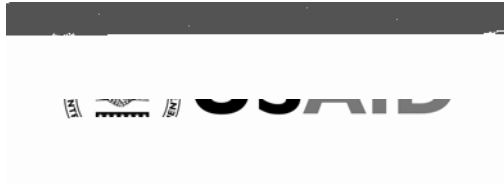


LECTURE NOTES

Degree and Diploma Programs
For Environmental Health Students



Funded under USAID Cooperative Agreement No. 663-A-00-00-0358-00.

Produced in collaboration with the Ethiopia Public Health Training Initiative, The Carter Center, the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education.

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Preface

The role of well-developed teaching materials to produce the required qualified health professionals, who are considered to shoulder the responsibility of improving housing through mobilization of the community, is recognizable. However, lack of appropriate textbooks that could meet the need for training professional on healthful housing has been one of the outstanding problems in the existing higher health learning institutions in Ethiopia.

The present lecture not

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Abbreviations

ARI	-	Acute Respiratory Illnesses
CP	-	Candle Power
dB	-	Decibel
EH	-	Environmental Health
ft-c	-	foot candle
ft	-	feet
GCIS	-	Galvanized Corrugated iron Sheet
MOH	-	Ministry of Health
RS	-	Registered Sanitarian
Sq.ft	-	Square feet
WHO	-	World Health Organization

CHAPTER ONE

General Introduction

1.1 Learning Objectives

After the completion of this chapter, the student will be able to:

1. Define housing and other related terms
2. Enumerate factors affecting the quality of housing and explain how these factors influence housing
3. Describe health importance of housing

1.2 General Introduction

Some literatures have evidently shown that humans in the prehistoric periods used the existing natural physical structures to protect themselves against those factors that put potential risks to their life. These structures have been used mainly to overcome adverse weather conditions, frightening wild animals, and to store some foodstuffs. It is therefore, understood that the quest for shelter has emerged from the time when people have appeared on earth. The present modern buildings are believed to be fruits of development or gradual progresses of human history. The basic fact of this is that human settlements are one of the basic factors governing the physical, mental, and social wellbeing of an individual and the family. Various studies conducted in different parts of the world have revealed that there is a direct and indirect association between health status of the inhabitants and the condition of housing. Thus, the quality of life of people depends on the general condition of their residences, which is the immediate human environment.

Although rudimentary and unorganized efforts have been made in improving housing through environmental health programs there was no significant improvement achieved. This is in part due to

economical problem, lack of organized program and a government policy with regard to housing.

Housing improvement is generally linked with or affected by factors such as: economic status, social conditions, educational status, custom, traditions, governmental and local housing policies and geographical conditions. Hence, a concerted and integrated effort of different concerned sectors including the occupants is necessary for effective housing program and improvement.

In Ethiopia, poor housing conditions attributed by overcrowding, poor housekeeping, poor designing and construction, etc. are the major factors for presence of substandard housing and poor health status of the occupant

This course is therefore, aimed to equip environmental health and other health professionals with basic knowledge, attitude, skills and motivate them to carry out programs for housing improvement in the rural and urban communities of Ethiopia. Moreover, they will be

3. **Zoning Code:-** involves the division of the area into a series of zones or districts according to the desired plan.
Example: residential zone, market zone, industrial zone, etc.
4. **Dwelling:-** is any part of a house, which is occupied by an individual family.
5. **Premises:-** is any house with building or land near to it that is owned by the same person.
6. **Standard Housing:-** is a house that is properly planned and constructed, comfortable, safe to live in and fulfill the basic

The following conditions directly or indirectly are responsible for the occurrence of substandard housing:

With the movement of people to cities, urban areas are congested, and desirable housing become unattainable.

Inadequate transportation facilities to and from work place makes it necessary for any people to accept less desirable housing, in the cities, closer to their work places.

Low income to afford satisfactory housing.

Slow measures by the local governmental units, to control potential problems, and lack of integrated efforts to control the problem.

Lack of housing legislation to enforce suitable zoning, building, and sanitation and poor support from courts.

Mismatch of the rate of construction of housing and rehabilitation to keep pace with population growth.

Obsolescence and lack of awareness (about disease prevention, sanitation and personal hygiene), are some of the other factors that cause growth of slum areas. Tenants or inhabitants may hesitate to be interested in maintenance work, especially when the houses are rented. Dwellings having four or more of the following basic deficiencies are considered to be an extreme slum:

1. Provided with inadequate and contaminated water supply
2. Lack of toilets or space to construct an excreta disposal facility outside of the structure
3. Lack of bathing facility inside or outside the structure
4. Greater than 1.5 persons per habitable room
5. Overcrowding of sleeping rooms (less than 3.6 m².) of rwa p~~eso~~.)

9. Lack of waste disposal facilities
10. Having problems of arthropods and rodents
11. Lack of proper drainage
12. Lack of open spaces, pathways, and all weather roads between individual structures and etc.

1.6 Exercises One

1. Discuss the types of houses commonly constructed and used in your local area, with special emphasis on material used to construct houses, design and construction aspects, average number of person per habitable room and etc.
2. What are the factors affecting the quality of residential environment in Ethiopia? Briefly discuss how these factors influence housing condition.
3. What are the factors contributing to substandard housing?
4. Explain both social and health effects of substandard housing.

1.7 Suggested Further Readings

1. M. Ehlers and W. Steel. Municipal and Rural Sanitation. Tata McGraw – Hill Publishing Company L.T.D. New Delhi, 1958.
2. Sileshi Taye. Guidelines for Healthful Housing. MOH. Department of Environmental Health Addis Ababa, 1995. (unpublished).

CHAPTER TWO

Basic Principles of Healthful Housing

2.1 Learning Objectives

Upon successful completion of this chapter, the student will be able to:

1. List the basic principles of healthful housing
2. Identify housing conditions that may affect normal physiological activities of occupants
3. Describe housing conditions that may affect psychological well being of the occupants
4. Mention factors associated with indoor accident and causation of communicable diseases
5. Explain sources, health effect and preventive measures of noise pollution

2.2 Introduction to the Chapter

Basic principles of healthful housing include all those fundamental requirements the house should fulfill and maintain them all the time to avoid health risks in the residential environment. Satisfaction of physiological needs and psychological needs of the family members, protection of the family against communicable diseases, accidents and excessive noise are among these requirements. The attainment of most of these fundamental requirements demands due attention during planning, designing, and construction of the house so that none of the important installations and important facilities are not missed or overlooked. Proper housekeeping and other hygienic aspects are maintained as regular practices.

