LECTURE NOTES

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Housing and Institutional Health

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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 note on “Housing and Institutional Health” is therefore, prepared to be used as a teaching material to train mainly environmental health and other students of health category in Ethiopia. It is believed this teaching material plays a significant role to solve the critical shortage of reference books, and texts on the subject. The lecture note is designed to make the training somehow have a practical application to the actual housing problems prevailing in the country. It contains six chapters in which the major current housing or institutional problems with their suggested solutions are discussed. Each chapter is presented in simple language and is provided with learning objectives, body, introduction, exercises, and suggested readings as appropriate.

Books, journals and my existing lecture manuscripts are mainly used to develop this teaching material.

Useful ideas of different instructors of the course were also incorporated to standardize it to its present status, which the author hopes to further improve the draft through the consultations, pretest and revisions. It is also hoped that this lecture note on “Housing and Institutional Health” will be of particular use not only for students of health category in colleges and universities, but also to those graduates working in health care service institutions.

Dejene Hailu,

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Finally, I thank all the individuals who have in some way contributed to this lecture note, either in conversations with me or through reviewing the draft.

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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 occupants. These problems are now rather increasing at an alarming rate particularly in developing countries including Ethiopia as homelessness, formation of slums and squatter settlement are becoming major problems especially in towns and big cities. Population growth, immigration of people from rural to urban areas in search of job, natural and man-made disasters, is creating an extreme overcrowding and poor housing in urban settings. For instance, the housing and population census of 1984 indicated that 81.4 per cent rural and 28.6 per cent urban dwellings in former Shewa region were single –room houses, each occupied by four persons on average. The census conducted in the same year also revealed that 52.2 per cent and 29.2 per cent of housing unit in the city of Addis Ababa had no ceilings and toilet facilities respectively. From health standard point of view each family and individual should have a decent home and a suitable living environment. Clear air, pure and adequate water, safe food, adequate shelter, unpolluted land and freedom from excessive noise and odors are the most important requirements. However, large segments of Ethiopian urban and rural population do not enjoy these fundamental needs.

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 able to conduct efficient house inspection and identify indoor health risk factors. The learner will also be able to educate, persuade and get households involved in healthful housing promotion programs of the society directed in solving health problems related to poor housing conditions in Ethiopia.

Achievement of these objectives require a careful planning for new settlements, conservation, maintenance, and redevelopment of existing communities to ensure that the public does not inherit conditions that are impossible or very costly to correct.

1.3 Definition of Terms

1. ***Housing or Residential Environment*:-** The WHO Expert Committee on the public health aspects of housing has defined housing as follows: "Housing is the physical structure that man uses for shelter and the environment of that structure including all necessary services, facilities, equipment and devices needed and desired for the physical and mental health and social wellbeing of the family and the individual." Examples: caves (natural or artificial), simple sheds, huts or tukuls, modern buildings, tents, caravans, vans and etc. have all temporarily or permanently been used as residential environment although they might not satisfy all the basic needs.
2. ***Housing Sanitary Code*:-** is the set of rules which deals with the sanitary conditions of the housing from public health point of view. Example: It deals with possibility of disinfecting water, application of vector control measures, environmental sanitation, etc. in or around residential environment

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 housing necessities (constructed in proper site, provided with safe and adequate water supply, safe and proper waste disposal , adequate light, space, well ventilated, etc.

7. ***Substandard Housing*:-** is a house, which is poorly sited, planned and constructed, inadequate floor space for the family (overcrowded), poorly maintained and does not in general comply with the more important sanitary facilities.

8. ***Slum***:- is an area in which substandard housing predominates and frequently accompanied with overcrowding.

9. ***Blighted area*:-** an area, which is undesirable for residential, agricultural, commercial, industrial or recreational purpose. *Examples:-* Marshy and rocky areas, gorges and mountainous areas, and plots nearer to sources of noise.

1.4 Public Health Importance of Housing

Human beings require protection against the physical elements that may have direct or indirect impact upon their health, a place to store and prepare foods, adequate, comfortable and secure place for all the families to enjoy. Inadequate housing conditions expose people to physical, chemical and biological hazards, and to various adverse psychological and social factors. These health problems arising from poor housing prevail or may be aggravated as a result of lack

of awareness of the inhabitants, poor design and construction of the house, inadequate illumination and ventilation, lack of maintenance and due to poor housekeeping practices. The level of hygiene in the dwelling is another environmental factor that should never be neglected especially for those who spend most of their time indoors, such as infants, young children, the elderly, and handicapped. Housing, along with food and clothing, is thus, a basic necessity for one's life. The WHO, in its book Health Principles of Housing (WHO, 1989), outlined a set of six principles regarding the relationship between housing condition and human health. These principles of housing include:

- Protection against communicable diseases;
- Protection against injuries,
- Prevention of poisonings and chronic diseases;
- Reducing psychological and social stresses to a minimum;
- Improving the housing environment;
- Making informed use of housing;
- Protecting population at special risk.

Improved housing decreases risk of communicable diseases, fire hazards, accident, reduces the creation of slum and cost of municipal services. Moreover, improved housing can also reduce crime since it may not be easily accessible to robbers, rapists etc.

1.5 Substandard Housing and Slums.

These housing problems usually prevail in nations with low socioeconomic status. Substandard housing is particularly the problem of both rural and urban areas, while the formation of slum area predominates in urban settings, especially in unplanned towns and cities. Globally, some six hundred million urban dwellers and one billion rural inhabitants live in life threatening housing conditions characterized by lack of water and sanitation services, proper and safe housing, and lack of basic sanitary and housing facilities.

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 m^2.) of sleeping area per person)
6. Lack of dual egress (doors for emergency exits)
7. Lack of installed electricity
8. Rooms lacking windows for light and ventilation

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 optimum healthful housing requirements applicable to Ethiopian situation.

2.3 Satisfaction of Fundamental Physiological needs

Any housing meant for human habitation should avoid all factors that may affect the normal physiological activities of the body of occupants. The conditions listed below have direct or indirect associations with physiological and metabolic activities of the human body.

1. The house should maintain thermal environment that will avoid undue heat loss from the human body during cold weather conditions (heating of building or blockage of entry of cold air draught to the house). It should also maintain the thermal environment that will permit adequate heat loss from the human body in warm weather conditions (permit good circulation of air). It has to be constructed in such a way that it can be well ventilated, or provided with artificial ventilation facilities (see chapter four)
2. Provision of adequate day light (sunlight) illumination and avoidance of undue day light glare such as unnecessary reflection in the room. Adequate sunlight helps the body to generate vitamin 'D' and also it has a bactericidal effect.
3. Provision of atmosphere of reasonable chemical and bacteriological purity i.e. indoor atmosphere should be free of chemical substances, dust particles, smoke, microorganisms and particulate matters.
4. Protection against excessive outdoor and indoor noise.
5. Provision of adequate artificial light preferably electricity to avoid possible indoor air pollution.
6. Provision of adequate space for exercise, gardening and for the play of children

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, that at least a bedroom should be shared with only one other person of the same sex except in the case of married couples and young children in the family. According to psychiatric opinions, separate bedrooms for the sexes are required at the minimum ages of 10 years and sleeping rooms of children over two years of age, should be separate from parents, for various reasons. Opportunities should also be given for adolescent boy and girls to meet under wholesome conditions. This requires a living room of adequate size, which can be used by all members of the family. Arrangements of the rooms for reading & spiritual purposes in the house may be necessary in areas where these services are not available to the family. The house should also secure the family members from the frightening conditions such as robbers, wild animals, reptiles, scorpions, etc, which under some circumstances may cause hallucination to them. Provision of facilities which make possible the performance of the tasks of the household without undue physical and mental fatigue, and possibilities for aesthetic satisfaction in the home and its surroundings play a vital role in promotion of psychological wellbeing of the family members.

