended summer season resulting from climate change also contributes to the increases in cases of increased human tick interaction. Warm temperatures found to be associated with the extension of ticks into Canada and Norway (Thomson and Stanberry, 2022).

4. Waterborne Diseases

Climate change also can increase the frequency of waterborne diseases like cholera, giardiasis, and salmonellosis. Extreme weather events, like floods, increasing temperature, heavy rains and runoff increases the risk of illness because peoples are exposed to contaminated drinking water. Water-borne illness includes gastrointestinal illness like diarrhea, and liver and kidney damage also. Changing water temperatures increases the harmful algal toxins in water and seafood at places where they were not found previously as a threat.

5. Food Insecurity and malnutrition

In recent time, climate change affects the production of food, leading to malnutrition, and food insecurity. High temperatures can increase cases of bacteria-related food poisoning because warm environments promote the growth of bacteria more rapidly, which cause gastrointestinal discomfort. Extreme events, such as flooding and drought, create challenges for food distribution if roads and waterways are damaged or made inaccessible.

6. Mental Health related issue

Changes in physical health and neighboring environment can also causes serious impacts on the mental health of a person. The increasing extreme weather events like droughts, floods, and others due to climate change can trigger major depressive disorder (MDD), post-traumatic stress disorder (PTSD), substance abuse, anxiety, vicarious trauma, depression, survivor's guilt, complicated grief, suicidal ideation and recovery fatigue. Climate changes can change agricultural conditions, change natural landscapes, weaken infrastructure, disrupt food and water resources, change land use and habitat displacement give rise to financial and relationship stress, amplified risks of aggression and violence and lead to the dislocation of whole communities. Globally, based on a 10-year organized analysis from 1990 to 2010, it was found that mental

illness comprises 7.8% of the worldwide load of disease. People taking medication for mental illness and unable to maintain their body temperature are particularly at high risk.

According to WHO (2007) report, it is estimates that climate change is responsible for at least 150,000 deaths per year and this number will be double by 2030. UN report also concluded that over one billion people are affected by climate change related tropical diseases (WHO, 2007)

6.3.2 Disorders caused by climate change to humans in temperate regions

Disorders caused by Climate change in temperate regions are almost similar to tropical regions including increased risks of infectious diseases, heat-related illnesses, and mental health problems. Research highlights that around 3.6 billion peoples are living in climate change susceptible areas. It is also estimated that between 2030 and 2050, climate change cause approximately 250 000 deaths per year, from malaria, diarrhea, malnutrition, and heat stress alone (WHO, 2023).

6.3.3 Disorders caused by climate change to humans in high elevation regions

In high-elevation there is an increased risk of altitude sickness (happen in high elevation due to low level of oxygen), increased exposure to extreme temperatures (both hot and cold), and similar health disorders including heat-stroke, heat exhaustion**,** malaria, dengue fever**,** expansion of vector-borne diseases, anxiety, depression, water scarcity, respiratory and cardiovascular impacts on human health. In summary, climate change imposes an all-round threat to human health in high-elevation regions. One of the major problems in high altitude is altitude sickness.

High-altitude Sickness

Due to Low air pressure and oxygen levels at high altitudes causes altitude sickness, also known as acute mountain sickness (AMS). It is a harmful effect of high altitude and different people respond differently depends on their body. Headaches, tiredness, vomiting, trouble sleeping, confusion, and dizziness are the symptoms of altitude sickness. As temperatures rise, individuals may be exposed to extreme heat at higher altitudes and changes in pressure and air density can also lead this sickness. High-elevation regions can experience both increased heat stress due to rising temperatures and potential for more severe cold spells, impacting health and well-being. Acute

mountain sickness can lead to high-altitude pulmonary edema (HAPE) and high-altitude cerebral edema (HACE), while chronic mountain sickness may happen after long-term exposure to high altitude.

Self-Assessment 3

1: Match the diseases with their transmission sources

Column A	Column B
A. Malaria	1. Ticks
B. Lyme Disease	2. Contaminated water
C. Cholera	3. *Anopheles* mosquito
D. Dengue	4. *Aedes* mosquito

2: Match health issues with contributing climatic factors

Column A	Column B
A. Respiratory problems	1. Ground-level ozone and smog
B. Waterborne diseases	2. Flooding and poor sanitation
C. Vector-borne disease spread	3. Changing rainfall and temperatures
D. Heat-related illness	4. Frequent heat-waves

3: Match symptoms with the health disorder

Column A	Column B
A. Nausea and dizziness	1. Climate-induced mental disorders
B. Confusion and coma	2. Asthma
C. Coughing and short breath	3. Heatstroke
D. Anxiety and PTSD	4. Heat exhaustion

4: Assertion (A): Climate change is increasing the frequency and intensity of vector borne diseases like malaria and dengue.

Reason (R): Warmer temperatures expand the habitat range of disease-carrying mosquitoes and prolong their breeding seasons.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

5: Assertion (A): Mental health issues such as PTSD, anxiety, and depression have no connection to climate change.

Reason (R): Climate change affects only physical health, such as respiratory or heat-related illnesses.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is false, but R is true.

D. Both A and R are false.

6.4 Control of disorder

While considering the health impacts of climate change on human population, we can suggest some controlling measures through a number of adaptation and mitigation strategies. Adaptation focuses on minimizing the undesirable health effects while; mitigation includes reduction in the emissions of greenhouse gases.

6.4.1 Adaptation

i. Strengthen our health systems

Investment in the field of health infrastructure, access to vital healthcare services and guidance to healthcare professionals will defiantly help to better manage the health effects of climate change.

ii. Improve early warning systems

There is an urgent requirement to development of a strong infrastructure for timely and accurate early warning declarations, along with improving monitoring, forecasting and communication strategies to combat with climate-related hazards.

iii. Development of climate-resilient infrastructure

Construction of infrastructure that are resistant to climate-related hazards can possibly reduce vulnerability to extreme weather events.

iv. Protect susceptible populations

Targeting susceptible populations including elderly, children, and those suffering with pre-existing health conditions, is crucial for developing efficient adaptation strategies.

v. Promote public awareness

Public awareness about the health impacts of climate change and the important safety measures is essential for developing efficient adaptation strategies. For example; Development of cooling centers, proper ventilation in buildings, indoor stay, proper hydration and public education campaigns about the dangers of heat exposure play important roles to mitigate heat-waves. Patients can be quickly cooled with cold packs and hydration. Keeping in mind the degree of severity of the situation, governments must act quickly and decisively to improve the threat that global warming poses to public health, including heat stroke.

Flood prevention measures can be developed by strengthening drainage systems. Likewise, improvement in flood forecasting can better help to reduce the risk of flood. Various vector control measures like mosquito netting, insecticide spray and apply mosquito repellent, will reduce the risk of vector-borne diseases like malaria, Chikungunya and dengue fever.

vi. Food and water insecurity

Development of sustainable agricultural practices by promoting high yielding and resistant crop varieties, diversifying food sources, introduction of latest agricultural technologies and ensuring access to clean water will reduce the health risks associated with food and water insecurity.

vii. Capacity building

WHO works to build capacity at global level in countries to address the health impacts of climate change and to promote health while reducing greenhouse gas and carbon emissions?

6.4.2 Mitigation

i. Reduction in greenhouse gas emissions

We should move towards the renewable energy sources, also by improving energy effectiveness, and implementation of sustainable transportation and agricultural practices.

ii. Adopt healthy lifestyles

Encourage physical activities as well as healthy diets in order to improve overall health.

iii. Ecosystem's conservation

Healthy ecosystems play a significant role in mitigating climate change. It provides a number of ecosystem services, including provisional (food, water, timber and other non-timber forest products), regulating (air and water purification, regulation of climate), supporting (nutrient cycling) and cultural (spiritual and esthetic) services.

Summary

- Climate change is a long-term shift in the temperature and average weather patterns of the earth's local, regional, and global climates.
- Major reasons of climate change are burning of fossil fuels, greenhouse effect, global warming, urbanization, and deforestation.
- Climate change unexpectedly harming human health especially true in tropical and subtropical regions that are mostly facing direct intensity, frequency, along with extreme weather conditions such as drought, hurricanes etc.
- The extent of environmental health problems due to climate change has expanded from indoor air pollution of a household to urban air pollution of a community, after that to regional acid rain up to global level.
- The increasing stresses such as changing precipitation patterns and temperature degrade the environmental as well as the physical and mental health.
- A warmer temperature is responsible for more frequent, intense, and longer heat waves. This will ultimately lead to an increase in heat-related deaths especially during summer months.
- Extreme heat can lead to heat stroke and dehydration, as well as other cardiovascular and respiratory disease.

- Climate changes badly affected the Indoors and outdoors quality, which can lead to serious health issues in humans like asthma attacks and other respiratory and cardiovascular problems.
- Warming and climate change, changes precipitation with increased flooding in some areas and drought in others, while developing best suitable background for vector-borne diseases
- As temperatures rise, individuals may be exposed to extreme heat at higher altitudes. Changes in pressure and air density can also lead this high-altitude sickness.
- Adaptation and mitigation strategies can be helpful in controlling health impacts of climate change on human population. Adaptation focuses on minimizing the undesirable health effects while; mitigation includes reduction in the emissions of greenhouse gases.

Terminal Questions

1. What is climate change phenomenon and describe its impacts on human health?

2. Explain various disorders caused by climate change to humans in tropical and sub-tropical regions?

3. List some disorders caused by climate change to humans in high altitude regions?

4. Describe various control methods to reduce the effect of climate change on human beings?

Answer Keys

Self -Assessment 1:

1-C, 2-B, 3-C, 4-C

Self -Assessment 2:

1-A, 2-C, 3-D, 4-A

Self -Assessment 3:

1. A–3, B–1, C–2, D–4, 2. A–1, B–2, C–3, D–4, 3. A–4, B–3, C–2, D–1, 4. 5. D

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Unit 7: Chemical-induced Human Disorders

Unit Structure

7.0 Learning Objectives

After going through this unit, you shall be able to:

- Understand about the chemical induced human disorders
- Mechanism of disorders
- Disorders caused by various toxic agents.

7.1 Introduction

Chemical-induced disorders in humans cover a wide range of health conditions caused by exposure to various chemicals, both manmade and natural. These problems can result from acute or chronic exposure and affect many organ systems, causing ailments ranging from respiratory infections to cancer. Understanding the toxicity processes and unique health effects of various substances is critical for developing prevention and management methods.

Mechanisms of Chemical Toxicity

Chemicals can cause toxicity via several mechanisms:

Oxidative Stress: Many chemicals produce reactive oxygen species (ROS), which causes cellular damage, inflammation, and DNA mutations.

Endocrine Disruption: Certain substances disrupt hormone systems, influencing reproductive health, development, and metabolism.

Neurotoxicity: Neurotoxicity occurs when some substances affect the nervous system, resulting in cognitive deficiencies, neuro developmental abnormalities, and neuro-degenerative illnesses.

Carcinogenesis: Long-term exposure to some chemicals can cause genetic mutations and disrupt cell development regulation.

7.2 The chemicals as environmental factors

Chemicals are present in all laboratories. It is good to consider all chemicals toxic and flammable unless one has definite information regarding its nature. Our body also contains number of chemicals but these are very delicately controlled in terms of their nature, amount and action. Every chemical whether required in the body or not becomes harmful at a certain concentration in the body. Ideally speaking no chemical can be considered totally safe or hazard free. The nature and extent of hazard varies and more so the long-time effects of many chemicals are not known. One is advised to exercise caution

in handling all chemicals and minimize exposure to them.

In a laboratory, human interaction with chemicals can occur in three different ways. They are:

1. Direct contact through spills or inappropriate handling

2. Inhalation of vapours, fumes, or dust.

3. Ingestion (oral route)

Apart from this, we can sometimes be affected indirectly. For example, in the event of an explosion, one may sustain physical injuries, such as a fracture. On the other hand, highly flammable substances can catch fire and cause serious burns.

- ✓ A laboratory worker's primary responsibilities include the storage and handling of chemical compounds. Both require sufficient safety precautions to avoid an accident. This section focusses on the storage and handling components of hazard control.
- ✓ Hazardous materials provided to the workplace must be marked in compliance with the Indian Motor Vehicles Rules 1988. The Bureau of Indian Standards (formerly known as the Indian Standards Institution) also recommends the classification and labelling of hazardous compounds in accordance with these guidelines; the system is an adaption of an internationally accepted approach.

7.3 Identification of Hazardous Chemicals

The UN Committee of Experts on the Transport of Dangerous Goods' classification of chemical hazards has been extensively used for the conveyance of hazardous chemicals via all means of transportation. Hazard types are classified into nine primary classifications, denoted numerically from 1 to 9. Many of these categories are further classified as divisions and subdivisions (Fig. 1).

With the exception of class 9, each United Nations hazard class has a unique diamond-shaped label with a symbol for easy identification. Figure 1 shows a colour scheme for all classes and subclasses.

Each label has a distinctive background colour. These colours represent the nature of several chemical substances, as listed below.

Colour	Nature
Orange	Explosives.
Red:	flammable
blue:	water-reactive
Yellow	Oxidizer
White	Toxic or infectious
White or yellow and white	Radioactive
Black and white	corrosive

Class-1: Explosives

These include commercial explosives, preparations and compounds used as blasting agents, ammunition, and fireworks. Examples include gun powder, chlorate mixtures, nitrate mixtures, nitro compounds, fulminates, ammunition, fireworks, detonators, gels, and so on.

Class- 2: Gases

A substance is categorised as a gas if its critical temperature is less than 50°C and its vapour temperature exceeds 3 bars absolute pressure (very volatile). Gases are classified into three subclasses based on their harmful character.

i) Flammable gases, such as acetylene and LPG.

ii) Toxic gases, such as chlorine and Sulphur dioxide.

iii) Nonflammable, harmless gases such as carbon dioxide, nitrogen, etc.

Class -3: Flammable liquids. Radiation and Chemical Hazards

The words flammable and inflammable have the same meaning. Flammable liquids are liquids, combinations of liquids, or liquids containing particles in suspensions or solutions that emit flammable vapour at temperatures no higher than 60.5"C. combustible liquids include petrol, alcohol, petroleum, naphtha, hexane, benzene, and toluene.

Class -4: Flammable Solids

Combustible solids are substances that are combustible, prone to spontaneous combustion, or produce flammable gases when in contact with water. Examples include camphor, cinema films, hay and straw, phosphorus, triethyl aluminium, sodium sulphide, alkali metals, alkali amalgams, uncoated aluminium powder, and so on.

Class -5: Oxidizing Substances

It contains oxidising agents and organic peroxides. Oxidising compounds contribute to the burning of other substances, as they are not combustible on their own. Organic peroxides (with a 0-0 bond) decompose thermally, resulting in an explosion and/or rapid burning. Examples include potassium permanganate, potassium dichromate, hydrogen peroxide, peracetic acid, and acetyl peroxide.

Class- 6: Poisonous and infectious substances.

These are the compounds that, if swallowed, inhaled, or come into touch with the skin, can cause death or serious injury. Infectious substances are those polluted with disease-causing microorganisms. Poisonous compounds include insecticides, tetraethyllead, and a variety of medications. Contaminated hospital wastes, disease strains, and so on are all deemed infectious.

Class-7: Radioactive Substances

Radium, uranium, and thorium are only a few examples.

Class- 8: Corrosive Substances

These compounds produce significant chemical harm when in touch with live tissue or, in the event of a leak, destroy or damage other materials. This class includes mineral acids such as hydrochloric and sulphuric acid, as well as sodium hydroxide.

Class- 9: Miscellaneous Dangerous Substances

Flammable substances are those that catch fire when exposed to air without the application of energy, easily catch fire after brief contact with an ignition source, or produce highly flammable gases when in contact with water or moist air.

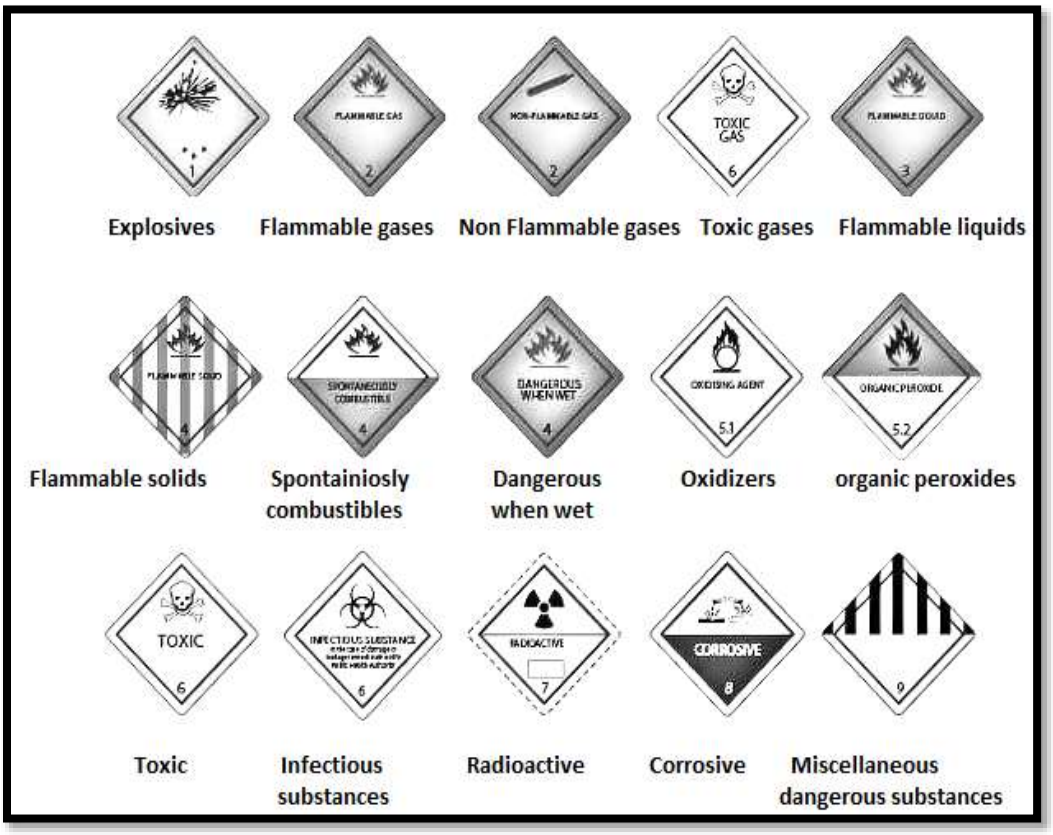
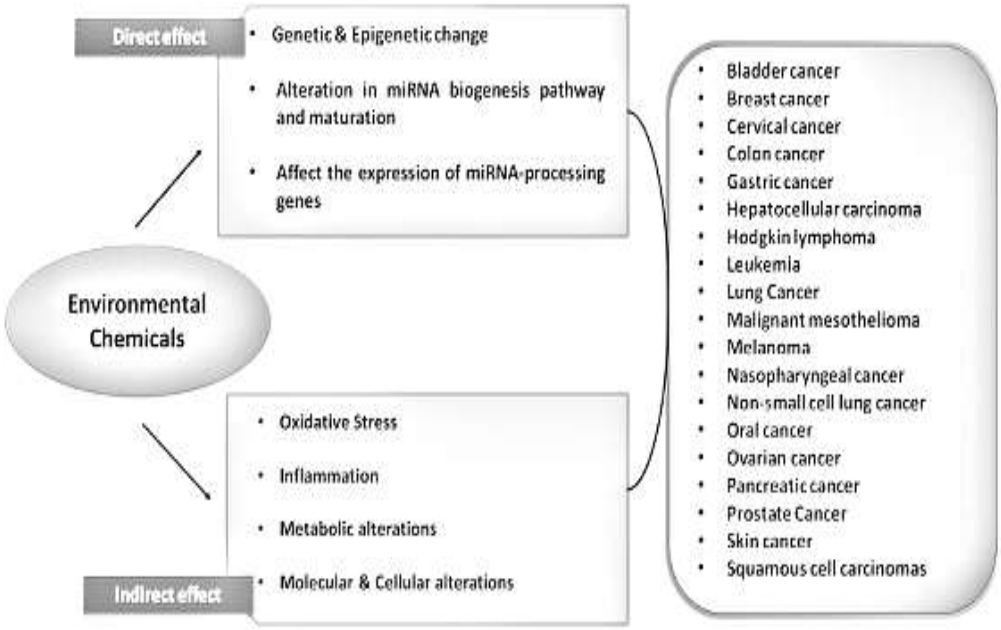


Fig 1. UN Hazard class symbols on transportation of hazardous goods

In addition to the identified classifications of harmful substances mentioned above, there is another class of chemicals and radiation known as carcinogens. These are the chemicals that lead to cancer. Many drugs have the ability to cause cancer months or years after the original exposure. Aniline, chloroform, benzyl chloride, lead and zinc chromates, hydrazine, and other chemicals are recognised or suspected carcinogens. Although it hasn't been proven, ninhydrin, the reagent used in biological and biochemical testing to detect the presence of proteins and amino acids, is likewise suspected of being carcinogenic. Similar to this, some stains, such as fuchsin, which is employed in biology labs, fall into this category and should be used with extreme caution. Toxic metals such as lead, mercury, arsenic, and cadmium can have severe adverse effects on human health. These metals can enter the body through contaminated food, water, air, or occupational exposure. Once inside, they accumulate in organs like the liver, kidneys, and brain, disrupting normal biological functions.



Health impacts vary depending on the metal and level of exposure. Lead can impair brain development in children, causing learning and behavioral problems. Mercury affects the nervous system and is particularly dangerous during fetal development. Arsenic exposure is linked to skin lesions, cancer, and cardiovascular diseases. Cadmium can damage kidneys and weaken bones.

Chronic exposure, even at low levels, may lead to long-term health issues. Therefore, minimizing environmental and occupational exposure to toxic metals is essential for public health. Figure 1 indicating the direct and indirect impact of Environmental chemicals.

7.4 Disorder(s) caused

Chemical substances, both synthetic and naturally occurring, have become integral to modern life. However, their pervasive presence in the environment and consumer products has led to significant health concerns. With the continuous development of chemical industries, a large number of chemicals have been produced, followed by the increased risk for the emergence of poisoning events, due to improper chemical management and disposal.

A well-known skin epidemic initially broke out in Fukuoka prefecture and later spread to more than 20 prefectures in Japan in 1968 (Kuratsune et. al 1972). The investigation indicated that a brand of Kanemi rice oil (rice-bran oil, edible oil) had been contaminated by accidental leakage of up to 2000 mg/L of polychlorinated biphenyls (PCBs), the main constituent of which was tetrachlorobiphenyl (Nakanishi et. al 185, Urabe and Asahi, 1985). In total, 1057 patients were confirmed to suffer from this contaminated oil-derived disease (i.e., Yusho disease) in 1971. The major symptoms of these patients were dramatic skin problems, such as the swollen upper eyelid, increased eye secretions, acne-like eruptions, and enlarged follicles. Another disease, known as Yu-Cheng disease, occurred in the Taiwan region, China, in 1979. The origin of this incident was the consumption of rice-bran oil containing high contamination of PCBs (Chen et. al 1985, Lü, and Wu 1985), and about 1700 people consequently suffered from skin symptoms (Miyata et. al 1985).

Another tragedy caused by a chemical spill occurred in Bhopal, India, in December 1984. At a local pesticide factory, water flowed into a storage tank full of methyl isocyanate (MIC) and triggered a violent reaction, resulting in a massive release of the volatile MIC [45]. The lethal gas with MIC floated at a low altitude, and quickly spread from a radius of 3 miles to 6 miles (Tachakra 1987). As one of the worst chemical accidents in history, the Bhopal disaster caused 2000 deaths and 100,000 injured (Murphy 2014). Thousands of the survivors are still suffering from the accident with all sorts of physical disabilities, such as cataracts (Crabb 2004, Tachakra 1987).

The public health issues associated with the indirect effects of chemical pollution are also widely concerned. For example, the algal toxin poisoning occurs from time to time due to the explosive growth of microalgae in aquatic systems. The cause is the extensive use of nitrogen fertilizer, phosphate fertilizer, and urea in agriculture, animal husbandry, and aquaculture, resulting in the intensification of offshore eutrophication, the consequent outbreak of algal blooms, and the large production of algal toxins (Gobler and Sunda 2012). An outbreak of Caruaru syndrome occurred at a dialysis clinic in Caruaru, Brazil, in 1996, and the etiological study confirmed the contamination of two cyanotoxins in the

water supply. The patients on routine hemodialysis suffered nausea, vomiting, and visual disturbances after treatment. According to statistics, 100 of 131 patients developed acute liver failure, and 76 of them died later (Carmichae et. al 2001).

1. Pesticide and Herbicide Exposure

Organophosphates (e.g., Chlorpyrifos): These chemicals inhibit acetylcholinesterase, leading to cholinergic toxicity. Chronic exposure has been linked to developmental neurotoxicity in children, including attention deficits and motor dysfunction.

Paraquat and Maneb/Mancozeb: Exposure to these herbicides has been associated with an increased risk of Parkinson's disease, possibly due to dopaminergic neuron damage.

2. Air Pollution and Respiratory Disorders

Exposure to pollutants such as particulate matter (PM2.5), nitrogen oxides (NOx), and sulfur oxides (SOx) can lead to chronic respiratory diseases, including asthma, chronic obstructive pulmonary disease (COPD), and lung cancer. These pollutants can also exacerbate cardiovascular conditions and contribute to systemic inflammation.

3. Neurotoxicants and Cognitive Impairment

Solvents (e.g., Toluene, Xylene): Chronic exposure to organic solvents is associated with cognitive deficits, mood disorders, and peripheral neuropathy.

Manganese: Occupational exposure to high levels of manganese can lead to a parkinsonism-like syndrome, characterized by motor dysfunction and cognitive impairment.

4. Drug-Induced Disorders

Acetaminophen (Paracetamol) Overdose: Excessive intake can lead to acute liver failure due to the accumulation of toxic metabolites.

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs): Long-term use is associated with gastrointestinal ulcers, renal impairment, and cardiovascular events.

5. Carcinogenic Chemicals

Benzene: Chronic exposure to benzene is a well-established cause of leukemia and other hematological malignancies.

Asbestos: Asbestos exposure is linked to mesothelioma, lung cancer, and asbestosis.

Dioxins: These compounds are potent carcinogens and can cause reproductive and developmental toxicity.

6. Developmental and Reproductive Toxicants

Exposure to certain chemicals during pregnancy can lead to birth defects, low birth weight, and developmental delays. Notably, phthalates and BPA have been implicated in such outcomes.

7. Inflammatory and Autoimmune Disorders

Chemical exposures can trigger inflammatory responses leading to conditions such as hepatitis, nephritis, scleroderma, and lupus. These effects are often mediated through the generation of reactive oxygen species and activation of immune pathways.

8. Ototoxicity

Certain chemicals, including heavy metals like mercury and lead, as well as solvents and pesticides, can cause hearing loss by damaging the cochlear cells. This is particularly concerning in occupational settings where combined exposure to noise and ototoxicants occurs.