This chapter is therefore, aimed at introducing the students to the

2.4 Satisfaction of Fundamental Psychological Needs

Each Family member requires some sort of privacy for specific personal affairs. This is possible only if everybody is provided with his own room. But, this may not always be possible, particularly in countries with low socio - economic status. It is imperative however,

important to strictly follow the sanitary recommendations to cut down the incidence of water borne diseases among the family. Locally accepted, but safe methods of waste disposal systems should be promoted. Modification of facilities that have already been used is the best means of improving sanitary conditions around

sometimes causes accidents by weakening joints or stairways. Hence, in zones of serious infestation, wood may better be avoided in foundations unless treated or barriers are used.

2. Control of conditions likely to cause fire or promote its spread. This calls for construction methods and materials, which do not result in fire hazards. The following precautions should also be noted for effective fire protection measures: -
 - a) Stoves and heaters should be mounted with fireproof materials. Gas Cylinders and other petroleum products should be placed out side the kitchen
 - b) Floors and walls should be fire proof as much as possible. Stoves and fireplaces should be placed some distances away from the walls, combustible furniture, etc.
 - c) Smoke pipes (chimney) should be placed away from combustible walls.
 - d) Chimneys should be supported by fireproof foundations and should be lined with fire resistant tiles such as clay.
 - e) Stairways should be enclosed in fire resistant materials.
 - f) Floors and roofs should be if possible non-combustible.
3. Provision of adequate emergency facilities for escape in case of fire (dual egress, windows), fire extinguishing facilities like fire hydrant, chemical extinguishers or locally available materials like sand and soil should be available at close proximity to the house.
4. Protection against danger of electric shocks in which proper electrical wiring is essential, such as proper installation of sockets, insulation of electric wires using conduits.
5. Protection against gas poisoning, which calls for proper ventilation or venting of the room to dilute the indoor air.

6. Protection against falls and other mechanical injuries in the house. It is essential to recognize the use of safeguards on bathtubs, stairs, windows, balconies, and roofs. Proper illumination is also recommended for accident prevention.

2. Building equipment, such as air-conditioning blowers, compressors, etc
3. Construction and maintenance equipment such as stone crushers, concrete mixers, compactors, etc.

Table 1. Noise intensity produced by common sources expressed in Decibels.

SN	Indicative sound / noise	Decibel
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Table 2. Level of Noise recommended at office, dwelling, and sleeping rooms.

<u>Place</u>	<u>Noise Level (Decibel)</u>	
Dwelling	Less than	50
Offices	Less than	35
Sleeping room	Less than	30

Source: W. Purdom: Environmental Health

2.7.4 Noise Prevention

Noise should be excluded from dwellings to the extent that the noise level does not exceed 50 decibels as indicated in the table above. Overcoming the community noise nuisance therefore, require the following actions:-

1. Education of the public about the health effects of noise and how to control it at the local level using for example, soundproof construction materials.
2. Mutual cooperation of industrial firms, utility companies, truck owners, businessmen, city authorities in the control of noise
3. Formulation and application of regulations of a reasonable and enforceable anti noise ordinance
4. Site of housing should be away from sources of excessive noise such as factories, high ways, railways, athletic fields (stadiums) sea and airports, etc.
5. In a house all plumbing, steam pipes and valves should be correctly constructed to stop hammering and singing. Refrigerators, heating equipment, pumps etc. should be firm not to give vibrations in the house.
6. Houses should be constructed in a way to reduce noises and be fitted with windows to give vibrations, and constructed to give vibrations.

CHAPTER THREE

Zoning and Town Planning

3.1 Learning Objectives

Upon completion of this chapter, the student will be able to:

1. Define zoning and town planning
2. Enumerate advantages of zoning
3. Describe how zoning and town planning help to develop healthy cities

3.2 Introduction to the chapter

Town planning is the activity where future direction of development of a certain town is designed to improve physical and social environments through wise use of community resources. It enables people to support each other in performing all the functions of life and in developing to their maximum potential. Town planning is therefore, becoming more and more important in urban affairs. The purpose of zoning and housing are:

1. To control the density of population per unit area,
2. Locate residential, commercial and industrial areas
3. Mark roads and highways,
4. Determine street width that will accommodate the traffic requirements;
5. Ensure safety of the population from other hazards including air pollution, noise pollution and other stresses arising from industries or commercial business centers.

In addition, zoning is the division of land (town/city) into different districts with particular characteristics. It is an integral part of town planning and help to ensure or facilitate appropriate distribution and

design of municipal services that include water supply, waste disposal, fire protection and public facilities such as recreation areas, schools, burial sites and other social facilities. Town planning and zoning controls land utility to conform to certain regulation when they develop the land for residential or business purposes. Zoning also controls the type of building to be erected in a given section of the community and helps to avoid the overcrowding traffic movements thereby reducing accidents. Installation of sanitary waste disposal system according to the characteristics and volume of wastes generated, become simple and convenient in well-zoned areas. It provides a degree of uniformity in planning special planting commissions in some community, to promote attractiveness/ beauty of the city.

Therefore, it will be apparent that zoning and housing are allied. A city that is logically zoned has a significant role in improving housing in several ways. Zoning ensures better living conditions in newly constructed dwellings. It curbs the encroachments of industry and business into residential district, helps to prevent the formations of blighted district which is undesirable for the residential purposes, and regulates the bulk of buildings, i.e. the proportion of the lot that may be occupied by the building.