2.5 Protection against Communicable Diseases

A good house must satisfy the need for protection of occupants from risk of communicable diseases through provision of safe water supply, proper excreta and refuse disposal, prevention of vermin, insects, rodents, and proper storage for foods. Cross contamination of water sources in the house should be eliminated, and it is very

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 homes. These installations should never produce nuisance, not be accessible to vermin and rodents, which may play a part in the transmission of diseases.

The walls of a damp house deteriorate rapidly and the woodwork and plaster decay, and release nuisance gases. Such houses are usually unhealthy; impart bad smell, uncomfortable and is very difficult to clean. It therefore, may serve as a temporary or permanent source of biological agents since they survive long in moist environment.

Provision of adequate sleeping spaces minimizes the spread of contagious infections such as scabies, and other dermatological problems, pediculosis, etc.

2.6 Protection against accidental Injuries

The incidence of indoor accidents is directly related to the housing condition, its engineering design and arrangements of physical objects in the house such as the different household equipment, and work methods etc. Improving housing and maintaining it, somehow can significantly reduce the rate of such accidents. The simplest way of addressing this topic is to list ways how accidents may arise and some of the methods to minimize if they are not prevented totally.

In general the following considerations should be given due attention.

1. Erection of dwelling with such materials and methods of construction as to minimize danger of accidents due to collapse of any part of the construction. Termite infestation

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.

7. Protection of the neighborhood against the hazards of automobile traffic i.e. location of housing projects should be considered with traffic conditions in mind.

8. Education of the public on prevention of accidents.

2.7 Protection Against Excessive Noise

Noise is defined as unwanted sound. Sound is any pressure vibration or stimulus, which produces sensory responses in the brain. Noise pollution is practically observed to be a problem of urban settings than rural. Towns and cities in Ethiopia are established with no prior planning to meet the town planning and zoning regulations. The consequence of this is that large population of such towns has faced the problems of noise pollution. It may be of public concern especially, where apartments or residential houses are located near airports, roads, commercial areas, etc. Exposure of family to such urban noise may serve primarily as source of nuisance if it doesn't impair hearing of the inhabitants. Effective control measures of noise around houses require first a clear recognition of sources of urban noise as presented below.

2.7.1 The principal sources of community noise pollution:-

1. Transportation facilities such as automobile or truck traffic, railways and other train transit systems, aircraft on the ground or on flight near terminal area.

2. Building equipment, such as air-conditioning blowers, compressors, etc
3. Construction and maintenance equipment such as stone crushers, concrete mixers, compactors, etc.
4. Electric distribution transformers
5. Factories from which noise escape to the surrounding area
6. Stadiums and other noisy sport centers when located close to homes
7. Mills & welding units
8. Loud music shops and etc. are all sources of noise pollution.

2.7.2 Health Effects of noise

The direct health effects of noise exposure depend on pressure level of noise, frequency of noise, daily exposure time, and total duration of exposure in a lifetime. Noise may be considered as disturbing sound, which interferes with work, comfort, sleep and rest of the family, especially children, the sick, and elderly. Hearing is likely to be permanently impaired among those constantly exposed to loud noise. It also triggers cardiovascular and digestive disorders such as increase in blood pressure and rate of heartbeat (tachycardia). Great strain is put on the nervous system in the attempts to overcome effects of noise and in the mean time, causes significant changes in the secretion of hormones and in brain functions. It causes irritability, tension, insomnia, moodiness, and interfere with normal development of infants. Noise decreases efficiency of workers and cause fatigue, which may lead to accidents.

2.7.3 Measuring Noise Level

The Decibel (dB) scale is the more commonly used unit to measure or express sound / noise level.

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

SN	Indicative sound / noise	Decibel
1	Just audible	0
2	Low whisper 3 ft away	20
3	Average residence	35
4	Commercial premises	50
5	Ordinary conversation 3 ft away	40-60
6	Noisy streets loud conversation	70
7	Heavy traffic, loud radio	80
8	Motor cycle	90
9	Loud auto-horn	100
10	Airplane propeller	120
11	Painful sound	130
12	Jet engine	140

N.B.: Most authorities agree that noise levels above 85 decibels present risks of hearing loss. Nevertheless repeated doses of even lower levels of noise may also present harm.

In practical sense of noise measurement, it may be difficult for a sanitarian to have access to measuring instruments like Audiometer to evaluate noise level in homes during visits or inspection. In this case, it is more advisable to check whether certain sources of noise can simply interfere with one's attention in the home that is performing some tasks deserving concentration such as reading and carrying normal conversation. The learner, however, should be aware that such common sense evaluations and judgments might not have acceptance particularly when the issue comes to the legal affairs.

Table 2. Level of Noise recommended at office, dwelling, and sleeping rooms.

Place	Noise Level (Decibel)
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 facilities, which reduce noise transmission. For

instance, an eight inches thick brick partition wall reduces about 50 dB noise transmitted through air, and wooden floor, plastering of the walls, and ceilings reduce 10 to 15 dB of noise.

2.8 Exercise Two

1. Divide the students into five groups (G_1, G_2, G_3, G_4, G_5). Assign each group to different communities in town or village (kebele or peasant association) and randomly visit about 20 dwellings. Each group needs to evaluate whether the visited homes satisfy the basic principles of housing as outlined above. Groups of Student should prepare a complete report and present it in class for every one to comment, participate and compare their findings.

For convenience:-

Group 1 evaluates the physiological requirements

Group 2 evaluates the psychological requirements

Group 3 evaluates if the housing prevents the family from communicable diseases.

Group 4 evaluates whether the housing prevents risk of indoor accidents.

Group 5 evaluates if the housing protects the family from excessive noise pollution.

2.9 Suggested Further Readings:

1. M. Ehlers and W. Steel. Municipal and Rural Sanitation. 6th ed. Tata McGraw- Hill Publishing Company L.T.D. New Delhi, 1958.
2. Rev.P.S. Samuel, O.O. Fasuyi, and P.Azuwuine Njoku A. New Tropical Health Science for West Africa. Macmillan, Nigeria, 1979.

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 and sewage disposal.
6. The area should be open for easy air movement
7. The site should be accessible to the road, commercial, and other social services (market, schools, recreational areas, health facilities).

The residential zone may be further subdivided into different sub zones if need arises, based on the type and standards of the houses erected, such as thatched roof houses, apartments, villas, etc. Such division may be of a particular advantage to provide the residential zone with basic services like water, electric light, telephone, appropriate disposal facilities for household wastes, etc. In the residential zone industries and commercial firms are prevented from being established to stop the potential hazards they may cause to the environment.

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.

Separate handling and treatment of these industrial hazardous substances safeguard both the aquatic and terrestrial ecosystem from health effects of industrial discharges and scraps.

3.3.4 Recreational Zone

Recreational zones include: beaches, swimming pools, hotels, camps, motels, clubs, sport fields, etc. These places accommodate many people per day mainly those who wants to relax themselves especially on holidays or weekends. Such areas used for mental refreshment should be considered during town planning, and

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.

CHAPTER FOUR

Facilities Required for Healthful Housing

4.1 Learning Objectives

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

1. Define ventilation, explain types of ventilation and its applications
2. Describe methods of illuminating houses
3. Explain methods of heating buildings
4. Identify factors affecting heat loss from human body
5. Mention some recommended number of persons per unit area of sleeping and living rooms.