9. Endocrine Disruption

Endocrine disruption refers to interference with the normal function of the endocrine system by certain chemicals known as endocrine-disrupting chemicals (EDCs). Endocrine-disrupting chemicals (EDCs) interfere with hormonal systems, often mimicking or blocking natural hormones, leading to a variety of health problems. These chemicals can mimic, block, or otherwise interfere with hormones in the body, leading to a variety of health problems. The endocrine system is crucial for regulating metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things. Disruption in hormonal signaling can, therefore, result in significant physiological and developmental disorders. Some of the major Chemicals are:

- Bisphenol A (BPA)

- Phthalates
- Polychlorinated Biphenyls (PCBs)
- Per- and Polyfluoroalkyl Substances (PFAS)

Sources of EDCs:

- Industrial chemicals (e.g., PCBs, dioxins)
- Pesticides (e.g., DDT, atrazine)
- Plastics and plasticizers (e.g., bisphenol A (BPA), phthalates)
- Personal care products (e.g., parabens, UV filters)
- Pharmaceuticals (e.g., diethylstilbestrol (DES))
- Heavy metals (e.g., lead, mercury, cadmium)

Disorders Linked to EDCs

Reproductive dysfunction (e.g., reduced fertility, PCOS)

Thyroid disorders

Metabolic syndrome and obesity

Hormone-sensitive cancers (e.g., breast and prostate cancer)

7.5 Mechanism of disorders

Complex interactions between biological systems and chemicals found in the environment, industry, and pharmaceuticals can result in chemical-induced human disorders. Numerous health problems may result from these interactions' disruption of biological processes. Some of them are as follows:

1. Oxidative stress and malfunctioning mitochondria

Oxidative stress results from the production of reactive oxygen species (ROS) and reactive nitrogen species (RNS) by numerous hazardous substances. DNA, proteins, and lipids are among the biological constituents harmed by this imbalance. For example, pyruvate dehydrogenase is inhibited by arsenic exposure, which interferes with cellular energy

synthesis and increases oxidative stress. Cadmium also damages antioxidant enzymes, which exacerbates oxidative damage.

2. Genotoxicity and Mutagenesis

Certain compounds, such as benzo[a]pyrene, are metabolised into reactive intermediates that bind to DNA, generating adducts that can result in mutations and cancer. These adducts can bend the DNA helix, causing problems in replication and transcription.

3. Endocrine Disruption

Endocrine disrupting chemicals (EDCs) interfere with hormone signaling pathways. They can imitate or inhibit hormones, causing changes in gene expression and developmental disorders. For example, bisphenol A (BPA) and phthalates have been related to reproductive and developmental problems. EDCs can affect the endocrine system by:

- Mimicking natural hormones (agonistic effect)
- Blocking hormone receptors (antagonistic effect)
- Altering hormone synthesis, transport, metabolism, or excretion
- Modifying the expression of hormone receptors

4. Immune System Modulation

Certain substances can alter the immune system, resulting in allergic reactions or autoimmune illnesses. Penicillin, for example, can produce reactive metabolites that bind to proteins, forming novel epitopes that elicit immunological responses, including hemolytic anemia.

5. Neurotoxicity

Neurotoxic substances can disrupt neurotransmitter systems, causing cognitive and motor impairment. Lead exposure, for example, impairs synapse function and neuronal growth by imitating calcium ions and altering neurotransmitter release and receptor function.

6. Reproductive and developmental toxicity

Chemicals like BPA and phthalates can disrupt fetal development by changing hormonal signaling pathways. These changes can cause birth abnormalities, developmental delays, and reproductive health difficulties.

7. Haptenation and the immune response

Some chemicals can attach to proteins and produce hapten-protein complexes, which the immune system recognizes as foreign. This can result in allergic reactions or autoimmune disorders. Penicillin, for example, can generate such complexes, eliciting immunological responses that lead to haemolytic anaemia.

7.6 Prevention and control of disorders

Heavy metals are detrimental to human health, and their exposure has increased as a result of industrial and anthropogenic activities, as well as modern industrialization. The past century's industrial activities have resulted in huge increases in human exposure to heavy metals.

Mercury, lead, chromium, cadmium, and arsenic were the most prevalent heavy metals that caused human poisoning. Acute or chronic poisoning can develop as a result of exposure to water, air, or food. Bioaccumulation of these heavy metals has a wide range of harmful effects on a variety of body tissues and organs. Heavy metals interfere with biological functions such as growth, proliferation, differentiation, repair, and death. In this scenario, lead interacts with ferrochelatase and aminolevulinic acid dehydratase. Genomic instability is caused by certain hazardous metals, such as arsenic, cadmium, and chromium. The three metals' carcinogenicity has been attributed to defects in DNA repair that occur after they induce oxidative stress and DNA damage. Despite our present understanding of the dangers posed by heavy metals, poisoning is still rather common and needs to be prevented and effectively treated.

Toxic metal contamination in water and air is a global environmental hazard that affects millions of people. Heavy metal pollution in food poses a health risk for both humans and animals. Metals, among other environmental contaminants, may occur naturally and persist in the environment. Hence, human exposure to metals is inevitable, and some

studies have found gender variations in the toxicity of metals (Vahter et al., 2007, Tchounwou et al., 2012).

They frequently interact with biological systems by losing one or more electrons and forming metal cations that bind to the nucleophilic sites of important macromolecules. Heavy metals have a variety of acute and long-term negative effects on different human organs. Heavy metal toxicity can cause gastrointestinal and kidney dysfunction, neurological system abnormalities, skin lesions, vascular damage, immune system malfunction, birth problems, and cancer. Exposure to many metals can have a cumulative effect (Fernandes Azevedo et al., 2012; Cobbina et al., 2015; Costa, 2019; Gazwi et al., 2020). Excessive exposure to heavy metals, particularly mercury and lead, can result in serious complications such as stomach pain, bloody diarrhoea, and kidney failure (Bernhoft, 2012; Tsai et al., 2017). Some preventive measures are as follows:

7.6.1 Primary Prevention: Eliminating Exposure

a. Regulatory and policy interventions.

- ✓ Hazardous substances are banned or restricted (for example, lead in paint and asbestos in building).
- ✓ Bans or restrictions on specific EDCs (e.g., BPA, DDT)
- ✓ Safe exposure limits and labeling requirements
- ✓ Public Health Strategies:
- ✓ Education and awareness campaigns
- ✓ Promoting the use of safer alternatives
- ✓ Encouraging reduced use of plastics and synthetic chemicals
- ✓ Personal Protective Measures:
- ✓ Avoiding microwaving food in plastic containers
- ✓ Choosing EDC-free personal care products
- ✓ Reducing use of pesticides and non-organic foods

- ✓ Establishing exposure limits through national and international organizations for Risk assessments by health authorities (e.g., WHO, EPA, ECHA) such as:
    - The Occupational Safety and Health Administration (OSHA)
    - The Environmental Protection Agency (EPA)
    - The World Health Organisation (WHO)
    - European Chemical Agency (ECHA)

b. Safe Chemical Substitution

- Replace harmful chemicals with safer ones (green chemistry).

For example, instead of solvent-based paints, use water-based ones.

c. Environmental controls

- Reduce industrial pollution by implementing emission controls, filtering systems, and waste treatment.
- Monitoring and remediation of contaminated air, water, and soil (for example, arsenic removal from groundwater).

7.6.2 Secondary Prevention: Early Detection and Monitoring.

a. Biomonitoring

Regular testing of biological samples (blood, urine, and hair) to detect early indicators of exposure (for example, blood lead levels).

b. Occupational health surveillance.

- Workers in high-risk occupations must get regular medical examinations and maintain health records.
- Use personal exposure monitoring devices.

c. Environmental Monitoring

Regularly monitor air, water, and soil quality around industrial and agricultural areas.

7.6.3 Tertiary Prevention (Reducing Impact Post-Onset)

a. Medical treatment

- Use chelating agents (e.g., EDTA for lead poisoning, dimercaprol for arsenic/mercury).
- Symptomatic treatment of respiratory, neurological, and hepatic consequences. Rehabilitation of cognitive or physical disabilities.

b. Lifestyle Changes and Support

- Nutritional measures can help limit heavy metal absorption. Affected individuals receive psychological and social support.

7.6.4 Public Awareness and Education

a. Community Education Programs

- Educating the public about the safe use of home chemicals, insecticides, and pharmaceuticals.
- Raising awareness about environmental health risks.
  a. Worker Training: Proper use of Personal Protective Equipment (PPE), including gloves, respirators, and goggles.
- Chemical safety training includes proper handling, storage, and disposal.

7.6.5 Engineering and Technology Controls

a. Industrial safety systems.

- Install ventilation systems, chemical fume hoods, and closed-loop systems.
- Automation reduces human exposure.

b. Personal Protective Equipment (PPE)

- Required for hazardous work situations.
- Regularly maintain and replace equipment.

7.6.6 Policies and Legislation

a. Global Agreements

• Stockholm Convention on Persistent Organic Pollutants (POPs)

• EU REACH Regulation

• Basel Convention on Hazardous Waste

b. National Frameworks

• Regulating and licensing chemical manufacturing and usage.

• Adhere to hazard communication guidelines, such as the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

7.6.7 Research and innovation

• Developing safer compounds using sustainable chemistry.

• Developing early detection technology like biosensors and real-time exposure monitoring.

• Longitudinal health studies to evaluate the effects of persistent low-dose exposures.

7.7 Disorders caused by mercury (Hg)

Mercury toxicity can cause tremors, cognitive impairment, and kidney damage. Mercury is a strong neurotoxin that poses serious health hazards to humans, especially wh en exposed to methylmercury, an organic form of mercury that accumulates in aquatic foo d systems. Chronic exposure may cause neurological and psychological problems, such as memory loss and mood swings. Air, water, and soil all contain mercury (Hg), which can be classified as elemental or metallic, inorganic (Hg+, Hg2+), or organic (Li R. et al., 2017).

- **At normal temperature, elemental mercury (Hg0**) is a liquid that easily evaporates to form vapour. The liquid form of mercury is less dangerous than the vapour. When a container breaks, mercury leaks out, and breathing in a lot of mercury vapour can be lethal.
- **Methyl mercury (Me-Hg) and** ethyl mercury (Et-Hg) are examples of organic mercury; these substances are more hazardous than inorganic ones. Hg0 < Hg2+,

Hg+ < CH3-Hg is the order of increasing toxicity associated with various types of mercury (Kungolos et al., 1999).

1. Neurological disorders

Mercury exposure, particularly methylmercury, harms the central nervous system. The growing brain is especially sensitive, resulting in cognitive deficits and developmental delays in youngsters. In adults, persistent exposure can cause tremors, memory loss, and mood swings.

a. Minamata Disease

Minamata illness, first discovered in Japan in the 1950s, is a severe neurological ailment caused by methylmercury poisoning from contaminated industrial wastewater. Symptoms include ataxia, numbness, muscle weakness, and, in severe cases, coma or death. Foetal exposure can cause microcephaly and cerebral palsy-like symptoms.

b. Erethism (Mad Hatters Disease)

Erethism is defined by behavioural changes such as irritability, sadness, and memory loss, which are frequently connected with occupational exposure to mercury vapours. Physical symptoms may include tremors and headaches.

c. Acrodynia (Pink Disease)

Acrodynia affects children who have been exposed to mercury, and symptoms include pink discoloration of the hands and feet, swelling, and desquamation. Irritability and sensory disturbances are common neurological symptoms.

2. Renal Toxicity

Inorganic mercury compounds can harm the kidneys. Acute exposure can cause proteinuria and renal failure, but chronic exposure can result in long-term kidney impairment.

3. Endocrine Disruption.

Mercury exposure can disrupt endocrine function, altering hormones like insulin, oestrogen, testosterone, and adrenaline. This disturbance may cause hypothyroidism, adrenal hyperplasia, and abnormal glucose metabolism.

4. Cardiovascular Effects.

Some studies suggest that mercury exposure may lead to hypertension and an increased risk of cardiovascular disease, but more study is needed to determine clear linkages.

5. Developmental and reproductive toxicity

- Mercury exposure during foetal and early life can cause developmental delays, co gnitive deficiencies, and motor disability.
- Pregnant women and young children are more vulnerable to these consequences.

6. Acute Toxicity

Inhaling elemental mercury vapours can result in respiratory symptoms such as coughing and chest tightness, as well as systemic effects such as gastrointestinal upset and kidney f ailure.

7.8 Disorders caused by lead

Lead is a very toxic heavy metal that poses serious health concerns, particularly to children, pregnant women, and workers in specific sectors. Lead exposure can occur through a variety of means, including consuming contaminated food or drink, inhaling lead dust or fumes, and coming into direct touch with lead-containing products. Lead enters the body and accumulates in organs such as the brain, kidneys, liver, and bones. This buildup can cause a variety of health problems impacting numerous organ systems (WHO, 2024).

1. Neurological disorders

- ✓ **Children:** Lead exposure is especially detrimental to the developing brain. Even modest levels of lead in the blood can have an impact on intelligence, attention span, and academic performance. Severe cases can result in coma, convulsions, and death. Children who survive severe lead poisoning may suffer lifelong neurological injuries, including deafness and intellectual inability.
- ✓ **Adults:** Lead exposure in adults can cause peripheral neuropathy, which manifests as numbness, tingling, and pain in the extremities. Chronic exposure may also cause cognitive deterioration and emotional disorders (NCBI).

2. Haematological Effects

- ✓ **Anaemia:** Lead disrupts the heme biosynthesis pathway by inhibiting enzymes such as δ-aminolevulinic acid dehydratase (ALAD) and ferrochelatase. This inhibition causes decreased haemoglobin production and increased fragility of red blood cells, leading in anaemia. Two types of anaemia are connected with lead exposure:
- ✓ Acute exposure to high levels of lead can cause **haemolytic anaemia.**
- ✓ Chronic exposure can cause **Frank Anaemia**, which has hypochromic and microcytic red blood cells.

3. Kidney (renal) dysfunction

- ✓ Lead exposure can harm kidneys by accumulating in the tubules, resulting in situations including acute kidney injury (characterized by tubular necrosis and reduced renal function).
- ✓ Chronic Kidney Disease: Prolonged exposure might cause renal failure and hypertension.

4. Cardiovascular Effects

Lead exposure has been related to higher blood pressure and a greater risk of cardiovascular disease. The World Health Organization forecasts that lead exposure will cause over 1.5 million deaths worldwide in 2021, mostly due to cardiovascular consequences.

5. Reproductive and developmental toxicity

- ✓ Lead can cross the placenta and cause unfavourable birth outcomes such as stillbirth, low birth weight, early birth, and miscarriage in pregnant women.
- ✓ Prenatal exposure to lead can cause developmental delays, reduced IQ, and behavioural issues in children.

6. Immune System Impairment

Lead exposure can depress the immune system, rendering people more vulnerable to infection. It can also affect immunological responses, which could lead to autoimmune illnesses.

7. Gastrointestinal symptoms

Acute lead poisoning can result in stomach pain, constipation, nausea, vomiting, and a loss of appetite. These symptoms are frequently nonspecific, which might delay diagnosis.

7.9 Disorders caused by chromium

Chromium, a heavy metal, exists in a variety of oxidation states, with trivalent chromium (Cr(III)) and hexavalent chromium (Cr(VI)) being the most common in environmental and occupational situations. While Cr(III) is a necessary ingredient for glucose metabolism, Cr(VI) is a strong carcinogen associated with a variety of health problems. This review examines existing research to determine the principal illnesses induced by chromium exposure, with an emphasis on respiratory, dermatological, gastrointestinal, renal, hepatic, and neurological consequences, among others.

1. Respiratory Disorders.

Occupational exposure to Cr(VI), notably in industries such as chrome plating, welding, and cement manufacturing, has been associated to many respiratory conditions:
1. Long-term exposure can result in lung fibrosis, and irritant-induced asthma.

2. The International Agency for Research on Cancer (IARC) classifies Cr(VI) compounds as human carcinogens, increasing the risk of lung, nasal, and sinus cancer through inhalation exposure. ATSDR+1OSHA+1

3. Direct contact with Cr(VI) compounds can lead to nasal septum perforation and ulceration. ATSDR+1De Gruyter Brill+1

2. Dermatological Effects

Repeated skin contact with Cromium can induce allergic reactions, including chronic rashe s and inflammation.

3. Gastrointestinal Disorders

- ✓ The ingestion of Cr(VI) compounds might result in abdominal pain, vomiting, diarrh oea, and gastrointestinal bleeding.
- ✓ Long-term exposure has been linked to an increased risk of stomach cancer.

4. Renal and Hepatic Toxicity

- ✓ Both Cr(III) and Cr(VI) can harm the kidneys: exposure can result in acute renal failu re, proteinuria, haematuria, and anuria, as the kidneys are the principal chromium excretory organ.
- ✓ Ingestion of chromium compounds can cause liver damage, which manifests as jaun dice, increased liver enzymes, and hepatomegaly.

5. Neurological Effects

- ✓ Long-term exposure may lead to nerve damage, resulting in symptoms such as numbness and tingling in the extremities.

6. Carcinogenicity

- ✓ Inhalation of Cr(VI) compounds increases the risk of lung cancer.
- ✓ Potential associations have been observed with cancers of the nasal cavity, sinuses, and stomach.

7.10 Disorders caused by cadmium

There are no known physiological advantages to cadmium (Cd), a heavy metal that is extremely toxic and non-essential. It is mostly contracted from contact to the environment, particularly through tainted food, water, air, and workplace conditions.
1. The main organs harmed by long-term exposure to cadmium are the kidneys. Renal tubular cells accumulate cadmium, which leads to progressive tubular dysfunction.
2. Osteoporosis (reduced bone mineral density and increased risk of fracture) is caused by cadmium's effects on calcium metabolism and bone remodeling.

- ✓ In Japan, cadmium exposure from tainted water sources has been linked to **itai-itai disease,** a severe sickness marked by osteomalacia, osteoporosis, and frequent bone fractures.

3. Long-term exposure to cadmium impairs memory and learning.

4. Mood and behavioural changes are also frequently brought on by cadmium exposure.

5. Because cadmium can pass across the blood-brain barrier, it can cause neuroinflammation and oxidative stress, both of which harm neurones.

6. Prenatal exposure may have varied effects depending on the sex of the offspring and result in unfavourable pregnancy outcomes and developmental problems in the offspring.
7. Chronic rhinitis and anosmia have been related to elevated cadmium levels in contaminated air.
8. Gastrointestinal hemorrhagic necrosis may result from acute cadmium consumption.
9. Cadmium is categorised as a carcinogen for humans. Long-term exposure is linked to a higher risk of kidney, prostate, and lung cancer.

10. Exposure to cadmium may accelerate the onset of musculoskeletal disorders.

7.11 Disorders caused by nickel

Nickel (Ni) is a naturally occurring metallic element that finds extensive usage in many industrial processes, such as the creation of coins, batteries, stainless steel, and electroplating. Even while some organisms require trace amounts of nickel, excessive exposure to nickel, particularly in industrial or occupational contexts, can have a number of negative health impacts. Depending on the type of nickel, the exposure route, and the length of time, these impacts can include skin disorders, allergic reactions, respiratory issues, and even cancer.

1. **Nickel Allergic Contact Dermatitis (NACD):** Especially among sensitised people, nickel is one of the most frequent causes of allergic contact dermatitis. Skin inflammation after coming into contact with nickel-containing items (such as jewellery, watches, coins, and belt buckles) is the condition's defining feature. Common signs of NACD include redness, itching, blistering, and dry or thickened skin.

2. **Pathophysiology:** Inflammation results from a type IV hypersensitivity reaction in which nickel ions enter the skin and combine with skin proteins to generate a compound that the immune system perceives as alien.
3. **Respiratory Disorders:** Inhaling nickel dust or fumes can cause respiratory problems, especially in work environments like electroplating, welding, or nickel refining. Chronic bronchitis is among the conditions linked to nickel inhalation, along with lung fibrosis and symptoms similar to asthma.
4. **Carcinogenic Effects:** According to the International Agency for Research on Cancer (IARC), several nickel compounds—such as nickel oxide and nickel sulfate—are classified as Group 1 carcinogens, meaning there is enough proof that they can cause cancer in people.
5. **Systemic Nickel Allergy Syndrome (SNAS):** SNAS is a disorder in which people who is sensitive to nickel in their diet experience fatigue, headaches, skin rashes, and gastrointestinal problems.
6. **Nickel Toxicity and Systemic Effects (from High Exposure):** Too much nickel c auses oxidative stress and organ damage by interfering with enzyme function and producing reactive oxygen species (ROS).

7.12 Disorders caused by arsenic

Arsenic is a naturally occurring metalloid found in soil, water, and air. It exists in both organic and inorganic forms, with **inorganic arsenic** (found in groundwater and industrial sources) being significantly more toxic. Chronic exposure to arsenic, particularly through contaminated drinking water, is a major public health concern globally, especially in regions such as Bangladesh, India, and parts of South America.

Arsenic exposure can lead to a range of **acute and chronic health disorders**, affecting multiple organ systems. The severity and type of disorder depend on the dose, duration of exposure, chemical form of arsenic, and individual susceptibility.

1. Acute arsenic poisoning is caused by consuming large amounts of food or water tainted with arsenic. Acute arsenic poisoning frequently manifests as intense stomach

discomfort, cramping in the muscles, vomiting and diarrhoea, hypotension, shock, and in extreme cases, multi-organ failure.

2. **Chronic Arsenic Toxicity (Arsenicosis):** Arsenicosis is caused by occupational exposure from mining, smelting, or pesticide use. The hallmark of long-term exposure to arsenic is dark blotches, particularly on the chest, back, and limbs. Arsenic promotes carcinogenesis by interfering with DNA repair, producing oxidative stress, and altering epigenetics.
3. **Blackfoot disease:** A rare peripheral vascular condition that causes gangrene of the limbs and is linked to arsenic exposure, especially in Taiwan.
4. Exposure to arsenic is associated with a higher incidence of type 2 diabetes, maybe as a result of compromised insulin signalling and beta-cell malfunction in the pancreas.
5. The WHO recommends a maximum limit of 10 µg/L.
6. In many impacted locations, levels of arsenic in drinking water surpass 50 µg/L, which poses serious long-term health hazards.
7. **High-Risk Areas:** Bangladesh, West Bengal, India, Nepal, and portions of Argentina, Chile, China, and the United States are the high-risk areas.

7.13 Disorders caused by nitrates

Nitrates (NO_3^-) are naturally occurring compounds found in soil, water, and food. They are essential nutrients for plant growth and are widely used in fertilizers. However, excessive nitrate exposure, especially through contaminated drinking water and food, can lead to serious health disorders, particularly in infants and vulnerable populations.

Nitrates themselves are relatively non-toxic, but their **biological conversion into nitrites (NO_2^-)** and **nitrosamines** (potentially carcinogenic compounds) in the human body can cause adverse health effects. The main routes of exposure are **ingestion** (from water and food) and to a lesser extent, **inhalation** and **dermal absorption**.

1. Methemoglobinemia ("Blue Baby Syndrome")

Because of their increased sensitivity to nitrite, infants under six months of age are predominantly affected by this potentially fatal illness (Blue baby Syndrome).

Cause:

- ✓ The infant's digestive tract transforms ingested nitrates, primarily from tainted drinking water or formula, into nitrites.
- ✓ Haemoglobin is oxidised by nitrites to methaemoglobin, which is less effective at carrying oxygen.

  Symptoms include: dyspnoea (bluish skin, particularly around the mouth and limbs); fatigue; vomiting; and shortness of breath are some of the common symptoms.

  • **In extreme situations:** death or coma

  WHO Limit:

  Nitrate concentration in drinking water should not exceed **50 mg/L** (as NO_3^-) or **10 mg/L** (as nitrogen)

2. Cancer Risk (Gastrointestinal and Other Cancers)

Nitrosamines, which are known carcinogens, can be created in the stomach when nitrates and nitrites combine with amines and amides.

Gastric carcinoma, or stomach cancer; Esophageal cancer, Cancer of the colon, Cancer of the bladder are some of the associated cancers.

Risk factors include consuming processed meats (such as sausages, bacon and ham) that are high in nitrates; eating foods that have been preserved with nitrites; and consuming insufficient amounts of antioxidants that prevent the development of nitrosamines, such as vitamin C.

Conditions of the Thyroid.

Thyroid hormone production is hampered by excess nitrate because it interferes with the thyroid gland's ability to absorb iodine.

Related Conditions:

Hypothyroidism Goitre, or swelling of the thyroid gland, and insufficient thyroid hormone levels in newborns and children can cause developmental delays.

Mechanism: By blocking the sodium-iodide symporter, nitrate lowers iodine absorption, which is essential for the production of thyroid hormones.

3. Reproductive and Developmental Effects

Studies suggest that high nitrate levels in drinking water may be associated with:

- ✓ Spontaneous abortions
- ✓ Low birth weight
- ✓ Neural tube defects
- ✓ Intrauterine growth retardation (IUGR)

These effects may be mediated by oxidative stress, reduced oxygen delivery, and hormonal disruption due to nitrate/nitrite interference.

Nitrate Exposure Sources:

- ✓ Animal waste and fertilizer runoff are the main causes of groundwater contamination in agricultural areas.
- ✓ Why Private wells are more dangerous and frequently uncontrolled.
- ✓ Nitrates are naturally present in leafy green vegetables, such as spinach, lettuce, and beetroot.
- ✓ Meats that have been processed and preserved with additional nitrites; cured meals (sausage, gammon and bacon).
- ✓ Farmers using fertilisers containing nitrogen.
- ✓ Employees in the food, chemical, and explosives sectors.
- ✓ Haemoglobin levels (for methemoglobinemia) in blood tests.
- ✓ For excessive environmental exposure or occupational exposure. Frequent testing of both public and private water sources; deployment of water treatment systems (ion exchange, distillation, and reverse osmosis).

- ✓ Controlled fertilizer application; and appropriate disposal of animal waste.
- ✓ Reduce your diet of processed meats and boost your intake of antioxidants (such vitamins C and E) to prevent the production of nitrosamines.
- ✓ Promoting sustainable farming methods
- ✓ Enforcing regulations for nitrate limits in food and water; and teaching communities how to utilize water responsibly.

7.14 Case study

Military personnel are exposed to environmental hazardous substances that can be very different from those for industry workers and for the general population (Figure 2). However, individual response to occupational hazards is extremely variable due to complex interplay among several factors, such as individual health, genetics, and time of exposure. Environmental samplings can be used to provide information regarding the presence of hazardous substances, while it is ineffective to determine individual exposure and response. To investigate relationships occurring between military health and warfare theater environment, it is necessary to use an integrated approach based on both analytical and molecular epidemiology. To assess whether a specific agent impacts on human health, it is necessary to make a complex evaluation that includes exposure, association, and effect indexes. For this purpose, it is important to adopt integrated monitoring programs which are able to integrate information resulting from analyses of exposure biomarkers, biomarkers of effect and biomarkers of susceptibility. Exposure biomarkers are represented by chemicals or their metabolites found in biological samples (urine, blood, breath, and saliva). The main utilities of this class of biomarkers are related to their ability to prove that exposure has occurred, to identify the route of exposure, and the absorbed dose of chemicals considered. Body burdens from exposure to many of the substances in military personnel are often difficult to be realized due to the remarkable logistic problems existing in the operative theaters where the priority is the military activity. Biomarkers of early effect can provide information dealing with the biological

consequences from an exposure and with time intervals, as typically occurs for carcinogens.