3.3 Types of Zoning/Districts

A well planned and zoned town or city may be divided into the following zones or district:

3.3.1 Residential Zone / District

This zone is assigned for residential purposes where residential dwellings predominate. The rapid growth of unplanned small towns and rural villages has led most of them to an overcrowding, poor housing and socio- economic condition. Populations living in such unzoned residential environments usually suffer from truck noises

released from motor vehicles, industrial and commercial units, wastes and other nuisances arising from factories, industries, and establishments. Locating separate districts for residential area is a good remedy to overcome and control all the problems that may be resulted from unplanned towns. Zoning ordinances in around residences is very explicit as to spacing individual houses from each other to ensure sufficient lot, air, and light. One should therefore, consider the following criteria while selecting suitable site for the residential district:-

1. Nearness to work place
2. Availability of construction materials
3. Availability of water, electricity for construction purposes and domestic use
4. The area should be free from dampness
5. Level ground for building; but the whole area for the city or town, should be slightly sloping for ease of rainwater drainage

3.3.2 Commercial (Business) Zone

Commercial zone may also encompasses variety of business needs such as neighborhood shopping centers which serve the day to day needs and sub urban shopping center for the residents. Markets and shopping centers are usually located along streets and central business districts. Zoning of commercial sectors into separate units is not only beneficial to promote community health, but it is also convenient for easy transportation, storage, and display of the products. These sections run similar activities and demand similar basic services. The size of free spaces between individual commercial sectors, allocating minimum distance from main street, placement of each commercial unit with respect to their type and services they render are all governed by the zoning ordinance.

3.3.3 Industrial Zone / District

Industrial zone may also have several subdivisions such as large or small scale or cottage industries. Establishment of separate district for industries prevents building of high or hazardous structures in residential areas. Industries are better located at out skirt of the town or city to isolate industrial pollutants such as smoke, hazardous chemical wastes, and noise from the population and minimize frequency of exposure.

logically zoned as a separate unit in the town. Zoning of relaxation sites is important to create many entertainment alternatives for the local residents and tourists. It is also convenient for controlling contamination or pollution of the site and to take appropriate measures immediately.

3.3.5 Institutional Zone (schools, hospitals and etc)

Zoning of institutes is carried out with respect to proximity to source of noise, possibility of safe and adequate water supply, solid and liquid waste disposal systems, accessibility to roads, etc. The detail aspects of institutional health will be discussed in chapter six of this lecture notes.

3.4 Exercise Three

1. Sketch a logically zoned map of a town with the following zones and compare with actual conditions of towns in your local areas.
 - a) Residential environment
 - b) Industrial Zone
 - c) Commercial Zone
 - d) Recreational Zone
 - e) Institutional Zone
2. Discuss the Environmental Health criteria for urban planning.

3.5 Suggested Further reading

1. M. Ehlers and W. Steel. Municipal and Rural Sanitation. 6th ed. Tata McGraw- Hill Publishing Company L.T.D. New Delhi, 1958.
2. Joseph A. Salvato, P.E. Environmental Engineering and Sanitation. 3rd ed. A. Wiley – Inter science Publication, New York.

Ventilation is the process of supplying air to or removing it from any enclosed space by natural or mechanical means. The consumption of oxygen in breathing, results in a reduction of the amount of oxygen in the atmosphere of a closed room and a proportional increase in the amount of Carbon dioxide (Co

The recommended velocity of air to attain comfort is 20 to 50 feet per minute (6.1 to 15.2 meter/ minute), with the lower values applying to heating systems and the higher to cooling. In having adequate ventilation, care must be taken so that fresh air is not admitted at too high velocity since it may be felt as an air draught. A draught is a steady stream of cold air directed upon the body, resulting in contraction of the capillaries of the skin and producing a feeling of chill.

Table 3. Air space volume per person used as a general guideline in the estimation of dimensions of the buildings.

Other means of natural ventilation include the following:

- In houses built of mud and poles, the mud is omitted from the top most part of the eaves

house is located between objects that may prevent free air movement such as trees, high storey buildings.

There are two methods of ventilation of houses. These are:-

- a. ***Through ventilation:-*** The windows are placed opposite to each other so that a current of air passes straight through the room.

Fig.1. Through ventilation for a round thatched tukul.

Fig. 2. Through ventilation in rectangular or square house.

b. **Cross ventilation:-**

4.3.1.2. Artificial (mechanical) Ventilation

It involves the use of mechanical apparatus such as fans and air conditioners. Such mechanical ventilators set air current in motion. Fans are either the extraction type (exhaust vacuum system), propulsion (plenum) type, or the balance system that combines both systems.

a. Exhaust vacuum system of ventilation: is the type of ventilation in which the air is exhausted to the outside by fan or blower, there by causing a lower pressure inside and a leakage inward through windows, doors, and walls. This method is largely used in kitchens to remove odors and smoke, in industrial plants and factories to remove dangerous dusts and fumes, the inlets to the ducts being placed near the point of their production, and in other circumstances where local ventilation is required.

b. The plenum system: is the type of ventilation which forces air into the room and cause a leakage outward, although exhaust ducts may also be provided. The forcing is accomplished by centrifugal fans, which operate in a manner similar to that of the centrifugal pump, or by impeller fans. The air in this method is introduced at a low level near the floors, so that the breathing line is completely bathed by the incoming air.

c. The balance system: pum.105(incomi (co)an)5.6(es b2()6(whi centri5.3(sts (ces whd))TJ -13.65870.371386 T

On the other hand, it has the following disadvantages:- It is expensive to be used by the average population particularly in developing countries, adopted rarely to the existing buildings, and requires skilled persons for its application. Therefore, the environmental health professionals and other concerned bodies need to analyze these advantages and drawbacks before recommending certain types of artificial ventilation.

4.4 Lighting of a House (Illumination)

Light is related to health in several ways. Light (sunlight) helps in combating diseases and in promot

1. **A luminous object:** emits light. It is seen by its own light.
E.g. Sun, stars, incandescent lamp, lighted candle.
2. **An illuminated object:** this reflects the light from luminous

2. **Artificial Lighting:** These are the systems of artificial (man made) lighting. Artificial lighting can be sub-divided into five i.e.

- Direct,
- Direct indirect,
- Semi-direct,
- Semi-indirect,
- Indirect.

