SHENDI UNIVERSITY

THE POST GRADUATE COLLEGE

ASSESSMENT OF BIOLOGICAL ALLERGENS IN AIR & SETTLED DUST IN SHENDI TOWN

A thesis Submitted for Ph.D. In Environmental Health Sciences

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Dedication

To my family,

My father,

My mother's soul,

My dear wife,

My sons and my daughter,

I dedicate this work

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I owe my greatest gratitude to my supervisors, Professor ABDEL GHANI ABDEL GALIL HASSAN (Chemical Engineer, have Special Studies on Environment, Pollution Control and waste Management, Ministry of Industry & Investment, Khartoum) and Dr. AIL BABIKER OSMAN (associate Professor of microbiology Shendi University). They have both provided excellent guidance and support throughout the process of this work. Their never-ending interest towards science has been a great inspiration for me. I am most grateful to them for their expert review of this thesis. I greatly appreciate their constructive comments and valuable advice in improving the final version.

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List of Abbreviations

AIDS	Acquire immune Deficiency Syndrome
AR	Allergic Rhinitis
CAM	Complementary and Alternative Medicine
CDC	Centers for Disease Control and Prevention
DG 18	Dichloran 18% Glycerol agar
EPA	Environmental Protection Agency
HIV	Human immune Virus
IAQ	Indoor Air Quality
IgE	Immunoglobulin E
IOM	Institute of Medicine
MEA	Malt Extract Agar
MVOCs	Microbial Volatile Organic Compounds
ODTS	Organic Dust Toxic Syndrome
PHCU	Primary health care units
PM	Particulate matters
QOL	Quality Of Life
RAST	Radioallergosorbent Test
SBS	Sick Building Syndrome

SSMO Sudanese Standards &Metrology Organization

UNESCO United Nation Education Scientific and Cultural Organization

US United States

VOC Volatile Organic Compounds

Abstract

People are exposed to a variety of potentially harmful agents in the air they breathe, the liquid they drink, the food they eat, the surface they touch and the products they use. An important aspect of public health is the prevention or reduction of exposures to environmental agents that contribute, either directly or indirectly, to increased rate of death, disease, discomfort or disability.

The objectives of this study are to measure the quality of biological agents i.e. bacteria and fungi in air and dust at shendi town and to show the types and the presence of the allergens in the area. The study was conducted by environmental monitoring, questionnaire and time - activity surveys. The town has been divided into five sectors, from each sector 24 air samples (12 indoor and 12 outdoor) and 12 dust samples (for bacteria) plus 24 samples (12 indoor and 12 outdoor) (for fungi), were collected. The samples were collected randomly by multistage sampling technique; the total is 180 samples (outdoor, indoor air and dust samples).

All project data are stored in Microsoft Excel spreadsheets. The preliminary characteristic and indoor pollutant exposure range also were calculated using Excel. Data were also exported to SPSS for additional statistical analyses. Descriptive analyses included frequencies, means and standard deviations as well as analysis of variance for mean comparisons and analyses for categorical variables. The tables, figures and plates present the results of the analyses of several demographic characteristics of the study

population and the outcome of the different laboratories. A walk-through inspection was performed to record home and occupant characteristics.

The total of exposed Petri dishes for bacteria growth were 180, (60 for indoor air samples, 60 for outdoor air samples and 60 for dust samples), most of them show bacterial colonies, these colonies were identified up to the specific level. Most of them were Gram –ve baclli 13 types. The most abundant frequent types were *Pseudomonos aeraginosa, Hafnia alvei, E.coli, Cedecea davicae, Providincia rettgeri and Klebsiella pneumoniae* (table 4.38). Of the total 120 exposed Petri dishes fungal spores were collected on only 105.The remaining lacked any fungal spores. Using the subculture method fungal colonies was obtained only on 60 Petri dishes and these colonies were identified up to the specific level into 17 types. The most abundant frequent types were *Aspergiluis, Penecillium, Alternaria; Cladospormm; Curvularia; Fusarium*. Thus a comprehensive study, of indoor air biological species, should be done by the Sudanese Standards &Metrology Organization (SSMO) in order to establish Standards for biological allergens.

مستخلص

يتعرض الناس للعديد من العوامل الضارة في الهواء الذي يتنفسونه والسوائل التي يشربونها والطعام الذي يأكلونه والأسطح التي يلمسونها و المنتجات التي يستعملونها . ومن أهم أختصاصات الصحة العامة الوقاية أوخفض التعرض للعوامل البيئية التي تساهم بطريقة مباشرة أو غير مباشرة في زيادة معدل الوفيات أو الأمراض أوعدم الراحة أو العجز.

تهدف هذه الدراسة إلى معرفة نوعية العوامل البيئية الأحيائية (بكتيريا و فطريات) الموجود في الهواء و الغبار في مدينة شندي .

أستخدمت عدة طرق لجمع المعلومات التي تساعد في تحقيق أهداف الدراسة شملت

1- قياسات بيئية : حيث أخذت عينات من الهواء الداخلي و الخارجي للمنازل في منطقة الدراسة , بهدف التعرف على العوامل الأحيائية , بإستخدام مضخة أخذ عينات الهواء تعمل بمعدل 15لتر/ الدقيقة ولمدة ساعة لكل عينة .
2- إستبيان و المسح : حيث تم ملىء 60 إستمارة مع سكان المنازل التي أخذت منها العينات في القياسات البيئية . بغرض التعرف على البيئة الطبيعية في المنزل ,أفراد الأسرة , التركيبية السكانية , الامراض الشائعة و أي معلومات يمكن أن تساعد في فهم النتائج .

لجمع المعلومات بهذة الطرق تم تقسيم المدينة إلى خمس قطاعات , وتم أخذ 24 عينة من الهواء في كل قطاع لفحص البكتيريا شملت 12 للهواء الداخلي ومثلها للهواء الخارجي , وعينات مماثلة لفص الفطريات , بالأضافة إلى 12 عينة من الغبار الداخلي لفحص البكتيريا.

قبل بداية العمل الفعلي في الدراسة تم تقييم الخطة و المعدات و الإجراءات بتجريبها في منازل خارج نطاق الدراسة .

المعلومات التي جمعت تمت معالجتها إحصائيا بواسطة برمج Microsoft Excel وأيضاً تم نقل جميع المعلومات إلى برنامج SPSS وتمت معالجتها للحصول على المزيد من التحليل الإحصائي . القياسات البيئية و الأحيائية تم تقسيمها و تصنيفها للوصل إلى بعض النحاليل الإحصائية .

الجداول و الأشكال و الصور تبين نتائج التحليل الإحصائي للمعلومات التي جمعت حيث تبين الجداول من 1 إلى 10 نتائج المسح و الإستبيان والتي أظهرت أن 83 % من المشاركين في الدراسة يسكن المنزل بالإيجار , 54% يملكون أغنام وكلاب و قطط في المنزل و 4/3 المنازل بها حشرات مثل الصراصير و البعوض و الذباب وغيرها . 26 % من المنازل مصنفة على أنها متسخة و أغلب المنازل مكتظة ومفروشة بالسجاد ورطبة . أكثر الأمراض هي أمراض الجهاز التنفسي

تم جمع 180 عينة للبكتيريا أظهرت معظمها نتائج إيجابية تم تصنيفها إلى موجبة الجرام وسالبة الجرام وكانت السالبة أكثر وهي 13 نوع أكثرها *Pseudomonos aeraginosa* , *Hafnia alvei* , *E.coli* , *Cedecea davicae* , *Providincia rettgeri* and *Klebsiella pneumoniae* الجدول رقم 39 يبين وجود البكتيريا سالبة الجرام خلال شهور السنة حيث كانت أكثر في أغسطس وسبتمبر وأكتوبر ونوفمبر وديسمبر (نهاية فصل الخريف وبداية الشتاء) وأقل في فبراير ومارس وأبريل ومايو (نهاية الشتاء وبداية الصيف) ومعدومة في شهور الأمطار (يونيو ويوليو) . أما ال120طبق الخاصة بالفطريات فقد ظهرت الفطور في 105 منها 17 نوع أكثرها وأهمها *Aspergiluis, Penecillium , Alternaria; Cladospormm; Curvularia;* Fusarium. لذلك على الهيئة السودانية للمواصفات والمقاييس إجراء دراسة شاملة للخروج بمواصفة للمحسسات الأحيائية في الهواء .

List of Contents

	Page

List of Tables

List of Figures

List of plates

1.1 Background and justification

Air is a mixture of 78% nitrogen and 21% oxygen with traces of water vapor, carbon dioxide, argon, other gases and a variety of suspended particles. Carbon dioxide is only 0.03% of air volume, but is vital for life on earth. Photosynthesis is the basis of life on planet earth. The oxygen we need is produced by plants, about 70% coming from ocean phytoplankton, the rest from land plants. (1)

Suspended particles in the air (aerosol) are critically important to the behavior of whole atmosphere and play a key role in determining human disease. Natural sources of atmospheric particles are volcanoes, dust storms, spontaneous forest fires, tornadoes and hurricanes. Clouds are a product of aerosols that seed the formation of water droplets. Man made air pollution now dominates aerosol production over cities with negative health effects. Aerosol particles may be solid or liquid; they range in size from 0.01 microns to several tens of microns (1)

Air inside buildings contains local aerosols that are sometimes more concentrated and more toxic than outdoor air. The term dust refers to the larger particles in the aerosol that settle on walls and furniture. Indoor air contains a living aerosol of microorganisms that infect or trigger allergic reactions. Spores of bacteria and fungi are microscopic and may persist for months or years. The abundance of microorganisms, even in a very clean house, surprises most people who have tests done to assess air quality. Over land up to a quarter of the total airborne particulates are pollens, fungal spores, bacteria, viruses, plant and animal matter. (1)

Air pollution, both indoor and outdoor, is a significant cause of health problems worldwide. Indoor air is often more polluted than outdoor air. A decrease in indoor air quality is the result of reduced ventilation and efficient construction practices, sealing homes and office buildings from the outdoor environment. Reduced ventilation contributes to the "Sick Building Syndrome" (SBS) with symptoms such as headache, fatigue, malaise, mental confusion, eye and throat irritation, coughing and wheezing. Reduced ventilation has resulted in complaints related to the "Sick Building Syndrome" (SBS). (1)

Information on human exposure has a Well- recognized role as a corollary to epidemiology. But it is more than this because understanding human exposures to environmental contaminant is fundamental to public policy. Global markets, urbanization and increased mobility have environmental contamination as a consequence. Assessing the quantities and distribution of potentially harmful contaminant exposure to human populations is a critical component of risk management. As long as disease prevention and health promotion are the principal tenets of public health, then assessing the levels of contaminant exposures in environmental and biological samples is necessary. (1)

People are exposed to a variety of potentially harmful agents in the air they breathe, the liquid they drink, the food they eat, the surface they touch and the products they use. An important aspect of public health protection is the prevention or reduction of exposures to environmental agents that contribute, either directly or indirectly, to increased rate of premature death, disease discomfort or disability. It is usually not possible, however, to measure the effectiveness of mitigation strategies directly in term of prevented disease, reduced premature death, or avoided dysfunction. Instead measurement or estimation of actual human exposure, coupled with appropriate assumption about associated health effect or safety limits, is the standard method used for determining whether intervention is necessary to protect and promote public health, which forms of intervention will be most effective in meeting public health goals, and whether past intervention effort have been successful. (1)

Assessing the relationship between exposure to air pollutants and disease is complicated by the problem of multiple exposures to a multiple pollutants. (1)

Many people spend large portion of time indoors - as much as 80-90% of their lives. We work, study, eat, drink and sleep in enclosed environments where air circulation may be restricted. For these reasons, some experts feel that more people suffer from the effects of indoor air pollution than outdoor pollution. Both indoor and outdoor pollution need to be controlled and/or prevented. (1)

Air pollution can affect our health in many ways with both short-term and long-term effects. Different groups of individuals are affected by air pollution in different ways. Some individuals are much more sensitive to pollutants than are others. Young children and elderly people often suffer more from the effects of air pollution. People with health problems such as asthma, heart and lung disease may also suffer more when the air is polluted. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging agents, i.e., the duration of exposure and the concentration of the agents must be taken into account.

Examples of short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Other symptoms can include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema. In the great "Smog Disaster" in London in 1952, four thousand people died in a few days due to the high concentrations of pollution.

Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.

Research into the health effects of air pollution is ongoing. Medical conditions arising from air pollution can be very expensive. Healthcare costs, lost productivity in the workplace, and human welfare impacts cost billions of dollars each year.

In many countries in the world, steps are being taken to stop the damage to our environment from air pollution. Scientific groups study the damaging effects on plant, animal and human life. Legislative bodies write laws to control emissions. Educators in schools and universities teach students, beginning at very young ages, about the effects of air pollution.

The first step to solving air pollution is assessment. Researchers have investigated outdoor air pollution and have developed standards for measuring the type and amount of some serious air pollutants. Scientists must then determine how much exposure to pollutants is harmful. Once exposure levels have been set, steps can be undertaken to reduce exposure to air pollution. These can be accomplished by regulation of man-made pollution through legislation. Many countries have set controls on pollution emissions for transportation vehicles and industry. This is usually done to through a variety of coordinating agencies which monitor the air and the environment. At the United Nations, the Atmosphere Management Program carries out worldwide environmental projects. In the United States, the primary federal agency is the Environmental Protection Agency. In addition, it is possible to prevent many types of air pollution that are not regulated through personal, careful attention to our interactions with the environment.

1.2 Research Importance

Prevention strategies in the field of asthma and allergies can aim at high-risk groups or at population as a whole – It is important to note that even if a preventive measure offers little to each individual it can bring large benefit to the community into which the preventive measure is introduced.(3)

1.3 Research Problem

The prevalence of asthma has been increasing in a number of countries in recent years. Although some of the increase may be the result of change in diagnostic classification and increased reporting. The causes of this increase are currently unknown, but environmental pollution is one potential contributory factor. (3)

There is a genetic component to the risk of developing asthma. Children with one asthmatic parent have an increased risk of developing the disease themselves, and when both parents are asthmatic, the risk is even higher. (3)

The effect of indoor and outdoor air pollution on allergic disease has received considerable attention. Environmental pollutants have been reported to contribute to the prevalence of allergic disease, the precipitation of allergic symptoms, and their intensity. (3)

The question of where environmental factors may be involved in the observed increase in the prevalence of allergy is a matter of controversy. (3)

Child hood asthma is becoming more common and doubled in the United Kingdom, New Zealand and Australia between 1970 and 1990. Because of their greater activity and their developing lungs, children may be more susceptible to sensitization as well as to adverse effects of irritants. (3)

Asthma and allergies disorders represent a substantial burden not only on the affected individual but also on health care resources in many countries. Environmental factors that have changed in the last decades appear to be largely responsible for the observed increase in the prevalence of asthma and allergic disease in many countries. The determinants of these changes need to be identified in order to design intervention that can reverse the trends. (3)

In Shendi the age structure indicates a very youthful age structure with large proportion of the population in younger age groups than in the older age groups. The percentage of the population in the age group 0-4 years is 15.2% which is higher than the national level, proportion of under 15 years population also higher (44-3%).(4)

Data on three major child hood mortality illness (fever, cough and cough with difficult breathing and diarrhea) collected 1999 indicate that 30% of under-five children had fever 32% had cough, 15.8% had cough with difficult breathing and 14% had diarrhea. (4)

There is no clear interventions that address the problem, thus conducting a study will provide data, which can be used, for identification of the causes, planning for control, making polices for treatment and prevention of the diseases.

1.4 Hypothesis

Is that "outdoor and indoor air and settled dust is polluted with biological agents which have potential allergenic impact on the local population in Shendi town".

1.5 Objectives of the study

1.5.1 Main objective is

to assess the biological agents in air and dust in Shendi town.

1.5.2 Specific objectives are to

1- Evaluate the indoor and outdoor air quality with respect to microorganisms.
2- Identify and define the biological allergens.
3- Determine the relationship between the biological agents and the ill health among the local population.
4- Determine the environmental factors those are involved.

LITERATURE REVIEW

2.1 Concepts and Definitions

Adverse effect Change in morphology, physiology, growth, development or life span of an organism exposed to air pollution, which results in impairment of functional capacity or impairment of capacity to compensate for additional stress or increase in susceptibility to the harmful effects of other environmental influences (WHO 1994a).

Aerosol A suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having a negligible falling velocity (ISO 1994).

Airway permeability Capability of allowing the passage of air through the natural passageway for air to and from the lungs (CMD 1997).

Allergen Any substance that causes manifestations of allergy. Among common allergens are inhalants, foods, drugs, infectious agents, contactants, and physical agents (CMD 1997).

Allergic Pertaining to, sensitive to, or caused by an allergen (CMD 1997).

Anemia A reduction in the number of circulating red blood cells (CMD 1997).

Asthma A disease caused by increased responsiveness of the tracheobronchial tree to various stimuli, which results in paroxysmal constriction of the bronchial airways (CMD 1997).

Biomass Organic substance of biotic origin:either living organisms or dead substances such as wood, crop residues, or animal dung.

Biomass smoke Term used for convenience for the smoke generated by burning biomass.

Biotic Of or relating to life (Webster 1994).

Bronchi The two main branches leading from the trachea to the lungs, providing a passageway for air (CMD 1997).

Bronchiole One of the smaller subdivisions of the bronchial tube (CMD 1997).

Bronchiolitis Inflammation of the bronchioles (CMD 1997).

Bronchitis Inflammation of the mucous membrane of the bronchial airways (CMD 1997).

Bronchoconstriction Constriction of the bronchial tubes (CMD 1997).

Bronchodilator A drug that expands the bronchial tubes by relaxing bronchial muscle (CMD 1997).

Building related illness Illness related to indoor exposures to biological agents (e.g. fungi, bacteria), biological and chemical substances (e.g. endotoxins, mycotoxins, radon, carbon monoxide, formaldehyde) which is experienced by some people working or living in a particular building and it does not disappear after leaving it.

Carbon dioxide A colourless, odourless, non-combustible gas, formula CO2. It is approximately 50% heavier than air, of which it is a normal constituent. It is formed by certain natural processes (see carbon cycle) and by the combustion of fuels containing carbon, and it has been estimated that the amount in the air is increasing by 0.27% annually. Only in the most exceptional circumstances do local concentrations of carbon dioxide in air rise to levels that are dangerous to health, but it plays a significant role in the decay of building stones and in corrosion (WHO 1980).

Carbon monoxide A colourless, almost odourless, tasteless, flammable gas, formula CO. It is produced, inter alia, by the incomplete combustion of organic materials (e.g. in automobile engines) and normally occurs in trace amounts in the atmosphere. At concentrations exceeding about 100 cubic cm / cubic cm (0.01%) it is highly toxic. Its affinity for hemoglobin (with which it forms carboxyhemoglobin) is between 200 and 300 times that of oxygen, and it has the effect of reducing the oxygen-transport capacity of hemoglobin and leading to death by asphyxiation. Concentrations of carbon monoxide in city streets (arising mainly from motor vehicle exhausts) can be sufficiently high to cause concern, as can those resulting from tobacco smoking in unventilated rooms (WHO 1980).

Carcinogenicity The production of cancer, equivalent carcinogenesis (CMD 1997)

Cardiovascular Pertaining to the heart and blood vessels (CMD 1997).

Centri-acinar Pertaining to the central terminal respiratory gas exchange unit of the lung, composed of airways and alveoli distal to a terminal bronchiole (CMD 1997).

***Chronic obstructive Pulmonary disease (COPD*)** A disease process that decreases the ability of the lungs to perform ventilation. Diagnostic criteria include a history of persistentdyspnea n exertion, with or without chronic cough, and less than half of normal predicted maximum breathing capacity. Diseases that cause this condition are chronic bronchitis, pulmonary emphysema, chronic asthma, and chronic bronchiolitis (CMD 1997).

Contagion A disease that is easily transmitted from host to host by casual dermal contact or respiratory droplets (CMD 1997).

Cor pulmonale Hypertrophy or failure of the cavity of the heart that receives blood from the right atrium and pumps it into the lungs via the pulmonary artery (CMD 1997)

Cough A forceful and sometimes violent expiratory effort preceded by a preliminary inspiration (CMD 1997).

Disease A pathological condition of the body that presents a group of clinical signs, symptoms, and laboratory findings peculiar to it and setting the condition apart as an abnormal entity differing from other normal or pathological condition (CMD 1997).

Dry deposition Removal of contaminants of air onto a substrate without involvement of rain, clouds or fog. Dust Small solid particles, conventionally taken as those particles below 75 mm in diameter, which settle out under their own weight but which may remain suspended for some time (ISO 1994). National standards may be more specific and include particle diameters or a definition in terms of a sieve of specified aperture. Dust occurs in the atmosphere both naturally and as a result of the activities of man (Willeke 1993).

Dyspnea Air hunger resulting in laboured or difficult breathing, sometimes accompanied by pain (CMD 1997).

Effect Change in morphology, physiology, growth, development of life span of an organism exposed to air pollution. It might be either an adverse effect or an alteration, which is not distinguishable from the range of a target variable observed in not exposed organisms of the same species (WHO1994c).

Emergency Department The portion of a hospital that treats patients experiencing an emergency (CMD 1997).

Expiration Expulsion of air from the lungs in breathing. Normally the duration of expiration is shorter than that of inspiration. In general, if expiration lasts longer than inspiration, a pathological condition such as emphysema or asthma is present (CMD 1997).

Exposure Exposure to a chemical is the contact of that chemical with the outer boundary of the human body. The outer boundary of the human body is the skin and the openings into the body such as the mouth, the nostrils, and punctures and lesions in the skin (WHO 1999).

Fine particles Particles with aerodynamic diameters below 2.5 micrometer.

Fog As international standard fog is a general term applied to a suspension of droplets in a gas. In meteorology, it refers to a suspension of water droplets resulting in a visibility of less than 1 km (ISO 1994). WMO defines fog as a suspension of very small, usually microscopic water droplets in the air, generally reducing the horizontal visibility at the earth's surface too less than 1 km (WMO 1992).

Forced expiratory Volume (FEV) The volume of air that can be expired after a full inspiration. The expiration is done as quickly as possible and the volume measured at precise times; at ½, 1, 2 and 3 seconds. This provides valuable information concerning the ability to expel air from the lungs (CMD 1997).

Fume Aerosol of solid particles, usually from metallurgical processes, generated by condensation from the gaseous state, generally after volatilisation from melted substances and often accompanied by chemical reactions such as oxidation (ISO 1994). By extension, also the gases charged by particles resulting from a chemical process or a metallurgical operation (WHO 1980). Often used the plural, fumes for visible clouds of gases, vapours, or aerosols that have an unpleasant and malodorous smell (WHO 1980; ISO1994).

Function The act of carrying on or performing a special activity. Normal function is the normal action of an organ. Abnormal activity or the failure of an organ to perform its activity is the basis of disease or disease processes (CMD 1997).

Genotoxic Toxic to the genetic material in cells (CMD 1997).

Gestational Pertaining to the length of time from conception to birth (CMD 1997).

Gram-negative Losing the crystal violet stain and taking the color of the red counterstain in Gram's method of staining bacteria (CMD 1997).

Gram-positive Retaining the color of the crystal violet stain in Gram's method of staining bacteria (CMD 1997).

Guideline Any kind of recommendation or guidance on the protection of human beings or receptors in the environment from the adverse effects of air pollutants. As such, it is not restricted to a numerical value but might also be expressed in a different way, for example as exposure-response information or as a unit risk estimate (WHO 1998a).

Guideline value A particular form of a guideline. It has a numerical value expressed either as a concentration in ambient air, a tolerable intake, or as a deposition level, which is linked to an averaging time (WHO 1998a). In the case of human health, the guideline value defines a concentration below which the risk for the occurrence of adverse effects is negligibly low. It does, however, not guarantee the absolute exclusion of effects at concentrations at or below the guideline value. For odorous compounds the guideline value represents an odour threshold.

Haze A suspension in the atmosphere of extremely small (dry) particles, individually invisible to the naked eye, but which are numerous enough to give the atmosphere an appearance of opalescence together with reduced visibility (ISO 1994, WMO 1992).

Hemangiosarkoma A malignant neoplasm (new and abnormal formation of tissue) originating from the blood vessels (CMD 1997).

Hematological Pertaining to the science concerned with blood and blood-forming tissues (CMD 1997).

Heme An iron-containing non-protein portion of the hemoglobin molecule (CMD 1997).

Hemoglobin The iron-containing pigment of the red blood cells which carries oxygen from the lungs to the tissues (CMD 1997).

Hepatocellular Concerning the cells of the liver (CMD 1997).

Hepatoxic Toxic to the liver (CMD 1997).

Hypoimmunity Diminished immunity.

Hypoxia An oxygen deficiency (CMD 1997).

Hypoxic Oxygen deficient (CMD 1997).

Illness The state of being sick (CMD 1997).