4.2 Introduction to the Chapter

The extent at which the housing conditions promote health depends on the availability and adequacy of different life supporting requirements. These include ventilation, illumination, heating systems to maintain optimum human body temperature, etc. This chapter presents the importance of these facilities and emphasizes on the technical application of these aspects. Few advanced installations discussed in this chapter however, may be expensive to be used widely except by few wealthy families in the cities. They are presented to introduce the technologies to the students so as to equip them with the necessary knowledge to be applied whenever applicable.

4.3 Ventilation

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_2).

In breathing, adults contribute about 0.67 cubic meter of carbon dioxide per hour to the atmosphere. Children contribute somewhat less. The average in mixed group is about 0.6 cubic meter per hour.

The reduction of oxygen and the increase of carbon dioxide may not be alarming except in tightly closed living or working environment. The reduction of oxygen and the increase of carbon dioxide content in a closed environment accommodating humans create a stagnant air and moisture in the breath. In addition perspiration and evaporation from the skin increases the humidity in the room. If people are in a room full of stagnant air, the air quickly becomes hot by the heat from the bodies of people and saturated with the moisture from their lungs. Such elevated heat is lost from houses mainly by convection. Most system of ventilation of houses depends on these methods of heat loss. Some studies revealed that a 0.5% of CO_2 increase in the living environment would require a slight increase of lung ventilation while 10% CO_2 increase cannot be endured for more than few minutes. Ventilation is therefore, aimed at removing these undesirable effects of poor ventilation from indoor environment. The motion of ambient air governs the effectiveness of ventilation as discussed below.

The cooling power of air is mainly dependent upon its temperature and motion. Anemometers with rotating or deflecting vanes are used for rough measurements of air motion. The katathermometer also known as comfort meter, is an instrument used to measure the cooling effect of the air in a given place.

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.

	Types of Building	**Air space volume per person (m^3)**
1	General Hospital	34
2	Infectious disease Hospital	53
3	Sleeping rooms	14.2
4	School class rooms	3.54
5	Dormitories	8.49
6	Cow sheds	22.7

(Source: Municipal and Rural Sanitation)

A person requires generally 300 ft^3 (8.49 m^3) of air per hour. It can be supplied to the room with out causing a draught by changing the air three times per hour and as such 1000 ft^3 (28. 3 m^3) of space is allotted to each person.

4.3.1 Methods of Ventilating a House

There are two means of ventilation: -

- Natural ventilation
- Artificial ventilation

4.3.1.1. Natural ventilation

It involves the use of natural forces of air diffusion and current by having properly built doors, windows, (such as fanlight, hopper or sliding sash windows). Natural ventilation is an efficient, cheap and satisfactory form of effecting air movement in the house. Natural ventilation might not be used successfully in theaters, auditoriums, large schools, or large churches, but it is applicable in homes and small offices. Such institutions require mechanical ventilation for efficient distribution and evacuation of contaminated air. It should be kept in mind that air movement into rooms through windows and a door depends up on winds and temperature differences between inside and outside air. The disadvantages of natural ventilation are:

- It is dependent upon wind direction
- It does not control the possibility of entrance of smoky, dusty, and generally undesirable air.

Types of Windows commonly used for natural ventilation:

a. ***Fanlight windows*:** is the small window or opening installed at the top of the doors or other windows. It has a small opening at the top made to open independently of the rest of the window. It may remain open at night or in bad weather, continuously supplying the room with fresh air when the main part of the window is closed. In hot countries and for a cheaper class of building, the space usually occupied by the fanlight may be left empty and covered with wire gauze as a protection against mosquitoes and other insects.

b. ***Hopper windows*:** are very suitable for schools, hospitals and similar buildings. They are windows, which are hung at the bottom, wings being provided to close the sides. Incoming air is directed upwards and is not felt a draught. These windows may be allowed to remain open even during heavy rain.

c. ***Sliding sashes***: this is a window made with sliding sashes and is a very good type of ventilating houses.

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 to ventilate and illuminate the house.
- Air perforated bricks and chimney flues may be used to construct the house.
- Simple wooden frame works also allow good fresh air circulation and adequate illumination.

4.3.1.2. Methods of natural Ventilation

Air Inlets and Outlets

These are the openings through which the process of ventilation is carried out. Inlets are intended for entrance of fresh air and the outlets are for escape of exhausted air. Warm air is less dense than cold air and therefore, it tends to rise. Because removal of warm air from a room is necessary, outlets should be placed near the top part of a room. In order to properly admit cold air, which is denser than warm air, inlets should be arranged at lower level. The best height for inlets is at a point a little above the head of a person sitting down, i.e. about 5 ft (1.5 meters).

Provision of windows

All habitable rooms, bathrooms, lavatory, staircase etc. need to have sufficient number of windows, in order to allow the entrance of enough light and ventilation. Total area of windows should be equal to 1/10 or 10% of the floor area. The area of windows that will be erected on walls butting to a verandah, beneath a canopy or balcony, the area must be increased by 5% for each 30 centimeter and for over one meter of extension of the verandah, balcony or canopy. With regard to school the window area is the same as above (10% of floor area) under normal condition. But the size of windows can be as large as 20% if air movement is very slow or the

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.

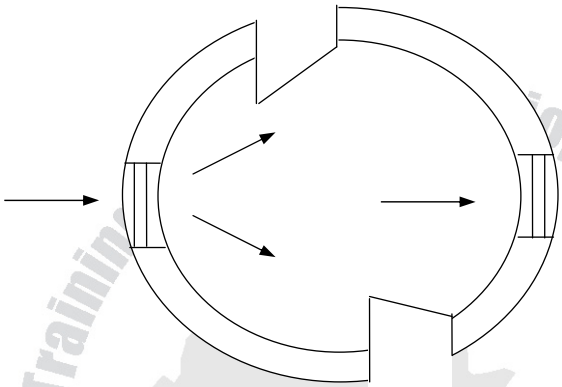

Fig.1. Through ventilation for a round thatched tukul.

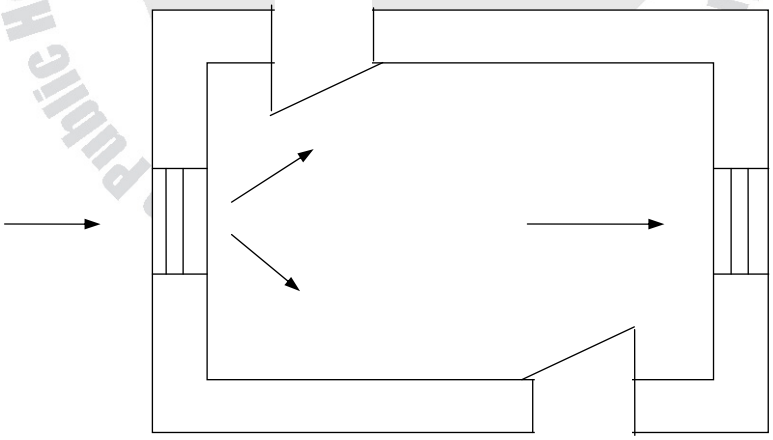

Fig. 2. Through ventilation in rectangular or square house.

b. ***Cross ventilation:-*** the windows are placed diagonally so that a current of air circulates and passes across the room.