- a. **Direct Lighting:** In this case, the light passes through transparent material. It is highly efficient and little or no light is absorbed before striking the work area. 90 to 100 per cent of the light of the luminaries is directed towards the usual working area. When direct lighting is used the luminaries should be placed high, preferably not less than 20 ft (6m) unless and otherwise enclosed in diffusing glassware to prevent glare. Direct lighting has the advantage of being highly efficient, as no light is absorbed before striking the work. However, it causes harsh shadows, and glare results from reflection on smooth or glazed surfaces.
- b. **Semi- Direct Lighting:** 60 – 90 per cent of the light is directed downward to the work. The remaining percentage is directed up ward. Such illumination may not be sufficient for electronic and watch repairs, and for reading.
- c. **Direct-Indirect Lighting:** is designed to provide generally diffused lighting, with nearly equal distribution in all directions (both up ward and down ward).
- d. **Semi-Indirect Lighting:** 60 to 90 per cent of the light is directed to the ceiling and upper walls. The direct light is 40 per cent or below.
- e. **Indirect Lighting:-** 90 – 100 per cent of the light is directed towards the ceiling and upper side walls from which it is reflected to all parts of room and 10% of the diffused light falls upon the working area.

N.B. No one system can be recommended to the exclusion of others. All have characteristics useful in varying degrees and their combination is useful for efficient performance, maximum comfort and prevention of accident and glare.

4.4.3 Characteristics of good lighting

Good lighting systems are those that fulfill the following characteristics:

- a. Must be adequate in power
- b. Constant and uniform
- c. Flickers and vibrations are absent
- d. Absence of glare and shadows.

Factors affecting good lighting in the house;-

1. Room dimension
2. Direct source of wattage
3. Spacing of luminaries
4. Routing of luminaries
5. Reflection factors:-

Smooth surfaces reflect more light than rough surfaces.

Walls, ceilings, and furniture painted light colors reflect more colors and thus increase brightness.

- Elimination of shadows
- Elimination of glare
- Control of outside light
- Lightness of working surfaces, walls, ceilings, fixtures, etc.

4.4.4 Methods of attaining adequate illumination in the room

1. Placing buildings within a reasonable distance from each other.
2. Install at least one external window per existing rooms.
3. Paint internal physical structures of the room with selected appropriate color.
4. Use voltage of recommended capacity with the respect to the size of the room.

Good lighting safeguards the eyesight, reduces accident hazards, and also saves the workers time, and thus economically profitable. Good lighting is also conducive to rest, comfort, sleep, study and thinking.

Table 4. The normal standard of light in some working places

	The amount of light needed in
--	-------------------------------

4.5 Heating of a House

Heating system of a building is necessary to maintain body temperature specially in cold regions. Heat is energy in transit and it refers to the energy only while it is being transferred from one object to another during a temperature change or during change of state of matter. Heating mechanisms of buildings therefore, need review of the ways in which heat is transmitted from place to place, namely conduction, convection and radiation.

1. **Conduction:**

1. **Direct heating**: the source of heat emitting device is placed in the room. E.g. Stove, open fire, radiator
2. **Indirect heating**: employs a central heating unit, which may be an ordinary furnace or steam coils over which the air passes, and the heated air is furnished to the room through the duct by fans or gravity. Rooms are heated by circulating hot water or hot air through coils of pipe in the floors, ceilings or walls. The function of this system may be controlled automatically by means of thermostats in order to keep rooms at the desired temperature.

The advantage of this method over the other is:-

No radiator or duct interfere with floor area

Absence of air current, therefore, curtains remain clean

Greater comfort is obtained particularly near the floor as heat is supplied where it is most needed

3. **Direct-indirect heating system**: this method uses heat source inside the room as well as introduces warm air from outside central furnace.

Other economical methods of attaining comfort are through insulation of buildings, and the stoppage of draft from doors, windows and fireplaces. Weather stripping of the exposed doors and windows may result in 20 per cent fuel saving. Complete house insulation (includes wall and roof) and weather stripping may save 60 per cent of fuel consumption. In addition, such insulation greatly increases comfort by preventing unduly cold walls and ceilings as the warmer bodies of occupants radiate heat and in the summer the cooler ceiling and walls do not radiate so much heat to the occupants. In hot environment buildings may also need to be cooled by passing cold air or cold water over coils in the walls or ceilings. Mechanical refrigeration is also used frequently to cool a building.

All the above mentioned ways of air conditioning of a building may be included under air conditioning system. But air conditioning may also involve the control of air pollution in addition to the above.

Heat Loss from the Body

Air conditioning is primarily the control of the indoor air environment by addition or removal of heat and secondly the removal of dust, fumes and odors. For a great comfort, air conditions should be maintained in the rooms so that necessary heat loss from the body could take place without causing unnecessary strain to the occupants.

Body heat is generally lost by conduction, convection and radiation. There is also a loss of heat from human body through evaporation or perspiration.

Factors that control (affect) heat loss from the body

1. Air temperature
2. Relative humidity of the air
3. Air movement
4. The temperature of surrounding surfaces such as walls, ceilings, floors, and radiators.

Operative temperature: is the mean temperature between the air and wall temperature. Operative temperature for normal person (normally closed and at rest) should be 65 F (18.3 °c) and at knee height (45 centimeter) in order to

3. When there is enough air movement to prevent a blanket of warm air from enveloping the body.
4. When the skin surface is moist and cooling by evaporation is in process.
5. When the relative humidity of the air is low, which speeds up heat loss by evaporation.

In still air heat loss by radiation accounts about 45% of the total heat loss, convection about 30% and evaporation about 25%. Evaporation losses consists 11% from the lung and 14% from the skin. But these percentages vary depending on air conditions and type of work.

Effective temperature: is an arbitrary index of the degree of warmth or cold felt by the body in response to the combined effects of temperature, humidity and air movement. The numerical value of the effective temperature for a given air condition is fixed by the temperature of moisture- saturated air at a velocity of 15 to 25 fpm (feet per minute) i.e. 4.57 to 7.61 meters per minute.

4.5.2 Physiological effects of heat

In order to maintain a constant body temperature, human body is continually adjusting itself to the effective temperature of the air. In cold weather somewhat more heat is generated and most of the changes involve the skin and the blood vessels that are directly beneath. If the air is cold, the blood vessels beneath the skin get constricted and blood is withdrawn from the skin to the inner parts where great loss of body heat is prevented. If the air is warm, but still cooler than the blood, the capillaries or small blood vessels beneath the skin expand, there by bringing blood nearer the surface and allowing excess heat to flow from the body. The greater the difference between body and air temperature (cooler air) the faster is the heat loss. Perspiration is secreted by the skin and its evaporation lowers body temperature. It is clear that with high air

temperature and high humidity evaporation is retarded and the heat is more oppressive.