Immune function Function of being protected from or resistant to a disease or infection by a pathogenic organism as a result of the development of antibodies or cell-mediated immunity (CMD 1997).

Immunoglobulin One of a family of closely related though not identical proteins capable of acting as antibodies, abbreviation Ig (CMD 1997).

Immunoglobulin A The principal immunoglobulin in external gland secretions such as respiratory and intestinal mucin (mucus glycoprotein), saliva, and tears (CMD 1997).

Immunoglobulin E An immunoglobulin that attaches to mast cells in the respiratory and intestinal tracts and plays a major role in allergic reactions, abbreviation IgE (CMD 1997).

Immunoglobulin G The principal immunoglobulin in human serum, important in producing immunity in the infant before birth, abbreviation IgG (CMD 1997).

Inflammation The non-specific immune response that occurs in reaction to any type of bodily injury (CMD 1997).

Influenza An acute, contagious respiratory infection characterized by the sudden onset of fever, chills, headache, tenderness or pain in the muscles, and sometimes absolute exhaustion (CMD 1997).

Legionnaires' disease A severe, often fatal disease characterized by pneumonia, dry cough, tenderness or pain in the muscles, and sometimes gastro-intestinal symptoms (CMD 1997).

Leukemia A malignancy of the blood-forming cells in the bone marrow (CMD 1997).

Life expectancy The number of years that an average person of a given age may be expected to live, according to mortality tables (CMD 1997).

Low birth weight Abnormally low weight of a new-born, usually below 2000 g (CMD 1997).

Lower respiratory symptom Symptom in the lower respiratory tract (i.e. the respiratory tract from trachea to bronchioles).

Lowest-observed-adverse-effect level Lowest concentration or amount of a substance, found by observation or experiment, which causes an adverse effect (WHO1994c).

Lung cancer Cancer that may appear in the trachea, air sacs and other lung tubes. It may appear as an ulcer in the windpipe, as a nodule or small flattened lump, or on the surface blocking air tubes. It may extend into the lymphatic and blood vessels (CMD 1997).

Lysozyme An enzyme found in white blood cells and in body secretions that destroys bacteria by breaking down their walls (CMD 1997).

Malaise Discomfort, uneasiness, or indisposition, often indicative of infection (CMD 1997).

Metaplasia Conversion of one kind of tissue into a form that is not normal for that tissue (CMD 1997).

Morbidity The number of sick persons or cases of disease in relationship to a specific population (CMD 1997).

Morphological Pertaining to the science of structure and form of organisms without regard of function (CMD 1997).

Mortality The death rate; the ratio of the number of deaths to a given population (CMD 1997).

Mutagenic Pertaining to an agent that causes genetic mutations (CMD 1997).

Myoglobin The iron-containing protein found in muscle cells that stores oxygen for use in cell respiration (CMD 1997).

Mycotoxin Substance produced by mould growing in food or animal feed and causing illness or death when ingested by humans or animals (CMD 1997).

Nausea An unpleasant sensation usually preceding vomiting (CMD 1997).

Neurological Pertaining to the branch of medicine that deals with the nervous system and its diseases (CMD 1997).

Neurotoxicity Having the capability of harming nerve tissue (CMD 1997).

Neutrophil A granular white blood cell (CMD 1997).

Particle Small discrete mass of solid or liquid matter (ISO 1994).

Particle aerodynamic Diameter Diameter of a sphere of density 1 g/cm3 with the same terminal velocity due to gravitational force in calm air as the particle, under the prevailing conditions of temperature, pressure and relative humidity (ISO 1995).

Particle size distribution The distribution of equivalent diameters of particles in a sample or the proportion of particles for which the equivalent diameter lies between defined limits (Willeke 1993).

Phlegm Thick mucus, especially that from the respiratory passages (CMD 1997).

Photochemical smog Result of reactions in the atmosphere between nitrogen oxides, organic compounds and oxidants under the influence of sunlight, leading to the formation of oxidising compounds or possibly causing poor visibility, eye irritation or damage to material and vegetation if sufficiently concentrated (ISO 1994).

Pneumonia An inflammation of the alveoli, interstitial tissue, and bronchioles of the lungs due to infection by bacteria, viruses, or other pathogenic organisms, or to irritation by chemicals or other agents (CMD 1997).

Pneumonitis Inflammation of the lung, usually due to hypersensitivity (allergic) reactions to organic dust, such as wheat or other grains, or chemicals (CMD 1997).

Respiratory Pertaining to respiration (CMD 1997).

Retropharyngeal Behind the passageway for air from the nasal cavity to the larynx (CMD 1997).

Rhinitis Inflammation of the mucous membrane of the nose. Symptoms include nasal congestion, thin watery discharge from the nose, sneezing and itching of the nose (CMD 1997).

Rhino-conjunctivitis Rhinitis and inflammation of the mucous membrane that lines the eyelids and is reflected onto the eyeball.

Sampling The collection of a representative portion for analysis and testing (WHO 1980). Continuous sampling is sampling without interruptions, throughout an operation or for a predetermined time. Grab sampling or spot sampling is the taking of a sample in a very short time (ISO 1994).

Scavenging by precipitation The process of removing pollutants from the atmosphere by precipitation (WMO 1992).

Sick building syndrome Specific symptoms with unspecified aetiology which are experienced by a proportion of people working or living in a particular building and disappear after leaving it.

Standard A level of an air pollutant, e.g. a concentration or a deposition value, which is adopted by a regulatory authority as enforceable.Unlike a guideline value, a number of elements in addition to the effect-based level and the averaging time must be specifies in the formulation of a standard. These elements include the measurement strategy, data handling procedures, statistics used to derive, from measurements, the value to be compared with the standard. The numerical value of a standard may also include the permitted number of exceedings (WHO 1998a).

Symptom Any perceptible change in the body or its functions that indicates disease or the kind or phases of disease (CMD 1997).

Teratogenicity Causation of abnormal development of the embryo (CMD 1997).

Tolerable intake An estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk (WHO 1994c).

Tonsillitis Inflammation of a tonsil (CMD 1997).

Trachea A cylindrical tube from the larynx to the primary bronchi (CMD1997).

Tubular Relating to or having the form of a tube (CMD 1997).

Ultra-fine particles Unit risk Particles with aerodynamic diameters below 0.1 micrometer.The additional lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 mg/m3 of the agent in the air they breathe (WHO 1987).

Viable organisms An organism that is able to live outside a host (CMD 1997).

Vital capacity The volume of air that can be quickly and forcibly breathed out (CMD 1997).

Wet deposition Removal of pollutants from the air through the processes of wash-out, rain-out, fog, and dew

Wheeze A continuous musical sound caused by narrowing of the space of a respiratory passageway (CMD 1997).

2.2 Classification of Air Pollution

Before discussing in detail the sources of air pollutants it is necessary to establish a few basic principles that will place the information on sources in context. Air pollutants may be either emitted into the atmosphere or formed within the atmosphere itself.

2.2.1 Primary air pollutants

Primary air pollutants are those that are emitted into the atmosphere from a source such as a factory chimney or exhaust pipe, or through suspension of contaminated dusts by the wind. In principle, therefore, it is possible to measure the amounts emitted at the source itself. This is relatively straightforward in terms of the factory chimney or vehicle exhaust pipe; it becomes very much more difficult when considering diffuse sources such as wind-blown dusts. When such sources are added together they comprise an emissions inventory of primary sources, as described below.

2.2.2 Secondary air pollutants

Secondary air pollutants are those formed within the atmosphere itself. They arise from chemical reactions of primary pollutants, possibly involving the natural components of the atmosphere, especially oxygen and water. The most familiar example is ozone, which arises almost entirely from chemical reactions that differ with altitude within the atmosphere. Because of this mode of formation, secondary pollutants cannot readily be included in emissions inventories, although it is possible to estimate formation rates per unit volume of atmosphere per unit time. Another important distinction must be made in relation to the physical state of a pollutant.

2.2.3 Gaseous air pollutants

Gaseous air pollutants are those present as gases or vapours, i.e. as individual small molecules capable of passing through filters provided they do not adsorb to or chemically react with the filter medium. Gaseous air pollutants are readily taken into the human respiratory system, although if water-soluble they may very quickly be deposited in the upper respiratory tract and not penetrate to the deep lung.

2.2.4 Particulate air pollutants

Particulate air pollutants comprise material in solid or liquid phase suspended in the atmosphere. Such particles can be either primary or secondary and cover a wide range of sizes. Newly formed secondary particles can be as small as 1–2 nm in diameter (1 nm = 10–9 m), while coarse dust and sea salt particles can be as large as 100 µm (1 µm = 10–6 m) or 0.1 mm in diameter. However, the very large particles have a short atmospheric existence, tending to fall out rapidly through gravity and wind-driven impaction processes. Thus in practice there are few particles in the atmosphere exceeding 20 µm in diameter, except in areas very close to sources of emission. Particulate matter can be separated from atmospheric gases by drawing air through a filter fine enough to retain the particles, or by accelerating air through a jet that fires them at a fixed plate, onto which the particles impact and are collected. Particulate air pollutants have very diverse chemical compositions that are highly dependent on their source. They are also diverse in terms of particle size.

2.3 Sources of air pollution

There are many ways of categorizing sources of air pollution, and this section explores some of the main subdivisions and their characteristics. One of the main distinctions frequently drawn is between *stationary* and *mobile* sources. This is a fairly obvious distinction whereby road vehicles, railway trains, ships, etc. comprise the mobile sources while industrial and household emissions, etc. comprise the stationary sources. In practice, however, air pollution science is rarely concerned with individual mobile sources but rather with the aggregated effects, such as that of all the vehicles travelling on a road within a defined period of time. Consequently, a more useful categorization of sources is:

- point sources
- line sources
- area sources.

The term point source refers to sources that appear as individual points in the context of a gridded emissions inventory, which may resolve emissions spatially down to a 1 × 1-km scale or lower. Thus, for example, a power station might be considered as a point source even though it has more than one chimney.

Individual industrial sites are typically considered as point sources of pollution unless the emissions occur from multiple sources within the site, probably at different heights. In such a case, each individual point of emission may need to be considered as a separate point source, particularly for dispersion modelling. Nevertheless, for the purposes of constructing emissions inventories, which tend to be concerned mostly with the masses of pollutant emitted as opposed to other characteristics of the release, individual company sites are often considered as point sources.

As stated above, air pollution science is rarely concerned with emissions from individual vehicles. Since road vehicles and railway trains typically travel along common routes, from the perspective of a source of emissions they form a line source. In the case of road vehicles, road networks are typically broken up into individual sections between junctions referred to as road links, and emissions from individual road links are added together to compile an inventory of total traffic emissions. Dispersion modelling uses formulae to calculate downwind concentrations from line sources that are modified from those used for point sources.

Many sources of emissions fit neither the point source nor the line source model. Rather, they are more diffuse and therefore spread over a significant spatial region. An example would be emissions from boilers used for space heating, whereby most homes would possess their own boiler, each of which is a small source of emissions. Rather than treating each as an individual point source, however, they are typically aggregated over an area, such as a grid square in an inventory or over a city, and treated as a uniform source within that area. This is justified provided they are distributed relatively homogeneously and no individual boiler makes such a large contribution that it requires modelling as an individual point source.

2.3.1 Properties of some types of source

2.3.1.1 Road transport

One of the major sources within any emissions inventory is road transport. The term is used to describe all road traffic emissions, irrespective of the size or usage of the vehicle. Emissions from road vehicles are typically thought of in terms of the exhaust, though this is only part of the story. Combustion of petrol or diesel fuel leads to the production of exhaust gas containing a range of potentially harmful pollutants. In many modern vehicles this passes through a control device, such as a three-way catalytic converter, before emission to the atmosphere. Pollutants emitted from the combustion of petrol or diesel fuels typically include carbon monoxide, oxides of nitrogen, VOC and suspended particles. Some countries still use lead additives in petrol and this generates an important air pollutant emission.

2.3.1.2 Stationary combustion sources

The burning of fossil fuels in stationary combustion plants is a further major source of pollutant emissions in most countries. High-temperature combustion is a source of nitrogen oxides, and also of sulfur dioxide if sulfur is present in the fuel. Fuel combustion also typically emits VOC, especially from coal and oil, which are difficult to combust completely. While emissions from domestic heating and cooking can normally be considered as a ground-level source, those from combustion plants can occur at a wide range of altitudes, ranging from ground level for most domestic boilers to heights of more than 300 meters for large power station chimneys. Consequently, per kilogram of pollutants emitted, the impact on ground-level concentrations is very different: the ground-level source leads to far higher local concentrations than the elevated point source, but the elevated source influences areas much further afield because of the widespread dispersion of emissions. Power stations have typically been among the greatest sources of combustion emissions but much is being done in the developed world to control the emissions from such sources. Examples are the use of burners producing low levels of nitrogen oxides and flue gas desulfurization of emissions from coal-fired power plants, in addition to the electrostatic precipitators normally fitted to limit emissions of PM.

2.3.1.3 Other industrial sources

A very wide range of industries and industrial processes lead to emissions of air pollutants, both the classical pollutants but also more esoteric pollutants that may be specific to a particular industrial process and may arise from leakage of an intermediate or product from a chemical plant.

The measurement of emissions from chimneys and designed process vents is generally fairly straightforward, although it may require many measurements to obtain representative data. As well as the defined process emissions, however, many industrial operations also generate fugitive emissions. These are those arising from other, less well-defined sources, such as the wind blowing of raw materials from exposed stockpiles, and these are very much more difficult to quantify. A good example is that of secondary metal smelters, many of which have been operational for a large number of years and caused substantial contamination of the site and local area at a time when emissions were far less closely regulated than at present. For such a smelter it is likely that the impact of stack emissions on local air quality is very small, whereas there is a much larger impact on local air quality from resuspension of metal-containing soils and dusts by the action of the wind.

2.3.1.4 Intermittent and poorly defined sources

Globally, forest fires and deliberate biomass burning represent a major source of combustion emissions, including nitrogen oxides, carbon monoxide, VOC and PM. These are typically intermittent and often unplanned events that are very difficult to account for in any inventory. There are also smaller sources of this kind, which may be quite significant in national inventories. Concern over the health consequences of dioxin emission has led to a very tight regulation of known sources, especially incineration of refuse. This has highlighted the importance of other sources, however, such as accidental fires and even planned events such as celebrations involving bonfires, as important sources of dioxin emissions. Because of their sporadic and very variable nature and the difficulty of measuring emissions, the magnitude of such sources (although included within emissions inventories) is rather uncertain. In less developed countries, burning of refuse and biomass-based fuels in clusters of poor households represent poorly defined and often intermittent sources that are very difficult to quantify.

2.3.2 Natural sources

Nature is an important source of many trace gases and particles within the atmosphere. One of the best known natural contributions to air pollution is the release of biogenic VOC from trees and other vegetation. These substances, which comprise isoprene, terpenes and other constituents, contribute to the production of both tropospheric ozone and secondary organic PM, and hence their impact on air quality through secondary pollutant formation can be very important. Globally, the natural production of sea spray and wind-blown soil is large, although its relevance to air pollution phenomena and health is likely to be very much smaller. In arid countries, dust storms can cause massive increases in PM concentrations, and wind-blown soils and dusts are one of the major particulate pollutants *(5)*.

2.4 Overview

With every breath, we inhale not only life sustaining oxygen but also dust, smoke, chemicals, microorganisms, and other particles and pollutants that float in air. The average individual inhales about 10 cubic meters of air each day, roughly the volume of the inside of an elevator. Because people typically spend so much time indoors, poor indoor air quality (IAQ) can greatly affect individuals and, more broadly, the public health and national productivity. The US Environmental Protection Agency (EPA) Science Advisory Board rated indoor air pollutants, excepting radon, as the third highest of 30 environmental risks, well ahead, of sixth ranked occupational exposures to chemicals. However, a shortage of IAQ research leaves us with too many unknowns, even as more and more occupants of contaminated buildings are reporting a variety of health symptoms that they attribute to poor IAQ. This also leads to health treatment, expensive remediation activities, and litigation.

Although poor IAQ is often viewed as a problem peculiar to modern buildings, linkages between air quality and disease have been known for centuries. Long before the germ theory of disease led to recognition of pathogenic microorganisms, foul vapors were being linked with infectious diseases. As our understanding of disease increased, public health workers made prevention of pathogen transmission a central concern. Today, we understand that airborne transmissions of pathogens, non-pathogenic organisms, fragments of microbial cells, and byproducts of microbial metabolism, collectively referred to as “bioaerosols,” can all cause serious problems. Contaminated indoor air thus has the potential to harm public health and significantly affect the economy of the countries.

Although the Centers for Disease Control and Prevention (CDC) do not track either the types or cases of illness attributable to bioaerosol exposure, bioaerosols are widely recognized to make asthma worse. Asthma affects an estimated 20 million Americans and costs the US economy more than $13 billion annually. The American Lung Association cites asthma as the sixth ranking chronic condition in the United States as well as the leading serious chronic illness of children, with numbers of those affected rising each year.

In a recent report, the Institute of Medicine (IOM) concluded that "there is sufficient evidence of an association between exposure to a damp indoor environment and asthma symptoms in sensitized asthmatic people" and that "there is a sufficient evidence of an association between the presences of 'mold' (otherwise unspecified) in a damp indoor environment and asthma symptoms in sensitized asthmatic people."

Moreover, the general public is becoming increasingly aware of IAQ problems. Over 3,500 news reports related to mold toxicity have been published since 2000, and some 10,000 mold related lawsuits are pending nationwide. Many of these lawsuits have been filed in regions with hot, humid climates, but construction defects and inferior maintenance practices can lead to buildings with poor indoor air quality anywhere.

Bioaerosols are collections of airborne biological materials. Ubiquitous indoors and out, bioaerosols in suspended, aerosolized liquid droplets typically contain microbes and cell fragments combined with byproducts of cellular metabolism. In addition, they may carry viruses, bacteria, and fungi that float on dust particles along with cells and parts of cells. Although there are no recognized standard levels for bioaerosols in schools, offices, and residential environments, several government agencies and professional organizations have published guidance documents that address bioaerosol concerns as an integral component of IAQ.

Viruses require a living host for replication, meaning they cannot by themselves multiply on or in building materials. However, they can contaminate interior spaces of manmade or natural structures such as occurred when Hantavirus infections resulted among building occupants because rodents had infested particular indoor environments. More commonly, many viruses that infect the respiratory tract spread from person to person, especially in crowded rooms with inadequate ventilation— thus making viruses common factors in poor IAQ. Coughing, laughing, and sneezing can discharge tens of thousands of virus filled droplets into the air and may readily spread illnesses in schools, offices, homes, or other settings.

In contrast to viruses, bacteria and fungi will grow, often to an alarming extent, on building materials if moisture is available. Background levels of airborne bacteria and fungi change frequently inside buildings as a result of human activity, especially operation of mechanical air handling systems. Indeed, building conditions that allow excessive growth of bacteria or fungi can lead to occupants developing various specific medical symptoms or other complaints. Exposure indoors to unusual bacterial populations generally attracts notice when infectious disease results, such as the 1976 outbreak of a serious respiratory disease among attendees at a Legionnaire convention in Philadelphia, later associated with a bacterial contaminated ventilation system in the hotel where they had gathered. Endotoxin, a component of some bacteria, also can cause illnesses among building occupants who inhale this contaminant. Fungi, especially filamentous fungi called mold, also lower air quality and cause public health problems though not typically as agents of infectious disease. Recently an IOM report stated that “there is sufficient evidence of an association between the presence of mold and bacteria in damp indoor environments and hypersensitivity pneumonitis” in sensitized persons. The IOM also referred to a possible association between exposure to damp environments, the presence of molds, and an increased risk of lower respiratory tract illnesses in otherwise healthy children. Of course, many fungi can play beneficial roles, for instance, when they help to recycle organic material such as fallen trees and leaves and when they are used in producing foods such as cheese, wine, and beer. However, when unwanted molds appear in ventilating systems or in other spaces within occupied buildings, exposures of occupants to those molds can lead to serious problems.

In general, the types and concentrations of mold that affect IAQ are similar to those found in outdoor air. However, background mold numbers may shift whenever water accumulates in buildings. Damage caused by floods, plumbing leaks, or roof and window leaks, and even climate and air conditioning related condensation can lead to long term water related damage indoors. Once water accumulates in building materials and furnishings, it takes less than 72 hours for mold to begin growing on those dampened surfaces.

Building practices for commercial and public structures as well as residences have changed markedly in the past three decades, making many buildings more prone to moisture problems that lead to higher levels of microbial contaminants. For example, condensation often can occur in those buildings that are tightened to improve energy efficiency when appropriate care is not given to ventilation or how insulation is installed. Widely used building materials such as components made from wood chips or walls consisting of paper covered gypsum board are more sensitive to moisture than is plaster. Poor understanding of moisture dynamics and careless building design and construction lead to structures that are more susceptible to water intrusion. Also, lack of good maintenance practices in some buildings can lead to moisture buildups that, when left alone, can result in microbial contamination and higher levels of bioaerosols.

Moisture is the principal determinant of mold growth indoors. Different levels of moisture are needed for growth of different molds. For instance, *Aspergillus* and *Penicillium* require little available moisture and often are found along drier areas of water damaged materials. Other molds that require higher levels of moisture include *Stachybotrys* and *Chaetomium*. Not only are moldy surfaces aesthetically displeasing, they may require expensive repair and clean-up operations. Moreover, their presence can also lead to illnesses and loss of productivity among those who occupy such contaminated buildings. When water intrusion shifts indoor mold populations to those organisms associated with allergenic reactions or toxigenic by-products, building occupants become more likely to report health problems and to incur increased costs for health care. Costs for building maintenance and repairs are also increased.

Americans spend up to 90 percent of their time indoors, where contaminants in bioaerosols are generally at higher levels than those found in outdoor air. Frequently the duration of exposure to such contaminants also is greater indoors than out. It is estimated that more than 30 percent of buildings in the United States and Western Europe have moisture problems serious enough to promote microbial contamination of indoor air. Exposure to high levels of indoor moisture is associated with upper respiratory symptoms, including higher incidence of coughing, wheezing, and asthma in sensitized persons, according to several large epidemiological studies cited by the IOM. Additional case studies, cluster investigations, and clinical experience associate other health complaints with living and working in damp buildings where mold and bacteria grow. Occupants of such damp buildings report a variety of additional symptoms, including:

_ Headaches

_ Nasal congestion and runny nose

_ Watery, burning eyes

_ Sore throat and hoarseness

_ dry, irritant-type cough

_ Tight chest, burning sensation, wheezing, shortness of breath

_ Nosebleeds, coughing blood (rare)

_ Skin and mucous membrane irritation, rashes

_ Exhaustion, severe fatigue

_ Memory and cognitive problems

_ Gastrointestinal problems such as nausea, vomiting

Health care professionals face the challenge that these symptoms are common and are associated with many different disorders. Medical conditions associated with exposure to viruses, bacteria, or fungi include infectious diseases, respiratory disorders such as bronchitis and asthma, and other allergic, inflammatory, and toxic responses. In some cases, evidence links these disorders to exposure to bioaerosols. For others, evidence is insufficient, reflecting the small numbers of exposed individuals who have been carefully studied. Research that could establish cause and effect relationships between exposure to specific biological agents and particular diseases awaits several critical developments. These include availability of methods to measure the spectrum of potential agents (mold spores and bacteria, their fragments, volatile and semi volatile emissions, and allergen- or toxin-bearing particles) with a high degree of accuracy or of having alternative methods to establish biomarkers that can link exposure and effect.

Most health effects attributable to bioaerosol exposures last only briefly and typically are reversible, particularly once moisture and consequent microbial contamination problems have been appropriately corrected. However, in some instances, health consequences may be serious and possibly irreversible.

Outdoor air pollution in cities is a major health problem. Much effort and money continues to be spent cleaning up pollution in the outdoor air. But air pollution can be a problem where you least expect it, in the place you may have thought was safest--your home. Many ordinary activities such as cooking, heating, cooling, cleaning, and redecorating can cause the release and spread of indoor pollutants at home. Studies have shown that the air in our homes can be even more polluted than outdoor air.

Many Americans spend up to 90 percent of their time indoors, often at home. Therefore, breathing clean indoor air can have an important impact on health. People who are inside a great deal may be at greater risk of developing health problems, or having problems made worse by indoor air pollutants. These people include infants, young children, the elderly, and those with chronic illnesses.

Biological pollutants are or were living organisms. They promote poor indoor air quality and may be a major cause of days lost from work or school, and of doctor and hospital visits. Some can even damage surfaces inside and outside your house. Biological pollutants can travel through the air and are often invisible. Some common indoor biological pollutants are:

- Animal Dander (minute scales from hair, feathers, or skin)
- Dust Mite and Cockroach parts
- Fungi (Molds)

- Infectious agents (bacteria or viruses)
- Pollen

Some of these substances are in every home. It is impossible to get rid of them all. Even a spotless home may permit the growth of biological pollutants. Two conditions are essential to support biological growth: nutrients and moisture. These conditions can be found in many locations, such as bathrooms, damp or flooded basements, wet appliances (such as humidifiers or air conditioners), and even some carpets and furniture.