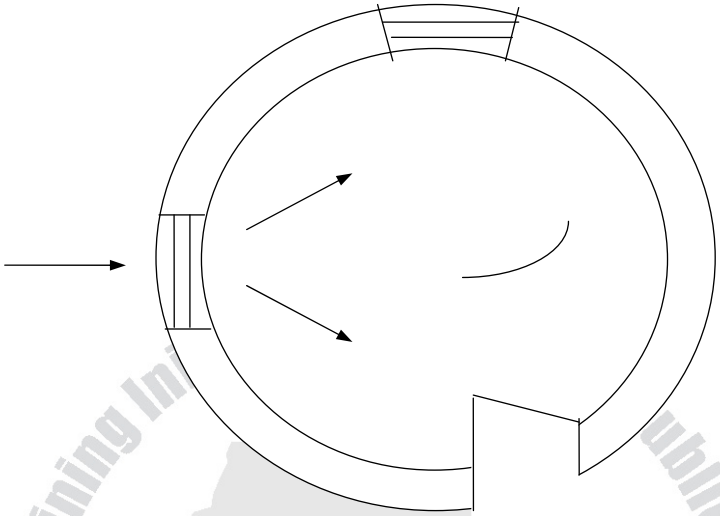

Fig. 3. Cross-Ventilation in a round house.

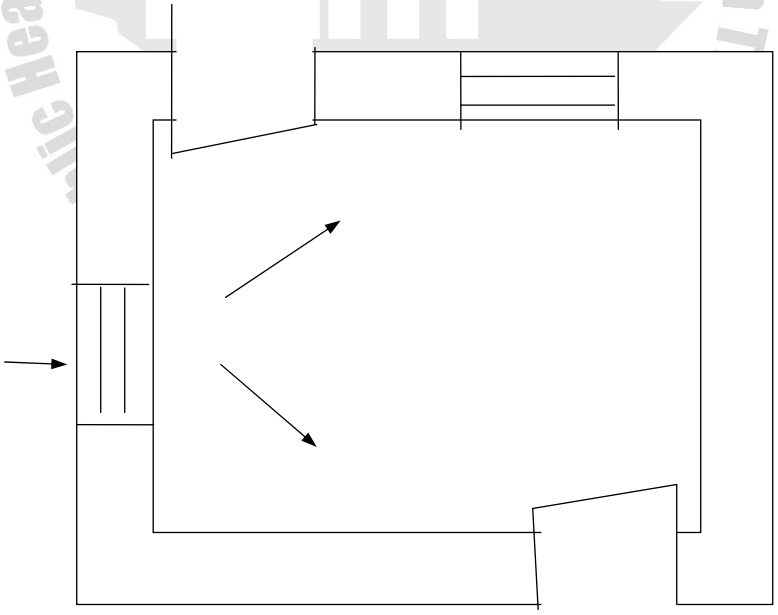

Fig. 4. Cross-ventilation in a rectangular or squ

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*****:-** is a combination of the exhaust and plenum system. Air is drawn in through ducts by centrifugal fan and extracted at suitable points by exhaust fans. For the efficient working of this system, it is essential that there should be no leakage through windows or doors.

In artificial ventilation, the air can be warmed, cooled, filtered, or humidified before allowing it to enter the building. It can also be supplied at any rate and at any level in side the room.

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 promoting metabolism. The ultraviolet rays have a beneficial effect in the health of the body as in the prevention of rickets by helping the body produce its own vitamin D. The ultraviolet rays have also bactericidal effect, and thus, may kill pathogens that are sensitive to light.

The environmental health worker is more concerned with the inside illumination. This concern in illumination has resulted in recognition of the effect of insufficient lighting upon the eyes, the comfort, and effect on work and productivity and upon the efficiency on school children. The importance of good lighting in reducing accidents and the need for street lighting that can cope with modern high-speed traffic is also of significance for public safety.

Proper lighting is essential for cleanliness, accident prevention and to reduce fatigue in the homes. It also takes into consideration the task, spacing of light sources, elimination, shadows and glare, control of out side light and lightness of working surfaces, walls, ceilings, fixtures, trim and floors. Hence, extent of visibility of an object is therefore, depends upon the nature of the object as discussed below.

An object can be seen if light coming from the object reaches the eye. The following are examples of visible objects.

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 sources.
   E.g. the moon, planets, earthly objects such as hills, people, table, etc
3. **Translucent object**: This allows some light to pass through it; the rest is reflected and absorbed. E.g. waxed paper, frosted glass.
4. **A transparent object:** this allows light to pass through it. E.g. water, window, glass
5. **An opaque object:** An opaque object does not allow light to pass through it. The light is either absorbed or reflected. Dark colored objects absorb light while light colored objects reflect light.
   E.g. a mirror reflects light but walls of a room absorb and reflect light.

4.4.1 Measurement of light

***Intensity of a light source*:** The luminous intensity or brightness of a source of light is measured in candle power (cp.) A candle power is the brightness of the light produced by a "standard candle" which have been internationally agreed upon so that it is approximately uniform. E.g. A modern 40-watt incandescent lamp furnishes about 40 candle power.

***Intensity of illumination*:** The intensity of illumination that a surface received at a certain distance from a source of light is measured in foot-candles (ft-c). A foot-candle is that intensity of illumination received by a surface 1 ft distant away from a
1-cp light source. The intensity of illumination varies directly as the candlepower of the source of light and inversely to the distance from the source of light. This fact is known as the law of intensity of illumination and may be expressed by the following formulae:

Foot -candles = $\frac{\text{Candle power}}{d^2}$

Where, d - distance

***Luminous flux*:** is amount or quantity of light and it is the rate of flow of light. Its unit is the lumen. If an area A is 1 sq. ft and is 1 ft. away from the candle, it is illuminated to an intensity of 1 foot candle. The total amount of light passing through area A, if the area is considered to be transparent, is 1 lumen. Therefore the lumen is the quantity of light required to illuminate 1 sq. ft to the intensity of 1-foot candle. The lumen is useful in specifying the amount of light, which a light source must supply.

For examples, if 100 sq.ft must be illuminated to an intensity of 10 ft-c, 100x10=1000 lumens will be required. If a 1-cp lamp is radiating light uniformly in all directions, it gives of 4π, or 12.57 lumens.

Light meter (photometry) is an instrument used to measure the intensity of luminous source or the brightness of an illuminated surface. The devise is also used to determine the luminous intensity of unknown intensity and make use of the inverse square law. They are used in photography to determine the amount of lens opening and the time of exposure to be used. Engineers will use the device to test the amount of light in schoolrooms, offices, houses, factories, etc. Light Meters are also called photometers, or foot-candle meters. For practical measurement of illumination of rooms, it may be difficult to get an access to these instruments. The Sanitarian, in this case may use heuristic methods. For instance, it may be considered that the habitable room is adequately illuminated if persons can read pencil written (normal letter size) papers sitting at the center of a room.

N.B. Work places should be well illuminated than homes.

4.4.2. Types (source) of Lighting

There are two types (source) of lighting:

1. Natural lighting
2. Artificial lighting

1. Natural Lighting: This is the natural day light from the sun. Light enters through doors and windows and is reflected from surfaces. Amount of daylight entering the house through windows or doors largely dependent upon the sky area visible at that point. Windows facing blank walls get and transmit only the reflected light. The lighting values of such windows, therefore, depend on the reflection factors of the outside surfaces. The minimum intensity of illumination in any occupied space should be 6 foot-candles on a horizontal plane and 30 inches above the floor. Natural lighting at any cost should therefore meet this minimum requirement. The window-glass area should be10% – 20 % the floor area, provided also that walls and ceiling are light in color.

It is advisable to use maximum window size if windows are made from opaque materials or installed in the corridor walls. Windows extending to less than 30 inches from the floor tend to cause glare and obstruct furniture placement without increasing illumination to any extent.