Therefore, there must be considerable air movement that aids evaporation and results in cooling of the body. Low air temperature combined with high humidity, is likely to cause discomfort because the accumulation of moisture in small amounts in the clothing lessens its efficiency as a non-conductor (as insulation) of heat.

Draughts or currents of cold air on the face or sudden temperature change cause contraction of the blood vessels and may cause local anemia. This loss of protecting blood supply allows an increase of bacteria and may result in the development of colds or other respiratory infections. Continual exposure to over heated air

used for facilitating heat loss. Complete air conditioning is the control of all those factors affecting both physical and chemical conditions of the atmosphere within any structure. These factors include temperature, humidity air movement (motion), dust, odors, toxic gases and bacteria, most of which affect in greater or lesser degree human health or comfort.

4. The objective of ventilation is, therefore, to achieve a comfortable indoor environment by the removal of slowly and continuously of vitiated air and the replacement of it with fresh

4.6 Space and Occupancy

There is a direct relationship between good housing and good mental health, since suitable housing is a prerequisite for a mental wellbeing. The house therefore, needs to satisfy the following requirements in order to promote the psychological wellbeing of the inhabitants:-

- a) **Provision of adequate privacy for family members:-**
Privacy is the ability of a person(s) to carry out an activity commenced without interruption or interference either by sight or sound. It deals with a "room of one's own". Overcrowding condition is the main cause of lack of privacy.

The maximum number of persons who may occupy any dwelling house is dependent upon three main factors:-

1. Separation of the sexes.
2. The number of rooms available.
3. The floor area of the rooms to be occupied.

A dwelling is overcrowded if the number of persons sleeping in it is more than "the recommended number", or it is such that:-

If two or more persons being ten years old or over, of opposite sexes (not being husband and wife) are sleeping in the same room.

If sleeping room for children over 2 years of age is not separated from the parent's sleeping room. According to psychiatric opinion, sleeping rooms of children over two years should be separate from the parents to avoid lack of sleep due to parents discussion and all children may talk what their parents talk

Standards

Four levels of health have been enunciated by the WHO Experts Committee on Public Health aspects of housing such as:

1. The prevention of premature death,
2. The prevention of disease, illness and injury,
3. The attainment of efficiency of living,
4. The provision of comfort.

The need for a good privacy and adequate space for each family member is therefore, aimed to bring occupants to such levels of health. These standards for housing would depend on the level of health aimed at and this again would depend on the country's resources. Some general standards recommended by the committee follows the 'koln standa

4.7 Housing Sanitation

A home is the most immediate environment for a family. People cook, eat, relax, sleep, and read, etc in their houses. The house should also provide the necessary shelter and comfort to the occupants. A good house is that which prompts health and enjoyable living. It has the following characteristics:-

- a. That which is sited in a well drained areas with good construction
- b. That which provides separate accommodations for human and animals
- c. That which is free from dampness and wetness
- d. Have adequate natural and artificial light and ventilation
- e. Should have a separate kitchen and store
- f. Should be rodent proof
- g. Should have clean and cleanable latrine
- h. Should have proper sewerage system (incase of water carriage waste disposal system)
- i. Should have an appropriate way of removing refuse (proper solid waste management)
- j. Must have safe and adequate supply of water within or near by.
- k. Has adequate space for recreation, play of children, and for

2. Discuss how housing facilities of health importance mentioned in question number one above can be attained in actual local conditions in Ethiopia.
3. How can we measure or evaluate the degree of lighting, ventilation, and heating of housing during the home visit program?

4.9. Suggested Further Readings:-

1. M.Ehlers and W.Steel Municipal and Rural Sanitation. Tata Mc Graw-Hill Publishing Company L.T.D. New Delhi, 1958.
2. Joseph Salvato A.Salvato. Environmental Engineering and sanitation. 3rd Wiley Inter Service Publication, New York, 1992.
3. W. Purdom. Environmental Health.

CHAPTER FIVE

Indoor Air Pollution

5.1. Learning Objectives

Upon successful completion of this chapter, the student will be able to:

1. Define indoor air pollution
2. List specific air pollutants and their sources
3. Describe acute and chronic health effects of indoor air pollution
4. Explain preventive measures against indoor air pollution

5.2. Introduction to the Chapter

Air is absolutely essential for sustainability of life. It is a mechanical mixture of gases and not a chemical compound. The pure ambient air that envelops the overlying earth's surface is the composition of various elements as shown in the following proportion by volume:

Nitrogen. 10.9%

them, which is one of the objectives of ventilation as discussed above.

The principal aim of this chapter however, is not to present the details of ambient air pollution, but to indicate the sources, health effect and control methods of indoor air pollution into the attention of the learners.

Indoor air pollution is defined as “The presence of one or more contaminants such as solid, liquid, or gases, in the indoor air in concentrations injurious to the inhabitants or which unreasonably interfere with comfort or enjoyment of humans”. It occurs through enrichment of indoor air with noxious gases, dust, bacteria, fungi, solvents, and other undesirable substances. Indoor air pollution is mainly caused by an inefficient and smoky fuels burned for cooking and heating. They are a troubling source of serious air pollution in many developing societies that uses biomass fuel. The use of such fuels causes air pollution problems both indoors and outdoors.

For many decades the public at large was made aware of the ambient air pollution problems. Such concept is even more dangerous and misleading to citizens, scientist and government officials of developing

due to indoor air pollution, which is caused by domestic heating, cooking and smoke (aggravated by inadequate ventilation and inappropriate energy sources).

In temperate climates technologies are developed to conserve energy and reduce indoor air exchange with the outside by methods such as triple glazing of windows and magnetically sealing of doors. However, such practice suppresses the possibility of free air circulation in the room.

5.3. Sources of indoor air pollution

Indoor air pollutants are generally grouped into the following major sources:

1. Radon gas
2. Combustion products
3. Building materials and chemicals
4. Biological aerosols and house hold dusts
5. Decomposition processes
6. Respiration

1. *Radon gas*

Radon gas seeps in to homes from the soil, brick, concrete and stone. It is produced from radioactive by-products of stone and soil under the house. The level and effect of radon accumulation is very high in unventilated buildings. It is estimated that in USA, 10% of lung cancer deaths may be attributed to radon gas exposure.