Modern material and construction techniques may reduce the amount of outside air brought into buildings which may result in high moisture levels inside. Using humidifiers, unvented heaters, and air conditioners in our homes has increased the chances of moisture forming on interior surfaces. This encourages the growth of certain biological pollutants.

Most information about sources and health effects of biological pollutants is based on studies of large office buildings and two surveys of homes in northern U.S. and Canada. These surveys show that 30% to 50% of all structures have damp conditions which may encourage the growth and buildup of biological pollutants. This percentage is likely to be higher in warm, moist climates.

Some diseases or illnesses have been linked with biological pollutants in the indoor environment. However, many of them also have causes unrelated to the indoor environment. Therefore, we do not know how many health problems relate only to poor indoor air.

All of us are exposed to biological pollutants. However, the effects on our health depend upon the type and amount of biological pollution and the individual person. Some people do not experience health reactions from certain biological pollutants, while others may experience one or more of the following reactions:

- Allergic
- Infectious
- Toxic

Except for the spread of infections indoors, allergic reaction may be the most common health problem with indoor air quality in homes. They are often connected with animal dander (mostly from cats and dogs), with house dust mites (microscopic animals living in household dust), and with pollen. Allergic reactions can range from mildly uncomfortable to life-threatening, as in a severe asthma attack.

Health experts are especially concerned about people with asthma. These people have very sensitive airways that can react to various irritants, making breathing difficult. The number of people who have asthma has greatly increased in recent years. The number of people with asthma has gone up by 59 percent since 1970, to a total of 9.6 million people. Asthma in children under 15 years of age has increased 41 percent in the same period, to a total of 2.6 million children. The number of deaths from asthma is up by 68 percent since 1979, to a total of almost 4,400 deaths per year.

2.5 What are Allergies?

Allergy is defined as the acquired potential to develop immunologically mediated reactions to allergens (substances that are normally innocuous, such as pollen, mold spores, animal dander, dust mites, foods, insect venom, and drugs). Although the term “allergy” is often used to describe any type of immunologic reactivity, it refers in its strict sense only to the clinical expression of atopic disease mediated by immunoglobulin E (IgE) antibodies. However, in discussions of food allergy, latex allergy, and drug allergy, the term “allergy” is used to refer to all immune reactivity, not just IgE reactivity.

An allergy is sensitivity to a normally harmless substance, one that does not bother most people. The allergen (the foreign substance that provokes a reaction) can be a food, dust particles, a drug, insect venom, or mold spores, as well as pollen. Allergic people often have sensitivity to more than one substance.

Allergies reflect an overreaction of the immune system to substances that usually cause no reaction in most individuals. These substances can trigger sneezing, wheezing, coughing and itching. Allergies are not only bothersome, but many have been linked to a variety of common and serious chronic respiratory illnesses (such as sinusitis and asthma). Additionally, allergic reactions can be severe and even fatal. However, with proper management and patient education, allergic diseases can be controlled.

2.6 Common Allergic Diseases

2.6.1 Allergic rhinitis AR (hay fever or "indoor/outdoor," "seasonal," "perennial" or "nasal" allergies): Characterized by nasal stuffiness, sneezing, nasal itching, clear nasal discharge, and itching of the roof of the mouth and/or ears .

2.6.2 Allergic asthma (asthma symptoms triggered by an allergic reaction): Characterized by airway obstruction that is at least partially reversible with medication and is always associated with allergy. Symptoms include coughing, wheezing, shortness of breath or rapid breathing, chest tightness, and occasional fatigue and slight chest pain .

2.6.3 Food Allergy Most prevalent in very young children and frequently outgrown, food allergies are characterized by a broad range of allergic reactions. Symptoms may include itching or swelling of lips or tongue; tightness of the throat with hoarseness; nausea and vomiting; diarrhea; occasionally chest tightness and wheezing; itching of the eyes; decreased blood pressure or loss of consciousness and anaphylaxis .

2.6.4 Drug Allergy Is characterized by a variety of allergic responses affecting any tissue or organ. Drug allergies can cause anaphylaxis; even those patients who do not have life-threatening symptoms initially may progress to a life-threatening reaction .

2.6.5 Anaphylaxis (extreme response to a food or drug allergy): Characterized by life-threatening symptoms. This is a medical emergency and the most severe form of allergic reaction. Symptoms include a sense of impending doom; generalized warmth or flush; tingling of palms, soles of feet or lips; light-headedness; bloating and chest tightness. These can progress into seizures, cardiac arrhythmia, shock and respiratory distress. Possible causes can be medications, vaccines, food, latex, and insect stings and bites .

2.6.6 Latex Allergy An allergic response to the proteins in natural, latex rubber characterized by a range of allergic reactions. Persons at risk include healthcare workers, patients having multiple surgeries and rubber-industry workers. Symptoms include hand dermatitis, eczema and urticaria; sneezing and other respiratory distress; and lower respiratory problems including coughing, wheezing and shortness of breath .

2.6.7 Insect Sting/Bite Allergy Characterized by a variety of allergic reactions; stings cannot always be avoided and can happen to anyone. Symptoms include pain, itching and swelling at the sting site or over a larger area and can cause anaphylaxis. Insects that sting include bees, hornets, wasps, yellow jackets, and fire and harvest ants .

2.6.8 Urticaria (hives, skin allergy) A reaction of the skin, or a skin condition commonly known as hives Characterized by the development of itchy, raised white bumps on the skin surrounded by an area of red inflammation. Acute urticaria is often caused by an allergy to foods or medication .

2.6.9 Atopic Dermatitis (eczema, skin allergy) A chronic or recurrent inflammatory skin disease characterized by lesions, scaling and flaking; it is sometimes called eczema. In children, it may be aggravated by an allergy or irritant .

2.6.10 Contact Dermatitis (skin allergy) Characterized by skin inflammation; this is the most common occupational disease representing up to 40 percent of all occupational illnesses. Contact dermatitis is one of the most common skin diseases in adults. It results from the direct contact with an outside substance with the skin. There are currently about 3,000 known contact allergens .

2.6.11 Allergic Conjunctivitis (eye allergy) Characterized by inflammation of the eyes; it is the most common form of allergic eye disease. Symptoms can include itchy and watery eyes and lid distress. Allergic conjunctivitis is also commonly associated with the presence of other allergic diseases such as atopic dermatitis, allergic rhinitis and asthma.

2.7 What Causes Allergies

The substances that cause allergic disease in people are known as allergens. “Antigens or protein particles like pollen, food or dander enter our bodies through a variety of ways. If the antigen causes an allergic reaction, that particle is considered an “allergen” – and antigen that triggers an allergic reaction. These allergens can get into our body in several ways:

1. Inhaled into the nose and the lungs. Examples are airborne pollens of certain trees, grasses and weeds; house dust that include dust mite particles, mold spores, cat and dog dander and latex dust.

2. Ingested by mouth. Frequent culprits include shrimp, peanuts and other nuts.

3. Injected. Such as medications delivered by needle like penicillin or other inject able drugs, and venom from insect stings and bites.

4. Absorbed through the skin. Plants such as poison ivy, sumac and oak and latex are examples.

Plant pollens that are carried by the wind cause most allergies of the nose, eyes and lungs. These plants (including certain weeds, trees and grasses) are natural pollutants produced at various times of the year when their small, inconspicuous flowers discharge literally billions of pollen particles.

Because the particles can be carried significant distances, it is important for you not only to understand local environmental conditions, but also conditions over the broader area of the state or region in which you live. Unlike the wind-pollinated plants, conspicuous wild flowers or flowers used in most residential gardens are pollinated by bees, wasps, and other insects and therefore are not widely capable of producing allergic disease.

2.8 What is the Role of Heredity in Allergy?

Like baldness, height and eye color, the capacity to become allergic is an inherited characteristic. Yet, although you may be born with the genetic capability to become allergic, you are not automatically allergic to specific allergens.

Several factors must be present for allergic sensitivity to be developed:

1. The specific genes acquired from parents.
2. The exposure to one or more allergens to which you have a genetically programmed response.
3. The degree and length of exposure.

A baby born with the tendency to become allergic to cow's milk, for example, may show allergic symptoms several months after birth. A genetic capability to become allergic to cat dander may take three to four years of cat exposure before the person shows symptoms. These people may also become allergic to other environmental substances with age.

On the other hand, poison ivy allergy (contact dermatitis) is an example of an allergy in which hereditary background does not play a part. The person with poison ivy allergy first has to be exposed to the oil from the plant. This usually occurs during youth, when a rash does not always appear. However, the first exposure may sensitize or cause the person to become allergic and, when subsequent exposure takes place; a contact dermatitis rash appears and can be quite severe.

2.9 Why are some people allergic to substances while others are not?

Scientists think that people inherit a tendency to be allergic, although not to any specific allergen. Children of allergic parents are much more likely to develop allergies than other children. Even if only one parent has allergies, a child has a one in four chance of being allergic. Another factor in the development of allergies seems to be exposure to allergens at certain times when the body's defenses are lowered or weakened such as after a viral infection, during puberty, or during pregnancy. (However, some women find that during pregnancy their hay fever symptoms diminish.)

People with pollen allergies often develop sensitivities to other troublemakers that are present all year such as dust and mold. Year-round allergens like these cause perennial allergic rhinitis, as distinguished from seasonal allergic rhinitis, or hay fever.

Normally, the immune system functions as the body's defense against invading agents (bacteria and viruses, for instance). In most allergic reactions, however, the immune system is responding to a false alarm. When allergic persons first come into contact with an allergen, their immune systems treat the allergen as an invader and mobilize to attack. The immune system does this by generating large amounts of a type of antibody (a protein) called immunoglobulin E, or IgE. (Only small amounts of IgE are produced in no allergic people.) Each IgE antibody is specific for one particular allergen. In the case of pollen allergy, the antibody is specific for each type of pollen: one antibody may be produced to react against oak pollen and another against ragweed pollen, for example.

These IgE molecules attach themselves to the body's mast cells, which are tissue cells, and to basophiles, which are cells in the blood. When the enemy allergen next encounters the IgE, the allergen attaches to the antibody like a key fitting into a lock, signaling the cell to which the IgE is attached to release (and in some cases to produce) powerful inflammatory chemicals like histamines, prostaglandins, leukotrienes, and others. The effects of these chemicals on various parts of the body cause the symptoms of allergy.

Your body's immune system is designed to attack harmful substances, like bacteria and viruses. With allergies, your immune system attacks substances that are basically harmless -- such as pollen, mold, dust mites, pet dander, food, latex, and medications. Allergies can be caused by just about any substance that you inhale, swallow, or touch.

Allergies can cause a range of annoying symptoms, such as sneezing, runny nose, itchy skin, and itchy eyes. Allergies can aggravate or trigger other conditions, such as asthma, sinusitis, and ear infections.

2.10 Overview of allergic diseases

2.10.1 Epidemiology

The prevalence of allergic diseases such as AR and atopic dermatitis has risen substantially in recent decades. (6, 7) AR alone is believed to affect almost 40 million Americans, including 20% of all adults and up to 40% of children (8, 9, 10) The costs associated with allergic disease are extraordinarily high: one analysis estimated it at $7.9 billion per year, of which $4.5 billion was spent on direct care and $3.4 billion on indirect costs, related primarily to lost work productivity

2.10.2 Impact on Productivity

Of all the allergic disorders, AR probably has the greatest impact on productivity, because it tends to be a lifelong condition, because the causative allergens are usually difficult or impossible to avoid, and because of its pathophysiologic relationship to asthma. Although AR often begins in childhood, its highest prevalence is between the ages of 18 and 49—the peak career-building, child-rearing years. (11). In addition to millions of days of workplace absence each year, AR causes about 28 million days of restricted work activity. The side effects of some allergy therapies can detract even further from workplace performance.

On any given day, 10,000 American children miss school because of AR, for an annual total of 2 million lost school days.(12) Even when they are in school, children with AR often have trouble concentrating or even staying awake because of the symptoms themselves and because of treatment-related drowsiness.(13)

One study of decreased productivity related to the sedating effects of traditional (or first-generation) antihistamines estimated the costs at $4 billion per year. AR also affects classroom productivity and functioning in children, chiefly because of school absences. In fact, AR and asthma are the 2 leading causes of absenteeism due to chronic illness. (14)

In a study comparing children without allergies, children with inactive allergies, and children with active AR, the latter group was found to have poorer short-term memory, impaired ability to acquire knowledge, reduced ability to apply knowledge, and shortened attention span.(14)

In another study, children with AR performed significantly worse academically than did non allergic children. Treatment with one of the newer (or second-generation) non sedating antihistamines elevated their performance to nearly that of non allergic children, whereas treatment with a first-generation antihistamine worsened their performance even further. (15)

While some evidence shows that first-generation agents impair scholastic performance and second-generation agents do not,(16) one trial by Bender and colleagues found no differences between placebo, a first-generation antihistamine, and a second-generation antihistamine in learning ability, reaction time, or self-reported somnolence in children with a history of seasonal AR.(17)

Urticaria is also associated with reduced productivity. For example, a study of 170 consecutive patients with various forms of urticaria found that 50% of those with delayed-pressure urticaria and 26% of those with chronic idiopathic urticaria had taken time off from work during the preceding week because of their condition. (18)

2.10.3 Impact on Quality of Life

Like productivity, quality of life (QOL) is affected adversely by allergic disease. (19,20) In a cross sectional study comparing QOL in 111 adults with AR and 116 control subjects, those with AR had lower scores on all of the 9 domains measured, including social functioning, role limitations, mental health, energy/fatigue, and pain; the difference was highly significant ($P<.0001$) in 8 of the 9 domains.(21)

In a separate study of 142 patients with chronic urticaria, QOL scores were almost identical to those of patients with coronary heart disease in terms of low energy levels, feelings of social isolation, and emotional distress. (22)

Allergies also affect QOL for younger patients. In a study of 18 adolescents, those with AR reported difficulty concentrating and doing schoolwork, feeling tired and worn out, accomplishing less than their peers, and feeling irritable and generally unwell. (20) Because of the discomfort caused by their symptoms, children and adolescents with allergies may be more likely than their non allergic peers to be unresponsive, apathetic, irritable, and uninterested in activities. These behaviors are so common in allergic children that the term “allergic irritability” has been coined to describe them. (14)

The QOL deficits caused by allergic disease can be alleviated or worsened by treatment, depending on the choice of therapy. For example, a number of studies have concluded that the adverse effects of first generation antihistamines worsen QOL for patients with AR, whereas second-generation antihistamines and intranasal corticosteroids significantly improve it. (19, 20, 21, 22)

2.11 Pathophysiology of allergic reaction

In atopic individuals, exposure to an antigen (allergen) sets off an immune-mediated cascade of inflammatory events that result in the classic symptoms of allergic disease. The process begins with the first exposure to the antigen, which is broken down into smaller peptides by antigen presenting cells. The peptides are presented to T cells, which secrete cytokines that induce B cells to produce antigen-specific (IgE). These IgE molecules then bind to high-affinity FcεRI receptors on basophils and/or mast cells. This step is described as sensitization.(23)

When a sensitized individual next encounters the same allergen, the allergen cross-links the IgE molecules bound to mast cells and basophils, activating them and causing them to release inflammatory mediators such as histamine, prostaglandins, and leukotrienes (24).

This step, called the immediate hypersensitivity or early phase reaction, occurs within minutes of re exposure to the allergen. (23)

Histamine is the most well studied of these mediators: its activation of the H1 class of histamine receptors causes certain smooth muscles to contract, stimulates sensory nerves, and increases mucus secretion and vascular permeability, resulting in fluid leakage and tissue edema (25).

This pathophysiologic reaction is the same regardless of the type of allergy; the clinical symptoms are determined by the nature of the allergen and the site of its effect. With an inhaled allergen, the affected site is the upper airway, and the response manifests as sneezing, nasal itching, congestion, and rhinorrhea.(23) With an ingested allergen, the affected site is the gut, and the response manifests as bloating, cramping, nausea, vomiting, and diarrhea.(26)

Many patients also have a late-phase reaction, which generally begins 2 to 6 hours (even later in some patients) after allergen exposure and is often more severe and prolonged than the immediate-phase reaction. During this phase, cytokine and chemokine gene induction leads to the accumulation of inflammatory leukocytes, including neutrophils, basophils, eosinophils, and T cells. The consequences are inflammation, swelling, mucus hypersecretion, and airway hyper responsiveness, this phase can persist for up to 24 hours before receding.(23)

As noted above, allergic reactions are strictly defined only as those mediated by IgE. However, certain disorders such as allergic contact dermatitis are loosely described as allergic reactions even though they are mediated by T cells and other pathways. A single allergic disease may involve more than one immunologic mechanism

2.12 New and future approaches to allergy management

Recent advances in the understanding of immune mechanisms, including mast cell activation, lymphocyte stimulation, inflammatory cell recruitment, and the actions of cytokines and chemokines, have provided new targets for the treatment of allergic diseases. For example, a monoclonal antibody directed against IgE has been shown to reduce serum IgE levels effectively and to reduce the symptoms of allergic rhinitis and allergic asthma. It has also been shown to increase the threshold of sensitivity to peanuts in allergic patients significantly, to a level that could protect against some unintended ingestions.(27)

2.13 Current issues in allergy management

There are several issues that the clinician must consider in managing allergy in today's healthcare environment. Among them are the role of alternative medicine, the impact of adverse effects on adherence, and strategies for supporting long-term acceptance of treatment. The role of Complementary and Alternative Medicine (CAM) and the use of complementary or alternative medicine, including a broad range of herbal and botanical agents, has burgeoned in the United States in recent years. Estimates are that in 1997, some 83 million people used alternative agents to treat their symptoms, spending in excess of $27 billion for these self-pay therapies—more than the out-of-pocket costs for all stays in American hospitals.(28) Allergy is second only to back pain as the most common chronic condition for which people seek alternative therapies.(29)

In a 2001 survey of 300 adults with rhinosinusitis or asthma, 127 respondents (42%) reported using a complementary or alternative agent during the previous year; of these, 33 subjects (26%) were not using any prescription medication.(29)

Although there are some data to support the use of some alternative agents in the treatment of AR, well controlled, rigorously designed research is scarce.(29). Despite the lack of evidence, many patients mistakenly believe that these agents are safe because they are derived from plants. In fact, the chemical composition of flowering and herbal plants is complex, and many are toxic.(29) Moreover, the manufacture of these agents is largely unregulated; there are no standards to ensure their potency or purity.(29)

Patients who perceive benefits from using these agents are likely to continue using them and will distrust physicians who simply instruct them to discontinue use. Unless the CAM product is clearly dangerous, the healthcare provider should instead seek opportunities to initiate a nonjudgmental dialogue about it and provide balanced education and information.

2.14 Allergy-Related Conditions

If you have allergies, you may find that they affect your body in different ways. Allergy-related conditions generally involve the head (eyes, nose, mouth, throat, and ears), the lungs, GI tract, and/or the skin, all of which are involved in the body's frontline of defending itself from foreign substances. Different allergy-related conditions may occur together because they involve shared passageways in the upper respiratory tract. Also, people with allergies are more likely to have more than one of these conditions because of their hypersensitive immune system.

Nasal allergies, Allergic rhinitis, Hay fever, Seasonal allergic rhinitis, Perennial allergic rhinitis, Pollen allergy, House dust allergy, Pet allergies, and Mold allergies. Children with such allergies tend to get more ear infections, more colds, and have more sleepless nights than their peers. Far too often, the underlying allergies are missed and children are treated for each symptom as it occurs.(30)

The lining of our noses contains tiny guardians called mast cells, whose purpose is to protect us from harmful particles in the air we breathe. People with allergies have hypersensitive mast cells that sound the alert in response to relatively harmless particles such as pollen, dust, or pet dander. When pollen sticks to the membrane of a mast cell of someone with pollen allergies, the cell begins to swell and swell. Finally the mast cell bursts, spilling histamine and many other potent chemicals into the surrounding tissue. These produce the sneezing, swelling, itching, and congestion associated with allergies.(30)

Developing allergies involves a genetic and an environmental component. Allergies tend to run in families. Asthma, eczema (atopic dermatitis), and allergic rhinitis (hay fever) often occur in the same families. Boys, firstborn children, those with eczema, those with food allergies, and those whose parents have nasal allergies are all more likely to develop nasal allergies. Early wheezing does not appear to increase the chances. .(30)

The environment also makes a difference. Allergic rhinitis is an over-exuberant response to substances in the environment. Both too much and too little immune response is unhealthy. Experiences in early childhood can teach the body to set the level of immune protection 'just right'.(30)

Children who are raised on a farm have a significantly reduced risk of asthma, eczema, and hay fever. Children in day care, those with older siblings, those with pets, and those who get plenty of colds are also less likely to develop nasal allergies. Parents are often told that their children are too young to have allergies. While allergies do become more common from ages 2 to 7, they certainly can be present earlier.(31)

Nasal allergies typically feature a clear nasal discharge with sneezing. There may be itchy, watery eyes and/or a dry cough. The "allergic salute" -- rubbing the nose with the hand, sometimes leaving a horizontal crease on the nose -- is another common sign. "Allergic shiners" -- dark circles under the eyes -- have long been associated with allergies, but are less predictive than the other symptoms. The symptoms tend to be seasonal if exposure to the triggers is seasonal (pollen), and year-round if the exposure is year round (pets). While some children outgrow nasal allergies on their own, most will continue to have nasal allergies unless they are treated with immunotherapy. (31)

A careful allergy history and physical exam will usually point to the right diagnosis. Looking at a swab of the nasal secretions under the microscope can confirm the diagnosis. Common triggers include pollens, molds, house dust mites, and animal dander (their shed skin cells, not their hair or fur!). Identifying your child's specific triggers can be very important. This can be accomplished with skin testing or with a blood test .(31)

In infants, a positive result with either test is likely to indicate a real allergy, but a negative test does not give much information. In older children, the opposite tends to be true. A negative test tends to rule out an allergy, while a positive test does not prove one. (31)

Most people think of specific allergies as black and white -- something you either have or you don't. The truth is much more complex. Being allergic to something is a continuum and that continuum changes over time. Most, but not all, food allergies get better over time. Most airborne allergies get more common as children get older. Some allergies peak before puberty and then disappear. Others don't even begin until puberty is over. Most people who do get tested for allergies have a single round of skin testing. This can provide a valuable snapshot of allergies at a single moment in time, but this just 'scratches the surface' of a child's long-term allergy story.(31)

2.15 Description and Diagnosis of AR

AR is an IgE-mediated reaction of the nasal mucosa in which the effects of histamine and other mediators on sensory nerves cause sneezing and itching, and the effects on vascular permeability and mucus secretion result in congestion and rhinorrhea.(33)

Repeated allergen exposure makes the nasal mucosa hypersensitive, so symptoms occur not only in response to low levels of allergen but also to nonspecific irritants such as tobacco smoke and perfume.(34)

Diagnosis of allergy rests primarily on the medical history and physical examination; in most cases, the results of skin and serologic testing merely confirm the clinician's suspicions and are used mainly to identify unsuspected allergens and guide the approach to immunotherapy if indicated. The allergens most often implicated in seasonal AR are grass, tree, and weed pollens and fungal spores,(35) and those implicated in perennial AR are usually house-dust mites, animal dander, mold, and cockroach allergens.(36)

Seasonal (intermittent) AR is characterized by watery rhinorrhea; repetitive sneezing; pruritus of the eyes, ears, nose, and throat; watery eyes; and nasal congestion. Perennial (persistent) AR has similar symptoms but is occasionally associated with more severe nasal congestion. Many patients have perennial AR with seasonal exacerbations, and in areas of the country in which climate and flora change minimally from season to season, there is little meaningful difference between seasonal and perennial disease.(37)

A thorough evaluation of AR includes checking for the presence of common comorbidities such as asthma, sinusitis, and otitis media. Growing evidence suggests that these conditions co-occur so often because AR plays a causative role. For example, intranasal challenge with relevant allergens in adult humans with AR and in sensitized monkeys produces classic AR symptoms along with eustachian tube dysfunction; by contrast, these symptoms are not produced by challenging subjects with allergens to which they are not sensitized or by challenging subjects with nonallergic rhinitis (38). For patients with both AR and asthma, treating the allergies with oral antihistamines or topical steroids improves pulmonary function and airway symptoms as well. However, treatment of asthma usually requires therapy beyond treatment of the associated AR.(39)

Conjunctivitis is a common feature of allergic disease, although it also can be caused by infections or hormonal changes. The most common complaint of patients with allergic rhinoconjunctivitis is watery or itchy eyes; ocular symptoms such as redness, soreness, stinging, or swelling also occur albeit less frequently.(40) In contrast, ocular pain and photophobia generally point to other diagnoses. Redness of the eyes can be a sign of allergy, or it may indicate conjunctivitis, corneal disorders, acute glaucoma, or acute uveitis

2.16 Prevention and Treatment of AR

As with all types of allergic disease, management of AR has 4 key components: allergen avoidance, systemic pharmacotherapy, topical pharmacotherapy, and immunotherapy. Proactive patient education and regular reinforcement are the foundation of each of these components. Patients and their families should be given written and verbal instructions on avoidance measures, when and how to use their medications, and what circumstances warrant an office or emergency room visit. For children with severe or life-threatening allergies, education should be extended to all caregivers, including school personnel.(45)

Allergen avoidance is a crucial step in allergy management and in reducing the need for pharmacologic intervention. Although it is very difficult to avoid completely the pollens, molds, and dust mites that cause most cases of respiratory allergy, conscientious use of environmental control measures can reduce allergen exposure considerably and should be recommended whenever feasible .(46)

Recent evidence suggests that primary prevention may be possible in infants who are at risk of developing allergies and asthma. For example, one study followed the infants of 291 couples in which both parents were atopic. The families were prenatally randomized into 2 groups: One implemented environmental measures to reduce prenatal and postnatal allergen exposure, and the other received no intervention. By 1 year of age, respiratory symptoms such as wheezing and use of medication for wheezing were significantly less common in the allergen-avoidance group than in the control group (30). Other evidence suggests that primary prevention of food allergies may be achieved by the mother's avoiding allergenic foods while breastfeeding and by delaying the introduction of solid foods to the child.31 Similarly, avoidance of food allergens and dust mites in infancy has been shown to significantly reduce the incidence of allergy and eczema at the age of 2 years in high-risk children.32 In one study, treating pregnant women and subsequently their infants with cultures of Lactobacillus GG halved the incidence of atopic eczema in the children compared with placebo-treated children.33 However, these types of trials are in their early stages, and more information is needed before there is general implementation of the approaches that have been evaluated.(32)

2.17 Asthma

Asthma is one of the most common disorders affecting children. As many as 10 percent of children have some degree of asthma, and the number has been rising steadily since about 1980. Thankfully, advances in the diagnosis and treatment of asthma have dramatically improved life for these children.(32)

Asthma is a chronic lung disease characterized by tight airways -- a result of airway hyper-responsiveness. Our airways are designed to be responsive to harmful substances in the air. If we walk through clouds of smoke, our airways will shrink, protecting our delicate lung tissues from the noxious ingredients in the smoke. They should return to normal when we begin to breathe fresh air. People with asthma have an exaggerated tightening response.(32)

Different people with asthma respond to different "triggers." Viral infections are the most common triggers in young children. Other triggers include smoke, animal dander, pollens, molds, house dust mites, fumes and fragrances, or cold air.