Inside walls should have reflection factors of at least 50 per cent, ceiling 70 percent, and floor and furniture 30% -35%. Direct sunlight is desirable, for at least part of the day for all dwellings especially in cold seasons or regions. For dwellings constructed in rows a desirable orientation of windows is to face 20^0 to 30^0 east or west or south.

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.

Example:- White paint on smooth surfaces reflects 90-92% of light it receives.

- Light yellow paint reflects 65% of light it receives.
- Light blue paint reflects 61% of light it receives.
- Light green paint reflects 47% of light it receives
- Red light reflects 13% of light it receives.
- Black paint reflects 0-5% of light it receives.

Consideration for proper lighting

- The task associated with lights
- Spacing of the light source

- 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	
Working place	**Lux (lumen)**	**Foot candle**
1. Hotel, Bar	200	20
2. Laboratory	500	50
3. Theater and film hall	200	20
4. Library	200	20
5. Typing room	300	30
6. Washing room	100	10
7. Cotton store	100	10
8. Watch repairing room	1500	150
9. Accounting, tabulating, book keeping	1500	150
10. Regular Office work	1000	100

Source:- Municipal and Rural Sanitation

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:** is the transfer of heat by direct contact from molecule to molecule. E.g. heating an iron rod.
2. **Convection:** is the transfer of heat in liquids and gases by means of motion of the liquid or gas. E.g. the hot air furnace and hot water furnace for heating a buildings work entirely by convection. A hot radiator in a room heats only the air in contact with it by conduction. The room is heated almost entirely by convection. A refrigeration unit is placed at the top of a refrigerator in order to create a convection current of air with in the box.
3. **Radiation:** is the transmission of heat from a body (e.g. Sun) across empty space. As the radiant heat waves strike matters, they are either absorbed or reflected and otherwise transmitted. By radiation heat is lost from a warm body to a cool one without warming the intervening air. For example, in a thermos flask equipped with a glass vacuum, the radiated heat is reflected by the silvered walls to prevent heat transfer by conduction or convection.

4.5.1 Methods of Heating a Building

The methods of heating buildings may be classified under the following headings:-

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 ^{0}c) and at knee height (45 centimeter) in order to prevent chilling of the legs and feet. Operative temperature for old people and young children is 70^{o}F (21.^{o} C) at knee height.

When does heat loss from the body become rapid?

1. When there are cold objects in the room like walls, because radiation is high.
2. When the air temperature is low. In this case heat is lost from the body by conduction.

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 increases the liability to draughts. Those people who are habitually in still and over heated air are more susceptible to the bad effect of chilling drafts. High temperature combined with high humidity, (as in the case of laundry workers) may result in chronic respiratory diseases.

4.5.3 Factors affecting the designing of heating facilities in the House

1. ***Climate*****:** affects both the designing of heating facilities and housing.
2. ***Insulation*****:** it is useful in reducing heating costs and it is an important tool in reducing temperature difference from floor to ceilings. Flooring materials of high heat (cold) conducting potential, such as concrete or tile should be avoided particularly in a place where children play on a floor. Curtains may be used to insulate Windows.
3. ***Ventilation*****:-** ventilating enclosed space by natural or mechanical means promotes heat loss from the house. Therefore, well-ventilated rooms reduce the cost of facilities

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 out door air of a suitable temperature and humidity.

Signs observed on occupants of used up or vitiated air

1. Occupants with fair skin will show flushed face
2. Some occupants will experience headache
3. Occupants will sweat
4. Some occupants may experience dizziness
5. Some may be fatigued
6. Some occupants may also faint.

Table 5. The normal standard of temperature, relative humidity and air Movement in working area

Climate of year	**Type of work**	**Temperature (^{0} C)**	**Relative humidity (%)**	**Air movement (m/s)**
Cold climate	Simple	22-24	40-60	0.1
	Moderate	18-20	40-60	0.2
	Heavy	16-18	40-60	0.3
Hot climate	Simple	23-25	40-60	0.1
	Moderate	21-23	40-60	0.3
	Heavy	18-20	40-60	0.4

Source: Municipal and rural sanitation

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 carryout 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

Effects of occupancy

There are five effects of human occupancy in unventilated rooms. These are:

1. Decrease in oxygen content
2. Increase the amount of carbon dioxide
3. Increase in organic matter (odor, bacteria from mouth, skin, clothing, etc)
4. Increase the temperature and humidity of the room.
5. Increase the transmission of communicable diseases such as skin disease, TB, etc.

According to American Public Health Association, the following guideline is used to avoid overcrowding and lack of privacy. Number of persons permitted to use a house for sleeping: Where the floor area of the room is: -

a) 10.2 m^2 or more ----------2 persons.
b) 8.36 m^2 to 10.2 m^2----------1 1/2 persons.
c) 6.5m^2 to 8.36m^2---------- 1 Person.
d) 4.6m^2 to 6.5m^2----------1/2 Person.
e) Under 4.6m^2 ---------- nil.

Some other countries such as England also recommend room occupancy of one room for two persons, two rooms for three persons, three rooms for five persons, four rooms for seven and a half person. Bathrooms are not counted as rooms. Kitchens or rooms used for preparation of food shall not be less than 4.0 m^2 and should have a minimum width of 1.4m. where advanced electrical facilities are used for cooking or otherwise more and good ventilation is needed in kitchens.

N.B.:- In counting the number of persons, each children under ten years of age & over one year counts as half a person; and a child of less than one year is not counted at all.

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 standard' (established in 1957) still seems to be the accepted international standard. It stipulates a living room, dining room, kitchen, one bedroom for husband and wife and one bedroom for every two children. In addition it stipulates that there should be a bathroom, lavatory and storeroom.

The following minimum areas of habitable room are also stipulated:

50 m^2 – for a family of three

55-60 m^2 – for a family of four

70 m^2 – for a family of five

A single person requires 1000 ft^3(28.34cubic meter)fresh air per hour. In a dwelling house where the temperature is not less than 22.5 ^{0}c (72.5^0 F) and not more than 29.5 ^{0}C (85 ^{0}F) the relative humidity should not be less than 20% and not more than 50%.

General guides of air space by type of dwelling

Type of building		Air space per person
1.	Sleeping rooms	14,5 m^3
2.	Dormitories	8.5 m^3
3.	Class rooms	3.6 m^3
4.	General hospital	34.2 m^3
5.	Infectious disease hospital	53 m^3

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 physical exercise

4.8 Exercise Four

1. Write a short note on the Health importance of the following. What is their general status in Ethiopia?
    a) Ventilation of a house
    b) Illumination of a house
    c) Heating of a house
    d) Lack of privacy in a household

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---------- 78.1%
Oxygen----------20.9%
Carbon dioxide---------0.03%

Argon gas, Neon, Helium, Hydrogen, Krypton, are also present in the air with a very small proportion in the atmosphere. This proportion remains more or less remarkably constant in the open air by diffusion of air currents. Because, plants by virtue of their chlorophyll content takes up carbon dioxide from the air and give off oxygen, thus compensating for the consumption of oxygen and formation of carbon dioxide. This is always going on as a result of the existence of animal life, combustion and etc. Rainfall and wind also help in reducing the impurities of air.

The former washes the air free from most of the suspended air pollutants, while the later produces a uniformity of composition of air and renders assistance in the removal of impurities by dispersing

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 countries. What is bad is all want to relate air pollution to industrialisation and to the ambient (out door) air only neglecting the contribution of indoor pollution.

Recent studies however, brought the problem of air pollution closer to home and proved now and again that the polluters are not only industries but also the activities of man inside his home. It has been found that levels of several health threatening air contaminants are now found to be significantly higher indoors than outdoors.