2. *Product of incomplete combustion*

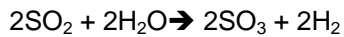
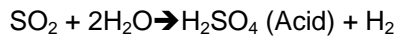
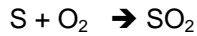
The use of biomass fuel, gas appliances such as gas stove, kerosene heaters, and cigarette smoke contributed to indoor air pollution. The incomplete combustion of raw biomass product and appliances for heating purpose produce different chemical compounds. Some of which are Carbon monoxide, oxides of nitrogen, sulfur dioxide and different hydrocarbons etc.

a) Sulfur dioxides

The major sources of this colorless pollutant gas are fuel or coal combustion in the presence of sulfur as an impurity in it. When sulfur-containing fuels are burned the sulfur is oxidized to form sulfur dioxide. Its reaction with water vapor produces different dangerous sulfur compounds.

Possible Reactions include:

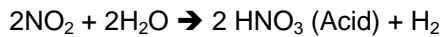
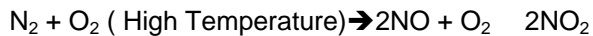
Coal + Oxidation → sulfur compound



b) Oxides of Nitrogen

This compound is formed when combustion occurs at very high temperature. It is one of the major cause for Acid rain in the outside environment.

Reactions



c) Carbon monoxide

It is a colorless, odorless, and non-irritating poisonous gas produced by incomplete combustion of carbonaceous fuel. It is a poisonous gas with a high fatality rate. Poisoning is possibly caused by:-

- Leaks in an automobile exhaust system
- Faulty appliances that lead to incomplete combustion
- Local or open wood -burning for cooking or space heating.
- Running a gasoline or diesel engine indoors.
- Insufficient combustion of animal dung
- bed room heaters
- Clogged chimney or vent, kitchen stoves.
- Improperly operating gas refrigerators.

Motor vehicles are also the principal sources of carbon monoxide air pollution. Concentrations of 70-100 ppm of carbon monoxide are usually common in city traffics.

d) Particulate Matter

Particulate matters occurs either in solid or liquid form including dust, tiny aerosols, poly aromatic hydrocarbon etc. Polyaromatic hydrocarbon (PAH) is formed by incomplete combustion of wood burning in homes. From all causes of indoor air pollution, biomass fuel accounts the greatest share particularly in developing countries. Respiratory problems and cancer are believed to be the common health problem observed usually among females mostly exposed to smoke and other combustion products. Biomass fuel includes:-

- * Wood logging wastes,
- * Saw dust,
- * Animal dung
- * Vegetable matters such as grass, leaves,
- * Crop residue and agricultural wastes.

Biomass fuels are generally composed

Table 6 : Global Energy Consumption in developed and developing countries,1982 (Million metric tons, coal equivalent)

S.No.	Item	Developing Nations	Developed Nation	Total
1	Fuel-wood	460	225	685
2	Crop-residue	340	15	355
3	Animal dung	100	-	100
4	Modern Fuel	2475	7775	10,250

Source: (UN and US department of energy. Global energy consumption).

It is estimated that 50% of the world's households cooking with biomass fuels uses approximately 1 Kg of fuel wood equivalent per person per day which is an equivalent of about 15 mega joule heat content.

Table 7. Comparison of air pollutant emission from energy equivalent fuels (Kg)

S.No	Type of fuel	Fuel equivalent (1million MJ heat)	SPM	CO	SO ₂	NO ₃	HC S
1	Industrial wood 360 (70%)	80	480	400	56	360	360
2	Residential wood (40%)	144	2170	18790	86	110	1450
3	Natural gas	30,000	7	10	-	38	4

- NO₃ =Nitric oxide

emanates from the outside cesspools, sewers, drains, cowsheds,

of the global population of 5.3 billion live in developing countries. If we assume one woman in a household who does all the cooking, roughly 700 million women world wide are affected making this the largest single "Occupational health" problem for women.

For instance, one study conducted in India indicated that pregnant women usually cooking over an open stove using biomass fuel had almost 50% chance of stillbirth.

In place where fuel is scarce collection of biomass fuel often requires exhausting journey to and from the source of supply. This will further cause severe back strain, bite from venomous snakes, leeches, insects or spiders to females. Allergic reaction to leaf mould, grass, pollen which will lead to chronic allergic respiratory disease. The most serious health risks are from the domestic use of biomass that result in smoke inhalation and burnns such as:

- Burns and scalds are common
- Initial heat damage to the conjunctiva and cornea
- Prolonged exposure will lead to keratitis causing impaired vision, cataract and ultimately blindness.

Of the principal categories of indoor pollution: combustion products,

as health effects. Health effect associated with exposure to indoor air pollution has not been rigorously investigated.

The picture that emerge from the available data, together with conclusion drawn from comparisons with relevant research in other areas such as cigarette smoking shows that the impact of indoor air pollution as a risk factors are too severe.

Such illnesses are quite widespread and serious in Africa, followed by Latin America and Asia who are mainly using biomass fuel for

available to heart, brain, and muscles leading to weakness, head ache, dizziness, nausea, vomiting, an impairment of psychomotor facilities, dimness of vision, coronary effects and then to death. Fortunately, the formation of carboxyl hemoglobin is reversible if a poisoned person is exposed to fresh air soon.

Sulfur Dioxide (SO₂)

Generally, it causes the following specific health problems:

- Broncho-constriction, often associated with wheezing and respiratory distress.
- Impairment of lung function
- Increased asthmatic attack.

Formaldehyde

The health effects of formaldehyde include: - irritation of eyes and respiratory tract, cause bronchial

CHAPTER SIX

Institutional Health

6.1 Learning Objectives

After completing this chapter, the student is expected to:

1. Define an institution
2. Identify basic health services to be offered in schools, hospitals, and prisons
3. Explain roles and responsibilities of health professionals to improve health status in the institution

6.2 Introduction to the Chapter

An institution may be defined as any organization established for educational, social, religious, political, etc purposes. An Institution accommodates a group of people at a time. Schools, colleges or universities, hospitals, orphanages, kindergartens, nursing homes, prisons, military concentration camps are all examples of institutions. Institutions have certain basic characteristics in common that require careful planning, design, construction, operation, and maintenance.