When we exercise, we breathe rapidly and are unable to bring air temperature all the way up to 98.6 degrees -- particularly if we breathe through the mouth. Thus, asthmatics who are sensitive to cold air will often wheeze with exercise. (Wheezing, the classic asthma symptom, is the noise made by air moving through these tight airways.) Because asthmatics respond differently to different triggers, their airways are tighter at some times than at others.(32)

Hyper-responsive airways tighten in three ways in response to triggers. First and most immediately, smooth muscle surrounding the airways constricts, narrowing the caliber of the airways. Second, the airways are narrowed by inflammation and swelling of the airway lining. This leads to the third component of airway narrowing, which is the accumulation of mucus and other fluids, which can plug the airways. The inflammation is the most important part of the disease. It perpetuates the cycle of airway narrowing. It also is the slowest to respond to treatment.

The risk of getting asthma depends both on genetics and on the environment. Asthma tends to run in families (along with eczema and hay fever). It is more common in premature infants and in those who have had bronchitis. Those who are obese are at much higher risk.(32)

Although wheezing (a tight noise when breathing out) is the classic symptom of asthma, many children's major symptom is a cough. The cough is nonproductive and often sounds tight. It tends to get worse at night, with exercise, or after being exposed to a trigger (e.g. cigarette smoke, animal dander, or house dust). Children with asthma often have a prominent cough when they catch a cold. Some children with asthma have wheezing with no cough; some have cough with no audible wheezing; and some have both.(32

As the airways narrow, breathing becomes faster. The child might have to work hard to breathe, as evidenced by grunting, flaring of the nostrils, or pulling in of the muscles between the ribs. The shortness of breath may exhaust the child, who becomes slow moving and talks only with difficulty.

2.18 Childhood Asthma

Today, millions of children have some form of bronchial asthma. Childhood asthma is considered one of the two most common pediatric ailments for hospital admission. Asthma is defined as a reversible obstructive airway disease. It is comforting to know that, with proper management, the symptoms of asthma are not permanent and that no lasting lung damage results from asthma attacks.(33)

As many as 90 percent of children with asthma have allergies. The allergens to which they are sensitized are primarily those which can be inhaled (including dust mite allergen, animal dander, and indoor mold). Taking steps to avoid or eliminate these allergens can lessen asthma symptoms, even for those with a severe case of asthma. Assured that you are taking care of this allergy in the most natural and safest way.(34)

Many children with asthma will outgrow it. The older children are when they start wheezing, the more likely they are to wheeze as adults. According to a study published in the January 2002 issue of the *American Journal of Respiratory and Critical Care Medicine*, wheezing in children before their second birthdays does not appear to make them any more likely than others to have asthma as adults - even among children who are at high risk for asthma and allergies. In this study, children with a strong family history of asthma and/or hay fever were followed from birth to age 22. Most children who wheezed as toddlers outgrew it before age 11, but among those who wheezed before age 2, 38 percent went on to eventually develop asthma. However, the same percentage of those who did not wheeze as infants, toddlers, or preschoolers also went on to develop asthma. Early wheezing does not seem to make a difference (35)

Asthma is sometimes diagnosed based on the history and physical exam. Recurrent episodes of coughing or wheezing are suggestive, especially if they follow exposure to asthma triggers and respond to asthma medications. Pulmonary function testing can confirm the diagnosis, if necessary.(34)

Breastfeeding reduces the risk of asthma. Many people underestimate the impact of nasal allergies, or allergic rhinitis. While only about 16 percent of those with allergies go on to develop asthma (as compared to 1 percent in the general population), 80 to 90 percent of people with asthma develop allergies first or at the same time. These allergies may be seasonal (pollen allergies) or year-round (dust allergies).(33)

2.19 Mold Allergy

Along with pollens from trees, grasses, and weeds, molds are an important cause of seasonal allergic rhinitis. People allergic to molds may have symptoms from spring to late fall. The mold season often peaks from July to late summer. Unlike pollens, molds may persist after the first killing frost. Some can grow at subfreezing temperatures, but most become dormant. Snow cover lowers the outdoor mold count dramatically but does not kill molds. After the spring thaw, molds thrive on the vegetation that has been killed by the winter cold.(47)

In the warmest areas of the United States, however, molds thrive all year and can cause year-round (perennial) allergic problems. In addition, molds growing indoors can cause perennial allergic rhinitis even in the coldest climates .When inhaled, microscopic fungal spores or, sometimes, fragments of fungi may cause allergic rhinitis. Because they are so small, mold spores may evade the protective mechanisms of the nose and upper respiratory tract to reach the lungs.(47)

In a small number of people, symptoms of mold allergy may be brought on or worsened by eating certain foods, such as cheeses, processed with fungi.

Occasionally, mushrooms, dried fruits, and foods containing yeast, soy sauce, or vinegar will produce allergic symptoms. There is no known relationship, however, between a respiratory allergy to the mold Penicillium and an allergy to the drug penicillin, made from the mold.

2.20 What is mold?

There are thousands of types of molds and yeast, the two groups of plants in the fungus family. Yeasts are single cells that divide to form clusters. Molds consist of many cells that grow as branching threads called hyphae. Although both groups can probably cause allergic reactions, only a small number of molds are widely recognized offenders.

The seeds or reproductive particles of fungi are called spores. They differ in size, shape, and color among species. Each spore that germinates can give rise to new mold growth, which in turn can produce millions of spores.

Molds are simple, microscopic organisms whose purpose in the ecosystem is to break down dead materials. Molds can be found on plants, dry leaves, and on just about every other organic material. Some molds are useful, such as those used to make antibiotics and cheese. Some molds are known to be highly toxic when ingested, such as the types that invade grains and peanuts. Most of the mold found indoors comes from outdoors.

Molds reproduce by very tiny particles called spores. The spores float in on the air currents and find a suitable spot to grow. Spores are very light and can travel on air currents. If mold spores land on a suitable surface, they will begin to grow.

Molds need three things to thrive- moisture, food and a surface to grow on. Molds can be seen throughout the house, and can be found in most bathrooms. Mold growth can often be seen in the form of discoloration, and can appear in many colors-white, orange, pink, blue, green, black or brown. When molds are present in large quantities (called colonies) they can cause health problems in some people.

Molds can be found wherever there is moisture, oxygen, and a source of the few other chemicals they need. In the fall they grow on rotting logs and fallen leaves, especially in moist, shady areas. In gardens, they can be found in compost piles and on certain grasses and weeds. Some molds attach to grains such as wheat, oats, barley, and corn, making farms, grain bins, and silos likely places to find mold.

Hot spots of mold growth in the home include damp basements and closets, bathrooms (especially shower stalls), places where fresh food is stored, refrigerator drip trays, house plants, air conditioners, humidifiers, garbage pails, mattresses, upholstered furniture, and old foam rubber pillows.

2.21 Which molds are allergenic?

Like pollens, mold spores are important airborne allergens only if they are abundant, easily carried by air currents, and allergenic in their chemical makeup. Found almost everywhere, mold spores in some areas are so numerous they often outnumber the pollens in the air.(48)

In general, *Alternaria* and *Cladosporium (Hormodendrum)* are the molds most commonly found both indoors and outdoors throughout the United States. *Aspergillus*, *Penicillium*, *Helminthosporium*, *Epicoccum*, *Fusarium*, *Mucor*, *Rhizopus*, and *Aureobasidium (Pullularia)* are also common.(49)

2.22 Fungal Species and Disease potential

Acremonium Mycetoma (colonization of tissue/bone), onychomycosis (colonization of nail), mycotic keratitis, allergen. Can cause a number of different disease types immunocompromised individuals.

Alternaria Cutaneous phaeohyphomycosis (colonization of skin), potent allergen (common cause of extrinsic asthma) . Can cause deep tissue infections in immunocompromised individuals.

Aspergillus Aspergilliosis (pulmonary allergic and colonizing), disseminated, central nervous system, cutaneous, nasal--orbital, and iatrogenic), potent allergen. Causes a number of different disease types in immunocompromised individuals**.**

Aureobasidi Cutaneous phaeohyphomycosis, invasive disease in immunocompromised individuals.

Bipolaris Pansinusitis, meningoencephalitis, chronic pulmonary disease.

Cladosporium Cutaneous phaeohyphomycosis, chromoblastomycosis (subcutaneous skin infections), mycotic keratitis, potent allergen.

Coccodinium No information.

Fusarium Invasive cutaneous infection (erythematous lesions and nodules), systemic granulamatous disease, allergen.

Gibberella Stalk rot, corn ear rot, Bakanae disease.

Nigrospora Allergen.

Pae- Mycotic keratitis paecilomycosis , pneumonia, allergen.

Penicillium Bronchopulmonary penicilliosis, potent allergen (hypersensitivity and allergic alveolitis).

Pleospora Leaf spot. Species can produce mycotoxins toxic to certain plants (e.g., the opium poppy).

Scopulariopsis Pneumonia in immunocompromised individuals, rare subcutaneous and pulmonary cases, associated with Type III allergy.

Trichophyton Dermatophytosis, allergen.(49)

Table (2.1) shows Fungal Species Capable of Affecting Humans and Plants. Identified in Samples of Atmospheric Desert Dust

Acremonium	Human	Wide distribution. Common in soil, on plants, and indoors.
Alternaria	Human and plant	Wide distribution. Common in soil, on plants, and indoors.
Aspergillus	Human, animal, and insect	Wide distribution. Common in soil, organic detritus, and indoors.
Aureobasidi-	Human and plant	Found in temperate areas. Common on plant tissue and indoors.

Bipolaris	Human and plant	Wide distribution. Common plants and indoors.
Cladosporium	Human and plant	Wide distribution. Most commonly isolated fungi in outdoor studies**.**
Coccodinium	Unknown	Found in tropical air samples.
Fusarium	Human and plant	Wide distribution. Common isolate in soil and indoors.
Gibberella	Plant	Wide distribution.
Microsporum	Human and animal	Wide distribution. Common in soil, organic detritus, and indoors.
Pae-	Human and insect	Wide distribution. Common in soil, organic detritus, and indoors.
Penicillium	Human	Wide distribution. Very common in temperate regions. Common in soils and indoors.
Pleospora	Plant	Wide distribution.
Scopulariopsis	Human and insect	Wide distribution. Common in soils and indoors.
Trichophyton	Human and animal	Wide distribution. Common in soils and indoors.

.(49)

2.23 Molds in the Environment

Molds live in the soil, on plants, and on dead or decaying matter. Outdoors, molds play a key role in the breakdown of leaves, wood, and other plant debris. Molds belong to the kingdom Fungi, and unlike plants, they lack chlorophyll and must survive by digesting plant materials, using plant and other organic materials for food. Without molds, our environment would be overwhelmed with large amounts of dead plant matter.

Molds produce tiny spores to reproduce, just as some plants produce seeds. These mold spores can be found in both indoor and outdoor air, and settled on indoor and outdoor surfaces. When mold spores land on a damp spot, they may begin growing and digesting whatever they are growing on in order to survive. Since molds gradually destroy the things they grow on, you can prevent damage to building materials and furnishings and save money by eliminating mold growth.

Moisture control is the key to mold control. Molds need both food and water to survive; since molds can digest most things, water is the factor that limits mold growth. Molds will often grow in damp or wet areas indoors. Common sites for indoor mold growth include bathroom tile, basement walls, areas around windows where moisture condenses, and near leaky water fountains or sinks. Common sources or causes of water or moisture problems include roof leaks, deferred maintenance, condensation associated with high humidity or cold spots in the building, localized flooding due to plumbing failures or heavy rains, slow leaks in plumbing fixtures, and malfunction or poor design of humidification systems. Uncontrolled humidity can also be a source of moisture leading to mold growth, particularly in hot, humid climates

2.24 Health effects & symptoms associated with mold exposure

When moisture problems occur and mold growth results, building occupants may begin to report odors and a variety of health problems, such as headaches, breathing difficulties, skin irritation, allergic reactions, and aggravation of asthma symptoms; all of these symptoms could potentially be associated with mold exposure.

All molds have the potential to cause health effects. Molds produce allergens, irritants, and in some cases, toxins that may cause reactions in humans. The types and severity of symptoms depend, in part, on the types of mold present, the extent of an individual's exposure, the ages of the individuals, and their existing sensitivities or allergies.

2.25 Specific reactions to mold growth:

2.25.1Allergic Reactions

Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Allergic reactions to mold are common - these reactions can be immediate or delayed. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes, and skin rash (dermatitis). Mold spores and fragments can produce allergic reactions in sensitive individuals regardless of whether the mold is dead or alive. Repeated or single exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive. Repeated exposure has the potential to increase sensitivity.(49)

2.25.2 Asthma

Molds can trigger asthma attacks in persons who are allergic (sensitized) to molds. The irritants produced by molds may also worsen asthma in non-allergic (non-sensitized) people.(49)

2.25.3 Hypersensitivity Pneumonitis

Hypersensitivity pneumonitis may develop following either short-term (acute) or long-term (chronic) exposure to molds. The disease resembles bacterial pneumonia and isuncommon.(49)

2.25.4 Irritant Effects

Mold exposure can cause irritation of the eyes, skin, nose, throat, and lungs, and sometimes can create a burning sensation in these areas.(49)

2.25.5 Opportunistic Infections

People with weakened immune systems (i.e., immune-compromised or immune-suppressed individuals) may be more vulnerable to infections by molds (as well as more vulnerable than healthy persons to mold toxins). *Aspergillus fumigatus*, for example, has been known to infect the lungs of immune-compromised individuals. These individuals inhale the mold spores which then start growing in their lungs. *Trichoderma* has also been known to infect immune-compromised children.

Healthy individuals are usually not vulnerable to opportunistic infections from airborne mold exposure. However, molds can cause common skin diseases, such as athlete's foot, as well as other infections such as yeast infections.(49)

2.25.6 Mold Toxins (Mycotoxins)

Molds can produce toxic substances called mycotoxins. Some mycotoxins cling to the surface of mold spores; others may be found within spores. More than 200 mycotoxins have been identified from common molds, and many more remain to be identified. Some of the molds that are known to produce mycotoxins are commonly found in moisture-damaged buildings. Exposure pathways for mycotoxins can include inhalation, ingestion, or skin contact. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available.(49)

Aflatoxin B_1 is perhaps the most well known and studied mycotoxin. It can be produced by the molds *Aspergillus flavus* and *Aspergillus parasiticus* is one of the most potent carcinogens known. Ingestion of aflatoxin B_1 can cause liver cancer. There is also some evidence that inhalation of aflatoxin B_1 can cause lung cancer. Aflatoxin B_1 has been found on contaminated grains, peanuts, and other human and animal foodstuffs. However, *Aspergillus flavus* and *Aspergillus parasiticus* are *not* commonly found on building materials or in indoor environments.(49)

Much of the information on the human health effects of inhalation exposure to mycotoxins comes from studies done in the workplace and some case studies or case reports.

Many symptoms and human health effects attributed to inhalation of mycotoxins have been reported including: mucous membrane irritation, skin rash, nausea, immune system suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects, and cancer. More studies are needed to get a clear picture of the health effects related to most mycotoxins.

However, it is clearly prudent to avoid exposure to molds and mycotoxins.(49)

Some molds can produce several toxins, and some molds produce mycotoxins only under certain environmental conditions. The presence of mold in a building does not necessarily mean that mycotoxins are present or that they are present in large quantities.

Information on ingestion exposure, for both humans and animals, is more abundant -- wide range of health effects has been reported following ingestion of moldy foods including liver damage, nervous system damage, and immunological effects.

2.25.7 Microbial Volatile Organic Compounds (MVOCs)

Some compounds produced by molds are volatile and are released directly into the air. These are known as microbial volatile organic compounds (MVOCs). Because these compounds often have strong and/or unpleasant odors, they can be the source of odors associated with molds. Exposure to MVOCs from molds has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue, and nausea. Research on MVOCs is still in the early phase.(49)

2.25.8 Glucans or Fungal Cell Wall Components (also known as ß-(1-->3)-D- Glucans)

Glucans are small pieces of the cell walls of molds which may cause inflammatory lung and airway reactions. These glucans can affect the immune system when inhaled. Exposure to very high levels of glucans or dust mixtures including glucans may cause a flu-like illness known as Organic Dust Toxic Syndrome (ODTS). This illness has been primarily noted in agricultural and manufacturing settings.(49)

2.26 Mold Spores

Mold spores are microscopic (2-10 *u*m) and are naturally present in both indoor and outdoor air. Molds reproduce by means of spores. Some molds have spores that are easily disturbed and waft into the air and settle repeatedly with each disturbance. Other molds have sticky spores that will cling to surfaces and are dislodged by brushing against them or by other direct contact. Spores may remain able to grow for years after they are produced. In addition, whether or not the spores are alive, the allergens in and on them may remain allergenic for years.(50)

Similar to pollen counts, mold counts may suggest the types and relative quantities of fungi present at a certain time and place. For several reasons, however, these counts probably cannot be used as a constant guide for daily activities. One reason is that the number and types of spores actually present in the mold count may have changed considerably in 24 hours because weather and spore dispersal are directly related. Many of the common allergenic molds are of the dry spore type -- they release their spores during dry, windy weather. Other fungi need high humidity, fog, or dew to release their spores. Although rain washes many larger spores out of the air, it also causes some smaller spores to be shot into the air.(50)

In addition to the effect of day-to-day weather changes on mold counts, spore populations may also differ between day and night. Day favors dispersal by dry spore types and night favors wet spore types.

2.27 Aspergillus species

Aspergillus is the most common genus of fungi in our environment with more than 160 different species of mold. Sixteen of these species have been documented as causing human disease. Aspergillosis is now the 2nd most common fungal infection requiring hospitalization in the United States.(50)

2.27.1 Aspergillus fumigatus. The most encountered species causing infection. It is seen abundantly in decomposing organic material, such as self-heating compost piles, since it readily grows at temperatures up to 55 C. People who handle contaminated material often develop hypersensitivity to the spores of Aspergillus and may suffer severe allergic reactions upon exposure.(50)

2.27.2 Aspergillus flavus. The 2nd most encountered fungi in cases of Aspergillus infection. It is also known to produce the mycotoxin aflatoxin, one of the most potent carcinogens known to man. In the 1960s, 100,000 turkey poults in Great Britain died from ingesting contaminated feed. Most countries have established levels for aflatoxin in food. However, the risks associated with airborne exposure are not adequately studied and no exposure standards exist.(50)

2.27.3 Aspergillus niger. The 3rd most common Aspergillus fungi associated with disease and the most common of any Aspergillus species in nature due to it's ability to grow on a wide variety of substrates. This species may cause a "fungal ball", which is a condition where the fungus actively proliferates in the human lung, forming a ball. It does so without invading the lung tissue. .(50)

2.28 Stachybotrys chartarum (atra)

This group of molds can thrive on water damaged, cellulose-rich material in buildings such as sheet rock, paper, ceiling tiles, insulation backing, wallpaper, etc. In the majority of cases where Stachybotrys is found indoors, water damage has gone unnoticed or ignored since it requires extended periods of time with increased levels of moisture for growth to occur. Stachybotrys is usually black and slimy in appearance. Events of water intrusion that are addressed quickly tends to support the growth of more xerophilic fungi such as Pencillium and Aspergillus.(50)

Stachybotrys is another fungi that has the ability to produce mycotoxins, ones that are extremely toxic, suspected carcinogens, and immunosuppressive. Exposure to these mycotoxins can result through inhalation, ingestion, and dermal exposure. Symptoms of exposure include dermatitis, cough, rhinitis, nose bleeds, cold and flu-like symptoms, headache, general malaise, and fever.(50)

2.29 Cladosporium species

These genera of mold are pigmented dark green to black in the front, and black on the reverse with a velvety to powdery texture. One of the most commonly isolated from indoor and outdoor air, Cladosporium spp. are found on decaying plants, woody plants, food, straw, soil, paint, textiles, and the surface of fiberglass duct liner in the interior of supply ducts.(50)

There are over 30 species in the Cladosporium genus. The most common are C. elatum, C. herbarum, C. sphaerospermum, and C. cladosporioides. These fungi are the causative agents of skin lesions, keratitis, nail fungus, sinusitis, asthma, and pulmonary infections. Acute symptoms of exposure to Cladosporium are edema and bronchiospasms, and chronic exposure may lead to pulmonary emphysema.(50)

2.30 Fusarium species

A common soil fungus and inhabitant on a wide array of plants, this fungi is often found in humidifiers and has been isolated from water-damaged carpets and a variety of other building materials. Human exposure may occur through ingestion of contaminated grains and possibly through the inhalation of spores. Fusarium spp. are frequently involved with eye, skin, and nail infections. More severely it can produce hemorrhagic syndrome (alimentary toxic aleukia) in humans which is characterized by nausea, vomiting, diarrhea, dermatitis, and extensive internal bleeding.

Several species can produce the trichothecene toxins which target the circulatory, alimentary, skin, and nervous systems. Vomitoxin is one such tricothecene mycotoxin that has been associated with outbreaks of acute gastrointestinal illness in humans. Zearalenone is another mycotoxin produced by Fusarium. It is similar in structure to the female sex hormone estrogen and targets the reproductive organs.(50)

2.31 Penicillium species

These fungi are commonly found in soil, food, cellulose, grains, paint, carpet, wallpaper, interior fiberglass duct insulation, and decaying vegetation. Penicillium may cause hypersensitivity pneumonitis, asthma, and allergic alveolitis in susceptible individuals.

The genus Penicillium has several species. The most common ones include *Penicillium chrysogenum, Penicillium citrinum, Penicillium janthinellum, Penicillium marneffei,* and Penicillium *purpurogenum*.

This fungi has been isolated from patients with keratitis, ear infections, pneumonia, endocarditis, peritonitis, and urinary tract infections. Penicillium infections are most commonly exhibited in immunosuppressed individuals. For example, P. marneffei is a fungus abundant in Southeast Asia that typically infects patients with AIDS in this area. Infection with P.marneffei is acquired via inhalation and initially results in a pulmonary infection and then spreads to other areas of the body (lymphatic system, liver, spleen, and bones), and is often fatal. An indication of infection is the appearance of papules that resemble acne on the face, trunk, and extremities.