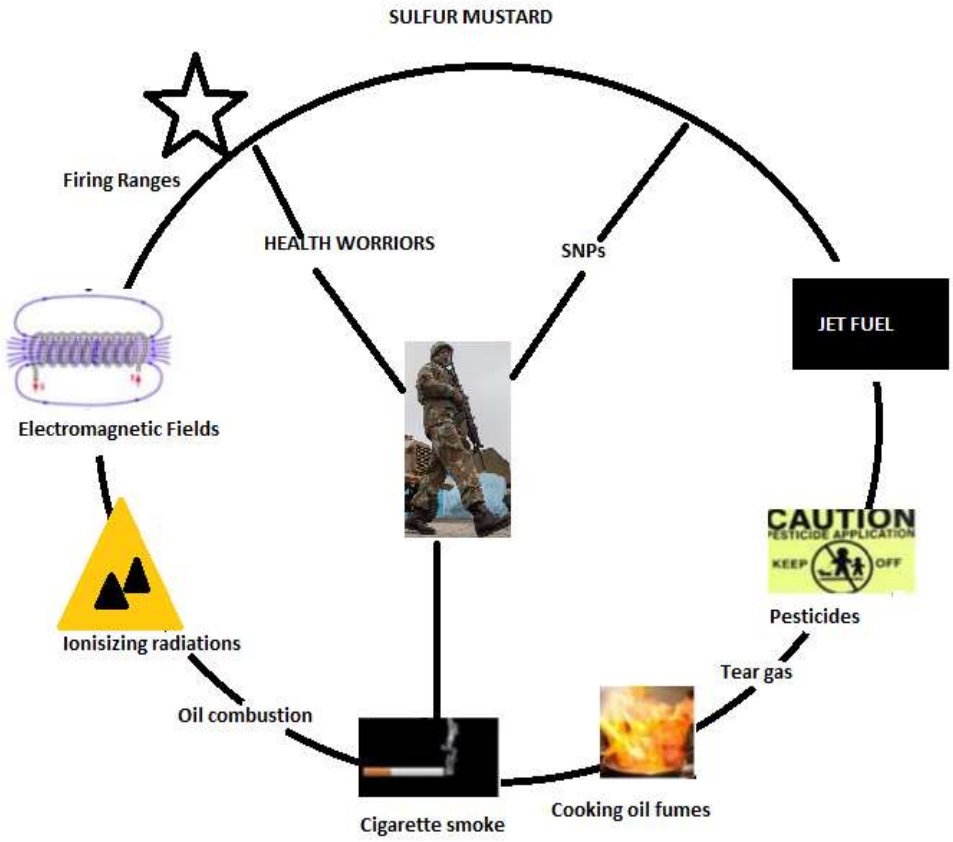


Figure 2. Possible exposures of military personnel to chemical and physical occupational hazards.

Biomarkers of effect are metabolites or molecules which are capable of inducing development of diseases, while biomarkers of susceptibility are factors, such as genetic polymorphisms which are able to modify individual's susceptibility to chemical exposures. The main characteristics of a good biomarker are sensitivity, specificity, and noninvasive sampling collection methods. Nevertheless, there are some sources of error. Indeed, some chemicals are characterized by short half-lives in the human body which influence their detection and sample timings.

Summary

Chemical-induced disorders represent a significant public health concern, with widespread implications across various organ systems. Preventive measures, including regulatory actions, public health initiatives, and individual protective strategies, are essential to mitigate the risks associated with chemical exposures.

The prevention and control of chemical-induced human disorders require a multi-tiered approach involving regulation, education, surveillance, and medical management. Collaboration among governments, industries, healthcare providers, and communities is critical to minimizing exposure and reducing the burden of chemical toxicity on human health.

Lead exposure is a significant public health issue with widespread implications for human health. It affects multiple organ systems and can lead to long-term health problems, particularly in children and pregnant women. Preventive measures, early detection, and appropriate medical interventions are crucial to mitigate the adverse effects of lead exposure.

Chromium exposure, particularly to Cr(VI), poses significant health risks, including respiratory, dermatological, gastrointestinal, renal, hepatic, neurological, and carcinogenic effects. Preventive measures, such as reducing environmental chromium emissions and limiting occupational exposure, are essential to mitigate these health risks.

Exposure to arsenic, particularly through tainted groundwater, poses a serious risk to human health and the environment. Multiple organ systems are impacted by prolonged exposure, which also raises the risk of cancer and neurological, dermatological, and cardiovascular diseases. Arsenic-related diseases must be prevented and mitigated by comprehensive public health policies that include early identification, industrial safety, access to clean water, and health education.

Nitrate exposure, especially through contaminated drinking water and processed foods, poses significant health risks, particularly for infants, pregnant women, and people with compromised health. Key disorders include **methemoglobinemia**, **cancer**, **thyroid**

dysfunction, and **reproductive effects**. Prevention requires integrated efforts in water safety, agriculture, food regulation, and public health education. Timely monitoring and mitigation can effectively reduce the risks associated with nitrate exposure.

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Unit 8: Drug induced Human Disorders

Unit Structure

8.0 Learning Objectives

By the end of this chapter, readers should be able to:

- Understand the concept of drug-induced human disorders.
- Identify drugs commonly associated with inducing human disorders.
- Recognize the mechanisms of drug reactions and their clinical manifestations.
- Evaluate strategies for controlling and preventing drug-induced reactions.

8.1 Introduction

Pharmaceutical agents are developed to prevent, manage, or cure diseases, yet their use is sometimes associated with adverse outcomes. Drug-induced disorders refer to a wide spectrum of physiological and psychological conditions that occur as unintended consequences of drug administration. These disorders can range from mild, self-limiting side effects to severe, life-threatening complications, and may be either predictable (dose-dependent) or idiosyncratic (dose-independent).

Drug-induced disorders are a significant concern in clinical medicine, accounting for up to 6% of hospital admissions and a considerable number of in-hospital complications (Pirmohamed et al., 2004). A comprehensive understanding of drug reaction mechanisms, risk factors, and control strategies is crucial to minimize morbidity and mortality associated with pharmacotherapy.

Drug-induced disorders are a significant concern in India, affecting various organ systems and leading to substantial morbidity and mortality. These adverse effects can result from direct pharmacologic actions, hypersensitivity reactions, or toxic metabolite formation. Some of the major drug-induced disorders prevalent in India are:

1. **Gastrointestinal Disorders: NSAID-Induced Gastritis**

Non-steroidal anti-inflammatory drugs (NSAIDs) are widely prescribed for pain, inflammation, and fever. While effective, chronic or inappropriate NSAID use is associated with gastrointestinal (GI) complications, including NSAID-induced gastritis. NSAID-induced gastritis is when your stomach lining gets inflamed from NSAIDs. So, the use of NSAIDs can lower the stomach's natural protection. This causes hurt and swelling. It is important to spot the symptoms early to treat them and avoid bigger problems. This condition involves inflammation of the gastric mucosa and can lead to more severe outcomes such as ulcers or bleeding. NSAID-induced gastritis is prevalent, especially among older adults, and often under diagnosed due to its sometimes subtle or asymptomatic nature. Awareness and early intervention are critical to prevent serious complications.

Mechanism: NSAIDs interact with phospholipids and uncouple mitochondrial oxidative phosphorylation, which initiates biochemical changes that impair function of the gastrointestinal barrier. The resulting increase in intestinal permeability leads to low-grade inflammation.

- ✓ The primary mechanism involves inhibition of cyclo-oxygenase (COX) enzymes, which are critical for maintaining gastric mucosal integrity.
- ✓ **COX-1 inhibition:** Reduces protective prostaglandins (PGE2, PGI2), which normally:

- Stimulate mucus and bicarbonate secretion
- Maintain mucosal blood flow
- Promote epithelial cell repair

✓ **Direct mucosal irritation:** NSAIDs are acidic and can disrupt the gastric epithelial barrier

✓ Increased gastric acid secretion: May exacerbate mucosal injury.

✓ The cumulative effect is mucosal injury, reduced healing, and increased risk for erosions, ulcers, and bleeding.

Case study: A study in a South Indian hospital identified that 76.8% of drug-induced upper gastrointestinal tract disorders requiring hospitalization were due to non-steroidal anti-inflammatory drugs (NSAIDs), particularly aspirin.

Management: Proton pump inhibitors (PPIs) eg. omeprazole 40 mg/day and selective COX-2 inhibitors are recommended to mitigate these adverse effects.

✓ Endoscopic intervention if active bleeding

✓ Evaluate alternatives for pain management:

✓ Lifestyle modifications:

✓ Avoid alcohol, smoking

✓ Avoid other ulcerogenic drugs (e.g., corticosteroids)

✓ Repeat endoscopy if symptoms persist or complications arise

2. Hepatotoxicity: Drug-Induced Liver Injury (DILI)

Drug-Induced Liver Injury (DILI) refers to liver damage caused by medications, herbal supplements, or other xenobiotics. It is a leading cause of acute liver failure and a common reason for drug withdrawal from the market. DILI can present with a wide spectrum of liver pathology, ranging from asymptomatic enzyme elevations to acute liver failure.DILI is classified into:

- ✓ Intrinsic (predictable): Dose-dependent and consistent among individuals (e.g., acetaminophen)
- ✓ Idiosyncratic (unpredictable): Not dose-dependent, varies among individuals (e.g., isoniazid, amoxicillin-clavulanate)

Mechanism: Drug-Induced Liver Injury (DILI) involves complex interactions between drugs (or their metabolites), the liver's detoxification system, and the immune response. The mechanisms are typically divided into **intrinsic** and **idiosyncratic** pathways:

- ✓ **Intrinsic (Predictable) DILI:** It is dose-dependent and occurs in most individuals at high enough doses. Example Acetaminophen overdose.
- ✓ Drug is metabolized in the liver by **cytochrome P450 enzymes.**
- ✓ Metabolism produces **reactive metabolites.**
- ✓ Under normal conditions, toxic metabolites are detoxified by **glutathione (GSH)**.
- ✓ Overdose → GSH depletion → accumulation of reactive metabolites.
- ✓ Reactive metabolites bind to cellular proteins → mitochondrial dysfunction, oxidative stress, and cell necrosis or apoptosis.

Idiosyncratic (Unpredictable) DILI

- ✓ Drug or metabolite forms **hapten** that binds to hepatic proteins.
- ✓ These **neoantigens** trigger an **adaptive immune response** (T-cell activation).
- ✓ Symptoms may include rash, fever, eosinophilia, and elevated liver enzymes.
- ✓ Associated with **HLA genotypes** (e.g., HLA-B*5701 for flucloxacillin).
- ✓ Due to **genetic variations** in drug-metabolizing enzymes (e.g., NAT2, CYPs).
- ✓ Leads to accumulation of **toxic intermediates**, mitochondrial stress, or endoplasmic reticulum stress.

Management:

A. Immediate Steps for the management are:

- ✓ Discontinue the suspected drug

- ✓ Monitor liver function tests (LFTs) regularly
- ✓ Rule out other causes: Viral hepatitis, autoimmune hepatitis, alcoholic liver disease, etc.
- ✓ Hospitalization if signs of liver failure (e.g., INR >1.5, encephalopathy)
- ✓ Avoid re-challenge with the offending drug
- ✓ Educate patients on early signs of liver injury

Case Study: A 2017 study published in the Indian Journal of Pharmacology reported a case of a 42-year-old male developing acute liver failure due to a combination of anti-tuberculosis therapy (ATT). Discontinuation of ATT and supportive care led to recovery.

3. Renal Disorders: Drug-Induced Nephrotoxicity

Drug-induced nephrotoxicity refers to kidney damage caused by exposure to various pharmacologic agents. Nephrotoxicity is a significant concern with the use of certain antibiotics, diuretics, and nonsteroidal anti-inflammatory drugs (NSAIDs).

The kidneys are particularly vulnerable due to:

- High renal blood flow (~20–25% of cardiac output)
- Active tubular reabsorption and secretion
- Concentration of toxins in renal tubules

Nephrotoxic drugs can impair glomerular function, tubular function, or both, and can result in acute kidney injury (AKI), chronic kidney disease (CKD), or electrolyte disturbances.

Common drug classes involved:

- Aminoglycosides (e.g., gentamicin)
- NSAIDs
- Radiographic contrast agents
- Amphotericin B
- Cisplatin
- ACE inhibitors and ARBs (in certain patients)

Mechanism: Drugs can cause renal injury through various mechanisms, including direct tubular toxicity, interstitial nephritis, and glomerular damage.

Management: Early detection through monitoring renal function tests and adjusting or discontinuing the offending drug can prevent irreversible kidney damage.

Case Study: In a study at AIIMS, Delhi (2016), a 55-year-old female developed acute tubular necrosis after being administered high doses of gentamicin. The condition improved following cessation of the drug and initiation of renal supportive therapy.

Management

- ✓ **Identify high-risk patients** (e.g., elderly, CKD, diabetes)
- ✓ **Avoid nephrotoxic drug combinations**
- ✓ **Adjust drug doses** for renal function
- ✓ **Ensure adequate hydration**, especially before contrast exposure
- ✓ Use **monitoring protocols** (e.g., serum creatinine, urine output, drug levels)

4. Dermatologic Reactions: Cutaneous Adverse Drug Reactions (CADRs)

Cutaneous Adverse Drug Reactions (CADRs) are among the most frequent adverse effects related to drug therapy. They represent a spectrum of dermatologic conditions that vary in severity, from mild rashes to life-threatening systemic syndromes. CADRs are unwanted skin reactions caused by medications. They can present shortly after exposure or be delayed by days or weeks. Most are benign, but some are severe and potentially fatal.

Common Culprit Drugs

- Antibiotics: penicillins, sulfonamides
- Anticonvulsants: phenytoin, carbamazepine, lamotrigine
- NSAIDs
- Allopurinol
- Antiretrovirals

Common Types of CADRs

Type	Clinical Features	Onset	Severity
Exanthematous (Morbilliform) Rash	Symmetrical erythematous macules and papules, often on trunk/extremities	4–14 days after drug	Mild
Urticaria/Angioedema	Wheals, itching, swelling of lips, eyelids, throat	Minutes to hours	Mild to moderate
Fixed Drug Eruption	Single/multiple rounds, dusky red patches that recur in same location	Hours to days	Mild
Photosensitivity	Exaggerated sunburn in sun-exposed areas	After sun exposure	Mild to moderate
Erythema Multiforme	Target lesions, often on palms/soles; may involve mucosa	Days to weeks	Moderate
Stevens-Johnson Syndrome (SJS)	<10% body surface detachment, mucosal involvement, systemic symptoms	1–3 weeks	Severe
Toxic Epidermal Necrolysis (TEN)	>30% skin detachment, full-thickness epidermal necrosis	1–3 weeks	Life-threatening
Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS)	Rash, eosinophilia, fever, lymphadenopathy, organ involvement	2–8 weeks	Severe

Management

Symptomatic treatment: antihistamines, topical steroids for mild cases

Systemic corticosteroids for severe reactions (e.g., DRESS)

Hospitalization: for SJS/TEN (preferably in burn units)

Supportive care: fluids, electrolytes, wound care

Avoid rechallenge unless clearly indicated

Discontinuation of the suspected drug and symptomatic treatment are essential. In severe cases, corticosteroids may be required.

Prevention

- ✓ **Genetic screening** in high-risk populations (e.g., HLA-B*1502 in Han Chinese before carbamazepine)
- ✓ **Patient education** and drug allergy documentation
- ✓ **Case study:** A study in South-West Rajasthan found that 39% of CADRs were associated with antimicrobial agents, particularly fixed-dose combinations of fluoroquinolones with nitroimidazoles.
- ✓ **Mechanism:** CADRs can result from hypersensitivity reactions or direct toxic effects of drugs on the skin.

5. Hematologic Disorders: Drug-Induced Hematological Toxicity

Drug-induced hematological toxicity refers to adverse effects of medications that impair the blood and bone marrow function, leading to abnormalities in one or more blood cell lines (red cells, white cells, or platelets). These toxicities can manifest as anemia, leukopenia, thrombocytopenia, or pancytopenia. They range from mild and reversible to severe, life-threatening conditions.

Common drugs implicated include chemotherapeutic agents, antibiotics, antiepileptics, antithyroid drugs, and others.

Mechanism: Drugs can cause hematologic toxicity through mechanisms such as bone marrow suppression, immune-mediated destruction of blood cells, or direct toxic effects.

- **Direct Toxicity to Bone Marrow:**

Some drugs cause dose-dependent myelosuppression by inhibiting proliferation or causing apoptosis of hematopoietic stem cells.

Examples: Chemotherapy agents (e.g., cyclophosphamide, methotrexate), chloramphenicol.

- **Immune-Mediated Destruction:**

Drugs or their metabolites act as haptens, triggering antibody formation against blood cells.

Results in hemolytic anemia, immune thrombocytopenia, or neutropenia.

Examples: Penicillin-induced hemolytic anemia, quinine-induced thrombocytopenia.

- **Idiosyncratic Reactions:**

Unpredictable, not dose-related, possibly due to genetic susceptibility.

Can cause aplastic anemia or agranulocytosis.

Examples: Chloramphenicol, carbimazole.

- **Suppression of Growth Factors or Cytokines:**

Some drugs interfere with production or action of growth factors (e.g., erythropoietin), impairing blood cell production.

Management: Monitoring blood counts during treatment and adjusting or discontinuing the offending drug can prevent serious complications.

- Discontinuation of the Offending Drug.
- Immediate cessation is critical.
- Blood transfusions for severe anemia or thrombocytopenia.
- Antibiotics or antifungals for infections due to neutropenia.
- To assess the severity and cause, especially if pancytopenia is present.
- Regular CBC monitoring during therapy with high-risk drugs.

6. Pediatric Considerations: Drug-Induced Diseases in Children

Children are particularly vulnerable to drug-induced diseases due to differences in pharmacokinetics and pharmacodynamics compared to adults. Their organs (liver, kidneys) are immature, leading to altered drug metabolism and clearance. Moreover, developmental stages affect drug sensitivity and toxicity risk. Drug-induced diseases in children can affect multiple organ systems including skin, blood, liver, kidneys, and the nervous system. These adverse effects may lead to acute illness or chronic health issues.

Pharmacokinetic Differences

Immature enzyme systems (e.g., reduced cytochrome P450 activity) alter metabolism.

Renal clearance is reduced in neonates.

Altered plasma protein binding affects drug levels.

Pharmacodynamic Sensitivity

Receptor expression and function differ in children, influencing drug response and toxicity.

Immune-Mediated Reactions

Hypersensitivity reactions and idiosyncratic responses may be more common or severe.

Dose Calculation Errors

Pediatric dosing requires precise weight- or body surface area-based calculations.

Off-label or extrapolated adult doses can cause overdose or toxicity.

Developmental Toxicity

Some drugs interfere with growth and development (e.g., tetracycline causes teeth discoloration).

Management of Drug-Induced Diseases in Children

1. **Prevention**

Use pediatric-specific formulations and dosing guidelines.

Avoid drugs contraindicated in children (e.g., aspirin in viral illnesses).

Genetic screening where applicable (e.g., G6PD deficiency).

Educate caregivers about potential side effects.

2. **Early Detection**

Monitor for symptoms and signs of toxicity.

Routine laboratory tests during high-risk therapies (e.g., CBC with chemotherapy).

3. **Immediate Action**

Discontinue suspected offending drug.

Provide supportive care tailored to affected systems.

4. **Supportive and Specific Treatments**

Blood transfusions for anemia.

Hydration and renal support for nephrotoxicity.

Antihistamines or steroids for hypersensitivity reactions.

Hospitalization for severe cases.

5. **Follow-up**

Monitor recovery and long-term effects.

Document adverse reactions to improve safety.

8.1.1 Case Studies

Case 1: Gray Baby Syndrome (Chloramphenicol Toxicity)

Patient: 2-week-old neonate treated with chloramphenicol for sepsis.

Presentation: Vomiting, cyanosis, hypotension, abdominal distension.

Mechanism: Immature glucuronidation in liver → accumulation of chloramphenicol → mitochondrial toxicity.

Management: Stop chloramphenicol immediately, supportive care (oxygen, fluids), monitor cardiac status.

Outcome: Symptoms resolved with treatment; drug avoided in neonates thereafter.

Case 2: Reye's Syndrome (Aspirin Toxicity)

Patient: 5-year-old with recent viral illness, given aspirin for fever.

Presentation: Vomiting, confusion, seizures, hepatomegaly.

Mechanism: Aspirin causes mitochondrial dysfunction leading to fatty liver and cerebral edema.

Management: Stop aspirin, intensive care support (ventilation, intracranial pressure control), avoid aspirin in children with viral infections.

Outcome: Early treatment critical; some children recover fully; others have neurological sequelae.

Case 3: Drug-Induced Hemolytic Anemia in G6PD Deficiency

Patient: 3-year-old male started on sulfonamide antibiotics.

Presentation: Sudden pallor, jaundice, dark urine.

Mechanism: Oxidative stress from sulfonamides causes hemolysis in G6PD-deficient red cells.

Management: Discontinue drug, supportive care with hydration and transfusion if needed.

Outcome: Recovery after drug withdrawal; genetic counseling recommended.

Case 4: Tetracycline-Induced Teeth Discoloration

Patient: 4-year-old treated with tetracycline for acne.

Presentation: Permanent yellow-brown discoloration of developing teeth.

Mechanism: Tetracycline binds to calcium in teeth during development.

Management: Avoid tetracycline in children <8 years; cosmetic dental treatment if needed.

Outcome: Teeth discoloration is permanent but non-toxic.

A study found that 1.004% of pediatric patients experienced drug-induced diseases, with erythmatous maculopapular rashes being the most common manifestation.

Mechanism: Children may have different pharmacokinetics and immune responses, making them more susceptible to certain drug-induced disorders.

Management: Careful dosing, monitoring for adverse effects, and prompt discontinuation of the offending drug are essential in pediatric patients.

Disease	Culprit Drug(s)	Mechanism	Management
Gray Baby Syndrome	Chloramphenicol	Immature metabolism → toxicity	Discontinue drug, supportive care
Reye's Syndrome	Aspirin	Mitochondrial dysfunction	Stop aspirin, intensive supportive care
Hemolytic Anemia (G6PD)	Sulfonamides, antimalarials	Oxidative hemolysis	Stop drug, supportive therapy
Teeth	Tetracycline	Drug binds to calcium	Avoid drug in young

Disease	Culprit Drug(s)	Mechanism	Management
Discoloration		in teeth	children

8.2 Drug as a disorder factor

Drugs, while developed for therapeutic benefit, can paradoxically become a source of harm, leading to the onset of various human disorders. These drug-induced conditions arise from unintended pharmacological actions, individual genetic predispositions, and interactions with other drugs or pre-existing diseases. When a drug becomes a factor in disease causation, it is referred to as a disorder factor.

8.2.1 Mechanisms by Which Drugs Act as Disorder Factors

Pharmacological Actions at Therapeutic Doses

Drugs may have adverse effects even when used within their therapeutic range. These effects are often extensions of the drug's known pharmacological actions.

Example: Beta-blockers can cause bradycardia and exacerbate asthma due to β-adrenergic blockade.

Toxic Effects at Supratherapeutic Doses

Excessive dosing, either accidentally or intentionally, can lead to toxicity.

Example: Acetaminophen overdose can result in severe hepatotoxicity due to the accumulation of toxic metabolites.

Hypersensitivity Reactions

Some individuals mount an immune response against drugs or their metabolites, leading to allergic or autoimmune disorders.

Example: Penicillin-induced anaphylaxis; hydralazine-induced lupus erythematosus.

Idiosyncratic Reactions

These are unpredictable, rare, and often related to genetic polymorphisms affecting drug metabolism or immune response.

Example: Stevens-Johnson syndrome from carbamazepine in HLA-B*1502 positive individuals.

Drug-Drug Interactions

Concomitant use of multiple drugs can alter their metabolism and pharmacokinetics, resulting in harmful effects.

Example: Combining warfarin with antibiotics like metronidazole can increase bleeding risk due to reduced warfarin clearance.

Cumulative or Chronic Toxicity

Long-term use of certain drugs can lead to organ-specific toxicity.

Example: Chronic use of NSAIDs can cause gastric ulcers and kidney damage.

Teratogenic Effects

Drugs taken during pregnancy can disrupt embryonic development, leading to congenital anomalies.

Example: Thalidomide caused severe limb malformations in fetuses when taken during early pregnancy.

8.3 Classification of Drug-Induced Disorders

Type A (Augmented) Reactions: Predictable and dose-dependent (e.g., bleeding with warfarin).

Type B (Bizarre) Reactions: Unpredictable and often immune-mediated (e.g., anaphylaxis from penicillin).

Type C (Chronic) Reactions: Occur after prolonged use (e.g., tardive dyskinesia from **antipsychotics).**

Type D (Delayed) Reactions: Occur long after exposure (e.g., secondary cancers from chemotherapy).

Type E (End-of-use) Reactions: Associated with withdrawal (e.g., opioid withdrawal syndrome).

System Affected	Disorder	Causative Drug(s)	Mechanism
Liver	Hepatitis, liver failure	Acetaminophen, isoniazid	Direct hepatotoxicity
Kidney	Acute tubular necrosis	Aminoglycosides, amphotericin B	Nephrotoxicity
Nervous System	Seizures, psychosis	Fluoroquinolones, corticosteroids	CNS stimulation
Cardiovascular	Arrhythmias, cardiomyopathy	Digoxin, doxorubicin	Ion channel disruption, oxidative stress
Skin	Rashes, SJS/TEN	Sulfonamides, allopurinol	Immune-mediated skin reaction
Hematologic	Aplastic anemia, thrombocytopenia	Chloramphenicol, heparin	Bone marrow suppression, immune destruction

8.4 Role of Genetic and Environmental Factors

Drug-induced disorders are not solely dependent on the drug itself. Genetic and environmental factors significantly influence susceptibility:

Genetic Factors:

Polymorphisms in metabolic enzymes (e.g., CYP2D6, NAT2, TPMT).

HLA alleles (e.g., HLA-B*5701 in abacavir hypersensitivity).

Environmental/Lifestyle Factors:

- Alcohol use (enhances hepatotoxicity with certain drugs).
- Smoking (induces liver enzymes, altering drug metabolism).
- Diet and concurrent herbal remedies.

Drug	Induced Disorder	Comments
Amiodarone	Pulmonary fibrosis, thyroid dysfunction	High iodine content, long half-life
Clozapine	Agranulocytosis	Requires regular blood count monitoring

Drug	Induced Disorder	Comments
Methotrexate	Hepatic fibrosis, bone marrow suppression	Folate antagonist
Statins	Rhabdomyolysis	Increased risk with CYP3A4 inhibitors
Valproic Acid	Hepatotoxicity, pancreatitis	Especially in children <2 years

8.5 Drug reaction and Their Mechanisms

8.5.1 Immunologic (Allergic) Reactions

These reactions involve an immune response to a drug and are classified into four types (Gell and Coombs classification):

Type I (Immediate Hypersensitivity) – e.g., anaphylaxis

Type II (Cytotoxic) – e.g., hemolytic anemia

Type III (Immune Complex) – e.g., serum sickness

Type IV (Delayed-type Hypersensitivity) – e.g., contact dermatitis

8.5.2 Non-Immunologic Reactions

These include toxic, idiosyncratic, or pharmacologic effects such as:

Toxic reactions – Overdose or accumulation (e.g., digoxin toxicity)

Idiosyncratic reactions – Genetic predisposition (e.g., Stevens-Johnson syndrome from carbamazepine in HLA-B*1502 carriers)

Pharmacologic side effects – Expected but undesirable at therapeutic doses (e.g., sedation from antihistamines)

8.6 Control of drug reaction

4.1 Pharmacovigilance

Monitoring, assessing, and reporting adverse drug reactions (ADRs) is essential to detect signals of potential drug harm. Systems like the WHO Programme for International Drug Monitoring and FDA's Med Watch play a vital role.