These includes:

1. Appropriate site selection, including subsoil investigation,
2. Accessibility to the community,
3. Proximity to sources of hazards such as noise and air pollution;
4. Accessibility to safe and adequate water supply for institutional use and fire protection;
5. Provision of sewers and a waste water/storm water disposal/drainage system;
6. Availability of roads

size of school, age group of students, the availability of the health services in the school. Schools, preferably better have their own health units. In the absence of school health facilities, the local health facilities such as hospital, health center, or health stations should serve school children through frequent visits.

Reasons for the Special Need of a health Program for schools:-

- a) Schools give an excellent opportunity for health education or transmitting health information effectively to the students and through them to the families of the students.
- b) During this part of their life, children are growing & developing both physically and mentally. Any improvement in their health, changing attitudes and behaviors of hygiene at this age and correction of their health defects may have a positive impact on their life.
- c) For many children, school is the first time they have come in to contact with people outside their family. This change may expose them to infectious diseases. Establishment of centers for the prevention of spread of these diseases is therefore, important.
- d) The school going age group generally forms larger number of the whole population hence changing behaviors of pupils means changing a large number of populations.
- e) The school is always part of the community and it may be one of the important areas where new ideas are transmitted and accepted.
- f) School children are quick to learn and change. Teaching them about disease and their control will keep them free from infectious diseases.
- g) To build schools on modern sanitary lines.

3. Provision of health essentials in the school environment.

This refers to school sanitation as it is applied to the school environment and classrooms.

a. *Location and space requirement of the school:*

- The school should be located where the buildings could get possible natural daylight in the classrooms. It should be within reasonable distances from large trees and other neighboring buildings, which may obstruct light.
- The location of the school must be away from sources of dust, gases, odors and noise. The following acceptable noise levels in school area should be maintained :-

Class rooms----- 34-40 dB

Cafeteria----- 50-55 dB

School Sites(outdoor noise level)----- < 70 dB

Health care rooms----- < 40 dB

Music ----- < 40 dB

- Presence of factories or railroads, deep rivers or streams and relation to streets where there are much traffic should be avoided from school sites.
- The school ground should be graded, well drained and must be adequate in size to include playgrounds.

b. *Provision of safe and ample water supply for drinking and personal hygiene of students and staff:*

- About 40 liters per student per day of water in boarding school, and 3-5 liters per student per day(excluding toilet flush and bathing)in day school should be provided.
- A water tap at the rate of one per 50 children should be provided. In communities without a municipal water supply, protected well, spring or a rain water roof catchment system with hand pump may be provided.

- Pupils should be prohibited from using common drinking cup to prevent the transmission of communicable diseases.

c. *Lighting, ventilation, and heating:-*

Lighting is one aspect of school sanitation, which should be given due attention. If the natural light is stopped by buildings or trees in the neighborhood measures should be taken. Top end of windows should be close to the ceiling in order to allow the maximum amount of sky light to enter the classrooms and to evacuate vitiated air from the classroom. Sources of direct light and glare should be avoided as much as possible. Proper paint colors for walls and ceilings; floor types and other arrangements should be carefully selected and the reflective values recommended in classrooms must be maintained.

Recommended class room reflective values in schools

All these surfaces should not be shiny in order to prevent glare. Artificial lighting is also necessary when skylight is obscured due to heavy clouds and for evening and night schools.

Table 9. The minimum recommended levels of illumination in different rooms in schools .

Tasks	Foot-candles on tasks
1. Reading printed material	30
2. Reading pencil writing	70
3. Reading spirit-duplicated material	100
4. Drafting bench work	100
5. Reading chalkboards, sewing, reading	150

(Source: *Municipal and rural sanitation, Ehlers and steel; 6th ed. 1965*)

Note: for practical purposes a classroom is considered illuminated if a student is able to read a sentence written in pencil with no difficulty.

- The reflective factors of the various colored surfaces are of such importance in imparting proper light brightness to visual task.

Heating and ventilation in school:

The various part of the school environment must be healthy and comfortable for the particular activities for which the room is used. It thus becomes necessary for the heating and ventilation systems to accomplish the following.

1. Supplying of clean air in sufficient quantities to dilute the room air below threshold of body odor detection and remove dust, fumes, obnoxious gases, and humidity.
2. Maintenance of a uniform room temperature without rapid fluctuations.
3. Supplying of heat for balancing losses from the human body

(not applicable to tropical climates such as Ethiopia.)

4. Supplying of makeup heat for room and building losses.

(not applicable to tropical climates such as Ethiopia.)

5. Removal of excess heat caused by body radiation, conduction, evaporation, or external conditions.

6. Diffusion of the atmospheric temperature without pronounced drafts or stratification.

The classroom should be cross-ventilated by means of windows or openings distributed in positions and in such manners to secure effective exchange of air. The lowest part of the opening should be slightly above the head of a seated person

(about 1.5 meters). Furnishing should also be selected to harmonize with lighting and to suit climatic conditions and educational requirements.

d. Cleaning and maintenance

Cleaning of all schoolrooms on regular basis and school sanitary campaign at least once a week should be practiced. The existing sanitary facilities such as lavatories, latrines, incinerators and etc. must be kept clean and maintained promptly if damaged. Health professionals should visit the physical structures of schools to prevent risks of accidents and for their proper function.

e. Proper selection of equipment and furniture to minimize accidents

Desks, blackboards and other teaching aids must be of a type that will not cause any accident or discomfort in the process of teaching. Hanging ceilings, broken windows and glasses, stairs and rails should be maintained.

4. Provision of aid in nutrition

Too often children through poverty or ignorance are improperly fed. So teaching good eating habits and provision of nutritional aid is

essential and necessary. Health professionals who have an active health education program in the school should encourage school garden as much as possible. School children who are active in school garden program could establish the same practice in their homes, hence it will improve nutrition of the family.

5. Provision of adequate activity for children to promote their physical fitness:

This requires provision for adequate playground and sports supplies. School children should be encouraged or motivated to have physical exercise as one requirement for mental and physical development.