Penicillium spp. do have the ability to produce mycotoxins. The mycotoxin known as Ochratoxin A, which is nephrotoxic and carcinogenic, may be produced by Penicillium verrucosum. Verrucosidin is another mycotoxin produced by this fungus that exhibits neurotoxity. Penicillic acid is another mycotoxin that is nephrotoxic (causes kidney and liver damage) .(50)

2.32 Mold Counts

2.32.1 What Is the Mold Count?

Mold and mildew are fungi. They differ from plants or animals in how they reproduce and grow. The "seeds," called spores, are spread by the wind. Allergic reactions to mold are most common from July to late summer.

Although there are many types of molds, only a few dozen cause allergic reactions. Alternaria, Cladosporium (Hormodendrum), Aspergillus, Penicillium, Helminthosporium, Epicoccum, Fusarium, Mucor, Rhizopus and Aureobasidium (pullularia) are the major culprits. Some common spores can be identified when viewed under a microscope. Some form recognizable growth patterns, or colonies.

Many molds grow on rotting logs and fallen leaves, in compost piles and on grasses and grains. Unlike pollens, molds do not die with the first killing frost. Most outdoor molds become dormant during the winter. In the spring they grow on vegetation killed by the cold. Mold counts are likely to change quickly, depending on the weather. Certain spore types reach peak levels in dry, breezy weather. Some need high humidity, fog or dew to release spores. This group is abundant at night and during rainy periods.

2.32.2 How are Mold Measured?

To collect a sample of particulates in the air, a plastic rod or similar device is covered with a greasy substance. The device spins in the air at a controlled speed for a set amount of time— usually over a 24-hour period. At the end of that time, a trained analyst studies the surface under a microscope. Molds that have collected on the surface are identified by size and shape as well as other characteristics. A formula is then used to calculate that day's particle count.

The counts reported are always for a past time period and may not describe what is currently in the air. Some counts reflect poorly collected samples and poor analytical skills. Some monitoring services give "total pollen" counts. They may not break out the particular pollen or mold that causes your allergies. This means that allergy symptoms may not relate closely to the published count. But knowing the count can help you decide when to stay indoors.

2.33 Allergy Testing and Diagnosis

Allergy testing can let you know for certain which allergens are affecting you. Testing may reveal allergens that you didn't even realize were causing you problems. Furthermore, testing is necessary if you wish to start immunotherapy (allergy shots).

The allergist will ask questions about your medical history to determine whether allergies run in your family. He or she may ask detailed questions about your symptoms, what you did to treat those symptoms, and whether it worked. Once non-allergic conditions are ruled out and allergy is suspected, your allergist will perform a diagnostic allergy test.

2.33.1 Skin prick or scratch test

When most people go to the allergist for the first time, they want to know right away -- "What am I allergic to?" Fortunately, skin testing can usually be done on your first visit, and you may get immediate answers to your questions. However, some medications may affect the accuracy of the test, such as antihistamines and antidepressants. If you are taking any prescription medications, ask your primary care physician and allergist how to prepare for the allergy tests.

The skin prick or scratch test is the most common and reliable test for most allergies. The procedure is fairly painless. A small needle or plastic device is used to lightly prick or scratch your back or forearm with a tiny amount of allergen. After 15-20 minutes, your allergist will be able to interpret the results by examining each spot where allergens were scratched or pricked into your skin. The spots where you are allergic will become red and swollen, and the others will remain normal.

2.33.2 Intradermal test

The intradermal test is done when the skin prick or scratch test results are unclear. It is similar to the prick or scratch test, but involves injecting a small amount of allergen under the skin using a needle.Reactions to skin testing should clear up quickly. Because skin testing involves the injection of allergens under the skin, there is a small risk of anaphylaxis. For this reason, allergy skin testing should only be performed in a medical setting, with access to emergency treatment.

2.33.3 Blood test

The blood test or RAST (radioallergosorbent test) measures the levels of allergy antibody, IgE, produced when your blood is mixed with a series of allergens in a laboratory. If you are allergic to a substance, the IgE levels may increase in the blood sample. The blood test may be used if you have existing skin problems like eczema, if you're on medications that are long-acting or you cannot stop taking, if you have a history of anaphylaxis, or if you prefer not to have a skin test. Some drawbacks of the blood test are the cost and the time required to wait for the results. Also, other conditions are associated with elevated IgE levels (e.g., HIV, skin diseases, and parasitic diseases), so the results are not always definitive and need to be compared to your allergy symptoms and medical history.

2.33.4 Challenge test

To confirm a food or drug allergy after a skin or blood test result is positive, your allergist may perform a challenge test. For the challenge test, you swallow a very small amount of the suspected allergen (e.g., milk or antibiotic). If there is no reaction, your allergist gradually gives you more until a reaction is noted. Due to the risk of a severe allergic reaction like anaphylaxis, challenge tests are done in a clinical setting and are only performed when absolutely necessary.

2.34 Allergy Treatment

Good allergy treatment is based on the results of your allergy tests, your medical history, and the severity of your symptoms. It can include three different treatment strategies: avoidance of allergens, medication options and/or immunotherapy (allergy shots).

When it is not possible to avoid your allergens and treatment with medications alone does not solve the problem, immunotherapy can often prevent allergy symptoms. It involves giving a person increasingly higher doses of their allergen over time. For reasons that we do not completely understand, the person gradually becomes less sensitive to that allergen. This can be effective for some people with hay fever, certain animal allergies, and insect stings. It is usually not effective for allergies to food, drugs, or feathers, nor is it effective for hives or eczema.

2.35 Allergy Prevention

The best way to prevent allergy symptoms and minimize your need for allergy medicine is to avoid your allergens as much as possible and to eliminate the source of allergens from your home and other environments.

There are some simple things you can do to prevent allergies at home, work, school, outside and when you travel.

2.35.1 At Home.

1. Dust to control mites. By dusting surfaces and washing bedding often, you can control the amount of dust mites in your home.
2. Vacuum often. Although cleaning can sometimes trigger allergic reactions, with dust in the air, vacuuming once or twice a week will reduce the surface dust mites. Wear a mask when doing housework and consider leaving for a few hours after you clean to avoid allergens in the air. You can also make sure your vacuum has an air filter to capture dust.
3. Reduce pet dander. If you have allergies, you should avoid pets with feathers or fur like birds, dogs and cats. Animal saliva and dead skin, or

pet dander , can cause allergic reactions. If you can't bear to part with your pet, you should at least keep it out of the bedroom.

4. Shut out pollen. When you clean your windows, do you see a film of pollen on the frame or sill? One easy way to prevent pollen from entering your home is to keep windows and doors closed. Use an air filter and clean it regularly or run the air conditioner and change the filter often.

5. Avoid mold spores. Mold spores grow in moist areas. If you reduce the moisture in the bathroom and kitchen, you will reduce the mold. Fix any leaks inside and outside of your home and clean moldy surfaces. Plants can carry pollen and mold too, so limit the number of houseplants. Dehumidifiers will also help reduce mold.

2.35.2 At Work.

Allergies at home and work are similar and affect millions of people each year. Allergy symptoms, like sneezing, nasal congestion and headache, may make it difficult to concentrate. Every work environment will have specific allergy problems so talk to your health care provider or pharmacist about how you can prevent allergies at your specific workplace.

2.34.3 At School.

Children may face allergens in the classroom and playground. In fact, children in the United States miss about two million school days each year because of allergy symptoms. Parents, teachers and health care providers can work together to help prevent and treat childhood allergies. Monitor the classroom for plants, pets or other items that may carry allergens. Encourage your child to wash his/her hands after playing outside. Many of the allergens in the home will also be found at school. Although it may not be an option to vacuum or dust the classroom, there may be treatment options to help a child manage his/her symptoms during the school day.

2.35.4 Outside.

There are certain times during the year when plants and trees release pollen into the air. The timing of these pollen seasons depends on your geographic location. Different regions have different types of plants that pollinate at different times. Depending on where you live, allergy seasons may be mild or severe. Experts estimate that 35 million Americans suffer from allergies because of airborne pollen!

Tiny particles that are released from trees, weeds and grasses are known as pollen. These particles are carried by the wind from tall treetops all the way to your nose. But before you shrug off fancy flowers in fear of sniffles, remember that the types of pollen that most commonly cause your allergies are from plain-looking plants, such as trees, grasses and weeds. These plants produce small and light pollen, perfect for catching a ride on a gentle breeze.

Similar to pollen, mold spores are a seasonal pest. If you are sensitive to mold spores, you may have symptoms from spring to late fall. Yet, even after the first frost of winter, some mold spores can continue to grow in freezing temperatures. The severity of your mold spore allergies can depend on the climate that you live in. In the warmest areas of the United States, mold spores grow all year! But before you move to Antarctica, remember that mold spores also grow indoors, making it a year-round problem.

2.35.5 Traveling.

We are all on the go and there are a few things to keep in mind to prevent outdoor allergies during peak season, when the pollen count is high.

1. Stay inside during peak pollen times, usually between 10:00 a.m. and 4:00 p.m.
2. Keep your car windows closed when traveling.
3. Stay indoors when humidity is high and on days with high wind, when dust and pollen are more likely to be in the air.
4. Wear a facemask if you are outside to limit the amount of pollen you inhale.
5. Shower after spending time outside to wash away pollen that collects on your skin and hair

2.35.6 Planes, Trains and Automobiles.

If you suffer from allergies, there may be other concerns when you travel. The allergy climate may be different than the one where you live. When you travel by car, bus or train, you may find dust mites, mold spores and pollen bothersome. Turn on the air conditioner or heater before getting in your car and travel with the windows closed to avoid allergens from outside. Traveling early in the morning or late in the evening when the air quality is better.

When flying to your favorite vacation spot, remember that air quality and dryness on planes can affect you if you have allergies. If a cruise is your next vacation, be aware of the season and temperature at your destination(s). In tropical, damp climates there are allergens like dust mites, mold spores and pollen. In cold, damp climates, you may be exposed to dust mites and mold spores. Once you arrive at your hotel, there may be dust mites and mold spores lurking. If you are staying with family or friends, the same types of allergens that you find at home may be present

2.36 Improve Your Indoor Air Quality

Indoor air quality in the home plays a major role in your respiratory health, particularly if you suffer from asthma or allergies. Research by the American Lung Association has shown that a majority of Americans (87%) are not aware that the air inside of most American homes is more polluted than the air outside.

Fortunately, there are some concrete action steps you can take to improve your living space:

- Keep your house clean and free of dust.
- Control all biological allergens (pollen from outside, dust mites, pet dander, mold, and mildew).
- Increase ventilation. Use exhaust fans when cooking, showering, and using the dishwasher.
- Make sure your clothes dryer is vented to the outdoors.
- Maintain a comfortable temperature and low humidity.

- Do not allow smoking in the house. Avoid using a wood-burning stove or fireplace. Make sure it is airtight if you do use one.
- Avoid using perfumes or scented cleaning sprays. Use trigger sprays instead of aerosols.
- Improve air filtration.

In order to avoid asthma and allergy symptoms, keep your indoor air as clean as you can by identifying and controlling the sources of airborne irritants in your home. There are three kinds of irritants:

- Biological allergens like pollen, mold spores, dust mite allergens, cockroach allergens, and pet dander
- Tobacco smoke and other combustion by-products
- Gases from wood products and other sources (e.g., radon, formaldehyde)

Proper ventilation in certain areas of the home is essential for improving your indoor air quality. An everyday task like cooking can produce odors, water vapor, and other potential irritants like grease and smoke. Avoid using standard window fans for ventilation, because they allow pollen and outdoor mold spores to enter the house. Use exhaust fans in the kitchen and bathroom to remove moisture and indoor pollutants.

Since many irritants can be trapped in dust, try to keep your house dust-free. Once a week, use a damp cloth to wipe all flat surfaces. Be careful with the cleaning agents you use. Some scented or aerosol sprays and other cleaners can be irritants for people with asthma and allergies. To be on the safe side, use trigger sprays and a face mask, and increase ventilation while cleaning to minimize your exposure to irritating chemicals.

Inspect the air ducts in your house. Sometimes dust and mold can accumulate in the ducts of your home's forced-air heating and cooling system, which may result in further dispersion of these allergens into the air. This can be a problem in homes with pets, or in areas of high humidity.

To improve your existing forced air heating/cooling system, consider installing an electrostatic filter. These filters, which work 3-4 times better than a standard foam filter, can be easily installed on your system to minimize small airborne particles that are potential allergens. An alternative to the electrostatic filter is the extended-surface air filter. This accordion-like filter, which is usually 2 to 6 inches thick, requires installation by a professional heating/cooling contractor. The extended-surface filter can last up to 2 years and can capture more airborne allergens than an electrostatic filter.

2.37 Exposure assessment

Information on human exposure has a Well- recognized role as a corollary to epidemiology. But it is more than this because understanding human exposures to environmental contaminant is fundamental to public policy. The adequacy of environmental mitigation strategies is predicated on improving or safeguarding human and ecological health. The public mandate for and acceptance of controls on emissions is first based on sensory awareness of pollution. Irritated airways, foul- smelling exhaust, obscuring plumes, oil slicks on water, dirty and foul – testing water and medical waste and debris on beaches are readily interpreted as transgressions against us and threaten commonly shared natural resources. As we enter the twenty – first century, we recognize that we, human have had profound but of then subtle impacts on the chemistry of the biosphere and lithosphere. Metals, organic compounds, particulate matter, and photo chemically produced gases widely dispersed recognizing no geographic or political boundaries. Global markets, urbanization and increased mobility have environmental contamination as a consequence. Assessing the quantities and distribution of potentially harmful contaminant exposure to human populations is a critical component of risk management. As long as disease prevention and health promotion are the principal tenets of public health, then assessing the levels of contaminant exposures in environmental and biological samples well be necessary. (1)

People are exposed to a variety of potentially harmful agents in the air they breathe, the liquid they drink, the food they eat, the surface they touch and the products they use. An important aspect of public health protection is the prevention or reduction of exposures to environmental agents that contribute, either directly or indirectly, to increased rate of premature death, disease discomfort or disability. It is usually not possible, however, to measure the effectiveness of mitigation strategies directly in term of prevented disease, reduced premature death, or avoided dysfunction. Instead measurement or estimation of actual human exposure, coupled with appropriate assumption about associated health effect or safety limits, is the standard method used for determining whether intervention is necessary to protect and promote public health, which forms of intervention will be most effective in meeting public health goals, and whether past intervention effort have been successful. (1)

Exposure is defined as contact overtime and space between a person and one or more biological, chemical, or physical agents. Exposure assessment is to identify and define the exposures that occur / or are anticipated to occur, in human populations. This can be a complex Endeavour requiring analysis of many different aspects of the contact between people and hazardous substances. (1)

The release of an agent into the environment, its ensuring transport, transformation and fate in various environmental media, and its ultimate contact with people are critical events in understanding how and why exposures occur.

2.38 Elements of exposure assessment:

Assessing human exposure to an environmental agent involves the qualitative description and the quantitative estimation of the agent's contact with (exposure) and entry into (dose) the body. Although no two exposure assessment are exactly the same. All have several common elements, the number of people exposed of specific concentration for the period of interest, the resulting dose, and the contribution of important sources, pathways and behavioral factors to exposure or dose.

2.39 Human exposure information in environmental epidemiology

Epidemiology is the study of the determinants and distribution of health status or health–related events, in human population. Environmental epidemiology searches for statistical associations between environmental exposures and adverse health effects (presumed) to be caused by such exposures. It is a scientific tool that can sometime defect environmentally induced health effects in population, and it may offer opportunities to link actual exposures with health outcomes. (1)

Exposure assessment methods can be used for identifying and defining the low or high exposure groups. They can also be used for devising more accurate exposure data from measured environmental contaminant levels and personal questionnaire or time – activity diary data, or estimating population exposure differences between days of high and low pollution, or between high and low pollution in communities using measured data. (1)

2.40 Human exposure information in risk assessment

Risk assessment is a formalized process for estimating the magnitude likelihood and uncertainty of environmentally induced health effects in population. Exposure assessment (e.g., exposure concentrations and related dose for specific pathways), and effect assessment (i.e hazard identification , dose – response evaluation) are integral parts of the risk assessment process . The goal is to use the best available information and knowledge to estimate health risk for the subject population, important subgroups within the population (e.g., - children, pregnant women and the elderly), and individuals in the middle and at the high end of the exposure distribution. (1)

Exposure assessment in the risk assessment frame work focuses on the initial portion of the environmental health paradigm: from sources, to environmental concentration, to exposure, to dose. The major goal of exposure assessment is to develop a qualitative and quantitative description of the environmental agents contact with (exposure) and entry into (dose) the human body. Emphasis is placed on estimating the magnitude , duration , and frequency of exposure , as well as estimating the number of people exposed to various concentration of the agent in question .(1)

Effects assessment examines the latter portion of the events continuums from dose to adverse health effects – The goals are to determine the intrinsic hazard associated with the agent (hazard identification) and to quantify the relationship between dose to the target tissue and related harmful outcome (dose – response/ effect assessment) . Risk characterization is the last phase of the risk assessment process. The result of the actual exposure assessment and the effect, assessment are combined to estimate the human health risks from exposure. (1)

Risk management decisions carried out by policy – makers are of four basic types = priority setting , selection of the most cost– effective method to prevent or reduce unacceptable risks , setting and evaluation compliance with standards or guideline , and the evaluation of the success of risk mitigation efforts. Exposure information is crucial to these decisions. In addition to data on exposures and related health effects, decision – makers also must account for the economic, engineering, legal, social and political, aspects of the problem. (1)

2.41 Human exposure information in status and trend analysis

Evaluating the current status of exposure and doses in the context, of historical trends is an important tool for both risk assessment and risk management. In many cases it requires collecting exposure data over a relatively long period of time .This can only be done through one exposure assessment study and Hen when contaminant has a long residence time in the environment or biological tissue. If concentration of a contaminant exhibit high variability in environment media the study may require relatively large samples sizes, the use of probability samples, and or extensive .follow – up to observe trends. Data on status and trends can be invaluable for identifying new or emerging problems, recognizing the relative importance of emission sources and exposure pathways, assessing the effectiveness of pollution control, distinguishing opportunities for epidemiological research and predicting future changes in exposure and effects. (1)

2.42 Exposure assessment approaches

Strategies for assessing environmental exposure can be categorized as one of two general approaches, direct or in direct. Direct approaches include personal exposure monitoring and biological markers of exposure. Indirect approaches include environmental sampling, combined with exposure factor information, modeling and questionnaire. (1)

2.42.1 Direct approaches to exposure assessment

Personal monitoring of exposure to environmental contaminants refers to collection of samples at the interface between the exposure medium and the human receptor. Personal monitors make it possible to measure exposures for an identified subset of the general population. Moreover, it study participants maintain records of their activities , then locations where highest exposure concentrations occur as well as the nature of emission sources can often be inferred .personal monitoring can be done for all potential exposure media (e .g. air, water, soil , food) and pollutants of interest. Although available, personal monitoring methods may not be employed in a particular investigation due to study design, time or exposure considerations. His principal limitation on the use of personal monitoring for exposure assessment is the availability of sample collection methods that are sensitive, easy to operate, able to provide sufficient time resolution, free from interferences and cast–effective. Consideration should be given to the likelihood that the inconvenience of complying with personal monitoring protocols may alter the normal behavior of the study participants. For example, participants tend to wear personal air monitors on days that then do not go to work (1)

2.42.2 Indirect approaches to exposure assessment

In direct estimates of exposure may be made by combining measurement of pollutant concentrations of fixed sites with information on rates of contact with these media recorded in data logs and diaries or time–activity survey. Although collection of environmental, time – activity. And questionnaire data needed for this exposure assessment approach is simpler then for personal monitoring, it is still invasive and laborious and may lead to selection bias. (1)

2.43 Environmental monitoring

Micro environmental monitoring is a special case of environmental monitoring in which the location where measurements are made is considered to be homogeneous with respect to concentration of the target pollutant over the averaging time of interest the concept of a microenvironment has been widely applied in air pollution exposure assessment. Examples of potentially important

2.44 Models

The micro environmental exposure equation describes a model commonly used for assessment of air pollutant exposure. More generally, models are useful tools for quantifying the relationship between pollutant exposure and important explanatory variable, as well as for expanding existing exposure information to estimation of exposures of new populations and subgroups, and future exposure sceneries. Validated exposure models reduce the need for expensive measurement programmers. The challenge is to develop exposure data bases and models that allow maximum extrapolation from minimum measurement or cost. Such models need to reflect the structures of the physical environments and human activities of interest in exposure assessment. (1)

An exposure model is a logical or empirical construct which allows estimation of individual or population exposure parameters from available input data. Such data may be measured or collected for this purpose, or obtained from other sources. Technological, logistic and financial constraints can make it difficult to monitor the exposure of human to the various environmental agents. It is, therefore prudent in many situations to use models to assess contaminant exposures. Models provide an analytic structure for combining data of different types collected from disparate studies in a manner that may make more complete use of the existing information on a particular contaminant than is possible from direct study methods. Exposure model which is supported by adequate observations can be used to estimate group exposures, or individual exposures. Model results also can be used to evaluate exposures at various points of population distribution which cannot be measured directly because of limitation of methods or resources. (1)

2.45 Measuring biological agent in air and dust:

Microbiological organisms have long played an important role – in the human ecology – Fungi are critical to the production of cheese and the fermentation of beer and in some cases are direct source of nourishment. In the first half of 2oth century, penicillium chrysogenum colonies were discovered to inhibit growth of other organism. Today pharmaceutical companies, among other are exploring fungal enzymes for a variety of reasons in duding new drugs, non – chemical pesticides, and biodegradation of waste and possible catalysis of chemical reaction. (1)

However, natural does mean benign. Human exposure to micro organism has resulted in allergic, toxic and infectious disease. As human have modified the environment through cultivation, land scraping and building structures, ecological balances have been disturbed. The distribution of moisture and nutrients has been altered to a point where it is quite common to encounter reservoir of fungi, bacteria and algae, and infestation of mites and cockroaches. (1)

Major outdoor allergens are plant pollen and fungal spores. Others include agricultural seed husks and algae. The seed husks dislodged into the air while managing grain elevators can be a source of considerable allergy problems to those in the immediate vicinity of a facility. For these situations, awareness as to the potential and likelihood of associated allergic problems is the simplest means for ascertaining that a problem exists. (2)

The principal indoor allergens are amplified fungal spores and spore-forming bacteria others include house dust mites, animal dander, and feathers. It should be noted also that indoor non allergenic bacteria are generally amplified in office building as well. This is due to the proximity of the occupants and confinement of contaminated air. Another potential indoor allergen which is of minimal concern yet may be worthy of consideration is algae. (2)

Environmental allergens for which procedures for identification and evaluation exist include the following categories:

1- Plant pollen
2- Molds spores
3- Bacterial spores
4- Animal allergens (e.g. house dust mites)
5- Some organic chemicals

The concern for allergens is associated with outdoor environments, indoor air quality office spaces, and indoor residential environments. (2)

There are three different basic approaches for the exposure assessment of biological particles: observation sampling, reservoir sampling (e.g. dust, surface) and air sampling. (1)

The two different approaches to assess the exposure to fungal particles are air sampling and dust sampling. For completeness other approaches to “dust” sampling include lifting spores from a surface with sticky tape or direct contact with culture agar. The most commonly used approach is air sampling of culture (viable) fungal particles. (1)

2.45.1 Air sampling for fungi

Several techniques have been described for volumetric sampling of fungi in outdoor and indoor environments. Some of the technique give total counts of all airborne particles, viable and non-viable, where as others only give count of viable fungal particles. For air sampling of fungal particles the following physical sampling principles may be distinguished. Impaction on to a solid or semi-sold surface (e.g. culture medium or an adhesive) centrifugal impaction, filtration and liquid impingement. (1)

Impaction on to a culture medium is the most widely used technique, particularly in non-industrial indoor environments. Media which are generally accepted for aerobiological studies include Malt Extract Agar (MEA), V8 juice agar and Dichloran 18% Glycerol agar (DG 18) MEA and V8 agar are broad spectrum media, where as many of the common fungal species in air can also be isolated. (1)

Few published data are available on the validity of the measurement of fungi in air as estimate of exposure. All commonly used cultural air samples use short sampling periods, typically 30 seconds to several minutes. The culturable fungal particles may comprise only a few percent of the total number of fungal particles. Thus, in order to optimize the information available from air sampling, both types of particle should be sampled. (1)

2.45.2 Settled dust for fungi

Settled house dust can be sampled for viable fungi in exactly the same way as for house dust mites and their allergens. The dust samples can be stored at room temperature but the analysis should be performed within a few days. However, as is the case for air sampling, a single dust sample is a poor estimate of exposure to fungi over time. (1)

2.45.3 Available methods of analysis for fungi:

Air samples obtained with sampling devices collecting total fungal particles can be analyzed by direct examination to obtain total counts of fungal particles. Samples collected on culture media have to be incubated to obtain counts of viable fungal particles. Dust can be plated either directly on to a culture medium or suspended and diluted prior to plating. Total count of fungal particles in dust can also be obtained by partitioning into an aqueous two-phase system followed be epifluorecence microscopy. (1)

Samples are incubated for at least 4 days; up to 7 days is the typical time needed for spores to generate identifiable colonies. Since most environmental fungi grow well between 20c° and 30c°, the incubation temperature is generally 25c°. (1)

Immunochemical assays for fungal are available for only few fungi, primarily because fungal allergens are poorly characterized and purified. Alternative indicators of exposure to fungi to be measured in (airborne) dust may also be considered. For example one can assess the level of cell wall components such as B-1.3 glucon.