4.2 Genetic Screening and Personalized Medicine

Pharmacogenomics helps identify patients at risk of ADRs.

Example: Screening for HLA-B*5701 in HIV patients before abacavir initiation to prevent hypersensitivity (Mallal et al., 2008).

4.3 Rational Drug Use

Use the lowest effective dose for the shortest duration.

Regular review and deprescribing in polypharmacy cases.

4.4 Clinical Guidelines and Protocols

Adherence to evidence-based prescribing guidelines (e.g., Beers Criteria for elderly).

Use of computerized alert systems to prevent interactions and dosing errors.

Summary

Drug-induced disorders present a serious challenge in healthcare, affecting patient safety and increasing healthcare costs. Understanding the pathophysiological basis, risk factors, and preventive strategies is key to minimizing these adverse outcomes. Incorporating pharmacogenetic testing, robust pharmacovigilance, and rational prescribing practices are essential strategies to safeguard against drug-induced harm.

Conclusion

Drug-induced human disorders, though often rare, can be severe or fatal. Continued surveillance, pharmacogenetic advancements, clinician awareness, and strict regulatory frameworks are essential to reduce their incidence and severity. A multidisciplinary approach—linking clinical medicine, pharmacology, and genomics—is key to safer therapeutics.

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Unit 9: Water-Related Human Disorders

Unit Structure

9.0 Learning Objectives

After going through this unit, you will be able to:

- Explain the importance of water
- Describe the effects and mechanisms of water related occupational diseases and disorders
- Identify various diseases and disorders in various water related industries
- Understand about the prevention and control of water related disorders

9.1 Introduction

Water is essential for the survival of life on earth. About 70% of Earth (often called as Blue Planet) surface is covered with water and it is the only planet in our solar system containing liquid water. The human body contains about 70 % water. Water is crucial in regulating all body temperature, organs and as well as dissolving solids and moving nutrients throughout the body. It various uses includes drinking, bathing, cleaning, washing clothes, cooling, irrigation and in industry.

At the same time, no other substance on this earth can exist in all three phase states i.e., liquid, solid, and vapour. Water, although is a simple molecule but it has a high

complex and anomalous character because of its hydrogen bonding. As a gas, water is the lightest known, as a liquid it is much denser than estimated and as a solid it is much lighter than expected when related with its liquid form. The continual movement of water around the globe is known as the hydrologic cycle. Also, we must remember that water is a "universal solvent" capable of dissolving many kinds of substances due to which natural water is never find absolutely pure. Due to its polar character, water is a good solvent for salts, polar organic compounds and gases. Because of this property almost all biochemical reactions occur in aqueous solutions and water is a crucial reaction medium for all metabolic processes in living cells. Water dissolves a very large number of molecules in concentrations that are sometimes small but sufficient to initiate biochemical or biological effects on organisms. As a solvent and a main principal participant of reactions and processes, water is a medium for biological processes, chemical reactions, and various physical phenomena. After mercury, water has the highest surface tension of all generally occurring liquids. Water's surface tension can hold weight that would normally sink. Floating a paper piece on top of the water, walking of some aquatic insects e.g., water strider is due to water surface tension property. The movement of water within the spaces of a porous material because of the forces of cohesion, adhesion and surface tension is known as capillary action. This property is essential for the growth of plants and trees where water enters the plant's roots and reaches to the tip of the plant through tiny tube-like structures called xylem. Water absorbs or releases more heat than many substances for each degree of rise or fall of temperature. Because of this, it is commonly used for cooling and for transferring heat in chemical and thermal processes.

Water is used for many different purposes throughout the world for domestic (drinking, cooking, personal cleaning, cloth washing, home cleaning, irrigation), industrial and for waste disposal. Globally, industry uses about twofold as much water as used in households, mostly for cooling in electricity generation. Water uses can be classified into consumptive and non-consumptive use. Consumptive use denotes that water which partially or totally used up, through evapotranspiration, transformation, contamination or other processes. This categorization is limited in extent as water never disappears from the water cycle and the amount of water cannot be increased or decreased on the planet. Rather, consumptive uses remove this water from the terrestrial part of the water cycle and return it to a vapour state. Examples of this uses

are water for domestic and municipal needs, irrigation and industry. Nearly 85% of total human consumptive use of water worldwide is for irrigation in agriculture and about 70% of the total water used in industry is for cooling purpose only. Non-consumptive uses do not reduce the volume of water available to that stage of the water cycle and it includes hydropower generation, recreation and water sports, fisheries, inland navigation, and ecosystem maintenance. Industries not only consume water but in turn pollute it. As per the World Development Report of World Bank (2003), few cities in developing countries treat their wastewater, thereby polluting downstream water bodies.

Hazard is an inherent capacity of a chemical or mixture to cause/create adverse effects on man or the environment under the conditions of exposure. Risk is the likelihood of occurrence of an adverse effect on man or the environment causing from a given exposure to a chemical or mixture. Disorder is an illness or problem of mind and body which disrupts normal mental or physical functions. Disorder can also be called as a disruption of the disease to the usual or regular functions in the body or body parts. Whereas a disease is an illness of people that produces specific symptoms or that affects a specific location caused by infection or a failure of health rather than by an accident. Disease is a health condition that has a clearly defined reason behind it, causing from a pathophysiological response to internal or external factors. A disorder is caused because of the presence of disease in the body. Disorders can be categorized into physical, mental, emotional, genetic, behavioural, and structural. In addition, there are work-related musculoskeletal disorders (WMSDs), which are a group of painful disorders of muscles, tendons, and nerves. Frequent and repetitive work activities, or activities with awkward postures cause these disorders. Depending upon type of work there is involvement of arms, hands and legs. Therefore, most WMSD affect the wrists, hands, neck, elbows, shoulders, legs, hips, ankles, feet and some back-bone related problems due to repetitive activities. In addition, workers are at risk of exposure to large amounts of synthetic chemicals, mineral and metallic dusts making them prone to different diseases.

The water related hazards can be classified into four categories i.e., physical, chemical, biological and nutritional health hazards. Physical hazards mainly due to water related accidents of boats or ships in water, drowning or immersion due to lack of swimming skills. Chemical hazards occur due to presence of chemicals in water

e.g., fluorosis due to fluoride, arsenicosis due to arsenic, lead poisoning due to presence of lead in old pipes, and Methaemoglobinemia (blue baby disease) due to nitrate contamination especially in agricultural areas. The biological health hazards can further be classified into four types as water-washed, water-borne, water-based and water-related insect-vector diseases. Typhoid, diarrhoea, cholera, amoebic dysentery are examples of water-borne disease, whereas trachoma, scabies are examples of water-wash diseases. Examples of water-borne disease are schistosomiasis and dracunculiasis while yellow-fever, filariasis, malaria are water-related (insect-vector) diseases. Malnutrition, water-born or water-related diseases cause anemia, a nutritional health hazard.

Water intensive industries are those industries which consume large amount of water. In India, after agriculture sector, industries are the second highest consumer of water. In India, there are no correct data regarding water consumption by the industrial sector, however as per the Ministry of Water Resources and the Central Pollution Control Board (CPCB) reports it varied between 6-8 % of the total freshwater abstraction. Further, the World Bank estimates that the present industrial water use in India is about 13 % of the total freshwater withdrawal. The water demand for industrial uses and energy generation will increase at a rate of 4.2 % per year, rising from 67 billion cubic meters (BCM) in 1999 to 228 BCM by 2025 (Aggarwal and Kumar, 2011). Industries not only use water but in turn also pollute it. The main source of water for the industries is surface water (41%) followed by groundwater (35%) and municipal water (24%) (FICCI, 2011). Textile, paper and pulp, and leather industries consume lot of water. The water industry delivers drinking water and wastewater amenities (including sewage treatment) to residential, industrial, and commercial sectors. Normally public services operate water supply networks. The water industry does not comprise suppliers and manufacturers of bottled water, which is part of the beverage production which comes under the food sector. Bottled water, soft drink and ice manufacturing, shrimp and fish farming, swimming pools maintenance, recreational water activities, sanitation are some professions where workers are comparatively more and regular contact with water. The workers employed in these industries and other water related professions like laundry, fisherman, farmers, in sewers are in continuous contact with water and may develop certain disorders and diseases. The emergence of disorders and diseases depends upon many factors like work experience, personnel habits,

worker immune system and regular use of personnel protective equipment's (PPE). The present unit will discuss different aquagenic disorders and diseases, their symptoms and their prevention and control.

9.2 Disorders- Causes, Effects and Mechanisms

As mentioned above that workers are exposed to water in different industrial settings and may get health impacts. In this section you will learn different aquagenic diseases, their causes and mechanisms under different work settings. The most common mode for various aquagenic disorders is by hand-to-mouth contact during drinking and, eating, or by wiping the face with dirty hands or gloves or by licking splashes from the skin. In addition, skin contact, through scratches, cuts, or penetrating wounds, i.e., from discarded hypodermic needles. Certain microbes can enter the body via the surfaces of the nose, eyes, and mouth.

9.2.1 Diseases Related with Aquaculture

Aquaculture is characterised by a high dominance of water related work, as well as simultaneous exposure to hazardous chemicals and biological agents. Skin symptoms are usually reported symptoms in epidemiological studies of aquaculture workers from different parts of world. Diseases like skin itching, dermatitis, fungal nail disorders, urticaria, different skin problems (like lesions, allergy, irritation, roughness, itching and sores, infections etc.), were reported among aquaculture workers (Ngajilo and Jeebhay, 2019).

9.2.2 Diseases Related with Wastewater Treatment Plant

One common effluent treatment plant or sewage treatment plant provides service to hundred or more industries and users respectively, thereby a vast range of chemicals may be present in the receiving waste water and sludge. The presence and organisms in wastewater, in sludge, and in the air at particular locations in treatment plants has raised doubts regarding their possible effects on worker's health in these plants. Workers in these plants may be exposed to chemicals or microbes through direct contact with wastewater and sludge, or by inhalation of aerosols, particles, gases, vapours, or droplets. The presence of bioaerosols in the air might pose a possible epidemiological risk. Studies reported that workers employed in wastewater treatment plant have a comparatively higher prevalence of the so-called "sewage worker

syndrome" with headache, dizziness, fatigue, respiratory symptoms and gastrointestinal symptoms. Many recirculating vertical flow constructed wetlands treated greywater can produce bioaerosols, which might affect worker health if inhaled, ingested, or come into human skin contact in critical amounts (Gross et al. 2007, 2008, 2015). In addition, these treatment plant workers exposed to chemicals or organisms mainly through ingestion of contaminated food or water or through unintentional ingestion of sludge or wastewater. Some chemicals from wastewater can enter into nearby air especially near weirs, aeration tanks, dewatering processes, and other sludge processes (compacting, drying, and incineration). As a result, workers working in these areas can get gastrointestinal and respiratory exposure from inhaled chemicals and organisms. Workers may also get exposure to chemicals while removing these substances from equipment's in the treatment plant. Disease organisms can also get entry into worker body through abrasions or cuts. The wastewater workers exposed to various types of viral diseases like gastroenteritis, infectious and serum hepatitis, aseptic meningitis, poliomyelitis and respiratory diseases. Bacterial diseases include salmonellosis, typhoid fever, shigellosis, cholera and gastroenteritis while from protozoa are amoebic dysentery, ameobiasis, balantidiasis, giardiasis, and meningoencephalitis (Brown, 1997).

9.2.3 Diseases Related with Wastewater Use in Agriculture

Globally, the agricultural sector is the biggest consumer of water and wastewater accounted for about 70% on average (Winpenny et al., 2010). Farmworker exposure is important because of longer exposure time higher contact frequency and multiple pathways. Heavy metals are toxic because of they are soluble in water, having long biological half-lives, and their potential to accumulate in different body parts. Further, the toxicity can be acute or chronic depending upon the exposure period and concentration (Dorne et al., 2011; Jarup, 2003). From soil these heavy metals may transfer into food crops which increase human beings' exposure of these potential toxic elements. Ordinary people get exposed to different types of heavy metals or other organic chemicals through contaminated food consumption. Ahmad et al. (2018) found that lead (Pb), chromium (Cr), copper (Cu), and manganese in wastewater for agricultural fields presented toxic consequences by causing digestive, excretory, respiratory, immune, and glandular malfunctions. Wang et al., 2005 reported consumption of fish and vegetables, contaminated with various heavy metals like

cadmium (Cd), Cr, Cu, mercury (Hg), Pb, and zinc (Zn) was the most possible means for exposure among people in Tianjin, China. It will induce a variety of respiratory adverse health effects, such as emphysema, lung inflammation, fibrosis, and tumours. Accumulation of Cd, particularly in the kidneys, leads to kidney damage and osteoporosis, known as ouch-ouch or itai-itai disease in Japan was found to be related with rice paddies irrigation with highly contaminated water (Jarup, 2003). Heavy metals in wastewater can cause various adverse gastrointestinal effects, impairment of kidneys, cardiovascular problems, neurological disorders, bone problems, convulsions, and paralysis. Accumulation of heavy metals beyond permissible limits has the potential to affect vital organs like liver, kidneys, bones, and blood and induce serious health hazards (Wu, 2020). Bioaerosols can be a career for the spreading of animal and human pathogens from wastewater. Antibiotic residues in wastewater, activated and digested sludge, and urban biosolids has become an increasingly recognized environmental concern (Zhang and Li, 2011). Crops absorb the antibiotics from polluted soils which are irrigated with wastewater. Antibiotics remaining in potable water will weaken the immunity and affect body immune system. For example, penicillin can cause allergic reactions to humans, while gentamicin is very toxic for the kidneys. Quinolones can raise the sensitivity of human body to light, and tetracyclines can seriously affect the children's teeth development (Kuemmerer, 2009).

9.2.4 Diseases Related with Swimming Pools/Water Recreational Parks

Individuals and swimming pool or water parks workers may develop different types of water related ocular diseases (WRODs). These diseases may develop due to exposure to irritants such as chloramines, especially nitrogen trichloramine or trichloride. Wide varieties of chlorine containing agents (such as sodium- or calcium hypochlorite and chlorinated isocyanuric acid) are used to disinfect water in swimming pools (Héry et al. 1995). The swimmers introduce nitrogen-containing matter in the pools through their urine, sweat, skin squama, and cosmetics. The free chlorine reacts with this nitrogen-containing material and form a number of disinfection by-products (DBPs) such as chloramines and trihalomethanes (Florentin et al. 2011; Parrat et al. 2012). Trichloramine is considered as the main agent responsible for causing ocular irritation (Florentin et al. 2011; Parrat et al. 2012). Acanthamoeba (free-living amoebae species), *Giardia lamblia* (protozoa), *Coenurus cerebralis* (a cystic larval stage of the dog tapeworm), *Burkholderia pseudomallei* (gram negative bacillus), Leptospira, larvae

of Toxocara species are some infective agents/pathogens which causes WRODs (Ahmad, 2018). Swimming pool or water parks related problems can be reduced by minimizing DBPs formation like managing all technical parameters during water disinfection, water quality regulation, ensuring good public hygiene and through awareness (Parrat et al. 2012). Public hygiene can be ensured by wearing proper cloths in the pools and parks and take shower prior to enter in the swimming pools.

9.2.5 Diseases Related with Oil Spill Cleanup in Oceans

Workers engaged in oil spill cleanup can face potential hazards from oil by-products, detergents, dispersants, and degreasers. Fatalities from drowning, heat illness and falls as well as encounters with aquatic animals are the hazards faced by them. These chemicals can enter the worker body through dermal (skin contact) i.e., absorption, respiratory system i.e., inhalation, ingestion and injection. Heat injury, sun burn, eye injuries, fatigue and stress are the associated health problems faced by these workers (OSHA, 2010). Engineering control, use of good quality respirators and PPE can reduce the risk in oil spill cleaning. An oil spill occurred in Daesan, South Korea during 2007 where 442 workers involved in the cleanup operations reported ocular symptoms, headache, skin symptoms, neurovestibular (balance disorder), respiratory and back ache (Na et al. 2012).

9.2.6 Diseases Related with Fishing Industry

Fishers engage in collecting or catching fish, shrimp, crabs, oysters, and clams are generally at a greater risk of occupational illnesses. Musculoskeletal problems are widespread across the fishing sector. Other related hazards comprise stings and bites from aquatic animals (some may be life-threatening), vessel engine noise, skin lesions of eruptions, eye diseases caused by sun radiations, and respiratory problems (due to protein aerosols exposures). Further, divers may pose many breathing and other hazards (Myers et al. 2018).

9.2.7 Diseases Related with Brief Contact with Water

These are commonly known as aquagenic cutaneous disorders in medical term. They include a group of rare diseases such as aquagenic urticaria, aquagenic pruritus, and aquagenic Acro keratoderma characterized by skin lesions or discomfort induced by brief contact with water. Although their clinical symptoms are quite different however, their origin is mainly water contact. One by one we will discuss these disorders in brief.

Aquagenic urticaria (AU) is a rare disease that causes people to have an allergic reaction when water touches their skin. Shelley and Rawnsley (1964) first described it in 1964. AU is a rare subtype of physical urticaria marked by pruritic wheals which quickly develop after water contact, regardless of source or temperature of water. The signs of AU are like to all other forms of physical urticaria, including wheals, intense pruritus, and flushing in areas exposed to water. Symptoms may develop at once or within minutes after skin contact with water, irrespective of water temperature, pH, or psychogenic factors. The symptoms generally disappear within 30–60 min after one water contact is stopped (Wang et al. 2017). Although the rash can grow any part of the body, but most commonly develops on the arms, neck, and upper trunk. The urticarial rash may be followed by minor to severe burning and prickling (Shelley and Rawnsley, 1964). In rare cases, headache, shortness of breath, wheezing, dizziness, and syncope (sudden loss of consciousness) may occur (Luong and Nguyen, 1998). In other exceptional instances, Bernard-Soulier syndrome a rare autosomal recessive disorder related with prolonged bleeding may occur. Shelley and Rawnsley (1964) advocated that the water interaction with sebum or sebaceous glands might give rise to a toxic substance which causes degranulation of mast cells and thus release histamine and form wheal. Another reason is that while with water contact, a water-soluble epidermal antigen spread throughout the dermis layer of skin and causes mast cells to release histamine (Chalamidas and Charles, 1971).

Aquagenic pruritus (AP) was first reported by Shelley in 1970 (Shelley, 1970) and it is categorized by the growth of intense pruritus or a tingling, stinging, or burning sensation – without any noticeable skin changes in areas of the body exposed to contact with water of any temperature. The burning pain induced by water is also referred to as aquadynia, which is considered to be a variant of AP (Shelley and Shelley, 1998). Water contact is the only trigger factor for AP. The primary cause is unknown. Aquagenic pruritus can affect people of both genders and of any age, however its dominance is in middle-aged or elderly persons (Steinman and Greaves, 1985). Perspiration and precipitation may also be triggering factors. The prevalence of bathing pruritus among Ambrose Alli University Ekpoma, Edo State, Nigeria undergraduate students was 23.8%, where respondents reported itching from rain water (23%) followed by cold water (19%) (Salami et al. 2009). Symptoms may develop at once or within minutes after exposure to water and can remain for about an

hour or more. Any part or the entire body may be affected but preferably occurs on legs, followed by arms, chest, back, face, and hips. The soles, palms, and mucous membranes are generally not affected. The condition can strongly harm patients' quality of life, especially in those with polycythemia vera (PcV) (Siegel et al. 2013). Histopathology in AP patients may reveal an increased number of mast cells, dermal eosinophils, and lymphocytes (Saini et al. 2010). However, there are no ultimate medical investigations to confirm the AP diagnosis.

Aquagenic Acro keratoderma (AA) *was* first described in 1996 by English and McCollough (English and McCollough, 1996). AA is a rare and acquired dermatosis, mainly affecting the adolescent women. Other terms or synonyms to AA are aquagenic syringeal Acro keratoderma, aquagenic palmoplantar keratoderma, aquagenic wrinkling of the palms, aquagenic pseudo keratoderma and transient reactive papulotranslucent keratoderma (Luo et al. 2010; Rongioletti et al. 2012). Aquagenic Acro keratoderma is characterized by shining or whitish papules and plaques that develop after short contact with water and resolve soon after drying (Rongioletti et al. 2012). The triggering factors for AA are swimming, showering and sweating. The precise pathogenesis for AA remains uncertain, however, irregular regulation of eccrine ducts has been found to be responsible (Luo et al. 2010). Other hypotheses describe about transitory structural or functional defects of the stratum corneum (outermost layer of epidermis), which causes more water absorption and, subsequently, AA lesions (Luo et al. 2010). Aquagenic Acro keratoderma is often related with cystic fibrosis (CF), suggesting that the increased salt concentration in sweat in the stratum corneum may play an important role in the rapid development of lesions after water exposure (Gild et al. 2010). It can occur in both genders, mainly affecting adolescent women. After exposure to water for 2–20 min lesions appear as whitish papules and plaques, edema, and hyper wrinkling with or without desquamation (skin peeling). However, within minutes to after one hour of drying lesions disappear. Warm water aggravates lesions more quickly compared with cold water. Salt water and detergent also induce lesions, more rapidly in some cases (Luo et al. 2009).

Treatment of aquagenic cutaneous disorders: The main purpose of treatment is to avoid those substances that cause the urticarial reaction, and find appropriate substitutes. Hands can be protected by using gloves however, in case some person is

allergic he can avoid the use of gloves. To minimise the reaction, medications can be used but can be taken after due consultation with doctor. For example, in case of Aquagenic urticarial (AU), *antihistamines* can be taken prior to water exposure. Ultraviolet-A and ultraviolet-B light as well as psoralen have been reported to AU symptoms in some patients resistant to antihistamines (Martínez-Escribano et al. 1997; McGee et al. 2014). The mechanism may be associated to the epidermis thickening induced by ultraviolet-A treatment, which protects the dermis from water entry (McGee et al. 2014). Barrier creams can also be useful prior to water exposure as an alternative as they can protect the skin from water while performing washing or water related work. Patients can also an umbrella or apron (protective clothing) to avoid water exposure if required. Antihistamines also prevent or reduce Aquagenic pruritus (AP) symptoms in some cases. Alternative therapeutic choices include analgesics, selective serotonin reuptake inhibitors, and alkalinization of bath water (bath with sodium bicarbonate, pH 8) (Ehrchen and Stander, 2008; Diehn and Tefferi, 2001) but can be used only after doctor advice. Use of baby oil on the skin prior to shower may be useful and drying the skin immediately after water exposure is another option in reducing AP symptoms (Diehn and Tefferi, 2001). Similarly, Aquagenic Acro keratoderma (AA) spontaneous reduction can be attained by water removal. Aluminum chloride hexahydrate 20 % in anhydrous ethyl alcohol, salicylic acid (5 %) and urea ointments, tazarotene gel, mixture of mometasone furoate and petroleum jelly, and formalin are also reported in (AA) treatment (Luo et al. 2009).

9.3 Prevention and Control of Disorders

Prevention it refers to steps that are applied to prevent the occurrence of a disease whereas, in control measures are applied to prevent disease transmission after it has occurred. Prevention can be primordial, primary prevention, secondary and tertiary. In primordial emergence or development of risk factors is prevented in population groups where the disease has not yet appeared. In primary prevention, actions were taken before the onset of disease, which eliminates the possibility of disease occurrence. Secondary prevention includes those actions which stops the progress of a disease at its emerging stage and prevents complications. Whereas, tertiary prevention focuses on available measures to decrease or limit impairments and disabilities, minimize suffering caused by existing departures from good health and to promote the patient's adjustment to irremediable conditions. Some key components of prevention are

awareness and education, research, monitoring environmental risk areas or situations, hazard evaluation at different levels, public health system improvement at different levels, and proactive behaviour by individuals (CDC, 2003).

9.3.1 Prevention of Disorders

As there are so many types of aquagenic disorders discussed in above sections, it is difficult to explain their prevention individually and in detail. In general workers can use physical barriers or PPE like gloves, gum boots or protective clothing to prevent water exposure. As workers are exposed to a wide range of workplace hazards, application of a single intervention measure will not reduce the occupational health risks. Most effective preventive intervention require an interdisciplinary approach that extract and assimilates information from various disciplines. Some interventions and their use in various aquaculture settings (Ngajilo and Jeebhay, 2019) are mentioned pointwise as:

i) Provision of ventilation at workplace
ii) Usage of appropriate safety equipment
iii) Equipment maintenance
iv) Implementing safety procedures
v) Keeping correct body position during lifting, variation/rotation, resting, training
vi) Having adequate staff so that workers can be shifted regularly from one section to another to avoid repetitive work. Workplace organization is also useful.
vii) Safe operating procedures
viii) Use and proper maintenance of PPE like chemical protective cloths, chemical safety goggles, and respirators
ix) Decontamination of the work area
x) Ensuring proper waste disposal
xi) Breathing and eye protective equipment
xii) Danger or hazard warning signs
xiii) Worker's information, awareness and training must be there
xiv) After work shift personal hygiene must be ensured strictly

xv) Provision and availability of immediate first aid especially during inhalation incident

9.3.2 Control of disorders

The term disease control incorporates ongoing actions aimed at reducing the incidence and duration of disease and subsequently the risk of transmission, the effects of infection, and the financial burden to the community. The risk and hazard controls actions must be selected as per the hierarchy that focuses on solutions e.g., hazard disposal or replacement at priority, followed by safe work practices, personal protective equipment and administrative controls (like training). The sewer and sanitary workers suffer mostly from biological and chemical hazards that can be prevented and controlled through engineering, curative and judicial measures. The engineering methods should emphasis on making the process more mechanical as in many countries use of robot for cleaning of sewers is already in practice. Occupational health services i.e., pre-placement and periodic health check-up must be carried out for these workers on routine basis. Further, the proper use of personal protective equipment and administrative protocols and can also reduce and control the disorders.

Risk management is a good technique which is based on the outcomes of the risk assessment and applying adequate control options. The main aim of risk management is to ensure worker protection and public health by managing risks as efficiently as possible by selecting and applying appropriate measures. Risk communication is very important in risk management where the exchange of information and opinion on risk is made among risk managers, risk assessors, and other interested groups, including the general public. In addition, implementation of different laws, regulations, rules and standards as specified by the government can further prevent the disorders and reduce their impacts.

Summary

In this unit we have studied and learnt that:

- Aquaculture, swimming pools, sewers, fishing industry, wastewater treatment plants are some work places where workers are in continuous contact with water.
- Various types of aquagenic disorders and diseases at different work places.

- Mechanism and treatment of different aquagenic disorders.
- Contaminants in wastewater can enter in human body through many ways, like through food chain (ingestion), via aerosols (inhalation), and from drinking and swimming (direct contact).
- Prevention and control strategies of aquagenic disorders and diseases.

Question for Practice

1. The continual movement of water around the globe is known as _____.
2. Typhoid, diarrhoea, cholera are examples of _____.
3. Differentiate between hazard and risk.
4. Differentiate between disorder and disease.
5. Name some chemical related water hazards.
6. Name different types of personnel protective equipment's used by the workers to prevent aquagenic diseases at work place.