This truth is harmful because most people (the young, the old, the sick and the disabled) are restricted to spend much more time in the homes and normally all people spend half of the day at home. An international conference on health and environment conducted in Pretoria, South Africa pointed out the risk of ill health and disability

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

$S + O_2 \rightarrow SO_2$

$SO_2 + 2H_2O \rightarrow H_2SO_4$ (Acid) + H_2

$2SO_2 + 2H_2O \rightarrow 2SO_3 + 2H_2$

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 out side environment.

Reactions

$N_2 + O_2$ (High Temperature)$\rightarrow 2NO + O_2 \rightarrow 2NO_2$

$2NO_2 + 2H_2O \rightarrow 2\ HNO_3$ (Acid) + H_2

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 of organic matters (cellulose and vegetable protein) carbohydrates, and trace amount of toxic metals such as cadmium and lead.

Globally, biomass fuels account for around 12% of total energy requirement. In developing countries however, it accounts to 36% of the global energy consumption as indicated in 1982. In Ethiopia wood, crop residue and animal dung are often the only fuels available for the great majority of the population in rural and semi-urban areas.

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 bio-mass 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	SO2	NO3	HCS
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

(Source: Environmental impact of wood combustion, Smith, 1981)

Key.

- SPM = suspended particulate matter
- HCS = Hydrocarbons
- CO = Carbon monoxide
- SO2 = Sulfur dioxide

- NO3 =Nitric oxide

When incomplete combustion occurs in an open fire, air pollution problem increase drastically. The above table compares the amount of air pollutant generated in industries and residential houses.

3. Building materials, furniture's and chemical products

A wide variety of household products contain formaldehyde and other hydrocarbons. These include foam insulation floor covering (carpet) and textile products, furniture polish, disinfectants, solvents, paint, etc, which largely contribute to the indoor air impurity.

4. Biological aerosols and house hold dusts

Pathogenic or any microbial pollutants, household dusts that contain organic or inorganic chemicals are the common pollutants. Animals living in the house also contribute to aerosolized pollutants. The great source of air bacteria is soil, which is teeming with microorganisms. Microbes are also emitted during coughing, laughing. Speaking and sneezing. Germs float in the air at optimum height eventually falling down to the ground depending on the indoor air movement. Pathogenic microorganisms are not present in the air except at proximity to patients or carriers whose exhaled air is charged with bacteria. The inorganic particles of dusts to be met with in the air are chiefly composed of silica, aluminum, silicate, carbonate, or phosphate of calcium, magnesium, sodium, chloride, carbon, etc. Those found in the indoor are due to debris arising from the wear and tear of articles in domestic use such as dust, soot and ashes. Mineral dusts from the neighboring industries, factories, and construction activities may likewise find access into houses through existing air inlets such as windows and doors.

5. Decomposition

Animal and vegetable matters when putrefy around the houses, gives off offensive poisonous and marsh gases (such as, hydrogen sulfide, ammonia, methane) and carbon dioxide. These usually

emanates from the outside cesspools, sewers, drains, cowsheds, and yards, where wastes are deposited. Bacteria, molds, and fungi grow rapidly in such rooms. Presence of 0.2% of hydrogen sulfide in the indoor air may produce unconsciousness.

6. Respiration

Impurities of air due to respiration are chiefly carbon dioxide, water vapor and organic matters. The expired air contains about 4.4% carbon dioxide. It loses about the same percentage of oxygen. On an average about 283.5 grams of water vapor is given off from the lungs of a man within 24 hours. When the amount of carbon dioxide in the air of a particular room rises from 0.03% to 0.06%, air becomes perceptibly stuffy to a person entering from fresh air environment and the occupants of the room begins to suffer from the unusual symptoms such as drowsiness, headache, nausea, vomiting, etc. which are common in overcrowded rooms.

Table 8. Proportion of gases, in the inspired and expired air per 100 parts.

	Inspired Air	**Expired Air**
Oxygen	20.9%	15.5%
Nitrogen	78.1%	79%
Carbon dioxide	0.03%	4.4%
Water vapor	Varies	Saturated
Temperature	Varies	At body temperature

Source: A handbook of Preventive and Social Medicine, 1997.

5.4. General and Specific Health Effects of Indoor Air Pollution

5.4.1. General Health Effects

The chronic effect of biomass fuel use is a major public health problem especially to women and children of developing countries. Nearly 60%

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, chemicals, biological agents and combustion generated pollutants mainly from solid-fuel-fired cooking stoves are widely studied in developing countries. Half of the world population is cook using these unprocessed fuel items in conditions where much of the airborne pollutants is released into the living area. The housing type in Ethiopia is such that it is constructed without separate kitchen, windows, chimneys or other openings to release the pollutants. Studies made in the rural areas of Jimma, Tigrai and the urban communities of Addis Ababa indicated the presence of significant pollutants such as carbon monoxide, poly aromatic hydrocarbon (PAH) and particulate matter resulting from the use of biomass fuel in the indoor environment.

Each part of the fuel cycle: production of fuel, collection of fuel, processing of fuel and combustion of fuel has its own hazards as well

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 domestic use. In these countries ARI and other respiratory diseases, which are presumed to be aggravated by biomass smoke are major causes of morbidity and mortality especially in the under five children,

5.4.2. Specific Health Effects of Indoor Air Pollution upon Occupants:

The direct exposure may cause:- Bronchitis, predisposing factor for tuberculosis and Asthma. Physiological and mental discomfort due to odor from skin and cloth of the occupants and increase in temperature as a result of heat generated from human body is significant.

Nitrogen Dioxide (NO_2)

- Cause respiratory tract irritation and inflammation.
- Cause an increased air-flow resistance in respiratory tract.
- Cause an increased risk of the respiratory infection.

Carbon Monoxide(CO)

Carbon monoxide combines readily with blood hemoglobin to form carboxyl hemoglobin, thereby reducing the amount of hemoglobin available to carry oxygen to other parts of the body. Hemoglobin has a greater affinity to carbon monoxide than for oxygen. Excessive exposure to this gas therefore, results in reduced oxygen

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 (SO_2)

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 asthma at higher doses. Cause occupational allergic contact dermatitis and skin irritation.

Tobacco smoke

- Eye, nose, and throat irritation
- Nasal congestion and rhinorrhea.
- Inflammation of the lower respiratory tract
- Lung cancer

Fungi and Bacteria

- Hypersensitivity pneumonitis, causing cough, dyspnea, and fatigue and allergic rhinitis.
- Humidifier fever, causing flu-like illness with fever, chills, myalgia, and malaise.

5.5. Prevention of Indoor air pollution

Generally the control measures for indoor air pollution are:

1. Stove design improvement (to increase the efficiency of complete combustion)

2. Use separate kitchen as much as possible
3. Use of clean fuel
4. Improving house design and construction of proper ventilation
5. Health education on control measures of indoor air pollution.
6. Improving standard of living

***Ventilation*:** This is the most important single measure that is practical, achievable and within the technological and economical limit of our local population. Having openings at the eave of houses (tukul) and having windows improves ventilation. It is not also impossible for almost all Ethiopians to have separate kitchen to at least protect some of the household members from exposure. Raised stoves will prevent burns and scolds which is common in the Ethiopian homes as open stoves are placed in the center of living rooms where toddlers are playing near the mother who is the main cook. Raising the stove will also help in evacuating the smoke away from the breathing zone of the cook and the child hence preventing effect of pollution on those exposed.

5.6. Exercise Five

1. Mention the types of fuels used as a source of energy in your local areas. Explain how these materials may contribute to health problems.
2. Discuss how you plan to implement the indoor air pollution control measures in your future career at health centre level.