2.46 Bacteria

Bacteria are prokaryotic cells. Certain bacteria are infections and can be transmitted by air and contact, including ingestion. Common contagious airborne diseases include tuberculosis and some forms of pneumonia. Other diseases, such as legionellosis from water, respiratory infections from pseudomonas in humidifiers and several others from handling animal are not transmitted from person to person.(1) The two approaches available to measure the presence of bacteria as indicators of exposure are sampling of air and sampling of soil, dust or water. (1).

2.46.1 Air sampling for bacteria

The most widely used devices for bacteria include multiple–hole impactors, centrifugal impactors and slit–to– agar impactors, provided with collection media suitable for viable bacteria.

The results, both quantitatively and qualitatively, depend on the sampling device and collection medium used. For specific groups of bacteria, selective media could be employed, such as half strength nutrient agar for thermophilic actinomycetes

2.46.2 Dust sampling for bacteria

The sampling of settled dust for bacteria can be conducted in exactly same way as for house dust mites and their allergens.

2.46.3 Available methods of analysis for bacteria:

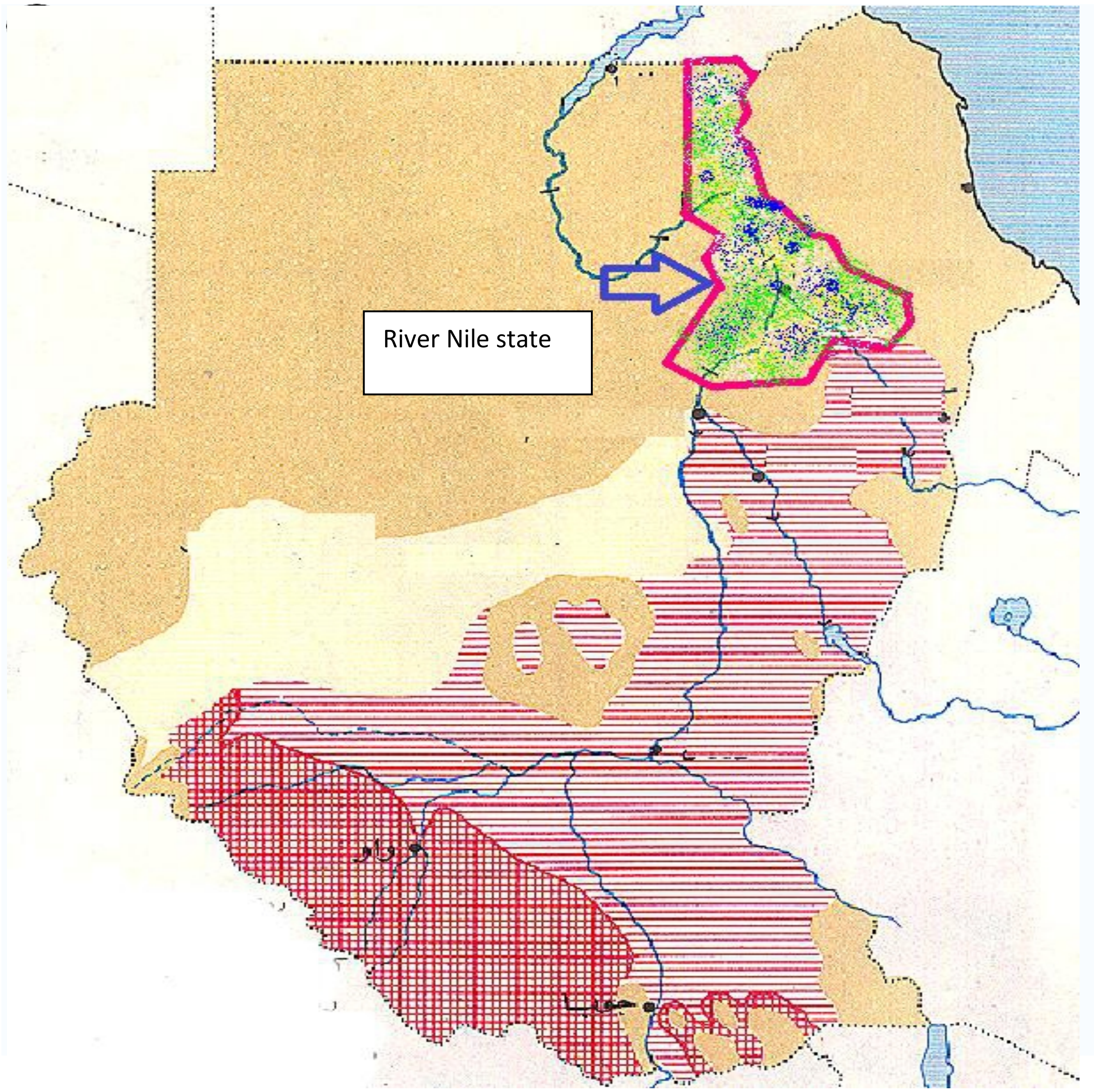
Air samples obtained with sampling devices collecting total bacteria can be analyzed by direct examination. Filter samples can also be used to obtain counts of viable bacteria.

Environmental samples are usually incubated for 2 – 7 days at 25c° or 37 c° and for thermophilic actinomycetes at 55c°. After incubation the number of colonies is counted and expressed as CFU/m3. (1).

3.1 The study area

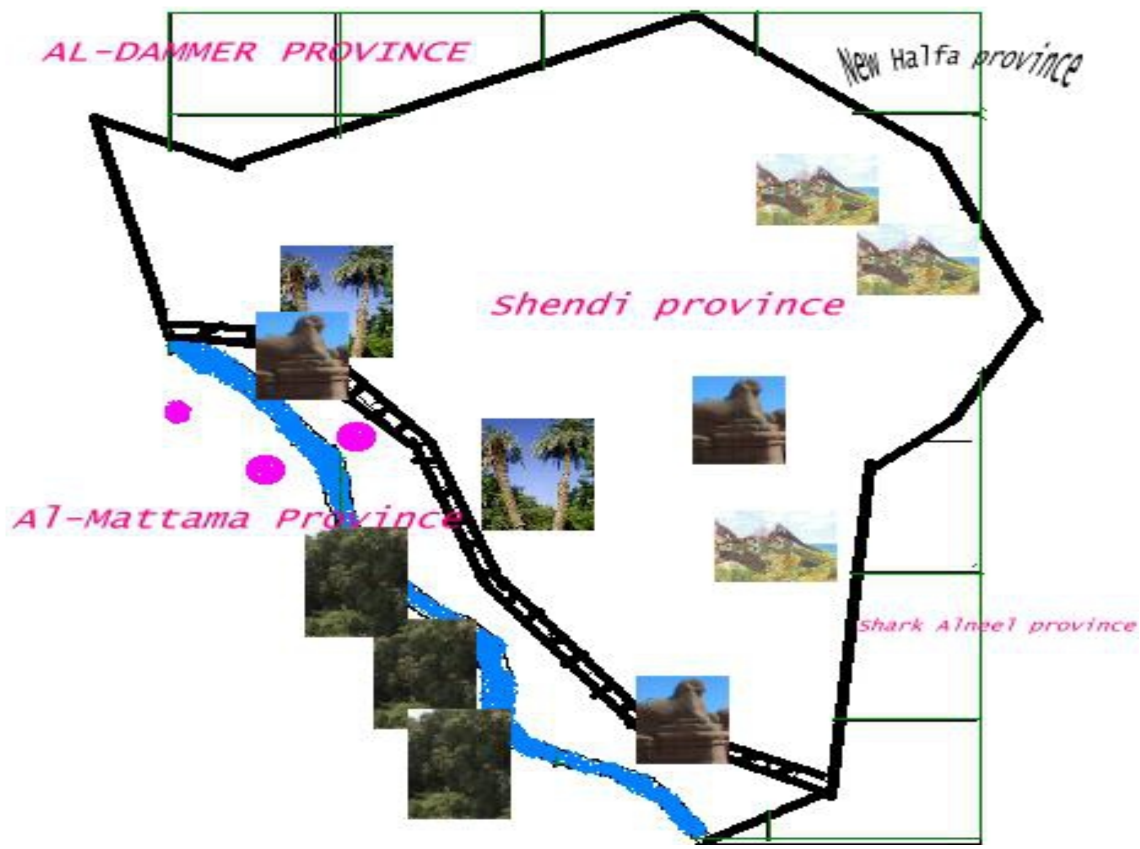
3.1.1 River Nile state

River Nile state (ولاية نهر النيل **Nahr an Nil**) is one of the 26 wilayat or states of Sudan. It has an area of 122,123 km² (47,152 mi²) and an estimated population of approximately 900,000 (2000). Ad-Damir is the capital of the state. Slightly north of Ad-Damir is the important rail junction town of Atbarah.(51)



3.1.2 Shendi

Shendi or Shandi (Arabic: شندي), situated on the Nile109 mi/175 km northeast of Khartoum, at 16° 41' 29" N and 33° 26' 3" E. Located on the east bank of the Nile, it is bounded by the Northern state to the North, Khartoum state to the South, River Nile to the West and Gadarf state to the East. Topographically it lies on a flat mud-sandy area adjacent to the River Nile with a few scattered mountains in the eastern part and it is accessible allover the year. Culturally the population is mixture of the various cultures that occur in Sudan. Shandi is the center of the Ja'aliin tribe and an important historic trading center. Its principal suburb on the west bank is Al-Matamma. A major traditional trade route across the Bayuda desert connects Al-Matamma to Marawi and Napata, 250 km to the NW.(51)



The total population is estimated at about 250000 of whom 180000 live in rural areas and 70000 in the urban. Growth rate2.3%, male 48.7%, female 51.3% and the average family size is 7 members. 78% of the population depends upon subsistence agriculture while the rest are traders, teachers and handcraft workers. About 60% of the population is rated as poor. The illiteracy rate is high both in the town and villages.(51)

Shandi is about 45 km SW of the ancient city of Meroe. The 1911 Encyclopedia Britannica relates the following:

"The origin of the name of the town came from the Daju tribe which inhabited it after being forced to migrate south & south-westward after the fall of Meroé in A.D. 350 which had been invaded by the army of Ezana, king of Axum (Ethiopia). The word 'sugaŋdé' or 'chendé' means in the Daju language: 'a sheep' (See Browne, W. G. 1806); this indicates that they were herders who moved south & south-westward to Kordofan and Darfur looking for abundant pasture. The Ababda tribe of Bedouins settled there in the early 19th century. Johann Ludwig Burckhardt passed through on his way to the Red Sea in 1812, and Charles Rothschild discovered the plague vector flea Xenopsylla cheopis there in 1901." .(51)

Very basic services and infrastructure mean that Shendi exists mainly as a center for trade in agricultural goods from nearby farms. Shendi was a large 18th-century market town. Regular power mean that expansion of the economy into industry at the present time. Now it's mainly visited on the way to the Meroitic ruins of the Naqa and Musawwarat temples. Tourism related activity from the nearby Meriotic ruins is minimal due to a lack of facilities within the town.(51)

Roads have begun to be laid cross the city however these remain largely unsafe as does the road to the capital Khartoum. The railway station in the city is no longer used for passenger travel however freight trains continue to use the tracks. Mobile telephone coverage exists within the city, neighboring towns of Misiktab and Al Mattamar, outlying villages and the ancient Meriotic pyramids to the north. Frequent bus service departs Khartoum. by road northeast of Khartoum.(51)

Schools exist within the town and local villages. A UNESCO funded center exists within the town to promote education in foreign languages and Information Technology. A university exists within the city and draws students from across Sudan to study there, though the student body is of entirely Muslim extraction.(51)

Shendi locality was one of the first localities to implement the primary health care strategy and to adopt the Health Area System. In Shendi there are three hospitals, (Shendi Teaching Hospital, Shendi Military Hospital and Al-Mac Nimer University Hospital) , 5 rural hospitals, 29 health centers, 15 dispensaries, 10 dressing stations and 9 Primary health care units (PHCU).

Environmental health activities are carried out by the environmental health staff. The small number of the qualified staff, lack of training courses, numerous administrative activities and the shortage of equipments , are the major constraints facing the environmental health activities .(51)

3.2 Materials and Methods

The study was conducted using:

3.2.1Environmental monitoring:

Micro environmental monitoring is a special case of environmental monitoring, in which the location where measurements are made is considered to be homogeneous with respect to concentration of the target pollutant over the averaging time of interest. Therefore the concept of microenvironments was used.

Outdoor and indoor air samples, for identification of the biological agents, were collected.

The air samples were collected from residential areas, using air-Sampling pump, at a flow rate of 15 L / min. for 1 hour. Bacteria and Fungal spores in the indoor and outdoor air were collected and studied by a combination of two methods-visual counts on filter and culture.

In the former method the filters were exposed horizontally for 1 h in an air sampling pump, placed at a height of 1m

In the culture method 8 cm petri dishes containing corn meal agar (for Fungal spores) and nutrient agar (for Bacteria) were exposed for a period of 3 min monthly at 10 a.m. This particular period was found to be most suitable for representing average weather conditions (temperature and humidity) of the days around the year with only slight variations. The petri dishes were placed on a stand and exposed horizontally at a height of 1 m above and parallel to the ground, adjacent to the gravity spore catching. The exposed Petri dishes were then incubated at 37°C for 5 to 10 days. Depending on the growth, some of the fast growing colonies were isolated for subculture on nutrient media to avoid masking of small colonies. After suitable growth of the colonies examination and identification were done. The individual types were isolated by sub-culturing them on tube containing nutrient media. These sub-cultures were maintained for confirmed identification.

The isolated Bacteria were identified be using Gram stain whereas the isolated fungi were identified microscopically. Dust samples, for seasonal and between-home variation, were also collected from bed rooms and living rooms.

The biological agents in indoor and outdoor dust of the rooms were studied and the viable bacteria and fungi were identified as previously described.

The factors affecting the concentration of pollutants in a given location were considered i.e.

a. The building structure.
b. The house characteristic (type of air conditioning, ventilation etc.)
c. Proximity to specific sources (i.e. heavy traffic, etc)
d. Timing of emission for each source.
e. Indoor/ outdoor air exchange rates.
f. Meteorological and topographic factors.

3.2.2 Questionnaire:

Questionnaires typically provide qualitative, often retrospective, information. So the questionnaire is used to categorize respondents, and is commonly used to aid in interpretation of personal and environmental results. Thus 60 questionnaires from the five sectors provide basic socio-demographic data, physical characteristics of the residential environment linked to health status.

3.2.3 Time - activity surveys

To have information about rates of contact between persons and pollutants in different microenvironments the following factors were studied:

a.The amount of time spent in a given activity.

b.The time of day, week and year of contact.

a. The expected frequency with which the person or population engaged in the activity.

The most basic division of micro-environments is whether a person is indoor or outdoor. Other typical microenvironments of interest in studying air pollution are home, work or school and modes of transportation.

In addition to time allocation measures and micro environmental parameters, information on the intensity of contact is collected to assess exposure; here the focus is on the micro level activities that affect the rate of contact e.g. cleaning.

3.3 Sampling frame

The town was been divided into five sectors, from each sector 24 air samples (12 indoor and 12 outdoor) and 12 dust samples (for bacteria) plus 24 samples (12 indoor and 12 outdoor) (for fungi), were collected. The samples were collected randomly by multistage sampling technique; the total is 180 samples (outdoor, indoor air and dust samples see *table (3.1*).

Table (3.1) The sampling time frame

sector / Week	**Sector 1**	**Sector 2**	**Sector 3**	**Sector 4**	**Sector 5**
1	5 Samples	5 Samples	5 Samples	5 Samples	5 Sample
2	5 Results	5 Results	5 Results	5 Results	5 Results

The above time frame activity table has been repeated monthly at each sector for 12 months.

3.4 Preparation of culture media

3.4.1 Nutrient agar (oxoid)

28 grams of the medium was suspended in one litre of water and dissolved by heating to boiling and distributed in 100ml bottles. The medium was sterilized in the autoclave at 15 Ib. for 15min (121 Cº), cooled to45 Cº and then distributed into sterile petri-dishes 20 ml each. Sometimes it was distributed into 10 ml sterile bottles, left in slope position to solidify and were used for some culture

3.4.2 Corn meal agar

40 grams of corn meal agar was boiled in one litre of water for 60 min and then filtered through muslin. 15 grams of agar was added, steamed to dissolve and distributed at 115 Cº for 30 min, cooled to 50 Cº and then distributed into sterile petri-dishes 20ml each. Sometimes it was distributed into 10ml sterile bottles, left in slope position to solidify were used for some cultures.

3.4.3 Reagent and chemicals

Lactophenol aniline blue

Distilled water	20.0ml
Lactic acid	20.0ml
Phenol crystal	20.0g
Aniline blue	.05g
Glycerd	40.0ml

Phenol crystal were dissolved in the lactic acid, glycerd and water by gentle heating, then aniline blue was added. (52)

3.5 Staining methods

The differential stains used during this study were Gram's stains and lactophenol alanine stain. Gram's method is as following;

1. Apply ammonium oxalate-crystal violet for ½ min.
2. Wash in water.
3. Apply lugol's iodine soln for 1/2min.
4. Tip of iodine but do not wash.
5. Decolorize with a few drops of acetone.
6. Wash thoroughly in water.
7. Counterstain with 0.5% satranin for 1/2min.
8. Wash and stand on end to drain or blot dry.

The whole slide must be flooded with each reagent and the previous reagent must be completely removed at each stage. Insufficient reagent may result in uneven staining or decolorization. Gram – positive organism are blue or purple, Gram – negative are red.(53)

3.6 Isolation of mould from examined samples

According to their morphological cheracters, mould colonies were picked up with their surrounding medium under septic condition and transferred to corn meal agar slopes and incubated at 27 Cº for 5-7days for further indentification.

3.6.1 Identification of isolated moulds

The identification of the moulds was based on the morphology of the colony, the rate of growth, the microscopic morphology of the isolates in a direct culture mount and micro-slide culture techniques.(54)

3.6.2 Microscopical examination

From the purified of 5-7days old mould colony a triangular piece was transferred by transparent sticker to a clean glass slide. One drop of lactophenol cotton blue stain was added to the slide before cutting the sticker followed by gentle pressure to remove the excess stain. The prepared slides were then examined under low power and oil immersion lens to characterized the measurement and morphological structures of the mould growth concerning the conidial stage, head, vesicle, sterigmata, conidiophores and conidia as well as the hull cells or other hyphal peculiarities, sclerotia and ascosporic stage.

3.7 Isolation and identification of bacteria

Pure culture is made from the primary culture by subculture of colonies on nutrient agar. Gram stain was made as a primary differential feature. Identification of Gram+ve bacteria and Gram-ve bacteria was made by several biochemical tests these include oxidase test, catalase, indol, methyl red, Voges proskeur, citrate, urease, glucose, lactose, manitol and sucrose.

3.8 Readiness

Prior commencement of the activities in the project's homes, readiness was assessed by field trial of equipment and procedures at non-project test homes. Instrument performance, samples collection, field team performance and data handling were monitored and judged and they are acceptable.

Five homes were tested as field trial. Data collected during these trials established the need for lower laboratory based quantization limits and particulate matter. Different laboratories were identified and used subsequently i.e. the faculty of medicine and health sciences' laboratory, Khartoum state ministry of health laboratory and the national health laboratory departments of occupational health and departments of mycology.

3.9 Data Analysis

All project data are stored in Microsoft Excel spreadsheets. The preliminary characteristic and indoor pollutant exposure range also were calculated using Excel. Data were also exported to SPSS for additional statistical analyses. Descriptive analyses included frequencies, means and standard deviations as well as analysis of variance for mean comparisons and analyses for categorical variables.

Environmental and biological measures were categorized for some analyses; cut off values were selected based on a combination of literature values, significance, experience of project staff, and the distributions observed in the study data.

The tables, figures and pictures present the results of the analyses of several demographic characteristics of the study population and the outcome of the different laboratories. A walk-through inspection was performed to record home and occupant characteristics. Homes were evaluated for dampness, cleanliness, pets, pests, and potential indoor pollutant sources.

The results

Figure (4.1) numbers of rooms in the house

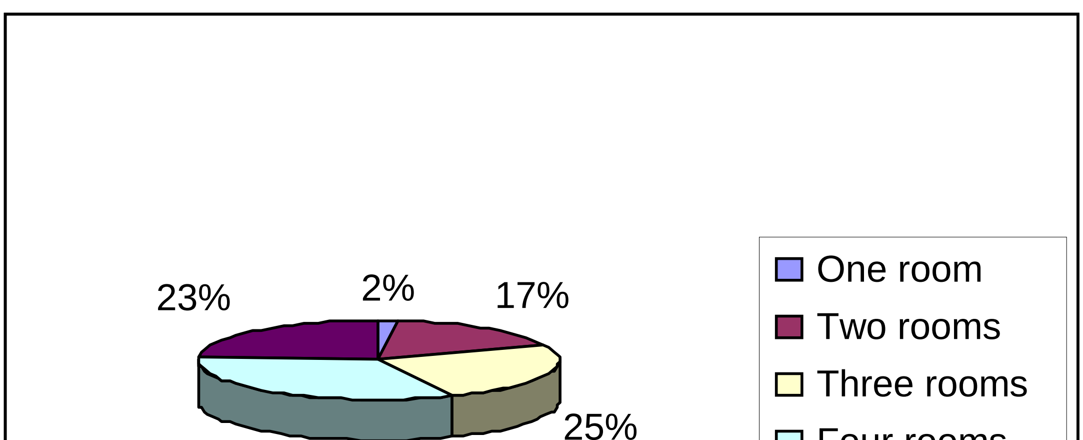


Table (2) Type of ventilation

Table (4.1) the main types of ventilation in the houses

type of ventilation	Number of houses	Percentage
Artificial	0	0
Natural	12	20.0
Both	48	80.0
Total	60	100.0

Table (4.2) number of windows per houses

Numbers of windows	Number of houses	Percentage
Two	6	10.0
Three	50	83.3
Four	4	6.7
Total	60	100.0

Figure (4.2) the types of animal in houses

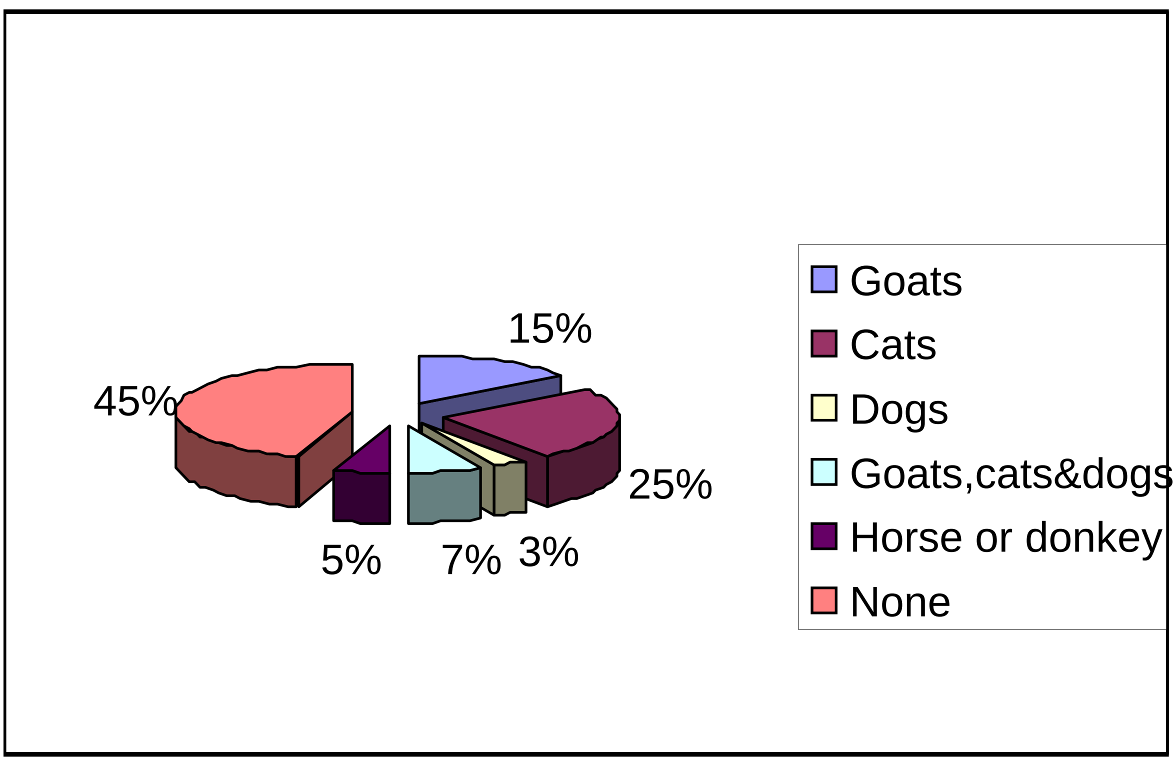


Table (4.3) the Frequency distribution of insect types in houses

Types of insects	Number of houses	Percentage
Flies	7	11.7
Mosquitoes	9	15.0
Cockroaches	2	3.3
all of the above	42	70.0
Total	60	100.0