Answer

1. Hydrologic cycle /water cycle
2. Water-borne disease
3. Hazard is an inherent capacity of a chemical or mixture to cause/create adverse effects on man or the environment under the conditions of exposure. Risk is the likelihood of occurrence of an adverse effect on man or the environment causing from a given exposure to a chemical or mixture.
4. Disorder is an illness or problem of mind and body which disrupts normal mental or physical functions whereas a disease is an illness of people that produces specific symptoms or that affects a specific location caused by infection or a failure of health rather than by an accident.
5. Chemical hazards occur due to presence of chemicals in water e.g. fluorosis due to fluoride, arsenicosis due to arsenic, and Methaemoglobinemia (blue baby disease) due to nitrate contamination especially in agricultural areas.
6. Chemical protective clothing, chemical safety goggles, respirators and gum boots.

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Terminal Questions

Q1. What are the common diseases related with aquaculture?

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Q2. Explain how a farmer is exposed to different types of chemicals and related diseases through water use.

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Q3. Describe various types of aquagenic cutaneous disorders caused by brief contact with water.

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Q4. Explain different modes of exposure for various aquagenic disorders.

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Q5. Discuss various strategies of prevention and control of water induced diseases among workers.

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Unit 10: Psychological Stresses

Unit Structure

10.0 Learning Objectives

After going through this unit, you shall be able to:

- Explain the concept of psychological stress;
- describe the nature and concept of stress;
- discuss the sources and measurement of stress; and
- Describe Workplace specific psychological stresses and mechanism of stress.

10.1 Psychological stresses

Psychological stress refers to the emotional and physiological reactions experienced when an individual perceives a situation as challenging, threatening, or beyond their coping abilities. It is a critical component in understanding human behavior and health outcomes.

Psychological stress occurs when an individual perceives those environmental demands exceed their adaptive capacity, resulting in physiological and psychological responses (Lazarus & Folkman, 1984).

According to Lazarus and Folkman's **Transactional Model of Stress and Coping** (1984), psychological stress occurs when a person evaluates a situation as taxing or exceeding their resources and endangering their well-being. This appraisal process determines the emotional and behavioral response.

"Stress is a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being."

Psychological stress is an integral aspect of human experience, influencing physical and mental health profoundly. Understanding the mechanism of psychological stress involves exploring how stressors are perceived, processed, and responded to by the brain and body. This chapter elaborates on the biological and psychological pathways of stress, highlighting key mechanisms and illustrating with scientific examples.

10.2 Stress and Trauma

Stress is basically a result of threatening and disturbing situations which cause the human being's body to suffer from disequilibrium or homeostasis. It is important for the person to gain back his homeostasis in order to rectify and rebuild his or her emotional and cognitive organizations. In our daily lives, we may suffer from two types of stress, namely stress (negative) and eustress (positive). Eustress is also called positive stress because it is experienced at times such as, when an individual is preparing for his examination or a presentation. This eustress provides motivation to the individual. The stress caused in eustress is taken in a non-harmful manner because it does not interfere with the person's

cognitive functioning. Another important term one needs to remember is the stressors. Stressors are objects, situations or stimuli that cause the stress. Stressors have no particular or specific demarcation; they may be of the slightest of danger to the person and sometimes they may be at the highest pressuring level.

Trauma on the other hand, is defined as an event that is caused due to human or nature, and leads to challenges being faced by the individual associated to food, shelter and safety. The 1987 edition of DSM-III-R defines traumas as the events that are usually outside the range of the normal life events. The definitions of trauma have been revised several times since then.

There are three types of stress disorders:

- ✓ Post-Traumatic Stress Disorder (PTSD)
- ✓ Dissociative and Conversion Disorder
- ✓ Acute Stress Disorder

10.2.1 Post- Traumatic Stress Disorder

The DSM-IV presented with a criterion and a number of symptoms which need to be met in order to be diagnosed with PTSD. The DSM stated that a person suffering from PTSD must have at least three numbing, two symptoms of hyperarousal and one intrusion. Out of the following, the person must show or report at least three numbing or symptoms that show avoiding behaviors:

- ✓ Ignoring any type of feelings or conversation about the traumatic event
- ✓ Making a hard effort to avoid going to places or seeing or meeting people who
- ✓ have been associated to the event in some way.
- ✓ Not being able to remember any aspect of the trauma
- ✓ Lack of interest to participate in any activity
- ✓ Showing numbness and being emotionless
- ✓ Restricted range of affect
- ✓ No futuristic plans or views

Out of the following, any two of the hyperarousal symptoms must be present or reported by the person:

- ✓ Lack of sleep
- ✓ Anger bursts very often
- ✓ Lack of concentration
- ✓ Hypervigilance
- ✓ Extreme and exaggerated responses

The patient must report at least one of the following intrusion symptoms:

- ✓ Repeatedly occurring and intrusive flashbacks of the trauma
- ✓ Nightmares
- ✓ Illusions or hallucinations
- ✓ Extreme distress

Etiology:

Biological factors: hippocampus and the amygdale are the two parts of the brain which are responsible for emotions and memory of an individual. Thus, when the traumatic event takes place, these two brain systems get activated and are held responsible for the memory and the related emotions with the trauma. There are two types of hormones which are also responsible in forming traumatic memories; these hormones are cortisol and norepinephrine. These two hormones rise in level when there is a memory recall of the traumatic event, which leads to the fear arousal in the individual.

Classical conditioning model: in this case the individual is stuck in a cycle, where he keeps experiencing negative emotions which are associated with the traumatic event. The individual is unable to avoid the emotions which arise due to the memory of the trauma. Thus, it forms a vicious cycle which is difficult to stop.

Events or trauma that could lead to PTSD:

- Death of a loved one
- War time

- Sexual abuse
- Childhood trauma or neglect
- Natural disasters
- Rape
- Terrorist attacks

Treatment of PTSD:

Debriefing: this form is not exactly a treatment but a way of preventing PTSD from happening. In Debriefing, the person who has been in the trauma or has witnessed the trauma is talked to. It involves only one interview where the helper or the professional tries to talk to the victim n tries to encourage him to speak about the event. This helps the person to let out his emotions. Debriefing is believed to have positive effects along with negative ones by pushing the victim closer to PTSD. It helps to avoid secondary traumatization that is helps in avoiding the person from any further imagination about the trauma.

Exposure techniques: this type of intervention involves the exposure of the most traumatic part of the traumatic event that took place. The person suffering from the trauma talks about the event to such an extent and till a point where he stops feeling any type of distress and trauma. This technique is very commonly used to overcome traumatic events.

Eye Movement Desensitization and Reprocessing (EMDR): this technique was developed and discovered by Shapiro (1995). This technique is one of the most popular and effective techniques.

Family therapy: in this type of therapy the patient gains love and support from his loved ones or the family. This type of therapy provides the patient with support and a reason to live happily.

Pharmacological intervention: there are many drugs involving some antidepressants such as MAOIs, SSRIs and tricyclics which have been effectively used for the treatment of PTSD.

10.2.2 Dissociative Disorders

(A) Dissociative Amnesia

According to the DSM-IV, dissociative amnesia is characterized as a type of dissociative disorder. Dissociative amnesia is characterized by the forgetting of important information about self. Forgetting like this is associated with the explicit memory such as personal information or information about the past and implicit memory such as general knowledge. Amnesia can be of three types, generalized amnesia, localized amnesia, selective amnesia and systematized amnesia.

Generalized amnesia is one which involves forgetting of personal information.

Localized amnesia is one where the person forgets about for a certain period of time.

Selective amnesia involves forgetting some parts of an event or act. And finally,

Systematized amnesia is one which includes forgetting a category of information such as forgetting all memories of one's family.

The onset of dissociative amnesia starts when there is uncontrollable stress and trauma such as times of war, loss of a loved one, death, violence, natural disaster etc.

(B) Dissociative Fugue

Another type is the dissociative fugue. This type of dissociative disorder is defined by DSM-IV as a sudden wandering away from home or place of work. In this disorder the person is confused with his personality or self. It is believed by several researchers that it is more likely that the patient is confused with his own present identity rather than acquiring a new identity altogether.

There is great evidence about the fact that dissociative fugue and dissociative amnesia is a result of trauma and too much stress. Psychiatrists also talk about the soldiers in war who suffer from immense trauma and stress and thus suffer from these stress disorders.

(C) Depersonalization

According to DSM-IV depersonalization is defined as repeatedly occurring and persistent feeling of being detached from one's own self, identity, physical body and mental process too. There are chances that the therapist may diagnose these symptoms as psychotic

symptoms. But these symptoms differ from delusions etc in one way, that they are present without the impairment of the reality. The person suffering may feel detached from his own body or may feel alienated, unreal and dead but he is not detached from the reality. The patient suffering from depersonalization feels like he is like a robot or a mechanical machine which is detached from the environment.

(D) Depersonalization

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There are four major characteristics of depersonalization disorder:

- A sense of alteration in self's body such as feeling like one is not in his own body.
- A precipitating factor such as substance abuse or an injury.
- A feeling like one is in a dream and everything seems unreal.
- Sensory alterations.

Like most dissociative disorders the causes for depersonalization disorder is the trauma, stress, child abuse, domestic violence or any other type of stressful event in childhood or at present.

(E) Dissociative Identity Disorder

Dissociative identity disorder has a major characteristic which helps in diagnosing this disorder. Patients suffering from DID behave in such a manner as if they possess two personalities or identities. These personalities or identities are also called alters. In the past, patients were diagnosed with few personalities.

These alters can range from 15 to 100. DSM-IV-TR has given a criterion for DID as follows:

- The person must possess more than two alters or personalities. Each personality state should have its own pattern of perceiving the world around, thinking and the way of behaving.
- At least two of these two personality states must be dominant at different points of time and take over the control of the person's behavior.
- The person is unable to recall the actions or the things said at the time the person possesses one alter.
- The disturbances or changes in the personality are not due to any physical problems, substance abuse or any type of medical condition.

10.2.3 Acute Stress Disorder

The major characteristics of acute stress disorder are not very different from those of the PTSD. The development of extreme anxiety, symptoms of dissociative disorders and several others that occur within the time span of 1 month of the trauma or the stress or loss of a loved one. Other symptoms are withdrawal from enjoyable activities, social gatherings, lack of self-care, low emotional responsiveness and a feeling of guilt and blaming oneself for everything.

Someone who suffers from an Acute Stress Disorder is one who experiences symptoms

including a feeling of detachment from one's own body; feeling like one is in a dreamlike state, lack of concentration and also an inability to recall parts or specific aspects of the traumatic event (dissociative Amnesia)

Another important thing about Acute Stress Disorder is that it involves at least one symptom from each cluster of symptoms for PTSD. These symptoms have been mentioned in the section about PTSD above.

The DSM-V listed 5 main diagnostic criteria:

- ✓ The first criterion includes the any serious accident or injury, sexual abuse of any kind or death.

- First-hand experience of the trauma
- Eye witness of the traumatic event
- Hearing about the death of a close one or a friend
- Experiencing various details or information about the traumatic event

✓ The second criterion of DSM-V is that the person must report at least 9 to 14 symptoms out of the following 4 categories mentioned ahead which may start or worsen after the trauma.

Intrusion:

- Repeatedly occurring thoughts and memories of the traumatic incident
- Nightmares
- Flashbacks of the trauma occurring or repeating itself
- Prolonged psychological and physiological reactions

Negative mood:

- Inability to experience happiness or satisfaction
- Dissociative symptoms including losing time, forgetting important parts of the traumatic event (dissociative amnesia) and feeling unreal

Avoidance symptoms:

Making efforts to avoid distressing thoughts and memories about the trauma

- Making efforts in order to avoid the places, people, objects, situations etc. that

Arousal symptoms:

- Difficulty in falling asleep or staying asleep
- Irritability and mood swings
- Lack of concentration
- Exaggerated response
- Hypervigilance

- ✓ The third criterion for Acute Stress Disorder is that the symptoms mentioned above or the disturbances seen should be at least 3 days to 1 month after the traumatic event has taken place.
- ✓ The fourth criterion is that these symptoms or disturbances must cause clinically significant effects in the person's social, personal and occupational functioning.
- ✓ The last and the fifth criterion is that the effects or changes must not be attributed or dueto any sort of substance abuse or physiological cause.

The Acute Stress Disorder may also continue and may result in PTSD. But there are chances that within one month the patient is treated and the disorder may not result or lead to PTSD. About 50% of patients develop PTSD after a month of being diagnosed with Acute Stress Disorder.

Treatment:

- ✓ Pharmacological intervention: just like PTSD SSRIs, Tricyclics and Benzodiazepines are extremely effective and helpful for Acute Stress Disorder.
- ✓ Cognitive and behavioral therapies: exposure to the information related to the trauma.
- ✓ Eye Movement Desensitization and Remission (EMDR)
- ✓ Psychodynamic Psychotherapy: focus on the development and relationships of the person.
- ✓ Present-centered and trauma-focused group therapies

10.3 Concept of stress

The term stress has been derived from 'stringer' that is a Latin word and means 'to draw tight' (Cox, 1978). It has today become a very commonly used term in every context whether school, workplace, day to day life and so on. We often come across people who say that they are stressed or experiencing stress in their lives. We ourselves experience stress often. The origins of stress can mainly be traced to physical sciences (Schafer, 1998).

During the 17th century it was exceedingly used to denote affiliations and hardships experienced by individuals and during the 18th century it came to be described mainly in terms of pressure, strain or force (Cartwright and Cooper, 1997). The initial conceptualization of stress mainly focused on stress as an external stimulus. Though later it came to be described as a response of an individual to certain disturbances. The study carried out by Cannon can be mentioned in this context, where he mainly studied the fight and flight reaction.

The focus of the study by Cannon was on the effect that stress has on animals as well as humans. Cannon also observed physiological changes in the participants of his study and he attributed these changes, as displayed by individuals, to stress.

Hans Selye (1974) described stress as a response of the body to certain demand that is made on it and he further stated that this response was non-specific. Baum et al. (1981) have defined stress as a "process in which environmental events or forces, called, stressors, threatens an organism's existence and wellbeing". Schafer (1998, pg 6) defined stress as "arousal of mind and body in response to demands made on them".

Both the above definitions focus on the demand and an individual's response to the same. Thus, the onus here is on the response of the individual. Though the first definition focuses only on body the second definition brings in the important aspect of mind, implying that stress is a response of both body as well as mind.

Yet another definition of stress was given by Lazarus and Folkman (1984, pg.1 9).

They define stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his/ her resources and endangering his/ her wellbeing". This definition emphasises the relationship between person and the environment, though here the stress is presented in a negative light and stress is not always negative and may have its own advantages. Lazarus and Folkman put forth the transactional model of stress and coping that focuses on how an event is interpreted or appraised by an individual, which in turn will determine the stress experienced by the individual. This model highlights that stress and coping with stress as being interrelated processes.

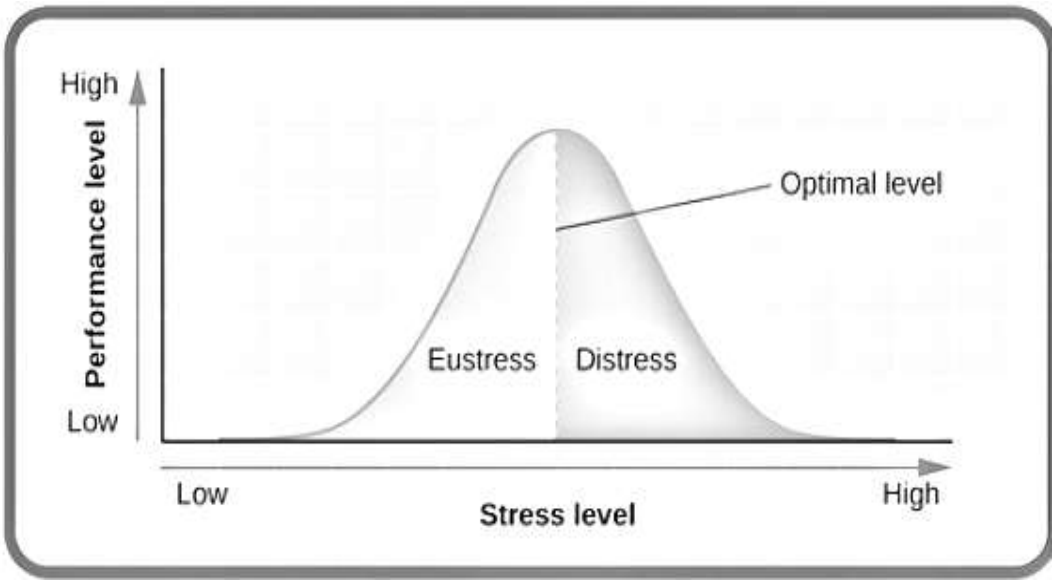
Truxillo et al. (2016, pg. 440) defined stress as "the body's reaction to a change

that requires a physical, mental or emotional adjustment or response". This definition has further elaborated the response as being physical, mental or emotional in nature.

The above definitions mainly looked at stress from a western perspective. If we describe stress from an eastern perspective, it denotes absence or lack on inner peace (Seaward, 2014). And thus, the stress managing techniques would also focus on achieving the inner peace.

While discussing the concept of stress it is also important to understand the term stressor, that can be described as situation, event, person or anything that leads to the stress response. Gerrig and Zimbardo (2005, pg. 430) defined stressor as a stimulus event that places a demand on an organism for some ''kind of adaptive response". At a given point of time an individual may have various stressors in his/ her life. It could be an upcoming official event, an impending report, examination and so on. Stressors can also be described as varied external and internal stimuli that may lead to stress. Stressors can be categorised into physical, psychological, environmental, social and as life events.

Stressors could range from adjusting to change, financial issues and problems, life events like separation, divorce, illnesses or death of a loved one, managing varied roles and responsibilities, facing frequent challenging situations and even technological changes and development.



10.4 Nature of Stress

Stress as such is like salt and pepper and a life without stress would be without motivation, as stress often motivates us to work in certain direction. Thus, without any stress in life, any individual will not be motivated to perform or carry our varied activities. As more salt than required can make food taste bad. In a similar manner, stress beyond optimal level can have a negative effect on the individual and will interfere with his/ her day today functioning. When stress experienced exceeds the optimal level of an individual, the individual may find it exceedingly difficult to cope with it and it can have detrimental effects on the wellbeing (both psychological and physiological) and performance and productivity of the individual. Stress is not altogether negative and does have numerous advantages. It is therefore important that stress is managed and is kept below the optimal level. In the present section of the Unit, we will discuss about the types and symptoms of stress.

10.5 Types of Stress

Stress can be categorised into different types as follows:

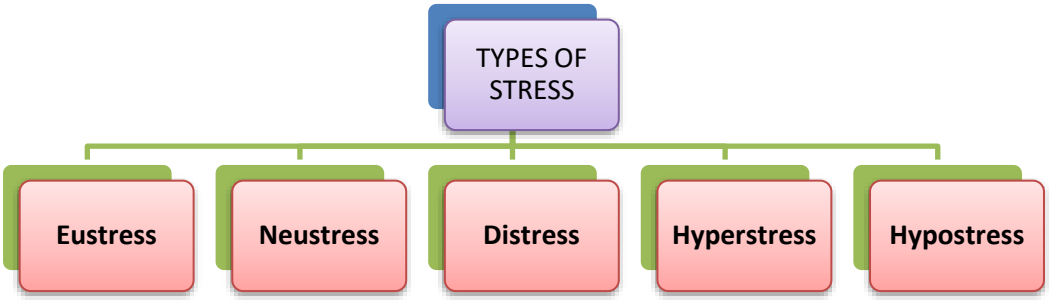
1) Eustress: Stress can be good stress that is explained as 'Eustress'. Eustress can be defined as "good stress, caused by a positive response to a desired stressor, such as a wedding or a new job" (Truxillo et al (2016).

2) Neustress: When stress is not helpful nor harmful, it can be described as 'Neustress' (Schafer (1998).

3) Distress: This is the third category of stress that most people commonly relate stress with. 'Distress' occurs when the arousal experienced by the individual is very high or very low (Schafer (1998). Distress can also be categorised into acute and chronic stress.

Acute stress can be termed as stress that is intense but does not last for a prolonged period of time.

Whereas, **chronic stress** may not be as intense but may exist for a prolonged period of time.



4) Hyperstress: Excessive stress is termed as 'Hyperstress'.

5) Hypostress: Insufficient stress is termed as 'Hypostress'.

10.6 Symptoms of Stress

Stress can have an impact on various aspects of life that include behaviour, cognition, emotions as well as physical health. Though stress will have a different effect on different individuals and each individual will react to stress in a different way, there are certain symptoms that can be related with stress. These are discussed as follows:

Physical symptoms: The physical symptoms of stress include low levels of energy, stomach upset, headaches and migraines, pain and aches, chest pain, rapid heartbeats, lack of sleep, dryness in mouth, experiencing tension in muscles, frequent infections and so on.

Emotional symptoms: The emotional symptoms include, displaying frustration, getting irritated or agitated easily, feelings of worthlessness, feeling lonely and even depressed.

Psychological symptoms: The cognitive symptoms related to stress include worrying constantly, experiencing racing thoughts, lack of organisation in thinking, forgetting, not able to focus, lack of judgement or poor judgement and also pessimism.

Behavioural symptoms: The behavioural symptoms of stress include deterioration in performance effectiveness, indulgence in substance use, prone to accidents, nervous mannerism, poor time management, displaying checking rituals, changes in appetite, procrastination, eating faster, even talking or walking faster, impaired speech and so on.

Thus, the symptoms of stress can be categorized into the above main four categories, but it is to be remembered that individual differences do exist in

the symptoms displayed by different individuals.

10.7 Sources of Stress

The sources of stress can be categories in to three main sources, namely, Frustration, Conflict of motives and Pressure (Coleman, 1970).

1: Frustration: Frustration occurs when a person is **blocked from achieving a desired goal or satisfying a need**, leading to emotional tension and stress.

As stated by Mangal (1984, p.g. 46) "a wide range of environmental obstacles, both physical and social and the internal factors in the form of personal limitations, biological conditions and psychological barriers may lead to frustration of our needs, motives and efforts". For example, A student studies hard for a scholarship but doesn't get selected due to limited seats. This **unmet goal** creates **frustration**, especially after the effort invested.

Effects:

- Anger, irritability
- Aggressive behavior or withdrawal
- Loss of motivation

2: Conflict of Motives: Stress arises when a person faces two or more opposing desires, goals, or needs that are difficult to resolve. These conflicts are internal and often emotional. The next source is conflict of motives that can cause stress as an individual has to choose between alternatives and decision making in this regard can lead to stress. Stress arises when a person faces two or more opposing desires, goals, or needs that are difficult to resolve. These conflicts are internal and often emotional. Conflict of motives can be of four different types, approach - approach conflict, avoidance - avoidance conflict, approach- avoidance conflict and double approach - avoidance conflict.

a) Approach-approach conflict: In this type of conflict the individual has to choose between two goals that are positive and are similar. For example, an individual may have to choose between two similar job opportunities.

b) Avoidance- avoidance conflict: The next type of conflict of motives is avoidance-avoidance conflict. Here again there are two goals that are similar but as opposed to approach- approach conflict, the goals here are negative. For example, an individual may have to take decision whether he/ she want to remain unemployed or take up a mediocre job that he/ she is not interested in.

c) Approach- avoidance conflict: Here there is a single goal which is both positive and negative. For example, an individual taking up a job abroad may be excited about the opportunity but also has to face the fact that he/ she will have to stay away from the family. Thus, this goal has both negative and positive consequences and thus the individual may experience stress.

d) Multiple approach-avoidance conflict: It may so happen that the conflicts faced by us are quite complex and they are combinations of approach and avoidance conflicts. In this conflict the individual has to choose between the options that have both positive and negative consequences. For example, a student may have to choose between two educational opportunities, one of pursuing music that he/ she is interested in which will make his/her parents unhappy and the other of pursuing engineering, which will make his/ her parents happy but he/ she is really not interested in it.

Effects:

- Indecisiveness
- Anxiety and mental exhaustion
- Delay in action or regret post-decision

3: Pressure: Pressure refers to the demand to perform or behave in a certain way, often under tight deadlines or high expectations, leading to stress if the person feels unable to cope. It can be external or internal.

a) External pressure: are pressures that could be as a result of demands from the environment, responsibilities and obligations that are mainly social in nature as well as demands and expectations of the significant persons in our lives.

b) Internal pressures: Internal pressures are caused by our own self for maintaining the picture of ourselves - as we think we could and should be".

An example of external pressure is when a child is pressurized by parents to do well in examination and an example of internal pressure is when a child himself/ herself feels that he/ she needs to study and do well in examination.

Sources of Pressure:

- Academic (e.g., exams, grades)
- Professional (e.g., targets, competition)
- Social (e.g., expectations from family or society)

Any stress can be categorized into the above three sources, though a person may experience stress due to more than one or all the three sources as well.

Besides the above sources, stress can also be as a result of personality factors that may make an individual prone to stress. Past experiences, basic temperamental factors, perception of control over the situation causing stress play an important role in determining the reaction of individual to stress (Parmeswaran and Beena, 2004).

Further, certain life events, like death of a near or dear one, divorce, pregnancy, child leaving home, change in conditions of living, retirement, marriage, losing one's job and so on can also lead to stress (Nolen- Hoeksema, 2009). Some of the specific sources of stress are:

Life events: Stress can be caused due to varied life events. These could be death of a loved one, divorce or separation, losing one's job, marriage and so on. These could be termed as significant life events in one's life that may put pressure on the adjustment and coping resources of the person as they expose the individual to certain new and unique challenges. Thus, life events can lead to stress which in turn can have detrimental effects on the day to day functioning as well as physical and psychological health of the individual.

Daily hassles: Similar to life events, daily hassles can also create stress. Daily hassles like lack of time, work overload, daily roles, responsibilities and duties and so on can lead to stress.

Interpersonal relationships: Stress can also be caused due to issues related to interpersonal relationships. Interpersonal relationships could be in the context of family, work or it could be with peer groups. Conflicts could occur between individuals that can

have an impact on the interpersonal relationship, which in turn may lead to stress. Issues in interpersonal relationship could range from misunderstandings to violence and abuse and can have negative impact on the physical and psychological wellbeing of the person.

Stress as a result of social conditions: Social conditions in which the individual exists can also lead to development of stress. These social conditions can be related to crowding, discrimination, technological developments and changes, pollution and so on. The individual today exists in a world that is much more complex. There is globalization, increased competition, and high amount of social pressure. These have a negative impact on the individual and makes him/ her prone to stress.

10.8 Measurement of Stress

Measurement of stress is a prerogative for effective diagnosis of stress. There are various ways in which stress can be measured. These are discussed as follows:

1) Physiological measures: Physiological measures could serve great purpose in identifying and understanding stress experienced by an individual. The physiological responses in terms of increase in blood pressure, rapid pulse rate, breathing rate and so on can be measured to understand the stress experienced by the individual. This can be done by using various instruments and machines, for instance a Polygraph. Though, physiological measures seem to be effective in detecting stress, there are a number of limitations. Firstly, the physiological changes may occur due to some other reasons and not stress. Secondly, the whole process of taking the physiological measure could create stress in the individual, as either blood test is taken or the individual is plugged to a machine. Further, the tests could also be costly and time consuming.