5.7. Suggested Readings

1. M. Ehlers and W.Steel. Municipal and Rural Sanitation. Tata McGraw-Hill Publishing Company, L.T.D. New Delhi, 1958.
2. Yash Pal Bedi. A Hand Book of Preventive and Social Medicine. 16th ed. Atma Raw and Sons, Delhi, 1997.
3. Faris, K., Survey of indoor air pollution problems in the rural communities of Jimma, Journal of Health Sciences , 2001.

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

7. Provision of facilities for the storage, collection, and disposal of all solid wastes generated in the institution.

Depending on the particular institution, they might have recreation facilities, such as a swimming pool or bathing beach. A hospital or educational institution might have its own laundry to promote frequent washing habits.

The provision and maintenance of an environment conducive to health at institutions of all types including hospital, convalescent homes, maternity hospitals, geriatric facilities, schools, jails and prisons encompass all the features of a well-rounded community public health program. To some extent the needs of the various institutions vary depending on the type of services they render, although the fundamentals of water supply, plumbing, sewage disposal, ventilation, vermin control are much the same at all types of institutions.

Standards for lighting, recreational space and special service facilities entail a close study of the type of institution, its uses, and the individuals involved. Institutional health is a recognized activity of health departments at any level. Local health department have to give consultation services, review plans and specification on new institutions, establish standards and promulgate rules and regulations which help local representatives to supervise effectively the construction, maintenance and operation of the institutions. Close relationships between health departments and other agencies, which have concern on the institutions, such as the education department for schools, prison board for prisons, etc is helpful in carrying out successful health service program in all institutions.

6.3 The School Health Programs

A school is one of the public institutions. School health and sanitation program is therefore, very crucial depending upon the

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.

A school health program should generally include seven important services in the following areas:

1. Control of communicable diseases:

This includes daily observation by the teacher to note signs and symptoms of illness among students. Although no attempt should be made to diagnose the specific disease or to treat the illness, the teacher should be able alert to such evident signs as flushed face, rash, difficulty breathing, abnormal cough, chills, fever, headache and diarrhea. The child who exhibits such abnormalities should be excluded from the class and sent to the school clinic (if any) or to local health institution to be seen by the health personnel and treated fully before returning to the school.

Counseling, follow ups, regular inspection and sanitary campaign of the school compound and immunization are integral part of school health programs. These activities should therefore, be included in the annual health care action plan of health institutions.

2. Minimizing of non-communicable defects*:*

This includes observations by the teacher as well as screening by specially trained individuals (such as team of health workers from the near by health center) to detect any evidence of defects in such aspects as:- vision problem, hearing, speech, tooth and posture defects. Convenience of physical environment such as good seat and desk arrangements, appropriate distance of seats from the blackboard, recommended number of students per unit area of a class room must be regularly checked for early measures.

When defects are noted the parents should be informed with a recommendation for remedial care. If financial difficulties prevent parents from taking prompt and effective action, the community services and facilities or charity organizations should be consulted for utilization.

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

	Reflective values
Floor----------	15-30 %
Desk Top----------	35 – 50 %
Walls above windows---------	75 – 80 %
Chalk boards----------	15_20 %
Walls----------	50 – 60 %
Ceiling and top of the wall----	80 – 85 %

(Source: Municipal and Rural sanitation 6th Ed.)

Examples of color selection:-

1. Ceiling and upper wall-----should be painted white plaster
2. Wall----------should be painted light cream
3. Floor---------- should be painted medium gray or brick red
4. Furniture----------should be painted light gray
5. Black board---------- should be painted green
6. Doors---------- should be painted medium gray

(Source: Municipal and rural sanitation).

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 sprit-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

refreshment courses as needed, by health professional from the local health institutions.

7. Integration of school and community health program

School health program should be integrated with the local community health program. Arrangement of visit of teacher to the family of the students encourages linkages and relationship between the school and families and promotes community action.

The school building

This calls attention on:

1. Fire protection, escape doors, fire extinguishers such as water.
2. Floor area and room volume per pupil equals 15 sq.ft (1.4 sq. meter) and 200 ft^3 (5.7 m^3) respectively.
3. Black board writing should be visible, also not be more than 32 ft (10 m) from the last row of seats.
4. Students should always be guided by a trained laboratory assistant and safety precautions should be displayed where they could be easily seen in the laboratories.

Sanitary facilities in school

If the sanitary facility Is a water flush system one separate seat will be required for 25 boys and girls; one urinal for 15 boys and one seat for 15 girls. In rural areas where there is no running water toilet with out water carriage such as pit latrines must be used. In the use of such latrines, the number of seat holes and urinals as practically applied in most of developed countries is:

a. 1 seat hole for every 15- 20 boys.
b. 1 urinal for every 30 to 45 boys.
c. 1 seat hole for every 10 to 20 girls.

However, what is currently observed in the majority of Ethiopian schools regarding number of students per one seat hole of a latrine is:

a) 1 seat hole for every 60-90 boys

b) 1 seat hole for every 30- 45 girls.

6.4. Hospital (Health Institutions) Sanitation

Hospitals are health institutions which give health services with at least four sub-specialties such as: medical, surgical, gynecology & obstetrics, and pediatrics. They can also be categorized in to three tier systems according to the scope and level of services (status) they provide:

a) Central Referral Hospital
b) Regional Referral Hospital
c) Rural Referral Hospital

- **Special Hospital:-** that which provides medical care for particular groups of population whether different sex or age group or on the type of health problems

  Eg:-- The Ethio-Sewedish Pediatric Hospital in Addis Ababa gives service to children.
  - Ghandi Hospital in Addis Ababa serves the mothers
  - Leprosy Hospital in Addis Ababa treats leprosy and skin problems.
  - Emanuel Hospital in Addis Ababa treat mental cases.

Hospitals and other health facilities like health centers are expected to provide an environment that will expedite the recovery and speedy release of the patient. However, less care, poor sanitation and various limiting factors in the hospitals have become a means of introducing contaminants and infections to the hospital environment that delay recovery, and may overburden the weakened patient. Hospitals have therefore, many potential hazards that can pose a threat to employees, patients and visitors. The main health hazards that are potential problem in the hospital setting are bacterial infections caused by streptococcus and staphylococcus, and viral infections such as hepatitis B. The central objectives of sanitation in hospitals is therefore aimed at maintaining a high

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 particularly while touching clothes and other articles soiled with body discharges.

2. ***Proper Disposal of wastes Generated in the hospitals and other Health institutions***

Most of the wastes generated from health institutions may comprise both infectious (biological) and non- infections organic matters such as garbage and rubbish. The infectious wastes are characterized by the ability to infect other living organisms including human. Wastes

specially generated from dressing rooms, maternity rooms, surgical rooms (pathological wastes), biological research institutions (resistance strains), laboratories (various specimens), are hazardous to staff and other people visiting these institutions.

Use and throw types of medical articles such as hypodermic needles, syringes, lancet catheters, etc. are also major sources of health risk. The present practices of handling these infectious wastes in most governmental health institutions in Ethiopia are not different from those of household wastes. It has been practically observed that open dumps have been used for final disposal of these infectious wastes, placing a high risk of infection to the surrounding community specially to children.

These problems should come to the attention of all health professionals working in the institutions and the administrative bodies to practically use an appropriate handling and disposal of these wastes. Incineration (for combustible wastes) and burying or controlled tipping (for non-combustible wastes, wet wastes due to body discharges and still births) are the best methods of disposal of infectious wastes in the health institutions. A deep pit constructed with a masonry work provided with a tight cover and a long vent pipe may also be used for biodegradable biological wastes such as placenta.