Table (4.4) the Frequency distribution of types of plants in houses

type of plants	Number of houses	Percentage
Trees	34	56.7
Grass	4	6.7
Trees and grass	11	18.3
None	11	18.3
Total	60	100.0

Table (4.5) the Frequency distribution of number of individuals in the families

Number of individuals per family	Number of families	Percentage
2 – 4	6	10.0
5 – 7	29	48.3
8 – 10	14	23.3
11 – 13	6	10.0
14 and above	5	8.3
Total	60	100.0

Table (4.6) the Frequency distribution of children less than 15 years in the families

children under 15years	Number of families	Percentage
None	15	25.0
1 – 3	25	41.7
4 – 6	16	26.6

7 – 9	3	5.0
10 – 12	1	1.7
Total	60	100.0

Table (4.7) number of males less than 15 years

males under 15	Frequency	Percentage
None	16	26.6
1 – 3	39	65.0
4 – 6	4	6.7
7 – 9	1	1.7
Total	60	100.0

Table (4.8) number of females less than 15 years

females under 15	Frequency	Percentage
None	22	36.7
1 – 3	34	56.7
4 – 6	3	5.0
7- 9	1	1.7
Total	60	100.0

Table (4.9) types of diseases and infections in the families

diseases in the houses	Frequency	Percentage
respiratory tract infections	36	60.0
GIT diseases	3	5.0

ENT diseases	3	5.0
eye diseases	1	1.7
skin diseases	1	1.7
Others	16	26.7
Total	60	100.0

Table (4.10) the Common signs & symptoms in the families

Common signs & symptoms	Frequency	Percentage
watery eyes	3	5.0
runny nose & sneezing	16	26.7
Coughing	11	18.3
wheezing & difficulty breathing	3	5.0
headache & fatigue	15	25.0
all of the above	12	20.0
Total	60	100.0

Table (4.11) knowledge of individual of the way of getting of Allergens into the body

Way of allergens	Frequency	Percentage
Inhalation	53	88.3
Ingestion	5	8.3
do not know	2	3.3
Total	60	100.0

Table (4.12) knowledge of individual of the causes of allergy

causes of allergy	Frequency	Percentage
pollen grain	28	46.7
Food	3	5.0
Drug	3	5.0

Animal	1	1.7
Microorganism	13	21.7
do not know	12	20.0
Total	60	100.0

Table (4.13) the common allergies

the common allergies	Frequency	Percentage
rhinitis (hay fever)	23	38.3
Asthma	7	11.7
food allergy	4	6.7
drug allergy	4	6.7
skin allergy	5	8.3
do not know	17	28.3
Total	60	100.0

Table (4.14) how long allergy last

	Frequency	Percentage
Minutes	11	18.3
Hours	14	23.3
Days	19	31.7
Weeks	3	5.0
Months	1	1.7
do not know	12	20.0
Total	60	100.0

Table (4.15) the activities that increase pollutants indoor

the activities	Frequency	Percentage

Cooking	4	6.7
Cooling	3	5.0
Cleaning	38	63.3
do not know	15	25.0
Total	60	100.0

Table (4.16) methods of allergy diagnosis

Methods of diagnosis	Frequency	Percentage
Signs	45	75.0
skin test	3	5.0
air sampling	2	3.3
do not know	10	16.7
Total	60	100.0

Table (4.17) treatment types of allergy

Treatment type	Frequency	Percentage
spontaneously	8	13.3
by changing the place	5	8.3
by changing the environment	3	5.0
Pharmacological therapy	34	56.7
do not know	10	16.7
Total	60	100.0

Table (4.18) prevention types of allergy

Prevention type	Frequency	Percentage
knowing the allergens	35	58.3
Cleaning homes	7	11.7
increasing the ventilation rate	7	11.7
controlling temp &humidity	4	6.7
do not know	7	11.7
Total	60	100.0

Table (4.19) definition of asthma

Definition	Frequency	Percentage
chronic lung disease	10	16.7
airway hypersensitivity	4	6.7
Bronchitis	13	21.7

viral associated wheezing	2	3.3
difficult breathing	21	35.0
do not know	10	16.7
Total	60	100.0

Table (4.20) the Frequency distribution of individuals with asthma in the homes

Number of individuals	Number of homes	Percentage
None	43	71.7
1 – 2	14	23.3
3 – 4	3	5.0
Total	60	100.0

Table (4.21) the Frequency distribution of age of individuals with asthma

the age of asthmatic	Frequency	Percentage
less than 15 years	2	3.3
16 – 25	4	6.7
26 – 35	4	6.7
36 – 45	0	0.0
46 – 55	3	5.0
56 and above	4	6.7
None	43	71.6
Total	60	100.0

Table (4.22) the impact of allergic diseases

impact of allergic	Frequency	Percentage
low productivity	8	13.3
role limitation	6	10.0
health effects	27	45.0
Death	9	15.0
do not know	10	16.7
Total	60	100.0

Table (4.23) the time spent by asthmatic at homes

Hours	Frequency	Percentage
24	6	10.0
12	10	16.7
6	2	3.3
do not know	42	70.0

Total	60	100.0

Table (4.24) the time spent by asthmatic at work

Hours	Frequency	Percentage
12	2	3.3
8	8	13.3
6	2	3.3
do not know	48	80.0
Total	60	100.0

Table (4.25) relative humidity x Dry bulb temperature indoor

Dry bulb temperature Cº	N	Mean	Std. Deviation	Maximum relative humidity	Minimum relative humidity	% of Total Sum
23 – 30	29	42.4	6.0	51.4	31.8	55.0%
31 – 38	27	34.0	9.6	51.7	16.9	41.1%
39 – 46	4	21.8	.5	22.5	21.5	3.9%
Total	60	37.3	9.6	51.7	16.9	100.0%

Table (4.26) relative humidity x Dry bulb temperature outdoor

Dry bulb temperature Cº	N	Mean	Std. Deviation	Maximum relative humidity	Minimum relative humidity	% of Total Sum
23 – 30	27	42.2	5.9	50.1	25.1	54.6%
31 – 38	23	31.1	9.5	46.0	16.9	34.3%
39 – 46	10	23.3	9.3	39.3	11.7	11.1%
Total	60	34.8	10.7	50.1	11.7	100.0%

Figure (4.3) Relative humidity X dry bulb temperature Indoor

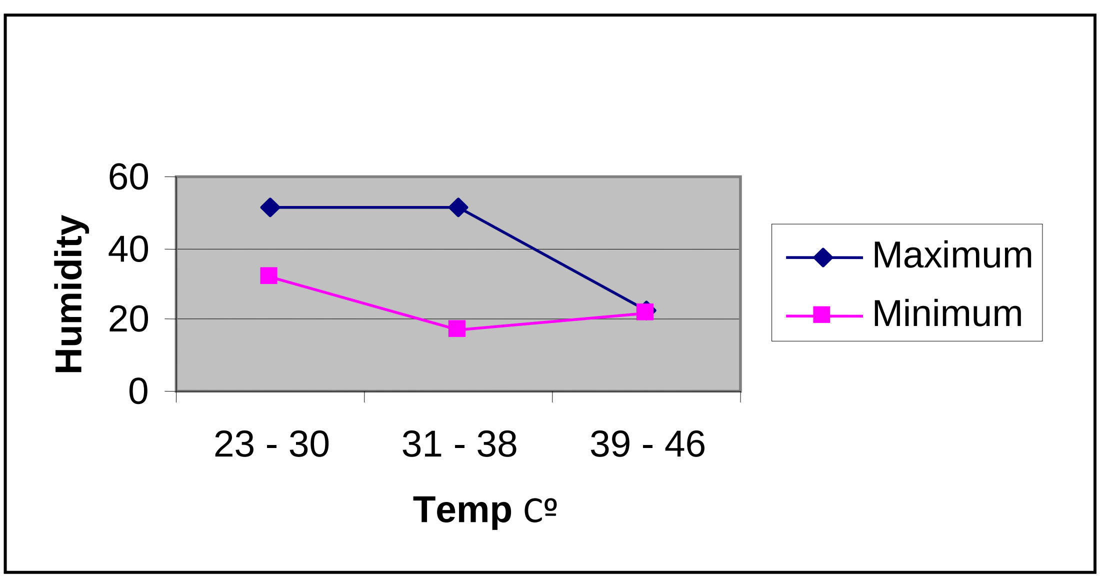


Figure (4.4) Relative humidity X dry bulb temperature Outdoor

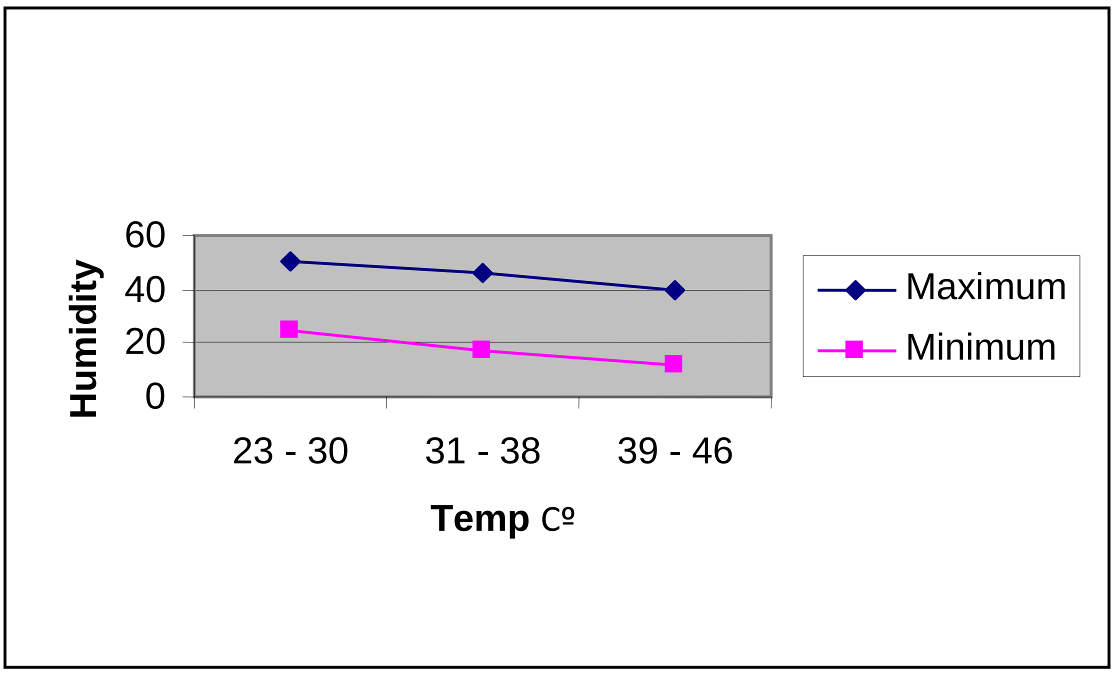


Table (4.27) relative humidity x Wet bulb temperature indoor

Wet bulb temperature Cº	N	Mean	Std. Deviation	Maximum relative humidity	Minimum relative humidity	% of Total Sum
10 – 15	1	45.3	.	45.3	45.3	2.0%
16 – 20	36	38.0	9.8	51.4	16.9	61.4%
21 – 25	17	32.3	8.1	48.2	21.5	24.6%
More than 25	6	44.9	4.6	51.7	41.6	12.0%
Total	60	37.3	9.7	51.7	16.9	100.0%

Table (4.28) relative humidity x Wet bulb temperature outdoor

Wet bulb temperature	N	Mean	Std. Deviation	Maximum relative	Minimum relative	% of Total

Cº				humidity	humidity	Sum
10 – 15	2	33.3	11.5	41.5	25.2	3.2%
16 – 20	35	37.2	11.0	50.1	11.6	62.3%
21 – 25	19	29.6	9.5	44.4	14.4	26.9%
More than 25	4	39.9	5.6	46.0	32.7	7.6%
Total	60	34.8	10.7	50.1	11.6	100.0%

Figure (4.5) Relative humidity X wet bulb temperature Indoor

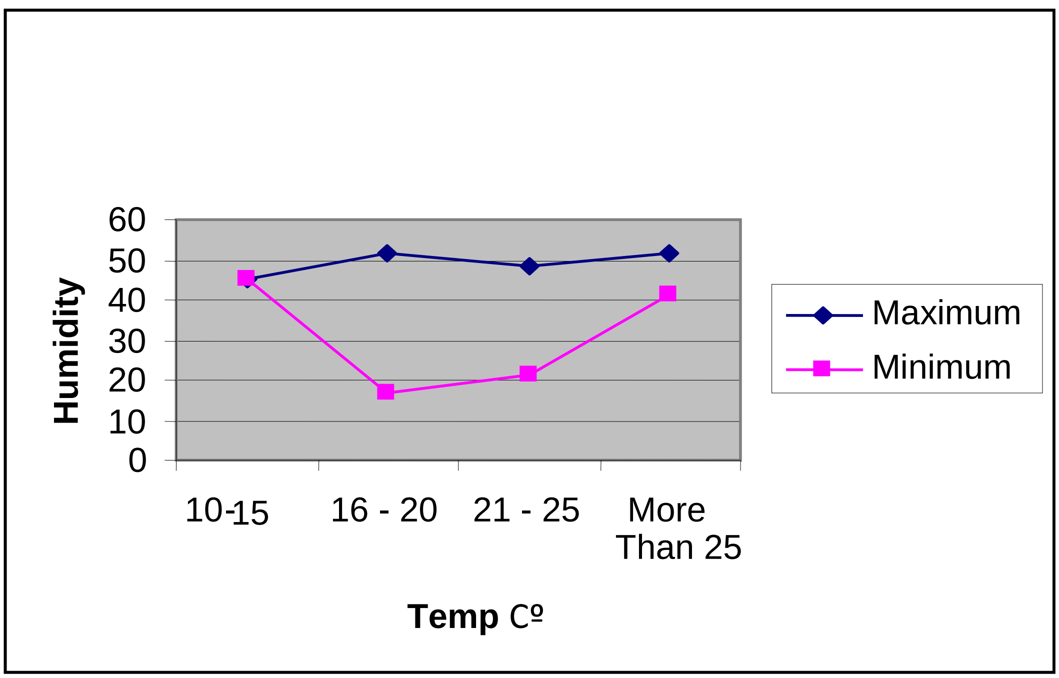


Figure (4.6) relative humidity X wet bulb temperature Outdoor

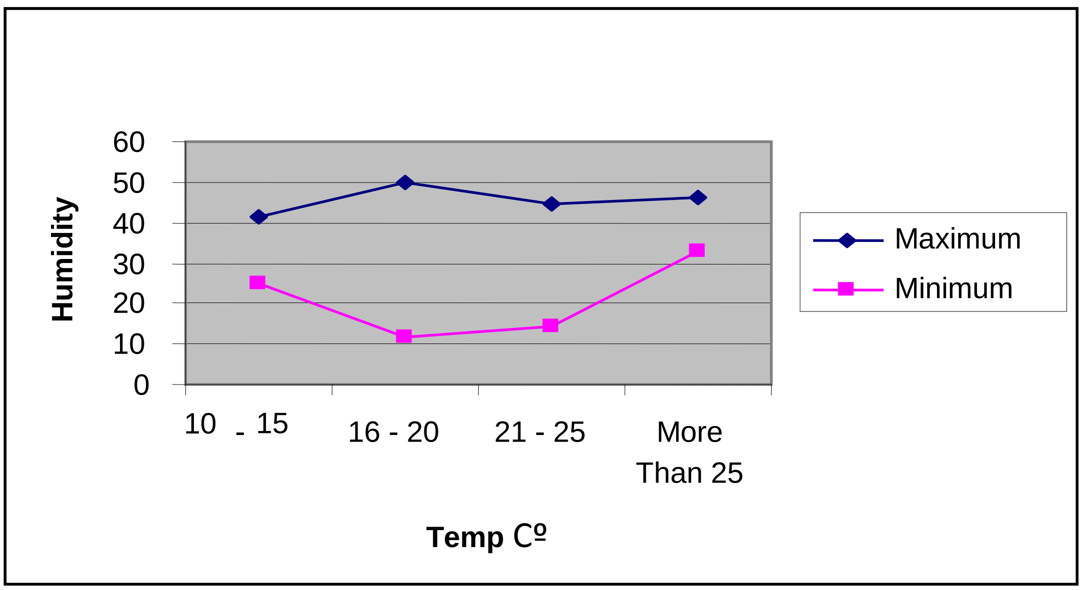


Table (4.29) ranking of the variables indoor ANOVA

The variables	Mean Square	F	Sig.
relative humidity	305.997	6.069	.000

air velocity	119.022	3.452	.000
average cooling time	792.839	2.495	.001
Site location	.371	1.686	.038
sampling time	12.044	1.093	.366

Table (4.30) ranking of the variables outdoor ANOVA

the variables	Mean Square	F	Sig.
relative humidity	406.491	7.567	.000
average cooling time	910.567	2.715	.001
sampling time	18.521	1.849	.031
Site location	.273	1.097	.367
air velocity	30.544	.547	.922

Table (4.31) the frequency of Gram +ve & Gram –ve bacteria in all sectors throughout months of the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nev	Dec
Gram +ve	7	10	9	9	12	15	15	14	8	7	6	9
Gram -ve	8	5	4	5	4	0	0	7	7	7	6	7

Figure (4.7) the frequency of Gram +ve & Gram -ve bacteria in all Sectors throughout months of the year

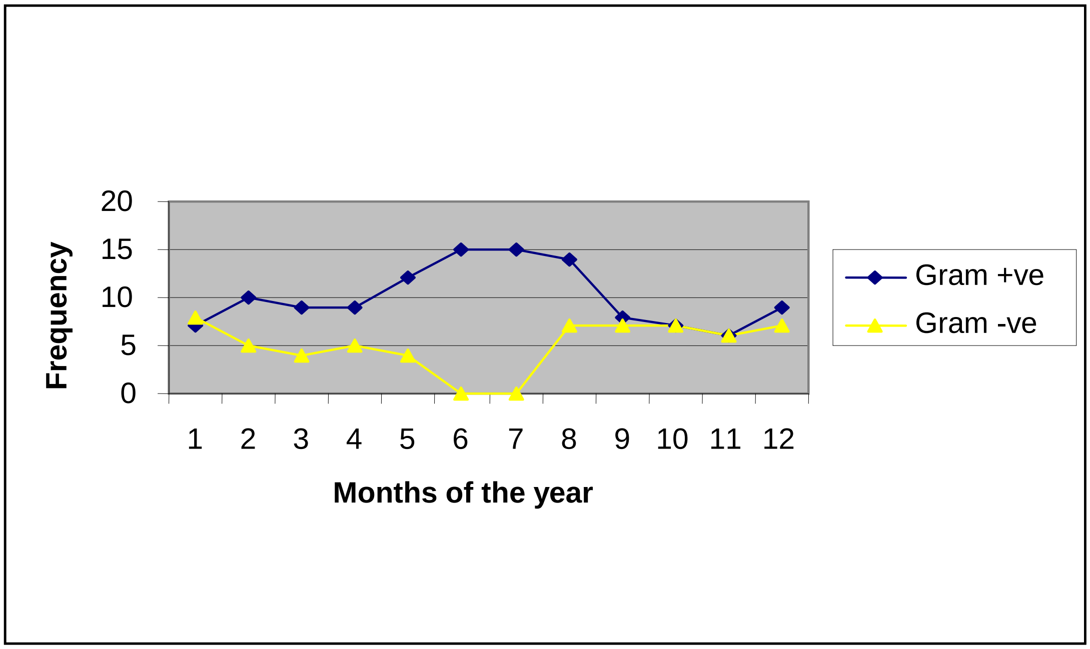


Table (4.32) the frequency of Gram +ve & Gram –ve bacteria indoor throughout months of the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nev	Dec
Gram +ve	1	4	5	4	5	5	5	4	2	3	2	2
Gram -ve	4	1	0	0	0	0	0	3	3	2	3	3

Figure (4.8) the frequency of Gram +ve & Gram -ve bacteria indoor throughout months of the year

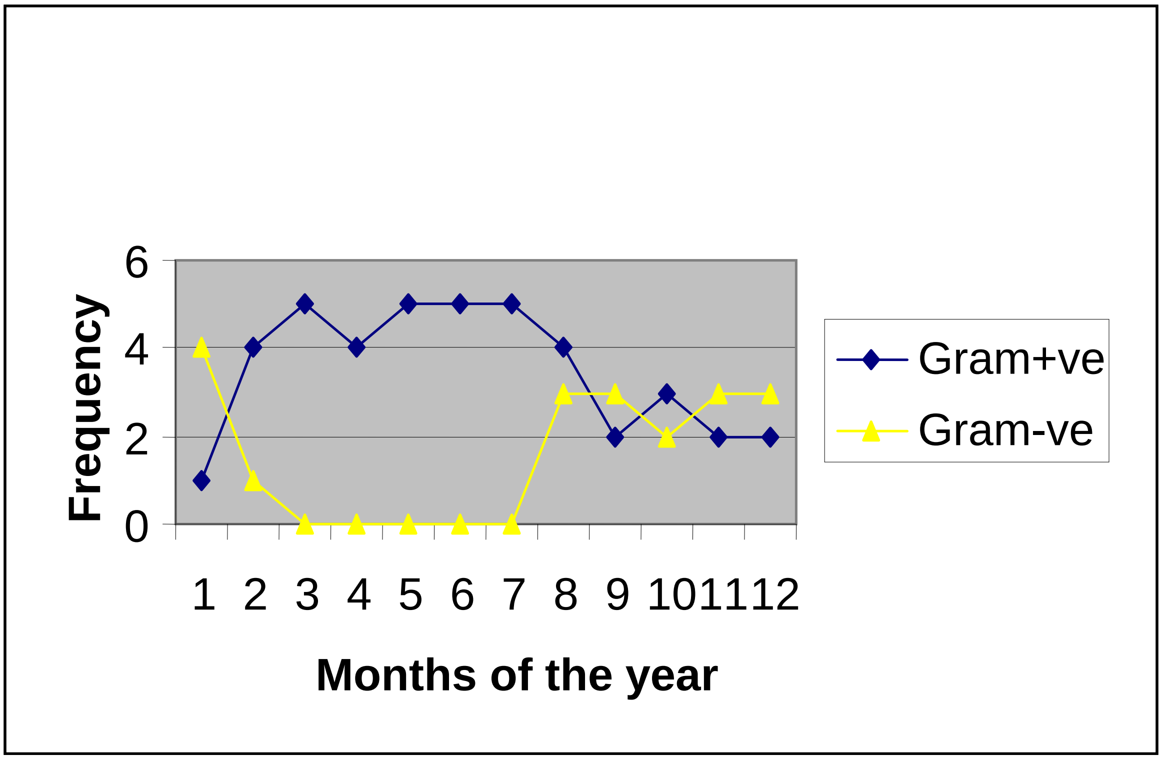


Table (4.33) the frequency of Gram +ve & Gram –ve bacteria outdoor throughout months the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Gram +ve	3	2	2	2	3	5	5	5	2	2	1	3
Gram -ve	2	3	3	3	2	0	0	2	3	2	3	3

Figure (4.9) the frequency of Gram +ve & Gram -ve bacteria outdoor throughout the year