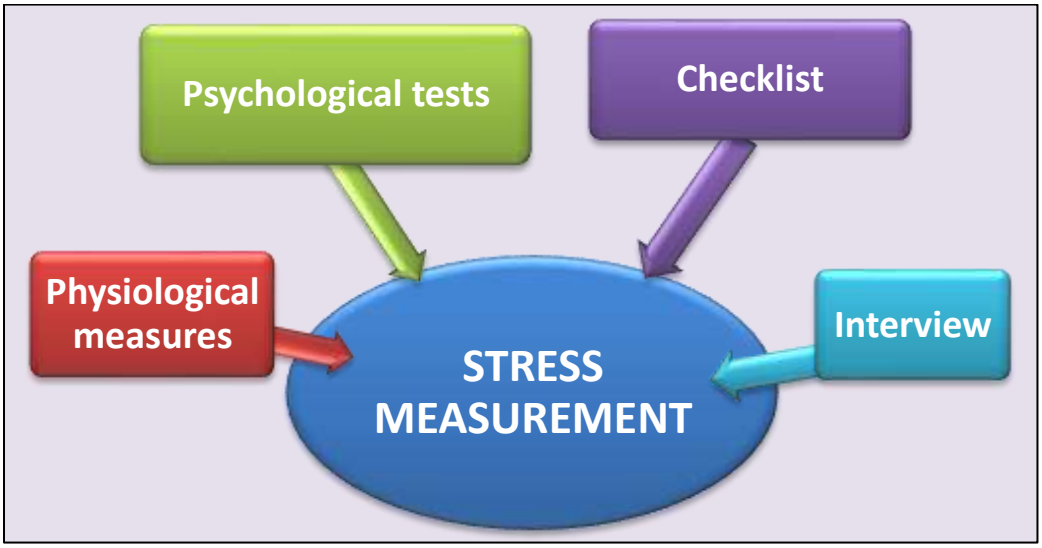
2) Psychological tests: A psychological test can be explained as a measure of sample of behaviour that is objective and systematic in nature. Various psychological tests that are standardized, reliable and valid can be used to measure stress. Such psychological tests could be self-report inventories.

Self-report inventories: The individual is expected to provide responses to certain statements and based on the response's interpretations can be made. Individual may not

understand the language in which the test is available or he/ she may not comprehend certain statements or words.

3) Checklist: A checklist can also be used to measure stress. For instance, a checklist can be used for major life events. The individual is asked to check the major life events from a list that the individual has undergone in a given period of time. The major life events could include, death of a near or dear one, divorce, transfer and so on. Any major event in one's life can put pressure on the individual's coping resources as he/she is trying to adapt to the situation. Also, if an individual is undergoing number of major life events at the same time, the stress that he/ she will experience is much more.

4) Interview: In interview, in-depth information is collected from the individual face to face. Interview can be structured, unstructured or semi-structured. Though with the help of interview method a lot of relevant information can be collected,it is a very time-consuming method as well as costly. Further, interviewer needs to be adequately trained in interview methods.



10.9 Effect of Stress

Stress can affect individuals in different ways. In some individuals it may have an impact on their physical health and in others it may affect their psychological wellbeing. Effects of stress on health, performance and productivity and relationships are interrelated and the effect of stress on one of these can affect the other(s). For instance, if a person falls sick

often due to stress, then his/ her productivity will decrease. Any issue that the person faces in relationship can lead to development of stress and that can have an impact on his/ her performance and productivity.

10.9.1 Effect of Stress on Health

Stress has an impact on the physical health of an individual. A number of illnesses like cardiovascular disorders, aches and pain, ulcers, hypertension, diabetes, asthma, hyperthyroidism, and even cancer can be attributed to stress.

- ✓ Stress can have an impact on the immune system of the individual and thus the individual may become easily prone to varied infections and illnesses stress can also accelerate ageing. When an individual is experiencing Stress, the resources and energy is diverted from immune system to systems in the body that play more important role in stress reactivity and thus, individuals who experience stress for long period of time are prone to develop infections as their immune system is compromised.
- ✓ Prolonged stress can also cause hypertension as sympathetic nervous system gets activated and blood pressure increases and remains increased for a longer period of time. And prolonged hypertension can again lead to development of cardiovascular disorders and could also lead to stroke and kidney related disorders. Glucose and fatty acids may also accumulate if an individual has hypertension for a long period of time and that in turn could lead to plaques in the artery.
- ✓ As a result of prolonged stress, an individual could also develop ulcers, irritable bowel syndrome and inflammatory bowel diseases.
- ✓ Activation of sympathetic nervous system that takes place when stress is experienced could lead to excess production of the hydrochloric acid and pepsin which in turn could lead to peptic ulcers.
- ✓ Stress is one of the factors that can also lead to individuals developing asthma. Asthma is denoted by breathing problem that occurs when the bronchial airways

- ✓ are blocked. This blockage could be due to mucus, inflation or spasms (Ghosh,2015).
- ✓ Prolonged stress could also lead to occurrence of cancer amongst the individuals.
- ✓ Migraine are headaches that an individual may experience for a prolonged period of time that occurs on one side of the head.
- ✓ Stress is one of the factors that can cause migraines in individuals. Stress also has a negative effect on the immune system.
- ✓ Stress can also cause hyperthyroidism, as experiencing stress for a prolonged period of time can negatively affect thyroid, the gland that is responsible for metabolism as well as regulation of various physiological functions.
- ✓ Stress can not only affect the release of hormone from pituitary gland, that stimulates thyroid, but also reduces the conversion to T3 hormone, that is, Triiodothyronine (Lutz, 2019). Thus, the functioning of the thyroid can get affected. Various hormones are also released as stress is experienced and this can lead to increased levels of glucose in blood.
- ✓ Stress can also cause anxiety and depression. When stress is experienced by an individual, there is a release of neurotransmitters (the chemicals that transmit signal between the neurons) Serotonin and Adrenalin. After the release of these neurotransmitters, the stress related hormones are released and these can have an impact on area of brain relevant to memory and regulation of affect.
- ✓ Extreme stress can also lead to development of Post-Traumatic Stress Disorder (PTSD). PTSD may develop in an individual after he/ she experiences a traumatic situation. You must have heard about soldiers developing PTSD after a war or individuals developing PTSD after experiencing a natural calamity like earthquake or Tsunami. The symptoms of PTSD include flashbacks and uncontrollable thoughts about the traumatic event. This again has been linked to the disruption of functioning of stress related hormones and neurotransmitters that are normally released after stress is experienced (Crannage, 2018).

Thus, it can be said that stress can have a negative effect on one's physical health as well as mental health. Further, it can also impact one's lifestyle and behaviour which in turn have adverse effects on one's overall health.

A) Neurodegenerative Diseases

Few exposures have been reported as occupational risk factors for neurodegenerative diseases with consistent evidence, including extremely low-frequency magnetic fields (ELF-MF) and military service for amyotrophic lateral sclerosis (ALS), pesticides for Parkinson's disease, and manganese for parkinsonism.

Some work characteristics, such as high job control and cognitive complexity, are suspected to be protective against dementia. However, more work is needed to disentangle these factors from other socio-economic factors to confirm their individual effects.

B) Cardiovascular and Metabolic Diseases

There is consistent evidence for the association between long working hours and stroke. There is limited/inadequate evidence that workplace exposures to metals, various chemicals, ionizing radiation, noise, physically heavy work, shift work, as well as decision latitude/job control, are associated with stroke. There is consistent evidence for an increased risk of ischemic heart disease (IHD) for workers who experience high job strain, low decision latitude/job control, and long working hours.

C) Mental Disorders

Anxiety has shown to be consistently associated with bullying, whereas the evidence for an association with violence, job insecurity, temporary agency work, working hours, and shift work is limited/inadequate. Several psychosocial work factors (decision latitude, psychosocial job demands, and lack of social support) for which consistent evidence exists on associations with suicide ideation, were also suspected risk factors for actual suicide, but with limited/inadequate evidence.

D) Musculoskeletal Diseases

There are no occupational exposures with consistent evidence for associations with either sciatica or sciatic pain, but there is limited/inadequate evidence for associations with

physically heavy work, trunk flexion/ twisting, manual material handling, lifting, spinal loading, whole body vibration, working with hands above shoulder level, kneeling/squatting, bending of the trunk, and sitting at work. Hand force, repetitive movements, and hand-arm vibration are associated with carpal tunnel syndrome with consistent evidence. Evidence for associations between carpal tunnel syndrome and extended/flexed wrist, computer work, psychosocial exposures, cold environment, and chemicals is limited/ inadequate.

A role of psychosocial exposures (including job demands, job control, and social support) has been suspected for subacromial pain syndrome, sciatic pain, and carpal tunnel syndrome, but with limited/inadequate evidence for an association. For nonspecific low back pain, there is consistent evidence for associations with job control, job dissatisfaction, job strain, and psychosocial job demands.

E) Cancer

Among the approximately 1000 agents evaluated since 1971, IARC has identified 47 occupational agents with consistent evidence for an association for one or more cancer types ("Group 1 agents"), (Loomis et al. 2018; Marant Micallef et al. 2018;). Lung cancer has been associated with the largest number of occupational carcinogens (n = 19), followed by cancer of the skin (n = 8), the haematolymphatic system (n = 7), the urinary bladder (n = 6), bone (n = 5), and nasal cavity and can be further classified into chemicals (n = 15) and chemical mixtures (n = 4), radiation and radionuclides (n = 12), airborne particles (n = 9), airborne complex mixtures (n = 2), and metals and metal compounds (n = 5). The primary routes of exposure are inhalation and dermal uptake. Additionally, 13 occupations, industries, and processes (e.g., rubber manufacturing or working as a painter) were identified as causally associated with cancer, though the specific agents were not identified.

10.10 Workplace Specific Psychological Stresses

Workplace-specific psychological stresses are unique forms of mental strain that arise from the work environment, organizational culture, job demands, and interpersonal dynamics. These stressors can significantly impact employees' mental health, job

satisfaction, and overall well-being. This chapter explores various workplace-specific psychological stresses, providing examples and insights based on scientific literature.

1. Job Strain: Job strain occurs when employees face high job demands with low control over their work. For example, a nurse working in a busy hospital unit may experience job strain due to long shifts, understaffing, and limited decision-making authority. A meta-analysis by Kivimäki et al. (2012) found that job strain is associated with an increased risk of coronary heart disease.

2. Technostress: Technostress refers to the negative psychological effects resulting from the use of technology in the workplace. For example, an employee overwhelmed by constant emails, software updates, and the pressure to be always connected may experience technostress. Research by Califf et al. (2020) highlights that technostress can lead to decreased job satisfaction and increased turnover intentions.

3. Workplace Incivility: Workplace incivility involves low-intensity deviant behavior with ambiguous intent to harm the target. For example, a colleague consistently interrupts during meetings or makes dismissive comments, creating a hostile work environment. Studies indicate that workplace incivility is linked to increased stress, depression, and decreased job satisfaction.

4. Workplace Bullying:

Definition: Workplace bullying involves repeated, health-harming mistreatment of one or more persons (the targets) by one or more perpetrators. For example, a manager consistently belittles an employee in front of others, undermining their confidence and performance. Research shows that workplace bullying can lead to anxiety, depression, and post-traumatic stress disorder (PTSD).

5. Presenteeism:

Presenteeism occurs when employees come to work despite being ill, leading to reduced productivity and potential spread of illness. For example, an employee with a cold continues to work, leading to decreased productivity and potential illness transmission among coworkers. Studies suggest that presenteeism can result in significant productivity losses and increased healthcare costs.

10.11 Mechanism of Psychological Stresses

The perception of stress originates in the brain, primarily involving the limbic system and prefrontal cortex.

A) Amygdala

The amygdala is essential for emotional processing and fear response. It detects threats and modulates HPA axis activity (Roozendaal et al., 2009). Hyperactivity of the amygdala has been associated with anxiety and post-traumatic stress disorder (PTSD) (Shin & Liberzon, 2010).

B) Hippocampus

The hippocampus regulates the HPA axis via negative feedback. It inhibits CRH release to terminate the stress response (de Kloet et al., 2005). Chronic stress can cause hippocampal atrophy, impairing this feedback and exacerbating stress responses (McEwen, 2007).

C) Prefrontal Cortex (PFC)

The PFC exerts top-down control over the amygdala, modulating emotional and stress responses. Dysfunction or reduced activity in the PFC can lead to poor stress regulation (Arnsten, 2009).

10.11.1 Psychological Mechanisms: Cognitive Appraisal and Coping

Lazarus and Folkman's transactional model emphasizes cognitive appraisal—how an individual interprets stressors—as pivotal in stress responses. Primary appraisal evaluates the threat level; secondary appraisal assesses coping resources (Lazarus & Folkman, 1984).

Effective coping strategies, such as problem-solving and social support, mitigate stress effects, while maladaptive strategies, like avoidance, can exacerbate stress.

10.11.2 The Hypothalamic-Pituitary-Adrenal (HPA) Axis

The HPA axis plays a central role in the stress response. Upon stress perception, the hypothalamus releases corticotropin-releasing hormone (CRH), stimulating the pituitary

gland to secrete adrenocorticotropic hormone (ACTH). ACTH prompts the adrenal cortex to release glucocorticoids, mainly cortisol in humans (Smith & Vale, 2006). Cortisol mobilizes energy by increasing glucose availability and modulates immune responses to prepare the body for 'fight or flight.' However, chronic activation can lead to detrimental effects such as impaired cognitive function, mood disorders, and metabolic disturbances (Sapolsky, 2000).

10.11.3 The Sympathetic-Adrenal-Medullary (SAM) System

Concurrently, the SAM system activates the sympathetic nervous system, releasing catecholamines (adrenaline and noradrenaline), which increase heart rate, blood pressure, and respiratory rate (Ulrich-Lai & Herman, 2009). This system prepares the body for immediate action.

Chronic Psychological Stress and Its Impact

- ✓ A classic example is chronic work-related stress leading to burnout. Prolonged exposure to psychosocial stressors without adequate recovery activates the HPA axis persistently, elevating cortisol levels and impairing immune function (Melamed et al., 2006).
- ✓ In one study, healthcare workers under chronic stress exhibited increased cortisol, reduced hippocampal volume, and impaired memory (Lupien et al., 1998). Such findings demonstrate the neurobiological impact of psychological stress.

10.12 Control of Psychological Stresses

Chronic psychological stress is linked to numerous adverse health outcomes, including anxiety, depression, cardiovascular disease, and impaired immune function (McEwen, 2007). Therefore, effective control and management of psychological stress are critical for maintaining mental and physical health.

This chapter explores strategies for controlling psychological stress, supported by scientific evidence, and illustrates practical examples for implementation.

Mechanisms of Stress Control

Effective control of psychological stress often involves both **cognitive** and **behavioral** strategies:

- ✓ **Cognitive Reappraisal:** Changing the perception of a stressful situation.
- ✓ **Problem-solving:** Taking active steps to reduce stressors.
- ✓ **Relaxation techniques:** Reducing physiological arousal.
- ✓ **Social support:** Utilizing interpersonal resources.
- ✓ **Lifestyle interventions:** Including physical activity, diet, and sleep.

10.12.1 Evidence-Based Strategies for Stress Control

1. Cognitive Behavioral Therapy (CBT)

CBT is widely recognized as a first-line intervention for stress-related disorders. It involves identifying and restructuring negative thought patterns that exacerbate stress (Beck, 2011). Meta-analyses have shown that CBT significantly reduces symptoms of anxiety and depression, often rooted in chronic stress (Hofmann et al., 2012).

Example: A study by Antony et al. (2001) demonstrated that individuals with generalized anxiety disorder experienced substantial reductions in stress and anxiety following 12 weeks of CBT.

2. Mindfulness and Meditation

Mindfulness-based stress reduction (MBSR) programs focus on developing awareness and acceptance of the present moment without judgment. Research indicates mindfulness training reduces cortisol levels (a biomarker of stress) and improves psychological well-being (Creswell, 2017).

Example: A randomized controlled trial by Goyal et al. (2014) found that mindfulness meditation programs led to moderate reductions in anxiety, depression, and pain.

3. Physical Exercise

Regular physical activity is a robust modulator of stress responses. Exercise enhances endorphin release, improves sleep, and promotes neurogenesis, which collectively mitigate stress (Salmon, 2001).

Example: A meta-analysis by Stubbs et al. (2017) confirmed that aerobic exercise significantly decreases anxiety symptoms in clinical and non-clinical populations.

4. Social Support

Strong social networks buffer against stress by providing emotional support, practical assistance, and a sense of belonging (Cohen & Wills, 1985). Loneliness and social isolation are strongly linked to increased psychological stress.

Example: Hawkley et al. (2003) showed that individuals with higher perceived social support had lower cortisol responses during stress tasks.

5. Relaxation Techniques

Techniques such as deep breathing, progressive muscle relaxation, and biofeedback reduce sympathetic nervous system activity. These methods lower heart rate, blood pressure, and muscle tension (Varvogli & Darviri, 2011).

Example: Lehrer et al. (2007) found that biofeedback-assisted relaxation significantly reduced anxiety and physiological stress markers in patients with hypertension.

6. Integrative Approaches

Combining multiple interventions often yields the best outcomes. For instance, MBSR integrates meditation, body awareness, and yoga to address stress holistically (Kabat-Zinn, 1990). Similarly, CBT combined with exercise enhances both cognitive and physiological resilience to stress (Herring et al., 2010).

Conclusion:

the term stress has been derived from ‘stringere’ that is a Latin word and means ‘to draw tight’ (Cox, 1978). It has today become a very commonly used term in every context whether school, workplace, day to day life and so on. We often come across people who say that they are stressed or experiencing stress in their lives. We ourselves experience stress often. Stress is like salt and pepper and a life without stress would be without motivation. Stress often motivates us to work in a certain direction and therefore stress is

not altogether negative and does have numerous advantages. Hans Selye (1974) described stress as a response of the body to certain demand that is made on it and he further stated that this response was non-specific. Various definitions of stress were also discussed in this Unit that mainly described stress in terms of demand and an individual's response to the same. The concept of stressor was also described that can be explained as a situation, event, person or anything that leads to the stress response. Stressors can be categorised into physical, psychological, environmental, social and as life events. Various types of stress including eustress, neustress and distress were also discussed in the Unit. The Unit then moved on to explain the various symptoms of stress that were categorised into behavioural symptoms, cognitive symptoms, emotional symptoms and physical symptoms. Further, the sources of stress mainly, frustration, conflict of motives and pressure were also explained. Lastly, the Unit focused on the measurement of stress, that is a prerogative for effective diagnosis of stress. There are various ways in which stress can be measured. Varied methods of measurement like physiological measures, psychological tests, checklist and interview were discussed.

Workplace-specific psychological stresses are multifaceted and can significantly affect employees' mental health and organizational outcomes. Addressing these stressors requires a comprehensive approach, including organizational changes, employee support programs, and fostering a positive work culture. By understanding and mitigating these stressors, organizations can enhance employee well-being and overall productivity.

The mechanism of psychological stress is a complex interplay between brain structures, neuroendocrine systems, and cognitive processes. Understanding these mechanisms offers insights into stress-related disorders and potential therapeutic targets.

Controlling psychological stress involves a multifaceted approach targeting cognitive, emotional, behavioral, and physiological domains. Scientific literature robustly supports interventions such as cognitive behavioral therapy, mindfulness, exercise, social support, and relaxation techniques. Future research should continue exploring personalized stress management programs that incorporate these evidence-based strategies.

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Unit 11: Occupational Health and Workers

Unit Structure

11.0 Learning Objectives

After completion of this unit, you will be able to:

- understand about different health measures;
- understand the concept of health education and medical first-aid;
- understand the management of medical emergencies;
- understand about epidemiological approaches

11.1 Introduction

Occupational health is a multidisciplinary approach that protect and promote the worker's health by preventing and controlling occupational diseases and accidents at work. It focuses to develop healthy and safe environment to enhance the physical, mental and social well-being of workers. This unit aims at providing learners a basic background information about different health measures, health education, first aid methods and management of any medical emergencies during workplace. This unit also deals about epidemiological approaches.

11.2 Health measures

To ensure safety of workers in any workplace, different preventive and protective measures are taken. These measures consist of workplace safety including proper hygiene, ventilation and sanitation facilities in the workplace. In many workplaces, Personal Protective Equipment (PPE) are given to the workers for their safety measures. Additionally, periodic health checkup of each employe is also done and preventive vaccination is also provided.

11.3 Health education

Health education in the workplace refers to organized efforts within a professional setting to inform, educate, and empower employees about health-related topics. The goal is to promote healthy behaviors, prevent illness and injury, and improve overall well-being, which can also enhance productivity and reduce healthcare costs. Health education in the workplace is the process of educating people with knowledge and skills to make educated decisions about their health and well-being at work and beyond.

11.4 Importance of health education

Educating about health and other health related disease to the workers is very important. Health education promotes the well being of the employee, that enhances the physical and mental health. Educating the workers about health prevents injuries and illness in the workplace, and makes a positive and supportive work environment. The first step of any health educator is to talk or listen carefully the problems of the workers and managers. Additionally, they also encourage the manger and worker of the factory to take necessary step whenever required in any accidental circumstances. The health education safety courses or training should be properly designed for the leaders and workers and regular meetings with factory managers, health personnel and safety officers was conducted.

11.5 Medical first-aid

First aid is the immediate care given to the victims of accidents before trained medical workers arrive. Its goal is to stop and if possible, reverse harm. It involves rapid and simple measures such as applying pressure to the bleeding wounds. The critical factors which shape first aid facilities in a workplace are work-specific risk and availability of definitive medical care. First aid is a fluid concept and a very careful attitude is also required. Every worker can be trained in the top 10 crucial steps of first aid. Although, the top 10 crucial

steps will change at each and every workplace and must be taught accordingly. First aid personnel are persons on the spot, generally workers who are familiar with the specific conditions of work. They might not be medically qualified but they must be trained and prepared to perform very specific tasks. First aid personnel should be selected carefully, taking into account attributes such as reliability, motivation and the ability to cope with people in a crisis situation.

Check your progress

1. Write a short note on health measures.
2. What do you understand by health education?
3. Explain the importance of health education?
4. Write a short note on medical first-aid.

Answers:

1. See section 11.2
2. See section 11.3
3. See section 11.4
4. See section 11.5

11.6 Management of medical emergencies

Management of medical emergencies in any workplace involves quick assessment, preparedness, planning, sudden response and timely escalation whenever required. Managing any type of medical emergencies is done by an employer, safety officer and staff members. Prevention and planning include basic first aid training and emergency response plan.

11.7 Epidemiological approaches

Epidemiology

The study of the distribution and determinants of health-related states and events in populations and the application of this study to the control of health problems. The fundamental goal of these investigations is to obtain a valid and reasonably precise estimate of exposure-disease association in groups. As applied to occupational health, epidemiology thus has the dual task of describing the distribution of deaths, accidents, illness and their

precursors in the workforce and of searching of the pollutants of health, injury and disease in the occupational environment.

Occupational epidemiology

The study of the occurrence of disease in relation to work- related determinants.

11.8 Types of Epidemiological study

Epidemiological studies measure the risk of disease directly in human populations. There is no need to rely on questionable extrapolations across animal species to estimate the impact of an exposure in humans. It is possible in epidemiology to examine the consequences of an occupational and experimental exposure in the manner in which it actually occurs in humans, not the artificial manner in which laboratory studies of animals are done. The issue of dose, route of exposure, concomitant exposures and host factors are also directly assessed. There are 3 types of epidemiological study, among them the third one is not used for practical study due to some ethical reason.

1. **Descriptive studies**
2. **Analytical studies**
3. **Intervention studies**

Descriptive studies: Descriptive studies elaborate the events that are totally based on observations and further develop the causal hypothesis that can be tested.

Analytical studies: In analytical studies, the hypothesis was tested, and once the hypothesis seems to be good, then it must be used for further intervention studies.

Intervention studies: This study checks wheather an exposure causes health impact on a population or not. And also assess the magnitude of the exposure to the human population.

The most common type of study in occupational epidemiology is the **cohort study**.

In this approach, data on one or more factors is gathered from a specific population, which is then monitored over time to observe the development of disease. Researchers compare the disease rates between individuals who were exposed to a particular factor and those who were not, to determine if there is a link between the exposure and the disease. Since this method involves long-term follow-up, it can take years to accumulate enough disease cases. To avoid this lengthy process, a retrospective cohort study can be conducted. This

involves using historical records to determine individuals' exposure status and tracking their health outcomes up to a certain point in time.

Case-control studies involve two groups: one includes individuals diagnosed with a specific disease, while the other consists of people from the same population who do not have the disease. Researchers collect data on past exposures and behaviors from both groups. If the exposure in question is more commonly reported among the cases than the controls, it suggests a possible association between that exposure and the disease. These studies are especially efficient for examining rare diseases or conditions that take a long time to develop. A **cross-sectional study** involves selecting participants without regard to their exposure or disease status. This type of study, commonly known as a survey or prevalence study, captures a snapshot of health and exposure patterns at a specific moment in time.

Check your progress

1. Write a short note on management of medical emergencies.
2. Explain epidemiology and occupational epidemiology.
3. Discuss different types of epidemiological studies.
4. How many types of epidemiological studies are there?
   a. 2
   b. 3
   c. 1
   d. 5

Answers:

1. See section 11.6
2. See section 11.7
3. See section 11.8
4. B

Summary

This unit describes about different health measures and the concept of health education and medical first-aid. Occupational health is a multidisciplinary approach that protect and promote the worker's health by preventing and controlling occupational diseases and accidents at work. It focuses to develop healthy and safe environment to enhance the

physical, mental and social well-being of workers. To ensure safety of workers in any workplace, different preventive and protective measures are taken. These measures consist of workplace safety including proper hygiene, ventilation and sanitation facilities in the workplace. In many workplaces, Personal Protective Equipment (PPE) are given to the workers for their safety measures. Additionally, periodic health checkup of each employe is also done and preventive vaccination is also provided. Management of medical emergencies in any workplace involves quick assessment, preparedness, planning, sudden response and timely escalation whenever required. Epidemiological studies measure the risk of disease directly in human populations. There are 3 types of epidemiological study: Descriptive studies, analytical studies and intervention studies. The most common type of study in occupational epidemiology is the cohort study.

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Unit 12: Occupational Health Disorders in Practice I

Unit Structure

12.0 Learning Objectives

After completion of this unit, you will be able to:

- understand about occupational health disorders;
- understand the concept of health disorder in paper and pulp industry;
- understand about health disorders in textile and distillery industry.

12.1 Introduction

Occupational health disorders are the diseases that are caused due to exposure to any hazardous substance and risk factors in the workplace. Due to these risk factors, several health disorders occur like respiratory problems, skin diseases, cancer, hearing loss and psychological disorders. The exposure of any chemical/hazardous substance leads to chemical poisoning and spread of infectious diseases due to contaminated equipment and poor hygiene practices. Several industries like paper and pulp industry, textile, steel and distillery have different time and fate of exposure, thus leading to different types of disorders. Noise pollution poses a health risk, especially in boilers and paper machines. The excessive noise will generate more than it is allowed and will result in partial and permanent deafness as well as elevated blood pressure. Let us discuss about some of the health disorders that occurs in paper and pulp industry, textile and distillery industry.

12.2 Paper and Pulp Industry

Paper and pulp manufacturing is a significant industrial activity. Depending on the procedure, this workplace involves a range of exposures. The pulping process has included the alkaline sulfate process, the acidic sulfite process, and different mechanical methods. Terpenes, bleachy chemicals, and wood dust have been the primary occupational hazards in pulp mills. Hydrogen sulfide and other reduced sulfur compounds are also utilized in sulfate mills, while paper dust and other additives are found in paper mills. This industry uses a wide range of chemicals, some of which may be carcinogenic and other additional risks include shift work, heat, noise, and microbes.