3. *House keeping*

All wastes should be properly stored in a watertight, covered corrosion and wet resistant containers (bins) until properly disposed. Dust particles should not be accumulated in hospital wards. Cleaning and sanitization in health institutions is a very important task or activity that must be frequently performed than even schools and hotels. Wet mopping specially with disinfectant chemicals is best to minimize the risk of infection. Floors are particularly important areas of emphasis since dust and bacteria tend to settle on them. If the floors are wet and mopped or cleaned with a

vacuum cleaner, the chance of spreading disease agents in the hospital environment is greatly reduced. The wall and floor surfaces must be thoroughly scrubbed after each patient leaves the room. Bedpans, kidney dishes, sputum cups and other equipment used for collecting discharges from the patient should be thoroughly washed, disinfected and replaced.

4. *Nursing Staff*

All nursing personnel must sterilize, disinfect or dispose of contaminated equipment properly so that no hazard exists for others. Health professionals helping or visiting patients should always wash his/ her hands thoroughly to minimize the spread of disease causing organism to other patients. Personal protective devices such as gowns, masks, gloves and caps must be worn and removed before entering clean areas such as lunchrooms, lounges, cafeteria, and patient rooms.

5. *Dietary*

Employees working in food preparation areas should be encouraged to stay home when sick and to visit the health services institutions before returning to the job. Thorough washing of food ingredients before preparation, and once washed must be separated from the unwashed foodstuffs. All the employees should be well trained on hygienic food preparation methods and how to maintain a good personal hygiene. Refrigeration of the perishable food products at proper temperature prevents the growth of microorganisms.

6. *Personal Hygiene*

All hospital staff should wash their hands with soap and adequate water after attending a patient and before touching another patient and at all other critical times such as after visiting the toilet. Hand washing facilities, toilet facilities, and personal protection devices should be adequately available. Nursing and other health staff should avoid wearing jewelers such as rings, especially if they are

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 important natural disinfecting characteristics. Continues and pressurized water supply, protection against radiation, vermin control and appropriate sewerage systems are also basic facilities for all hospitals and other health care facilities.

8. *Central Supply*

The central supply and sterilizing area is responsible for the sterilizing any soiled materials used in surgery and treatment rooms. Surgical instruments should first be dumped into a disinfectant solution after surgery and before being removed from the Operation Theater. They should then be cleaned and sterilized.

Autoclaves are used to sterilize surgical supplies and equipment, syringe, textile products, enamelware, and rubber gloves. Dry heat is preferred for sterilizing needles and sharp cutting instruments.

Staff working in sterilization room should be careful with puncturing and cutting surgical instruments while washing. If an accident happens direct disinfecting and washing should immediately be done on the affected skin or on lesion, which has come in contact

with the contaminated instruments. Sterile packs that have been stored for considerable time can become source of infection unless they are inspected and re washed or sterilized again before use.

9. *Formation of Infection Control Committee*

A major hospital acquired infection control mechanism is the establishment of a representative infection control committee. Establishment of this committee is important to coordinate and ensure that medical, nursing, house keeping, maintenance, and supportive staff is following good practices and procedures. The committee is responsible to follow procedures and activities including nosocomial infection surveillance and control, proper waste handling, good sanitation, safety radiation, and occupational health protection. The committee is also responsible to follow up and control general sterilization techniques in the hospital, disinfecting techniques of infectious wastes, and isolation of hazardous wastes.

6.5. Prison Health

Prison is also an institution where prisoners are kept under custody for a certain period of time. If the conditions of a prison are closely observed, one can easily recognizes that the prisoners are under risk of health problems. Because, the prisoners usually live in an overcrowded conditions and use a single room for living, sleeping, reading, and etc. Moreover, some prisoners may have an infection before they are sentenced. Communicable disease transmission is very rapid in such crowded condition, which is apparent in prison.

Aim of Prison Health Services

1. To solve the immediate physical and mental health problems of the prisoners.
2. To teach prisoners the basic principles of healthy living so that when they are released from the prison to join their

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.
2. Infection that originate in the prison it self because of poor environment (Poor housing, inadequate ventilation, overcrowding, malnutrition, poor hygiene due to lack of facilities, inadequate water supply, etc).

Experiences have shown that health problems such as psychological problem, dysentery (due to poor hygiene), febrile illnesses like relapsing fever, malnutrition and anemia, gastrododenites, upper respiratory infection, skin infection or diseases, etc are common in the prisons.

Transmission of these health problems is basically prevented through active involvement of the prisoners and the prison administration in the identification, prioritization, planning, implementation and evaluation of preventive measures. So health workers in health centers and health stations have professional responsibilities to solve health problems that may arise in prisons through the following strategies:

- Discuss and convince the prison administrators to actively participate in the planning and implementation of health activities in the prison environment.
- Organize the prisoners & form health committee to clean their environment on a regular basis.

- Give continuous health education in a language the prisoners understand which is useful for them to solve their immediate health problem.
- Treat cases & do follow ups to ensure relief, recovery and cure.
- Screening the prisoners for any communicable disease before assigning cells when they first arrive at the prison.
- Regular inspection of the prison environment for any actual or potential sources of health risks.

Methods of Prevention and Control of Communicable diseases in the Prison

1. Buildings which are used for prison inmates should be structurally sound, secure, and, fire resistant:

- The cells should be designed to provide at least $5m^2$ ($50\ ft^2$) of floor area for each prison inmate.
- The cells should be provided with a minimum of 30 ft-c illumination.
- A minimum of 4 m^2 sleeping area per person is required to avoid overcrowding.
- Height of the ceiling should not be less than 2. 35 m and a minimum height of 2.8 m if double beds are used.
- All beds should be raised by 30 cm from the floor.
- There should be a minimum space of 90 cm between two beds and 120 cm if double beds are used.

2. Cleanliness and maintenance:-

- There must be provision for cleanliness or personal hygiene of inmates
- The jail/prison authorities are obliged to maintain high standards of maintenance of buildings.

3. Physical examination of inmates and inspection of the basic necessities.

4. Lighting and ventilation: - all rooms should receive natural and artificial light as well as adequate ventilation.
5. Water supply and sewage disposal system:-

- Water for prison should be treated and the reservoirs must be washed and disinfected twice a year. At least one drinking tap should be provided out side of the physical structure for 100 prisoners.
- Adequate number of showers (at least one shower should be provided per 50 prisoners).
- All the sewage generated in the prisons should be properly disposed in to septic tank or cesspool.

6. Prison authorities together with prisoners should be responsible to control vectors such as rodents and insects.
7. There should be a regular inspection of food preparation, proper training to food handlers and regular medical check up of food handlers.
8. The prison should also be provided with appropriate refuse disposal facilities.
9. The prison is recommended to have a day temperature of 20^0c-22.2^0c and a night temperature of 15.56^0c in cells, offices, and similar areas.
10. There should be one water closet and one lavatory for eight prisoners, or one seat hole of a pit latrine per 50 prisoners. The latrines should be placed 30 m away from prison cells.

Environmental health programs in prison would minimize the problem of food poisoning, poor and insufficient food, vermin infestations and communicable diseases. Overcrowding is also a known case of unrest and illnesses in the prison. Overcrowding condition often overtax the ventilation system and sanitary facilities. Environmental Health professionals should therefore make regular inspections and reports of the facilities in the same manner as is done for other regular health service programs.

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 an inspection checklist for hospitals, schools and prisons. Get all students together and finalize the inspection checklist. Now assign the groups to each of the institutions. Students should prepare a report of their findings and present it to the class.

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 burning of biomass fuel.

11. **Vitiated air:-** Polluted/contaminated or used up air.

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.

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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.