6. Health education:

The role of health education in increasing level of health awareness of school community is highly recognizable and is very important. Topics selected for health education basically depends on both general and specific local health problems. For instance, general topics such as:

- a. Proper habits in diet to prevent malnutrition.
- b. Care and protection of the sensory organs.
- c. Prevention of means of spread of communicable diseases and methods of prevention
- d. Proper use and handling of sanitary facilities.
- e. Importance of personal Hygiene, etc. can be provided on regular basis. To this end, all the local health institutions should have regular school health programs in their weekly program.
- f. Formation of different clubs such as environmental protection club, Red Cross Club, HIV/AIDS Prevention Club, First Aid Club and etc. in schools, helps to provide useful information to school community and may encourage to perform health promotion activities. These clubs should also receive

degree of cleanliness and effective sterilization techniques in order to prevent nosocomial infections.

Nosocomial Infection

It is an infection that is acquired in the hospitals. Most nosocomial infections cause a considerable morbidity resulting in excess days of hospital stay. Common sites usually involving nosocomial infection include the urinary tract, surgical wounds, lower respiratory tracts, etc. The main sources of hospital infections are dust accumulated at the corners of walls, droplets, contaminated medical articles and instruments, patients, and health personnel moving from patient to patient.

Control procedures of Nosocomial Infections

1. Laundry

Patient clothes are one of the vehicles to spread infectious agents in the hospital environment. The clothes of the patients to be admitted should therefore be disinfected and washed as soon as possible. Bed sheets and linens should always be placed in the bags at bedside, rather than be carried through the halls to a collection bag. These bags used for collection of patient clothes have to be preferably colored for easy identification by the cleaners as well as other people. Thorough hand washing and the use of rubber gloves are essentially basic infection control methods

involved in patient care. Fingernails and hair should be kept short and clean.

7. Maintenance of physical structure

Regular maintenance of physical structure of hospitals and other health care facilities is important in order to minimize accidents and risk of disease transmission. Structures should be constructed from fireproof materials, should have dual egress and proper wiring of electric systems. Maintenance of electrical outlet, appliances and servicing of other equipment is mandatory in health care facilities. Wall paints should be of high quality enamel, so that it will withstand the frequent washing and the effect of disinfectants. Poor ventilation system in hospitals may enhance the easy transmission of air pathogenic contaminants through out the hospitals. All rooms in the hospitals should be well lighted and ventilated by natural means as much as possible as both the natural air and light have

community once again, they can convey whatever health messages they get in the prison.

3. To prevent the infections diseases specially the chronic ones such as tuberculosis & Leprosy.
4. To advise prison administration on health and environmental conditions of the prison.

Sources of Diseases in the Prison:

Infections may occur from two sources in the prison:

1. Some prisoners may join the prison with apparent or inapparent infection from outside & infect healthy ones.

6.6. Exercise Six

1. Briefly explain the similarities and differences between hospital and school environment from sanitary point of view, construction, and design of physical structures.
2. What is the reason that specific illumination is prescribed for class rooms and hospitals.
3. What is the main problem of overcrowding in prison cells. What should be the space size for one inmate?
4. Divide the class into three groups. Assign each group to design

GLOSSARY

1. **Chemical wastes:-** are chemicals such as antiseptics, disinfectants, acids and alkaline, reactive and explosive chemicals, expired drugs, which produce considerable health problems when inhaled, ingested, or injected into the body.
2. **Habitable room:** is a room constructed or adapted to be used as a living or sleeping room, or work room.
3. **Infectious Wastes:-** are all wastes that are suspected to contain viral, bacterial, or parasitic agents. They are also called biological wastes, and generated from medical laboratories, surgery, dressing and treatment rooms, delivery rooms, examination rooms and etc.
4. **Non- Infectious Wastes:-** These encompasses those general and ordinary wastes whose direct contact or exposure to them cause no illness to human.
5. **Pathological Wastes:-** are wastes such as blood, body discharges, amputated body parts on minor or major surgeries, organs and dead body, tissues, placenta, still birth and etc.
6. **Thermostat:-** A device used for regulating temperature automatically in central heating.
7. **Sharps:-** stitch, sucker, blade, lancet, broken glasses, needles, and etc which may cause physical injuries if improperly handled.
8. **Inmates:-** Prisoners assigned to one cell in a prison.
9. **Biomass:-** Energy from organic matter such as wood, cowdung, leaves, crop residue.
10. **Particulate:-** Dust particles including smoke produced by

12. **Controlled tipping**:- A method of refuse disposal where a quantity of waste is dumped into a hole dug in the ground and immediately covered with soil to avoid exposure to flies and other vermin.

13. Nosocomial infection:- Infection principally acquired in hospitals and other health care facilities.

12. Smith, Environmental impact of wood combustion, 1981.
13. W. Moeller. Environmental Health - Revised Edition. Harvard University press, London, 1997
14. W. Purdom. Environmental Health.
15. W. Wikie. Jordan's Tropical Hygiene and Sanitation. 3rd ed. Bailliere, Tindall and Cox, London, 1960.
16. Yash Pal Bedi. A Hand Book of Preventive and Social Medicine. 16th ed. Atma Ram and Sons, Delhi, 1997.

ANNEX

Housing Inspection Check List

1. **Grounds and structures:** Risk of flood, cleanliness of the area, presence of dampness, availability of material for fire prevention, safety, accident prevention facilities and construction etc must be assessed in the home visit programs.
2. **Utilities:**
 - Facilities for proper solid and liquid wastes disposal,
 - Availability of water
3. **Shelter:** Convenience of indoor temperature and possibility of controlling it, intensity of indoor illumination both by natural and artificial light, adequacy of space per person in the family, extent to which the house is ventilated both by artificial and/or natural means, extent by which the house protects the family from noise pollution, level of indoor accident prevention, dual egress, methods of house keeping must be critically assessed.
4. **Services and Facilities:** food protection measures, prevention of radiation, prevention against vermin, presence of recreational facilities, safety of the plumbing system (if any), presence of emergency cares.
5. **Cleanliness/ hygiene:** inspection for house infestation by indoor insects, bedding, toilet facilities, bathing, and barber and beauty sections (if any).
6. **Defective Roofs:** leakage, rainwater gutter, and etc.
7. **Deposited materials:** Presence of accumulated rubbish, which may shelter vermin.
8. **Large trees surrounding the house:** may attract moisture and reduce the drying action of sun and wind.
9. Conduct regular supervisions and follow-ups.