12.3 Impact of paper and pulp industry on human health

The high exposure of chemicals used in paper industry causes lung disease, allergies, respiratory disorders and sometime leads to death. The pulp and paper industry causes health risks mostly from handling chlorine and bagasse, and to a lesser degree from mechanical injuries brought on by coal handling. Another threat, in few papers and pulp mill industry is noise pollution. Pheumoconiosis, bagassosis and other allergic and inflammatory reaction are caused due to coal dust, and inhalation of the chlorine gas. Formaldehyde, organic solvents like xylene, toluene, styrene and benzene, silica and asbestos are considered as health hazards. Increased respiratory symptoms and lung function in employees exposed to paper dust.

Additionally, workers exposed to soft paper dust have been reported to have asthma and chronic obstructive pulmonary disease. The most common cause of cancer-related mortality for both men and women living close to the paper and paper board sectors is lung cancer. Male employees in pulp and paper factories had a higher mortality rate from malignant cancer. These cancers were linked to the following known or suspected carcinogens that the workers were exposed to: formaldehyde causes kidney and brain effects, asbestos causes pleura, and Hodgkin's disease.

Check your progress

1. Write a short note on occupational health disorders.
2. What do you understand by paper and pulp industry?

3. Discuss the impact of paper and pulp industry on human health.

Answers:

1. See section 12.1
2. See section 12.2
3. See section 12.3

12.4 Textile industry

There are many departments in the textile industry, including weaving, spinning, dying, and printing, and in addition to other processes that are necessary for producing finished clothing or fabric. One of the most important issues facing the working personnel in the textile sector is health and safety. It is a type of industry where employee's health is impacted by their occupation. There are several risks and hazards related to these professions. These risks have an impact on employees mental and psychological well-being in addition to their physical health. A significant deterioration in respiratory function is a hallmark of the illnesses that emerged from the textile industries. Workers in the textile sector are subject to a number of risks, including chemical, biological, and physical risks as well as psychosocial risks such as psychological imbalance and mental stress.

12.5 Impact of textile industry on human health

The most common occupational hazard in the textile sector is lung disease, which is followed by disorders of the reproductive system, noise-induced hearing loss (NIHL), and heart-mental stress, neurotoxicity, various dermatological disorders, and diseases that are linked to the eyes. Hepatic disorders are highly connected with the occupation in the dyeing process.

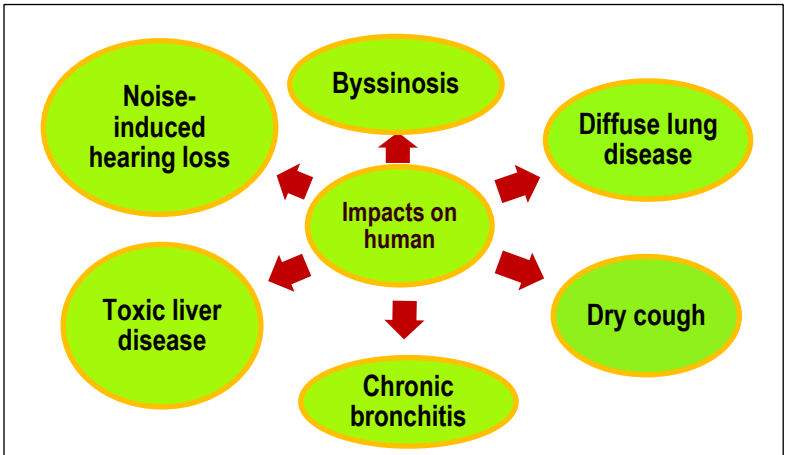

Fig. 1. Impacts on human

There are many Occupational safety and health standards and regulations, such as **C155** (Occupational Safety and Health Convention, 1981), **R164** (Occupational Safety and Health Recommendation, 1981), **C187** (Promotional Framework for Occupational Safety and Health Convention, 2006), **R197** (Promotional Framework for Occupational Safety and Health Recommendation, 2006), **C161** (Occupational Health Services Convention, 1985) and **R171** (Occupational Health Services Recommendation, 1985).

Due to the exposure to cotton dust and other materials used in the industry like wool, hemp, flax, the workers get possible respiratory diseases affecting the alveoli and bloodstreams. Prolonged exposure to cotton dust causes brown chest or byssinosis and sometime also leads to chronic dry cough. The eyes, skin, and upper respiratory tract may become irritated by textile dyes. Additionally, contact dermatitis, allergic conjunctivitis, rhinitis, occupational asthma, and other allergic reactions have been described by workers exposed to reactive dyes. To reduce noise levels at work, machine maintenance should be mandatory. Each employee receives the same treatment. There must be a safety officer in every industrial company. No industry can function without a safety officer on duty. The government is in charge of keeping abreast of any changes made to the records. From the standpoint of the company, all employees ought to receive the same treatment. Industries should provide a suitable and useful protective clothing for the production line. Regular organizational inspections should be established in order to detect the dangers and eliminate them from the workplace. Since it is essential for regulatory bodies to identify potentially hazardous businesses in order to safeguard the health of employees, the government must to take a stand on this issue.

12.6 Distillery industry

Among the 17 categories of highly polluting industries, distilleries are regarded as one of the most water-polluting sectors. As per the 2009 report on the technical EIA guidance manual for distilleries, there are 295 distilleries in India, primarily located in Tamil Nadu, Maharashtra, U.P., Gujarat, and M.P. Liquor, a distilled beverage, is a drinkable liquid made from fermented grains, fruits, and vegetables that contains ethanol. A significant volume of water (wastewater) is released during the distillation process, which has an adverse effect on both the environment and people. Both highly organic and inorganic chemicals can be

found in the highly colored effluent produced by the distillery business. Wastewater from distilleries poses a major threat to living things, increasing environmental stress. Approximately 3 billion liters of alcohol and 45 billion liters of waste wash are produced annually by more than 325 distilleries in India. During the alcohol production process, distillery units produce a significant amount of wastewater; on average, 10–15 L of wastewater are emitted for every 1L of alcohol produced. Numerous investigations have documented the presence of a wide range of organic and inorganic contaminants in distillery effluent, including melanoidin, polysaccharides, reduced sugar, proteins, waxes, N, K, Ca, sulphates, phosphates, and more.

12.7 Impact of distillery on human health

Exposure to various alcohol and ethanol fumes results in chronic respiratory irritation, headaches, disorientation, and respiratory issues. Workers at distilleries are at danger for burns, sprains, and chronic discomfort due to the possibility of fire and explosion. The distillery industry's long-term consequences on employees include cancer, noise-induced hearing damage, and respiratory and breathing issues.

Check your progress

1. Write a short note on textile industry.
2. Explain the impact of textile industry on human health.
3. Discuss about distillery industry.
4. What is the different impact of distilleries on human health?

Answers:

1. See section 12.4
2. See section 12.5
3. See section 12.6
4. See section 12.7

Summary

This unit describes about different occupational disorders that are caused by chemical, organic and inorganic substances. Occupational health disorders are the diseases that are caused due to exposure to any hazardous substance and risk factors in the workplace.

Several industries like paper and pulp industry, textile, steel and distillery have different time and fate of exposure, thus leading to different types of disorders. The pulping process has included the alkaline sulfate process, the acidic sulfite process, and different mechanical methods. The most common occupational hazard in the textile sector is lung disease, reproductive system, noise-induced hearing loss (NIHL), and heart-mental stress, neurotoxicity, various dermatological disorders, and diseases that are linked to the eyes. A significant volume of water (wastewater) is released during the distillation process, which has an adverse effect on both the environment and people. Exposure to various alcohol and ethanol fumes results in chronic respiratory irritation, headaches, disorientation, and respiratory issues. Workers at distilleries are at danger for burns, sprains, and chronic discomfort due to the possibility of fire and explosion.

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Unit 13: Occupational Health Disorders in Practice II

Unit Structure

13.0 Learning Objectives

After going through this unit, you will be able to:

- Understand key features that causes occupational health illness in the steel and construction industries.
- Different health disorders in construction and steel industries: their cause and prevention measures.
- Role of legal and regulatory bodies.
- Practices to develop a health management strategy.

13.1 Introduction

According to the World Health Organization, "health" is a state of complete wellbeing (physical, mental, and social), but it also covers all the way from the ideal state of complete wellbeing to death. Occupational health is one of the branches of public health,

which broadly concerned with the identification and control of health risks in the working and of working conditions. It aims to promote and maintain the highest degree of physical, mental and social well-being of works in the occupations. The main occupational health hazards include breathing issues, back pain, skin irritation/issues, and stress. By identifying their risks and using safety measures, a supportive environment can be created for workers safety and productivity. Occupational health nursing is a term which involves promoting and maintaining the health and well-being of workers in the workplace, focusing in preventing and managing work-related injuries and illnesses.

13.1 Impact of Construction and Steel Industries on Health

The construction and steel industries have a high risk of health problems due to their nature of labor. Some key features of the construction and steel industries that became the primary cause of health disorders are as follows:

13.1.1 Features of the Construction

Building and infrastructure projects which include heavy machinery, high-altitude work, and surface and chemical exposure are the main focus of construction industries. High-altitude activities might increase the risk of falls and related injuries, while heavy machinery like excavators, cranes, etc., can result in mishaps and injuries. Conversely, exposure to chemicals and surfaces can cause respiratory problems and skin disorders.

13.1.2 Features of the Steel Industry

Workers in the steel sector face risks from exposure to chemicals, heavy machinery, and intense heat during the manufacture of steel. Workers who handle molten metal at high temperatures run the risk of suffering burns and heat exhaustion, while those who handle heavy machinery and materials may sustain musculoskeletal injuries. In the same manner, the chemical exposure during the steel-making process will result in disorders of the skin and respiratory system.

Questions for Practice

Q1: What is the primary focus of occupational health?

A. Reducing the cost of healthcare

B. Promoting and maintaining the well-being of workers

C. Increasing industrial profits

D. Minimizing holidays for workers

Q2: Exposure to chemicals in the steel industry can lead to respiratory and skin disorders. **(True/False)**

Q3: According to the World Health Organization, health is a state of complete _____, not merely the absence of disease.

Q4: Assertion (A): Workers in the construction industry are prone to injuries from high altitude activities.

Reason (R): Construction work often involves tasks like operating heavy machinery and working at heights.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

Q5. Match the Following:

Industry Features	**Health Risk**
A. Construction - High-altitude work	**i.** Respiratory problems, skin disorders
B. Steel - Molten metal handling	**ii.** Falls and related injuries
C. Steel - Chemical exposure	**iii.** Burns and heat exhaustion

13.2 Occupational Health Disorders in the Construction

Working in surroundings with a variety of possible risks is common in the construction industry, and this can result in a number of specific health conditions, especially those that affect the respiratory system. Construction work can release dust and pollutants into the air, causing respiratory problems. Also, the noise from construction activities can lead to stress, sleep disturbances, hearing impairment. Here are some health disorders arises from construction industry:

13.2.1 Respiratory Disorders

Silicosis: Silicosis is caused by breathing in fine silica dust from sandblasting, concrete work, and rock crushing. Breathing problems, lung scarring, and perhaps chronic lung conditions like lung cancer result over time.

Asbestos-Related Diseases: Long-term exposure to asbestos fibers, which are frequently present in building materials, can result in pleural mesothelioma, asbestosis, and lung cancer, all of which can seriously impair lung function.

Chronic Obstructive Pulmonary Disease (COPD): A lung condition frequently associated with construction-related dust, chemical, and fume exposure. It results in chronic bronchitis and emphysema, among other long-term respiratory issues.

13.2.2 Musculoskeletal Disorders

Back Injuries: It arises from using incorrect lifting techniques, carrying too much weight, and performing repetitive motions, all of which can lead to chronic spine pain and problems.

Repetitive Strain Injuries (RSIs): RSIs are brought on by doing repeated chores, which can cause joint and muscular pain, edema, and stiffness, particularly in the hands and arms.

Joint and Muscle Pain: Joint pain and muscle discomfort can result from overusing muscles, using the wrong equipment, and not getting enough sleep. These conditions are frequently made worse by physically demanding tasks.

13.2.3 Hearing Loss

Noise-Induced Hearing Loss (NIHL): Long-term exposure to loud noises from construction equipment, tools, and surroundings can cause permanent harm to one's hearing. Protection through earmuffs or earplugs is essential for prevention.

13.2.4 Skin Conditions

Contact Dermatitis: Redness, itching, and swelling are caused by exposure to irritants such as paints, cement, and solvents.

Skin Irritations from Chemicals: Burns or rashes can result from substances that irritate the skin, such as cement, turpentine, and acetone. Skin damage can be avoided by using appropriate handling techniques and wearing protective clothing.

13.2.5 Mental Health Issues

Stress and Anxiety: Long hours, strict deadlines, high demands of construction labor, and safety concerns all contribute to mental health issues like stress and worry, which can cause agitation, exhaustion, and difficulty concentrating.

Depression and Fatigue: chronic mental health issues that impact one's mood, vitality, and general well-being. Extreme fatigue, low motivation, and despair are among symptoms that can affect performance and safety.

Table 1: Health disorder with associated risk in construction

Type	Health Disorder	Risk Description
Respiratory	Silicosis, Asbestos-Related Diseases, COPD	Causes lung scarring, difficulty breathing, and long-term lung diseases.
Musculoskeletal	Back Injuries, Repetitive Strain Injuries, Joint & Muscle Pain	causes pain, discomfort, and injury as a result of overuse, repetitive work, and inappropriate lifting.
Hearing	Noise-Induced Hearing Loss (NIHL)	causes irreversible hearing loss as a result of extended exposure to harsh construction noises.
Skin	Contact Dermatitis, Chemical-Induced Skin Irritations	causes skin irritation, burns, and rashes as a result of chemical and building material exposure.
Mental Health	Stress, Anxiety, Depression, Fatigue	impacts mood, vitality, and concentration as a result of long hours, safety issues, and job pressures.

By identifying and addressing these health risks, the construction industry can take steps to protect workers and ensure a safer, healthier work environment.

Questions for Practice

Q6: Which of the following is *not* a respiratory disorder caused by construction work?

A. COPD

B. Silicosis

C. Contact Dermatitis

D. Asbestosis

Q7: Noise-Induced Hearing Loss (NIHL) is a reversible condition caused by short-term exposure to loud sounds in construction sites. **(True/False)**

Q8: _____ is a respiratory disease caused by inhaling fine silica dust from construction activities like rock crushing and sandblasting.

Q9: Assertion (A): Construction workers are at risk of developing musculoskeletal disorders.

Reason (R): This is due to repetitive tasks, improper lifting techniques, and physically demanding work.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

Q10. Match the Following:

Health Disorder	**Associated Risk**
A. Asbestosis	**i.** Caused by exposure to paints and solvents
B. Back Injuries	**ii.** Caused by long hours and safety pressures
C. Contact Dermatitis	**iii.** Caused by asbestos fibers in materials
D. Depression	**iv.** Caused by improper lifting and overuse

13.3 Occupational Health Disorders in the Steel Industry

13.3.1 Physical Hazards

Noise: Continuous loud noises from equipment can cause fatigue, hearing loss, and even make it more difficult to communicate, which raises the risk of accidents.

Vibration: Prolonged exposure to high vibrations from tools or machinery, either through the hands or the body, can lead to discomfort and health problems.

Heat and Cold Stress: Working with heated equipment or in extremely hot or cold temperatures can cause stress on the body and result in dangerous illnesses like heat exhaustion.

Poor Lighting: In addition to causing eyestrain, poor illumination can also make people drowsy, agitated, and less attentive.

Machinery Hazards: Serious incidents like cutting, crushing, or entanglement can result from poorly maintained machinery or from missing safety devices.

Cranes and Hoists: Materials may fall or a crane may collapse as a result of improperly maintained lifting equipment or disregard for safety precautions.

Hazardous Energy: During maintenance, energy sources like hydraulics and electricity must be carefully turned off and managed because they can be extremely dangerous otherwise.

Falling Objects: People below may sustain injuries from unsecured tools or materials that fall from heights.

Slips, Trips, and Falls: Falls and injuries might result from cluttered sidewalks, missing handrails, or exposed holes.

Transport Hazards: If raw material transportation is not handled appropriately, it might result in crashes or incidents involving autos or rail carriages.

Fire & Explosions: If safety precautions aren't taken, flammable chemicals and sparks from hot metal work can quickly start fires.

Confined Spaces: Strict safety measures must be taken before entering places like silos, tanks, or tunnels since they may contain poisonous gases or insufficient oxygen.

13.3.2 Chemical hazards

Chemical Exposure: Hazardous chemicals can be inhaled by workers through their skin, lungs, or unintentional swallowing, which can result in immediate or long-term health issues.

Inhalable Agents: Steel production-related dust, gasses, and fumes can lead to lung conditions like cancer or silicosis as well as other major health problems. Because they displace oxygen, certain substances can be dangerous right away.

Heavy Metals & Acid Mists: Organ damage can result from exposure to lead, chromium, and other metals (in dust or fumes). Acid mist irritates skin, eyes, and lungs, especially when it comes from cleaning procedures.

13.3.3 Radiation Hazards

Ionizing Radiation: Because even small exposures over time might increase the risk of cancer, regular monitoring and exposure limitation are crucial.

Non-Ionizing Radiation: If precautions are not followed, UV, visible, and infrared radiation can result in burns, eye injuries, and long-term damage like cataracts.

13.3.4 Ergonomic Hazards

Pain, strain, and long-term ailments like joint tension or back pain can result from heavy physical lifting, repetitive jobs, awkward working positions, and poorly constructed instruments.

13.3.5 Psychological Hazards

Bullying, discrimination, long hours, excessive job pressure, and a lack of support can all have a detrimental effect on mental health and result in stress, burnout, or depression.

Table 2: Health disorder with associated risk in Steel Industry

Type	Risk Description	Health Disorder
Physical	Noise, Vibration, Heat/Cold, Machinery	Hearing loss, HAVS, heat stroke, eye strain, fractures, burns, crush injuries

	Slips, Falls, Fire, Confined Spaces	Sprains, head injuries, trauma, asphyxiation, respiratory damage
Chemical	Dust, Fumes, Heavy Metals, Acids	Silicosis, asthma, bronchitis, lung cancer, dermatitis, heavy metal poisoning
Radiation	Ionizing & Non-Ionizing Radiation	Cancer, cataracts, eye burns, retinal damage, skin burns
Ergonomic	Poor posture, repetitive work, lifting	Back pain, tendonitis, RSIs, carpal tunnel
Psychological	Workload, stress, harassment	Anxiety, depression, sleep issues, mental fatigue, burnout

Questions for Practice

Q11: What health condition is most likely caused by prolonged exposure to vibration in the steel industry?

A. Cataracts

B. Hearing loss

C. Hand-Arm Vibration Syndrome (HAVS)

D. Asthma

Q12: Non-ionizing radiation from infrared and UV sources in steel plants can cause cataracts and skin burns. **(True/False)**

Q13: Exposure to _____ like lead and chromium in the steel industry can result in heavy metal poisoning and organ damage.

Q14: Assertion (A): Workers in the steel industry may suffer from psychological disorders.

Reason (R): High workload, bullying, and lack of support can lead to stress and burnout.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

Q15. Match the Following:

Hazard Type	Disorder
A. Physical Hazard	**i.** Heat stroke
B. Chemical Hazard	**ii.** Silicosis
C. Radiation Hazard	**iii.** Cataracts
D. Ergonomic Hazard	**iv.** Tendonitis
E. Psychological Hazard	**v.** Burnout

13.4 Practices for Health Management in Construction

Construction is a high-risk industry that includes a variety of building, modifying, and/or repairing tasks. Numerous tasks performed by construction workers put them at risk for major injuries, including falls from rooftops, unprotected machinery, being struck by large machinery, electrocutions, silica dust, and asbestos.

These Construction Industry offer tools, resources, and information to help anyone working in the field—employers or employees—identify, minimize, and get rid of construction-related risks.

With millions of workers working on several projects, India's construction sector significantly boosts the country's economy. But it's also one of the riskiest industries, with a high rate of occupational accidents and health problems. Maintaining safety on building sites is not only required by law, but it is also morally necessary to safeguard the lives and welfare of employees.

The BOCW Act (1996) ensures that construction workers receive fair treatment at work, access to clean drinking water, safety gear, and health examinations.

The 2020 OSH Code: The goal of this updated code is to make workplace safety regulations simpler to implement and enforce.

Indian Standards (IS) are technical safety regulations that help avoid mishaps on the job site, such as how to handle explosives or erect scaffolding.

Among the most significant risks on a building site are:

- When falling from a height, always employ rails, nets, and safety harnesses.
- Avoid slipping or stumbling by maintaining clear, well-lit paths.
- Exposure to hazardous materials: Wear gloves and a mask, and observe handling guidelines.
- Accidents involving machinery: Only skilled personnel should operate machinery, and it needs to be kept in good condition.

Groups like the National Safety Council of India (NSC) and DGFASLI provide guidelines, training, and even awards for businesses that succeed in safety. Establishing a safety-first culture on Indian building sites is the aim.

Laws and punishments do matter. Beyond that, however, safety raises morale, productivity, and trust. Employees perform better when they feel respected and protected. Additionally, fewer accidents translate into happier, healthier staff and cheaper expenses for businesses.

The technical aspects of safety in construction deal with following criteria:

Area of Interest	Safety Measures
Excavation	During excavation work, safety must be ensured through proper fencing, shoring, equipment use, access paths, supervision, and precautions against collapses, gases, and other common site hazards to protect workers, the public, and nearby structures.
Drilling and Blasting	Drilling and blasting operations must follow strict safety procedures for transporting, handling, storing, and firing explosives to prevent accidents and ensure protection of workers, property, and the public.
Piling and deep foundations	Safe piling and deep foundation work require understanding the machinery,

	monitoring equipment condition, using protective gear, and taking strict precautions during operations to prevent injuries, accidents, and structural damage.
Tunneling	Tunnelling safety hinges on managing drilling, blasting, mucking, and support operations in confined, hazardous conditions—with strict precautions, protective gear, and constant equipment checks being crucial to prevent accidents and ensure smooth underground work.
Road making	Road construction safety revolves around handling hot machinery, bitumen, and traffic with caution—using protective gear, maintaining equipment, managing heat and fumes, and ensuring workers and the public stay safe near heavy operations.
Site Transport	Safe site transport depends on alert drivers, well-maintained vehicles, smart traffic flow planning, and preventing shortcuts—because human error and poor upkeep are the biggest causes of on-site mishaps.
Floor and wall opening	Openings in floors, walls, and walkways must be securely guarded with railings, covers, or toe boards to prevent dangerous falls—because one careless step shouldn't be a fatal one.
Demolition	Demolition work is high-risk and demands meticulous planning, structural support,

	protective gear, and safe disposal methods to keep workers, the public, and nearby structures out of harm's way.
Structural Steel erection	Structural steel erection involves careful planning, safe use of cranes and hoists, precise column alignment, and ensuring the safety of workers through proper equipment, scaffolding, and safety measures to prevent accidents and ensure stability during construction.
Concrete framed Structure	Erection of concrete framed structures involves safe handling of materials, mixing, and placement of concrete, with strict safety measures for equipment, scaffolding, and pre-stressed or pre-fabricated components to prevent accidents.
Material Handling	Material handling on construction sites involves careful storage and transportation of raw materials and finished products, with specific safety measures for various materials like acids, cement, steel, and chemicals to prevent accidents and ensure proper use.
Compressed Air	Working in compressed air requires strict safety measures, including proper equipment, medical checks, and careful handling of pressure to prevent health risks like nitrogen bubbles in the bloodstream.
Tools	The proper usage, maintenance, and safety precautions for various electrical,

	pneumatic, and hand tools on construction sites, emphasizing the importance of correct handling, personal protection, and regular inspections to prevent accidents and injuries.
Construction machinery	Ensure the safe operation, maintenance, and transportation of construction machinery by following proper precautions, regular checks, and using protective measures to minimize accidents and hazards.
Common Hazards	Construction sites pose various hazards, including airborne contaminants like dust and toxic fumes, lead poisoning, noise, vibration, electrical risks, and inadequate lighting, which can all affect workers' health and safety. Proper precautions, such as PPE, ventilation, noise control, and good housekeeping, are essential to mitigate these risks.

Questions for Practice

Q16: What is the purpose of the BOCW Act (1996) in the construction industry?

A. Promote machinery sales

B. Reduce project deadlines

C. Ensure worker safety and welfare

D. Encourage demolition work

Q17: The National Safety Council of India (NSC) and DGFASLI only provide punishments for safety violations. **(True/False)**

Q18: In construction, _____ and _____ must always be used when working at heights to prevent falls.

Q19: Assertion (A): Safe site transport helps reduce accidents on construction sites. **Reason (R):** Human error and poor vehicle maintenance are major causes of site transport mishaps.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

Q20. Match the Following:

Construction Activity	Key Safety Practice
A. Demolition	**i.** Safe explosive handling procedures
B. Drilling and Blasting	**ii.** Use protective gear and careful planning
C. Tunneling	**iii.** Ventilation, protective gear, equipment checks
D. Material Handling	**iv.** Careful storage and transport of materials
E. Road Making	**v.** Manage traffic, heat, and bitumen fumes

13.5 Practices for Health Management in Steel Industries

One of the sectors in India that is expanding is the steel sector. Because of the growing need for steel products, a sizable portion of the workforce is employed by the industry. After China, India is currently the world's second-largest producer of steel. According to estimates from the International Labour Organization (ILO), India will overtake all other nations in terms of steel production by 2030.

According to estimates, India's steel industries employ 0.95 million people. One According to a report by the International Labour Organization (ILO), occupational diseases and injuries cause 2.8 million fatalities annually. According to estimates, over 374 million workers have occupational accidents and non-fatal injuries.

Every day, about 6000 deaths were reported. In the United States, hearing loss is the most common occupational disease, according to the Centers for Disease Control and Prevention (CDC). Hearing loss is more common in workers who are regularly exposed to heat, metals, solvents, asphyxiants, or loud noises. The most common occupational morbidities in India include silicosis, musculoskeletal injuries, pneumoconiosis,

asbestosis, byssinosis, pesticide poisoning, heat stroke, and hearing issues. According to the data, 30% of industrial fatalities globally occur in India alone. The guidelines for occupational health and safety in the steel industry were explicitly mentioned by the Indian government.

The steel industry is officially classified as hazardous under Indian law because of the many serious risks it involves. These risks come from working with extremely high temperatures, toxic and explosive gases, heavy material handling, and labor-heavy processes. The dangers increase even more during project work outside regular operations, especially when dealing with chemicals, electricity, steam, heights, and tight spaces.

According to the ILO, the most common reasons workers get injured in the steel industry include slipping or tripping, falling from heights or being hit by falling objects, and getting caught in or around unguarded machines. Other major risks include working in tight spaces, using heavy equipment like cranes or forklifts, exposure to harmful substances like dust or chemicals, contact with hot or reactive materials, explosions, extreme heat, radiation, loud noise, electric shocks, and doing physically demanding or repetitive tasks.

The **World Steel Association** highlights five major causes of accidents in the steel industry and how to stay safe:

1. **Moving Machinery** – Always shut off and lock energy sources before working on any machines.
2. **Working at Heights** – Use proper safety harnesses and provide regular training to prevent falls.
3. **Falling Objects** – Regularly inspect and secure anything stored up high to avoid things dropping on workers.
4. **On-Site Traffic** – Organize and control all traffic on site, including vehicles and pedestrians, to avoid collisions.
5. **Process Safety Incidents** – Spot any risks that could lead to fires or explosions and put safety systems in place.

Health, safety, and better working conditions aren't just good for workers—they also help boost the economy. When employees are healthy and safe, they work more efficiently and fewer accidents happen, which saves money for businesses. Understanding how important this is, the **Ministry of Steel (Government of India)** has

stepped in to lead the way. They've set up a **Working Group** to create clear safety guidelines that will apply to **both large and small companies** in the steel industry, helping to manage risks more effectively.

To make steel industry workplaces safer across the board, the **Ministry of Steel** took a hands-on approach by actively engaging with people who know the industry best. They held in-depth discussions with leading steel producers like **SAIL, RINL, Tata Steel, JSW, JSPL, Essar Steel (ArcelorMittal Nippon Steel), Tata Steel BSL**, and others, as well as important players like **NMDC, MECON, KIOCL, MOIL, and Jindal Stainless**.

They also brought in voices from **industry associations** such as **ISA, AIIFA, SIMA, AISRA, and ASPA**, and tapped into the knowledge of top **academic institutions**, including **IIT Kharagpur** and **NISST**.

Their goal is to create a **set of common minimum safety guidelines**—a practical, industry-wide safety benchmark that every steel plant in India can adopt.

To make this happen, the Ministry formed a **core team of experts**—a working group and sub-group—made up of safety professionals and thought leaders from **SAIL's SSO, Tata Steel, IIT Kharagpur, NISST, AIIFA, AISRA, and ASPA**. Together, they're shaping the foundation for a safer future in steel.

Following are the technical aspect of safety used in steel industry:

Area of Interest	Safety Measures
Storage, handling & use of gas cylinders	To avoid leaks, explosions, or injuries, gas cylinders need to be handled carefully, stored upright, and securely fastened.
Working at Height	To avoid severe falls, make sure platforms are solid and use appropriate fall protection, such as guardrails and harnesses.
Working in a Confined Space	To prevent suffocation or toxic exposure, make sure that adequate ventilation, gas testing, and backup rescue measures are in place.

Permit to Work (Operation & Maintenance)	Before beginning high-risk tasks, a formal permission system must be followed to guarantee that all safety inspections are finished.
Illumination at workplace	In order to minimize eye strain and avoid accidents brought on by low visibility, adequate illumination must be provided.
Lance cutting	When cutting with oxygen lances, wear protective gear and adhere to fire safety procedures to avoid burns, fires, or explosions.
Gas cutting & Gas Welding	When handling gas, always make sure there is adequate airflow, use safety equipment, and look for leaks.
Arc Welding & Arc Cutting	Be prepared and be grounded to avoid fumes, electric shock, and sparks.
Equipment and Machinery guarding	First line of defense is to always operate machinery with the appropriate guards in place.
Hydraulic System safety	Before beginning any work, make sure to check for leaks and carefully release any stored energy. Don't take pressure for granted.
Barricading	Keep people out of dangerous areas, especially where work is being done, by using obvious signs and barriers.
Demolition of Building and Structure	Demolition is about preventing collapses, not just tearing structures down.
Material handling (manual and mechanized) & storage	Store items to prevent them from falling or shifting abruptly, and lift carefully rather than forcefully.

Work on Electric Overhead Travelling (EOT) Crane	The crane should only be used by trained individuals; always inspect it first and avoid taking short cuts.
Electrical safety	Because electricity is invisible but lethal, turn it off, lock it out, and check everything twice before touching it.
Fire Safety	Know the exits, keep extinguishers close by, and never overlook a minor fire hazard because it can quickly increase.
Excavation	Know what's underground and take precautions against cave-ins before you dig; it could save your life.
Personal Protective Equipment (PPE) Management	Wearing PPE is not enough; ensure sure it fits properly and is in good condition.
Operation and Maintenance of Conveyor Belts	Before approaching, turn it off and shut it out because belts aren't forgiving.
Oxygen & Nitrogen Gas line	Gas lines should be handled carefully since improper handling can result in dangerous mishaps
Handling of Fuel Gases	Cylinders should always be kept away from heat sources and sparks.
Energy isolation	Lock everything out before doing any repairs, and make sure it remains off until you're finished.
Safe handling of Liquid Metal	Use the right equipment and avoid the splash zone because molten metal is serious business.
Transportation in steel industry	In plant areas, drive carefully by staying on the roads, paying attention to signs, and staying aware.

Loco Operation	Before moving a loco, stay vigilant, move slowly, utilize signals, and confirm that the track is clear.

Questions for Practice

Q21: What is the most common occupational disease in the United States, particularly in the steel industry, according to the CDC?

A. Heat stroke

B. Silicosis

C. Hearing loss

D. Pneumoconiosis

Q22: The steel industry in India is not considered hazardous under Indian law. **(True/false)**

Q23: The Ministry of Steel aims to create a common set of _____ safety guidelines to be adopted across all steel plants in India.

Q24: Assertion (A): The use of Personal Protective Equipment (PPE) is essential in steel plants.

Reason (R): PPE prevents all accidents and eliminates the need for other safety systems.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

Q25. Match the Following:

Hazard Area	**Safety Measure**
A. Working at Heights	**i.** Use harnesses and solid platforms
B. Lance Cutting	**ii.** Wear protective gear and follow fire safety rules

Hazard Area	Safety Measure
C. Electrical Safety	**iii.** Turn off power, lock out, and double-check systems
D. Confined Space	**iv.** Ensure ventilation, gas checks, and rescue plans
E. Gas Cylinder Storage	**v.** Store upright and fasten securely

Summary

Occupational health risks in the construction and steel industries, focusing on common disorders and safety practices. The key points of unit are as follows:

- Occupational health aims to protect workers' physical, mental, and social well-being by identifying and managing risks like respiratory issues, musculoskeletal problems, and stress.
- **Health Risks in Construction:** Construction workers face risks like lung diseases (e.g., silicosis), musculoskeletal injuries, hearing loss, skin conditions, and mental health issues, mainly due to dust, chemicals, heavy machinery, and stress.
- **Health Risks in Steel Industry:** Steel workers are exposed to physical hazards (e.g., noise, heat), chemical risks (e.g., fumes, heavy metals), radiation, ergonomic issues, and psychological stress.
- **Health Management Practices:**
  - In construction, safety involves proper equipment, PPE, and safe procedures for tasks like excavation and material handling.
  - In steel, safety includes measures for working with chemicals, machinery, and heights, plus strict protocols for PPE and fire safety.
- This unit stresses the importance of implementing safety measures and health management strategies to protect workers in both industries, improving their well-being and productivity.

Answer
Q1. B
Q2. True
Q3. Wellbeing

Q4. A
Q5. A- ii, B-iii, C-i
Q6. C
Q7. False
Q8. Silicosis
Q9. A
Q10. A-iii, B-iv, C-i, D-ii
Q11. C
Q12. True
Q13. Heavy Metals
Q14. A
Q15. A-i, B-ii, C-iii, D-iv, E-v
Q16. C
Q17. False
Q18. Safety Harness, Quardrails
Q19. A
Q20. A-ii, B-I, C-iii, D-iv, E-v
Q21. C
Q22. False
Q23. Minimum
Q24. C
Q25. A-I, B-ii, C-iii, D-iv, E-v

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Unit 14: Occupational Health Disorders in Practice III

Unit Structure

14.0 Learning Objectives

After going through this unit, you will be able to:

- Understand the different types of occupational hazard in dairy, food and pharmaceutical industries.
- Udnsterd the diseases associated to occupational hazards.
- Discuss the Effective hazard management option at workplace.

14.1 Introduction

In earlier Unit we have learned about the health hazards in practice related to construction, and steel industries. In this chapter we will learn about the health disorder associated with the food processing units, dairy and pharmaceuticals industries. Promotion of health at workplace is an essential area of personnel safety since they are exposed to different factors that cause sickness in their working environment. Specifically, the food processing, dairy, and pharmaceutical industries are in a different operational category because of risk factors. These sectors apart from being vital in the economy have a big influence on the health of the society. It is important to know the Occupational health (OH) which commonly affect these industries in an effort to find appropriate strategies that can be used to prevent them and promote the health of the workforce.

Food processing is an exciting subsector involving modification of food from its natural state into a form that is suitable for consumption. As a sector this industry encompasses a vast array of processes such as slicing, cooking, packaging, quality

assurance among others. Although food processing is essential for providing safe and convenient food for consumer, it involves workers in a range of physical and chemical risks. Incidences of Musculoskeletal disorders (MSDs) caused by responsibilities such as; repetitive movements, lifting and standing for long periods. Also, workers are likely to be exposed to dangerous cleaning solvents and preservatives which cause respiratory problems, skin diseases. Exposure to noise from the machinery aggravates these effects adding on permanent hearing-impaired affect associated with the noise exposure.

When it comes to the health consequences in the dairy industry the risks are similar as well. Employees are often contaminated with organic dust, bacteria and allergens resulting to farmer's lung and asthma, among others. There is also the work content feature that includes lifting of heavy objects and performing tasks that require awkward postures are seen on the dairy farms which predisposes the workers to MSDs. Employees are at a high risk of contracting zoonotic diseases because of the close contacts used with animals. Mentioned diseases such as allergies and infections cases can originate from direct contact with the dairy products which prove that health issues are a common thing to the employees in this line of production.

The pharma industry like other industries has occupational health risks given the background of its adherence to high standards and largely delivering high stakes output. Active pharmaceutical ingredients (APIs) are normally handled by the employees and these are likely to cause harm if the required precautions are not observed on the handling of the substances. Chemical involvement cause affects both the short-term and long-term health of the individual therefore; workers should observe the usage of personal protective equipment (PPE) and health check-ups frequently. Ergonomic hazards are also present because of repetitive movements in drug manufacturing and packaging which cause strain injuries. Besides, bring on high pressure that can lead to the deterioration of the mental health of the employees' some aspects of stress and burnout. It is equally important to note that those occupational health disorders should be treated not only as legal requirements for employers, but as humanitarian missions, since they aim at preserving the health of workers.

Addressing these OH disorders is not only a legal responsibility for employers but also a moral obligation to protect employees' health. Prevention approaches play a crucial role in mitigating risks. Education and Training on safe work practices are fundamental,

as they permit workers to recognize and respond to potential hazards. Providing appropriate PPE is also vital in protection against chemical exposure and physical injuries. Regular health checkup can help in identifying the early signs of health issues, enabling timely preventions and care. Additionally, improving work conditions through ergonomic solutions and reducing noise levels can enhance employee safety and comfort.

All these industries are closely related, and this underlines the significance of overall occupational health programs. The world's population is growing as the demand for food, dairy products, and pharmaceuticals increases; this means that workers remain at risk of being harmed. In this case, organizations can promote the health-related safety culture to change the ways in which work activities are conducted to reduce the risk of occupational health disorders and, at the same time, to improve productivity.

Self-Assessment 1

Very short answer type questions

1. Which industry involves risks from Active pharmaceutical ingredients?
2. Which disorder is commonly caused by repetitive movements?
3. Which disease is associated with organic dust in the dairy industry?
4. Which equipment is essential for chemical protection?
5. Which process increases risk of hearing impairment in food processing?
6. Which sector modifies food into consumable form?

14.2 Common Occupational Hazards /disorders

An incident or exposure that takes place at work and either causes or exacerbates a preexisting ailment is known as an occupational illness. A guided history should be taken if an occupational disorder is suspected, paying special emphasis to determining the temporal link between exposure at work and symptoms. The most common occupational lung disease in developed nations is occupational asthma, which manifests as the typical asthma symptoms of coughing, wheezing, chest tightness, and difficulty breathing. Exposure to generic vapours, gases, dusts, fumes, and cigarette smoke has been associated with occupational chronic obstructive pulmonary disease. The most frequent cutaneous exposure is occupational contact dermatitis. Numerous agents, such as physical agents, mechanical trauma, biologic agents, and primary

irritants or sensitisers, can be causal reason for it. Medial or lateral epicondylitis and carpal tunnel syndrome are two prevalent repeated injuries that fall under the category of occupational musculoskeletal disorders. In general, occupational diseases are treated similarly to nonoccupational disorders. To protect the worker, exposure should ideally be managed. An industrial accident can have detrimental effects on quality of life.

Occupation asthma

About 15% of new adult instances of asthma are caused by occupational asthma, the most common occupational lung disease in developed nations. According to a 2012 survey of over 200,000 patients across 22 states, an estimated 1.9 million new instances of occupational asthma were reported (Mazurek et al., 2012). Occupational asthma results in approximately 38,000 deaths and 1.6 million disability-adjusted life-years annually (Tarlo et al., 2009). Because of the high prevalence of occupational asthma, it should be considered in any adult with new-onset asthma (Tarlo and Lmiere, 2014; Anees et al., 2011). Coughing, breathing difficulties, chest tightness, and wheezing are all symptoms of occupational asthma that are comparable to those of nonoccupational asthma.

Management

Complete agent avoidance is the recommended first line of treatment for occupational asthma (Tarlo and Lmiere, 2014; Tarlo and Malo, 2013). However, bronchial hyperresponsiveness persists in up to 70% of patients even years after cessation of exposure (Tarlo and Lmiere, 2014). Personal respiratory equipment can result in a temporary improvement of respiratory symptoms, but not complete suppression (Tarlo and Lmiere, 2014). Therefore, it is most useful as an interim measure while implementing efforts to control exposures at the source or in the environment (Tarlo and Lmiere, 2014; Baur et al., 2012; Tarlo and Malo, 2013). As with asthma in general, occupational asthma is treated pharmacologically with leukotriene modifiers, bronchodilators, and inhaled corticosteroids (Baur et al., 2012). Even following total exposure avoidance, only roughly one-third of individuals with occupational asthma experience long-term symptomatic recovery or remission of objective measures of airway dysfunction, indicating a generally unfavourable prognosis (Lytras et al., 2014).

Self-Assessment 2

True/false types questions

1. Occupational asthma is the most common occupational lung disorder in industrialized countries.
2. Symptoms of occupational asthma are completely different from those of nonoccupational asthma.
3. The best way to manage occupational asthma initially is to completely avoid exposure to the triggering agent.
4. Occupational contact dermatitis is the least common dermal exposure in the workplace.
5. Treatment of occupational disorders is generally the same as for nonoccupational disorders.
6. Personal respiratory equipment can fully eliminate symptoms of occupational asthma.
7. Bronchial hyperresponsiveness may persist in occupational asthma patients even years after they stop being exposed.

14.3 Occupational Hazards related to Dairying

(https://lindstromgroup.com/in/articles/protective-workwear-and-safety-measures-in-dairy-processing)

Milk and milk products can induce food-borne disease just like any other food. Environmental pollution, chemical additions, nutritional degradation, and pathogen proliferation and contamination may impact the quality of milk and related products.

1. Biological hazards

Biological hazard includes microbial infection (bacteria, viruses, fungi, or biological toxins) during the process or due to inadequate controlled measured. Since milk is a perfect environment for bacteria and other microorganisms to develop. Microbiological hazards are a significant food safety problem in the dairy industry. The environment or the dairy animals themselves may introduce these substances into the milk. Milk can contain harmful microorganisms such as *Salmonella*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Staphylococcus aureus*, *Yersinia enterocolitica*, *Bacillus cereus*, *Clostridium botulinum*, *Mycobacterium bovis*, *Brucella abortus* and *Brucella melitensis*. Similarly, an infectious disease known as a zoonosis can spread from vertebrate animals to people. Leptospirosis, salmonellosis, listeriosis, brucellosis, and tuberculosis are zoonotic illnesses that are frequently linked to milk and milk products.

2. Chemical Hazards

Unintentionally introducing chemical dangers into milk and milk products might render them dangerous for human consumption. The hazardous chemical may accumulate in the milking animals ingest chemical-containing feed and/or water. Inadequate environmental, equipment, and milk storage facility control could be additional sources of contamination. Detergents, teat disinfectants, dairy sanitisers, antibiotics, anti-parasites, herbicides, pesticides, and fungicides are examples of chemicals that might cause harm.

3. Physical Hazards

Physical hazard such as noise, slip and fall injuries etc. can occur due to liquid spills, working machinery, radiation and heat.

4. Psychosocial Risks

Workers involved in dairy facilities may experience stress due to isolation, long hours and cultural barriers.

14.4 Occupational Hazards related to Food Processing industries

The common occupational diseases associated with food and drink industries are mentioned in Table 1. Occupational health hazards include biological, chemical, physical, and psychological concerns are all part of the in the dairy, food processing, and pharmaceutical industries. Physical risks including slips and accidents, as well as exposure to pathogens and cleaning agents, are all part of the dairy industry. Biological dangers associated with food processing include chemical residues, foodborne infections, and injuries from equipment. Risks associated with pharmaceuticals include exposure to chemicals, hazardous equipment, and possible biohazards.

Table 1. Most common occupational diseases in the food and drink industries (Tomoda, 1993)

Occurrence	Health Hazards
Most common	Bronchitis, asthma, Diseases induced by inhalation of substances, Hearing impairment, Respiratory disorders, Physical coordination disorders, Musculoskeletal disorders

Second most common	Hearing impairment, Diseases induced by physical and chemical agents, asthma, Musculoskeletal disorders skin diseases, Strains in various parts of body (knees, elbows), skin disease, Allergies (contact with chemical agents)
Third Most common	Septicemia, infection, Hearing impairment, ski diseases, allergies, Septicemia (blood poisoning) and other infections
Other	Infections transmitted by animals, parasites, Circulatory disorders, skin diseases, allergies, Respiratory conditions associated with toxic substances, infections.

Biological Hazards

The foodborne illnesses caused by bacterial like *E. coli*, *Salmonella* and mycotoxins (toxin produced by fungal) can be a major concern (Table 2). Mycotoxins can cause reduced appetite, diarrhoea, vomiting, pulmonary disease, impaired growth, cancers, extent of exposure (Shukla et al., 2009; Mohapatra et al., 2017).

Chemical Hazards

In food processing environments, exposure to cleaning agents, sanitizers, preservatives, and pest control chemicals can pose significant health risks. Workers may suffer from respiratory issues, skin irritation, or eye damage due to frequent contact with these substances. Inadequate ventilation or improper use of personal protective equipment increases these risks. Long-term exposure can also result in chronic health problems (FAO/WHO, 2020).

Physical Hazards

Physical hazards in food processing involve the risk of injury from sharp tools, machinery, and equipment such as slicers, mixers, or conveyors. Workers are also exposed to slips, trips, and falls due to wet or cluttered floors. Inadequate training or lack of safety measures can lead to cuts, fractures, or even amputations. Consistent adherence to safety protocols is essential to minimize these risks (OSHA, 2021).

Table 2. Types of infections reported in food and drink industries

Infection Type	Source/Exposure	Common Symptoms
Brucellosis caused by *Brucella* sp.	Handling infected livestock (e.g., cattle, goats, sheep); exposure to raw dairy	Fever, fatigue, joint pain, night sweats, appetite loss, arthritis-like symptoms
Erysipeloid caused by *Erysipelothrix rhusiopathiae*	Contact with infected fish or pigs through cuts or abrasions	Red, swollen, and painful skin lesions; can spread to lymph nodes and bloodstream
Leptospirosis caused by *Leptospira*	Contact with urine from infected animals or contaminated water	Headache, muscle pain, fever, vomiting; severe cases involve liver/kidney failure and neurological issues
Dermatophytosis (Ringworm)	Contact with contaminated animal hair or skin	Circular rashes, hair loss, itchy or scaly skin
Toxoplasmosis caused by *Toxoplasma gondii*	Exposure to undercooked meat or contact with infected animal tissue	Flu-like symptoms, swollen lymph nodes; can cause serious birth defects if contracted during pregnancy
Epidermomycosis	Fungal infection from handling animals or contaminated surfaces	Skin irritation, blistering, and erythema
Salmonellosis caused by *Salmonella* sp.	Consuming undercooked eggs, poultry, or unpasteurized milk	Diarrhea, stomach cramps, fever, nausea, vomiting
Listeriosis caused by *Listeria monocytogenes*	Ingestion of contaminated ready-to-eat foods (e.g., deli meats, soft cheeses)	Fever, muscle aches, diarrhea; serious risks for pregnant women, elderly, and immunocompromised
Campylobacteriosis caused by *Campylobacter jejuni*	Handling or consuming undercooked poultry	Abdominal pain, diarrhea, fever, vomiting

Norovirus Infection	Poor hygiene in food handling, contaminated surfaces or food	Sudden onset of vomiting, diarrhea, stomach cramps
Hepatitis A	Ingestion of food or water contaminated by fecal matter	Fatigue, jaundice, abdominal pain, loss of appetite, nausea
Occupational Lung Infections (e.g., due to Papillomavirus + inhaled chemicals)	Working with animal meat in combination with inhalation of harmful fumes	Chronic respiratory issues, potential risk of lung cancer

Source: https://www.iloencyclopaedia.org/part-x-96841/food-industry/overview-and-health-effects

Psychosocial Risks

Stressful work environments, long hours, and potential exposure to dangerous equipment can contribute to mental health problems.

Employees in the meat or food processing industries face numerous health and safety hazards on the workplace are given in Table 3.

Table 3. Cause of health hazards at work places or food processing unit (Gupta and Bisht, 2019)

S. No.	Health Hazards	Causes
1.	Breathlessness	Preparation of masalas, medicines, lifting heavy items
2.	Cough, sneezing	Preparation of masalas
3.	Eye and skin irritation	Preparation of masalas, pickles, squashes
4.	Burns	Cooking soiling, spilling
5.	Cuts	Chopping or grating of vegetation, fruits
6.	Slips/falls	Lifting and carrying crates slippery floor due to spilling of water, oil
7.	Muscle pain and discomfort	Long working hours, lifting loads

Self-Assessment 3

Fill in the blanks type questions

1. Microbiological hazards are a major food safety concern in the dairy sector because milk is an ideal medium for the growth of _____ and other microbes.

2. _____ hazards in the dairy industry can occur due to liquid spills, working machinery, radiation, and heat.

3. Consumption of contaminated milk can lead to zoonotic infections such as _____ and _____.

4. In food processing environments, long-term exposure to cleaning agents and chemicals without proper ventilation or protective equipment can cause chronic _____ problems.

5. Stress due to isolation, long hours, and cultural barriers are examples of _____ risks faced by workers in dairy facilities.

14.5 Occupational Hazards related to Pharmaceuticals

There are various health issues reported to pharmaceutical industries at various stages like drug development, manufacturing, and packaging processes as discussed below (ILO, 2010)

Biological Hazards

Exposure to pathogenic microorganisms during production of vaccines using *E. coli*, viruses used in gene therapy. The use of animal-derived materials such as bovine serum may carry zoonotic agents. Further, improper sterilization protocols may result in contamination and health risks to workers and patients.

Chemical Hazards

The active pharmaceutical ingredients like cytotoxic drugs used in chemotherapy. Solvents (e.g., acetone, methanol) used in formulation and synthesis can be toxic and flammable. Similarly, cleaning agents like isopropyl alcohol or hydrogen peroxide are inflammable in nature and may cause acute or chronic toxicity. Substance like colouring, preservative and filler may cause Skin irritation, respiratory problems in powder form.

Physical Hazards (OSHA, 2021)

Noise from high-speed machinery and heating, ventilation and air conditioning (HVAC) systems. Heat exposure in sterilization areas (e.g., autoclaves), Radiation from X-ray or gamma-ray sterilization processes. Ergonomic hazards from repetitive tasks and poor workstation design.

Hazard Controls Management

To protect their workers from harm, employers are required to establish engineering controls for dangerous equipment, safety, and emergency response programs. They also must make proper personal protective equipment (PPE) readily available for any employee who will be working in a dangerous area or operating heavy machinery and train their employees on the applicable PPE. Other controls include maintaining walking/working surfaces to prevent slips, trips, and falls, machine guarding, and ergonomics programs. Employers should also provide appropriate training to their employees in the food processing industry. Common training for food processing industry workers includes:

- Personnel Protective Equipment training
- Hazards of extreme temperatures (hot and cold);
- Incident investigation
- To ensure the chemical safety in the workplace, information about the hazards and identities of the chemical should be available and understandable to workers. The five key elements outlined by OSHA regulations Hazard Communication Standard (HCS) under 29 CFR 1910.1200h must follow to ensure safe working place for employes are material inventory (hazard identification), safety data sheets, labeling, safety program training to employee, and program implementation.
- Use of Biosafety cabinets, PPE, and aseptic processing for handling the biological hazards
- Adherence to biosafety levels (BSL) appropriate for the risk level.
- Acute or chronic toxicity
- Material Safety Data Sheets (MSDS)
- Use of protective barriers, hearing protection during high intensity physical activities.

- Regular maintenance of equipment
- Regular ergonomic assessments (evaluating the fit between workers and their work environment to identify and mitigate risks of musculoskeletal disorders (MSDs) and other injuries) and training of employees.
- Slip-resistant flooring and proper housekeeping

Summary

- The chapter highlights the occupational health hazards predominant in food processing, dairy, and pharmaceutical industries. These sectors are vital to the economy and public health but also pose unique risks to workers. Food processing exposes workers to physical and chemical hazards, such as repetitive tasks leading to musculoskeletal disorders (MSDs), chemical exposure from solvents and preservatives, and noise-induced hearing loss. Similarly, dairy industry workers face risks from biological agents like bacteria, mycotoxins, allergens and the threat of zoonotic diseases due to close animal contact. However, physical hazard such as noise, slip and fall injuries etc. can occur due to liquid spills, working machinery, radiation and heat.
- Various common occupational diseases affect workers in these industries, including occupational asthma, chronic obstructive pulmonary disease (COPD), contact dermatitis, and MSDs. Occupational asthma is particularly prevalent, often triggered by more than 250 agents, and accounts for a significant portion of new adult asthma cases worldwide. Managing these conditions includes reducing exposure, using respiratory protection, and pharmacologic treatment like that of non-occupational conditions. Despite these measures, full recovery is rare, and workers often experience long-term health impacts.
- The dairy and food processing industries also encounter hazards from microbial contamination (e.g., *Salmonella*, *E. coli*), chemical residues from cleaning agents and pesticides, and physical risks from machinery or slippery floors. Mental health risks, such as stress and burnout due to long hours and cultural isolation, also affect worker well-being. The pharmaceutical sector faces similar threats, including biological hazards during the designing and production of bioengineering product like vaccine development, chemical

hazards from solvents and active ingredients, and physical hazards from machinery, heat, and radiation exposure.

- Effective hazard management in these industries requires a comprehensive approach. Employers must provide personal protective equipment (PPE), ensure proper training, and establish safety protocols to minimize risks. Engineering controls, proper housekeeping, chemical safety programs, ergonomic assessments, and adherence to biosafety standards are vital. Prevention through education, regular health check-ups, and a proactive workplace culture is key to protecting workers and promoting both health and productivity in these critical sectors.

Terminal Questions

1. Discusses the occupational Hazards associated to Pharmaceuticals?
2. Explain various types of hazards control management option?
3. What is the element of OSHA regulations Hazard Communication Standard (HCS)?
4. Discuss five biological health hazards (diseases) caused by food and drink industries?
5. Discusses the common occupational health hazards?

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18. https://www.cdc.gov/niosh/

Answer Keys

Self -Assessment 1: 1 – Pharmaceuticals; 2 – Musculoskeletal disorders; 3 – Asthma; 4 – personal protective equipment; 5 – Noise; 6 – Food processing

Self-Assessment 2: 1 – True; 2 – False; 3 -True; 4 – False; 5 – True; 6 – False; 7 – True

Self-Assessment 3: 1 – Bacteria; 2 – Physical; 3 - tuberculosis, brucellosis; 4 – health; 5 - psychosocial