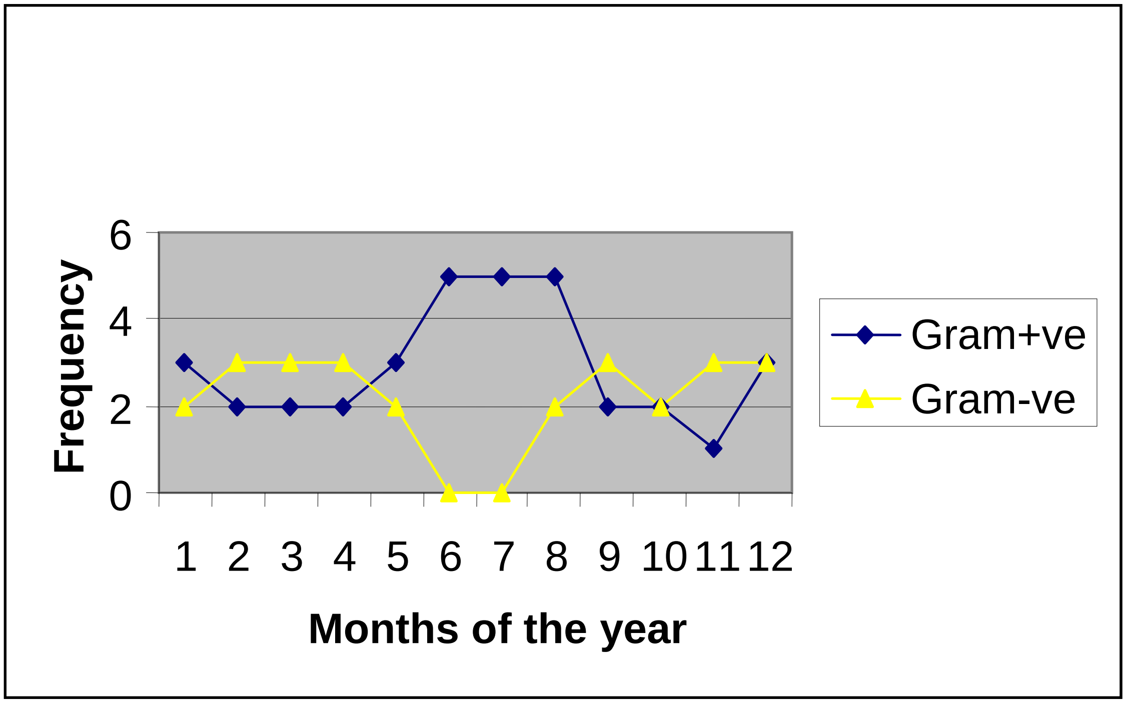


Table (4.34) the frequency of Gram +ve & Gram –ve bacteria in dust throughout month the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gram +ve	3	4	2	3	4	5	5	5	4	2	3	4
Gram -ve	2	1	1	1	1	0	0	2	1	3	0	1

Figure (4.10) the frequency of Gram +ve &Gram-ve bacteria in dust throughout the year

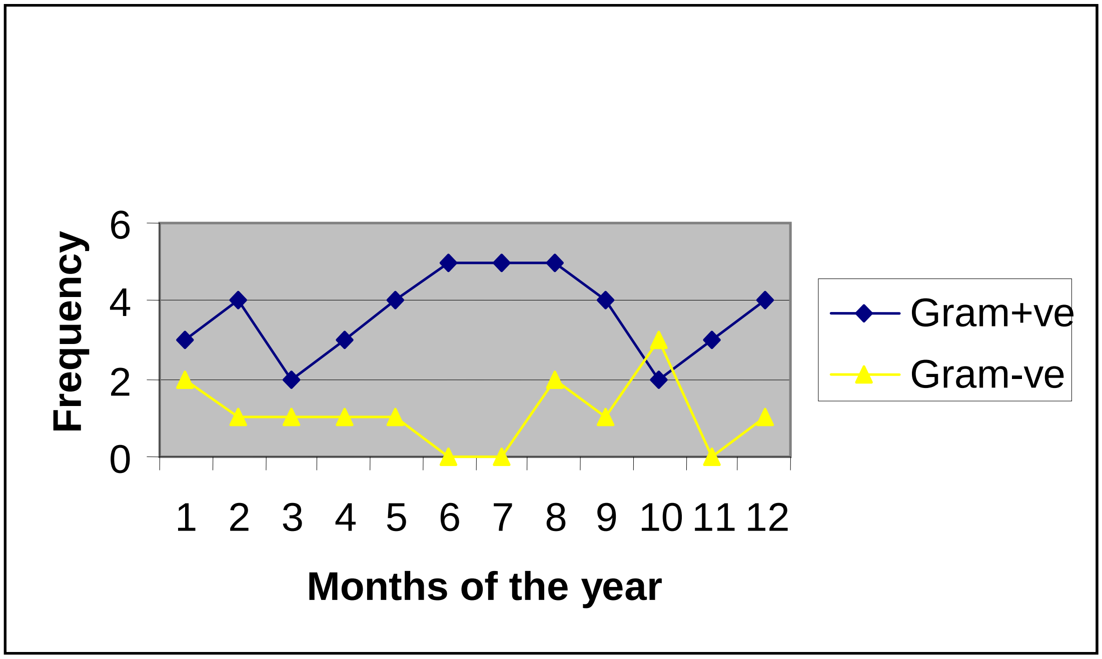


Table (4.35) the frequency of species of Gram –ve bacteria

Gram –ve bacteria spp	Frequency
Pseudomonos aeraginosa	33
Providincia stuartii	1
E.coli	6
Cedecea davicae	4
Citrobacter freundii	1

Enterobacter aerogenes	1
Enterobacter sakazakii	1
Hafnia alvei	6
Klebsiella pneumonia	2
Providincia rettgeri	2
Citrobacter diversus	1
Edwardsiella tarda	1

Table (4.36) the frequency of species of Gram –ve bacteria throughout months of the year

Gram–ve spp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
Pseudomonas aeraginosa	2	3	4	5	2	0	0	6	3	1	4	3	33
Providincia stuartii	1	0	0	0	0	0	0	0	0	0	0	0	1
E.coli	4	0	0	0	1	0	0	0	1	0	0	0	6
Cedecea davicae	1	1	0	0	0	0	0	0	0	1	1	0	4
Citrobacter freundii	1	0	0	0	0	0	0	0	0	0	0	0	1
Enterobacter aerogenes	0	0	0	0	0	0	0	1	0	0	0	0	1
Enterobacter sakazakii	0	0	0	0	0	0	0	0	0	1	0	0	1
Hafnia alvei	0	0	0	0	0	0	0	0	2	2	1	1	6
Klebsiella pneumonia	0	0	0	0	0	0	0	0	1	1	0	0	2

Providincia rettgeri	0	0	0	0	0	0	0	0	0	1	0	1	2
Citrobacter diversus	0	0	0	0	0	0	0	0	0	0	0	1	1
Edwardsiella tarda	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	9	4	4	5	4	0	0	7	7	7	6	7	59

Table (4.37) the frequency of fungal Species in air Samples throughout months of the year

Fungal Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Aspergillus	3	3	3	0	5	0	0	3	3	0	0	5	25
Fusarium	1	0	0	1	0	0	0	0	0	0	0	0	2
Curvularia	2	0	1	1	1	1	0	0	0	0	0	0	6
Alternaria	0	2	1	1	0	0	0	0	0	3	0	1	8
Bipolaris	0	1	1	0	1	0	0	1	1	0	0	0	5
Penicillium	0	1	0	0	0	0	0	0	0	0	0	0	1
Exserohilium	0	0	1	0	0	0	0	0	0	0	0	0	1
Zygomycotes	0	0	0	1	0	0	0	1	0	0	0	0	2

Bactrodesium	0	0	0	1	0	0	0	0	0	0	0	0	1
Phaeosclera	0	0	0	0	0	1	0	0	0	0	0	0	1
Pseudoallscheria	0	0	0	0	0	1	0	0	0	0	0	0	1
Aureobasidium	0	0	0	0	0	0	3	0	0	0	0	0	3
Cladosporium	0	0	0	0	0	0	0	0	0	0	0	1	1
Absidia	0	0	0	0	0	0	0	0	0	0	0	1	1
Chactomium	0	0	0	1	0	0	0	0	0	0	0	0	1
Ascotrchia	0	0	0	1	0	0	0	0	0	0	0	0	1
Unidentified	2	0	2	0	2	0	0	0	0	0	0	0	6
Total	8	7	9	7	9	3	3	5	4	3	0	8	66

Table (4.38) the frequency distribution of Fungal Species indoor & outdoor air

Species	Indoor	Outdoor	Frequency
Aspergillus	15	10	25

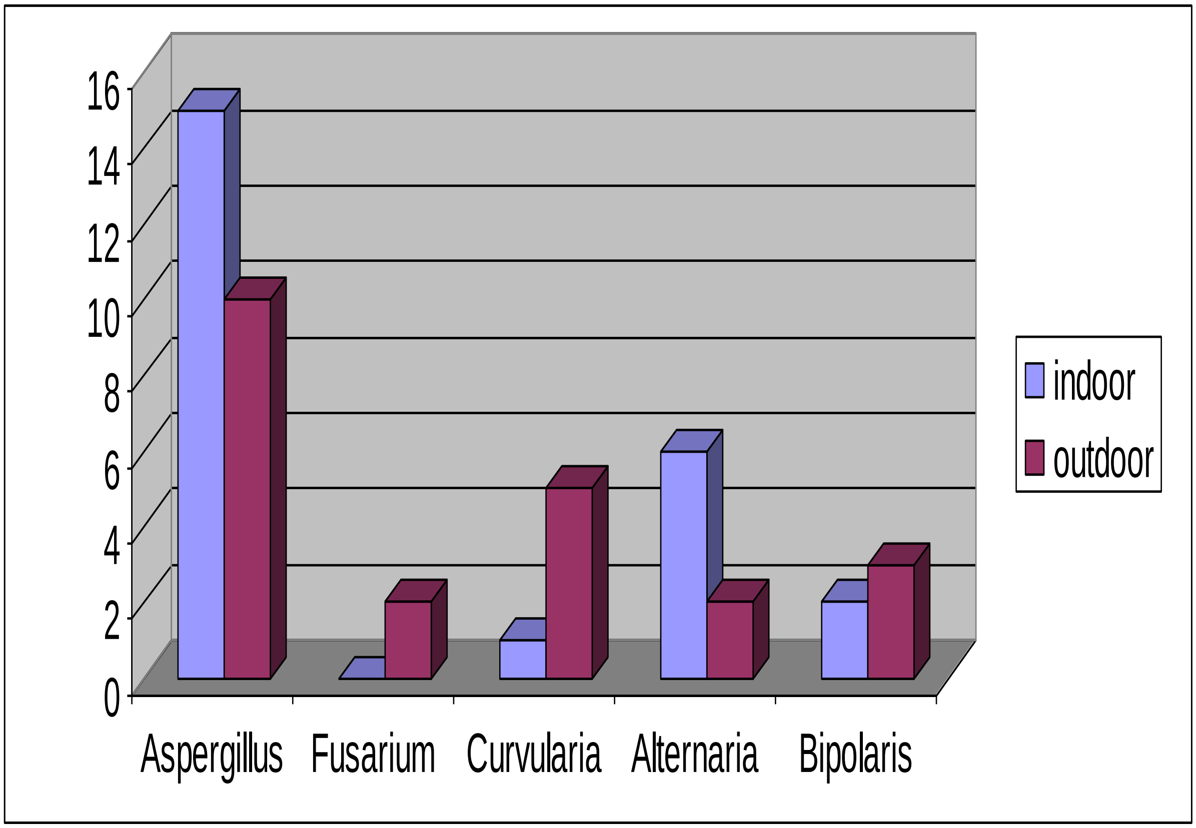
Fusarium	0	2	2
Curvularia	1	5	6
Alternaria	6	2	8
Bipolaris	2	3	5
Penicillium	0	1	1
Exserohilium	0	1	1
Zygomycotes	1	1	2
Bactrodesium	0	1	1
Phaeosclera	1	0	1
Pseudoallscheria	1	0	1
Aureobasidium	0	3	3
Cladosporium	1	0	1
Absidia	0	1	1
Chactomium	0	1	1
Ascotrchia	1	0	1
Unknown	3	3	6
Total	32	34	66

Table (4.39) the frequency distribution of fungal species in air samples throughout the year in all sectors

Fungal Species	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Total
Aspergillus	4	5	5	4	7	25
Fusarium	1	1	0	0	0	2
Curvularia	2	1	3	0	0	6
Alternaria	1	3	0	2	2	8
Bipolaris	1	1	0	0	3	5
Penicillium	0	0	1	0	0	1
Exserohilium	0	1	0	0	0	1
Zygomycotes	2	0	0	0	0	2
Bactrodesium	1	0	0	0	0	1
Phaeosclera	1	0	0	0	0	1

Pseudoallscheria	0	0	0	0	1	1
Aureobasidium	0	1	1	1	0	3
Cladosporium	0	0	1	0	0	1
Absidia	0	0	0	1	0	1
Chactomium	0	0	0	1	0	1
Ascotrchia	0	0	0	0	1	1
Unidentified	1	0	1	2	2	6
Total	14	13	12	11	17	66

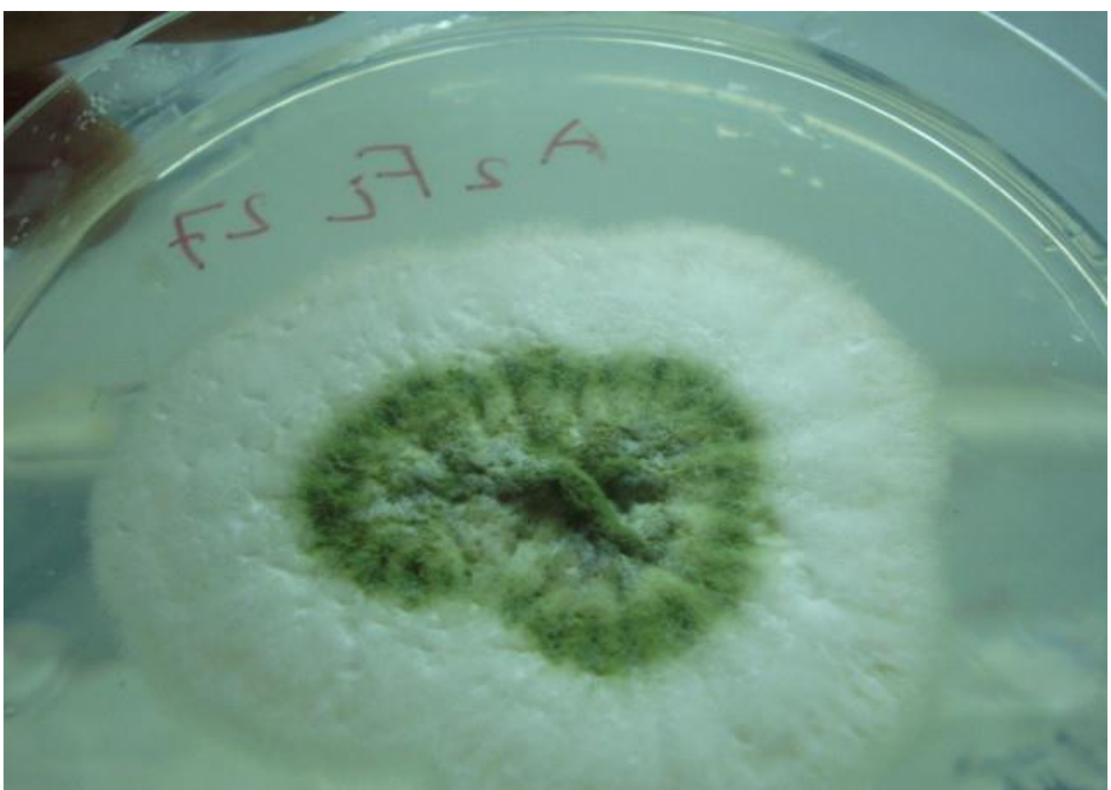
Figure (4.11) Comparison between the frequencies of the main found molds in air in Shendi



16
14
12
10
8
6
4
2
0
Aspergillus
Fusarium
Curvularia
Alternaria
Bipolaris
indoor
outdoor

Plate (4.1) colony of *Aspergillus spp* on corn meal agar from indoor air of sector 2 taken at January (sample A2fi)

Plate (4.2) colony of *Aspergillus spp 2* on corn meal agar from indoor air of sector 2 taken at January (sample A2fi)



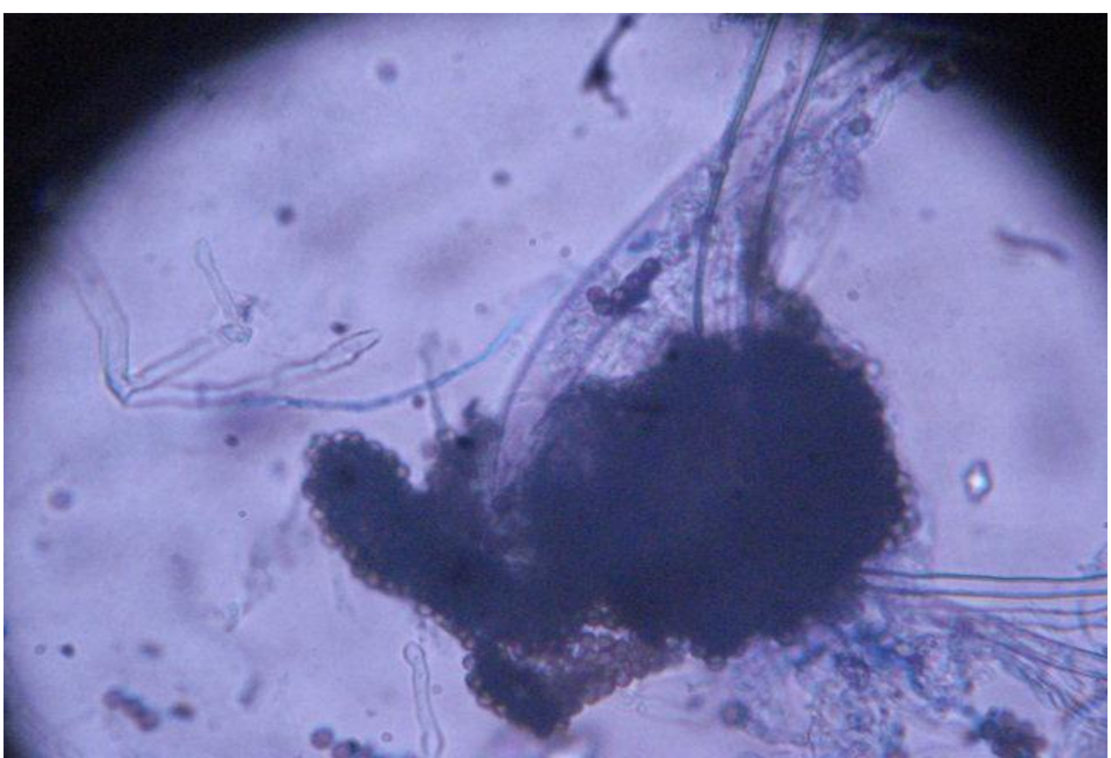


plate (4.3) microscopic view of *Aspergillus spp* stained by lactophenol cotton blue (sample A2fi)

plate (4.4) colony of *Bipolaris spp* on corn meal agar from indoor air of sector 1taken at February   (sample B1Fi)

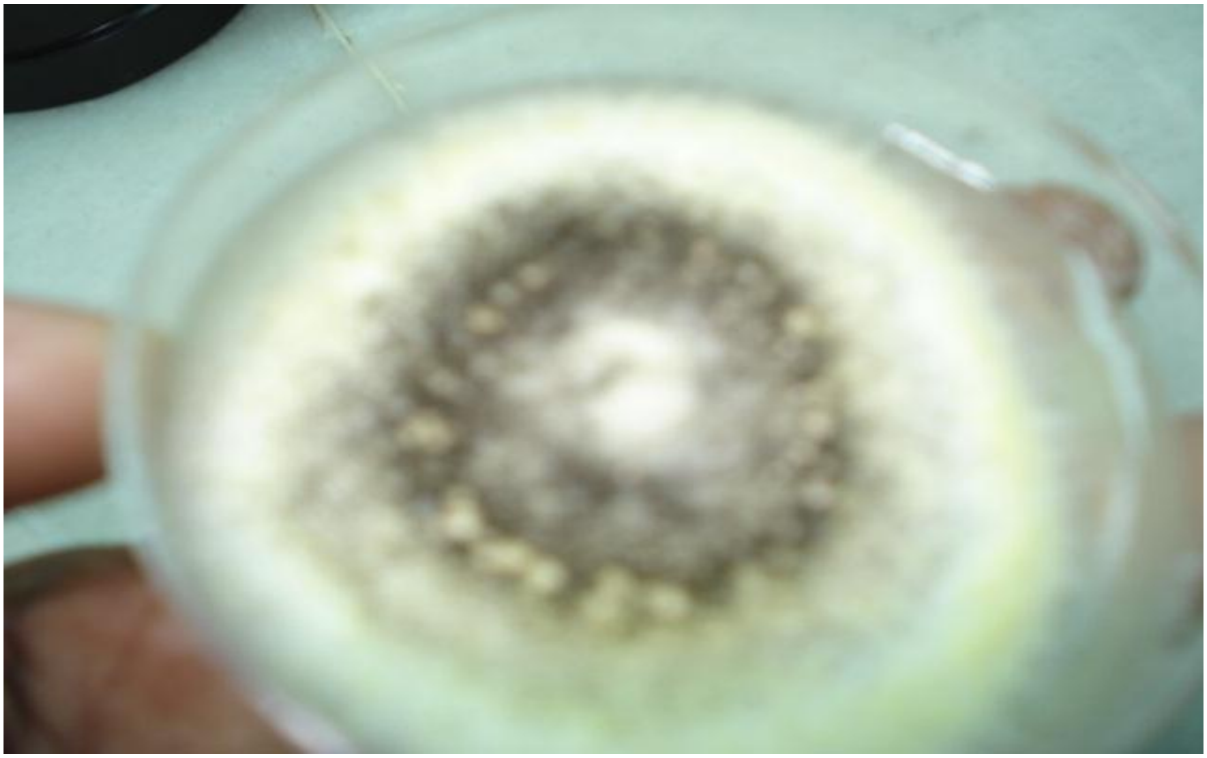


plate (4.5) colony of *Alternaria spp* on corn agar from indoor air of sector 2 taken at February(sample B2Fi)

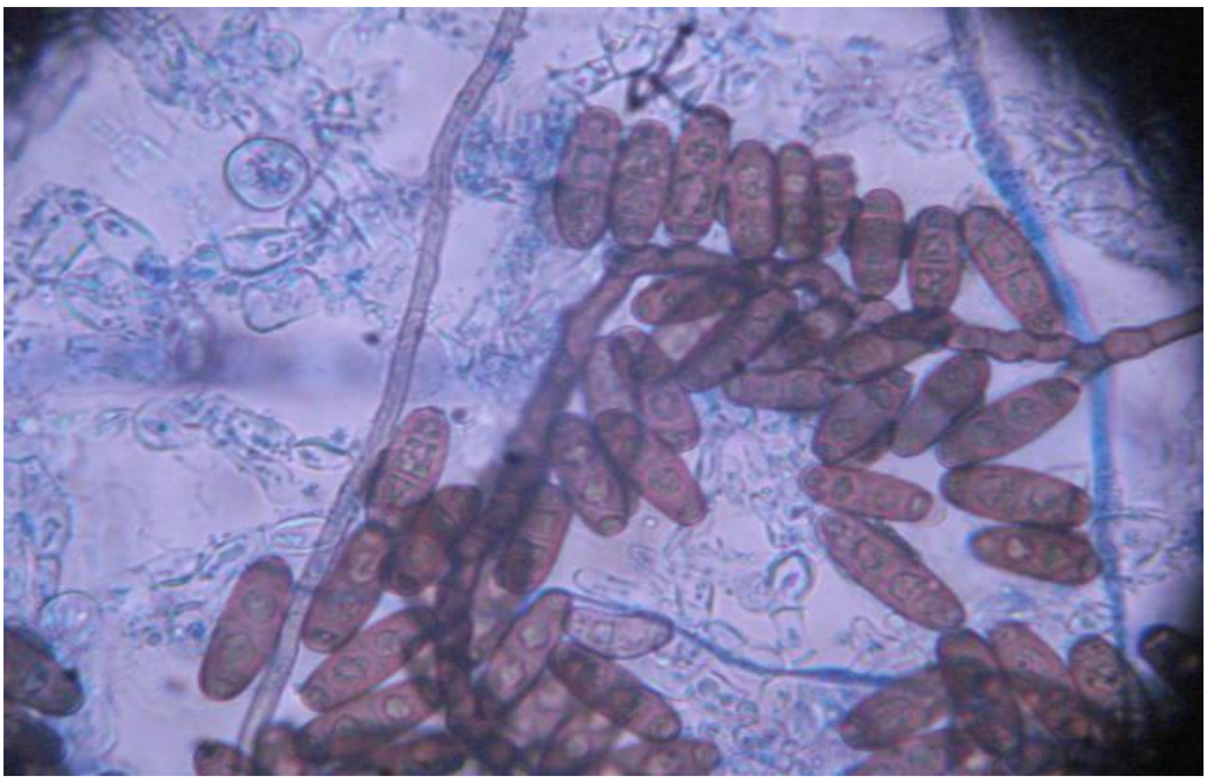


plate (4.6) microscopic view of *Alternaria spp* stained by lactophenol cotton blue (sample B2Fi)

plate (4.7) microscopic view of *Alternaria spp* stained by lactophenol cotton blue (sample B2Fi)

plate (4.8) 2 colonies of Penicillium spp on corn meal agar from outdoor air of sector 3 taken at February (sample B3Fo)

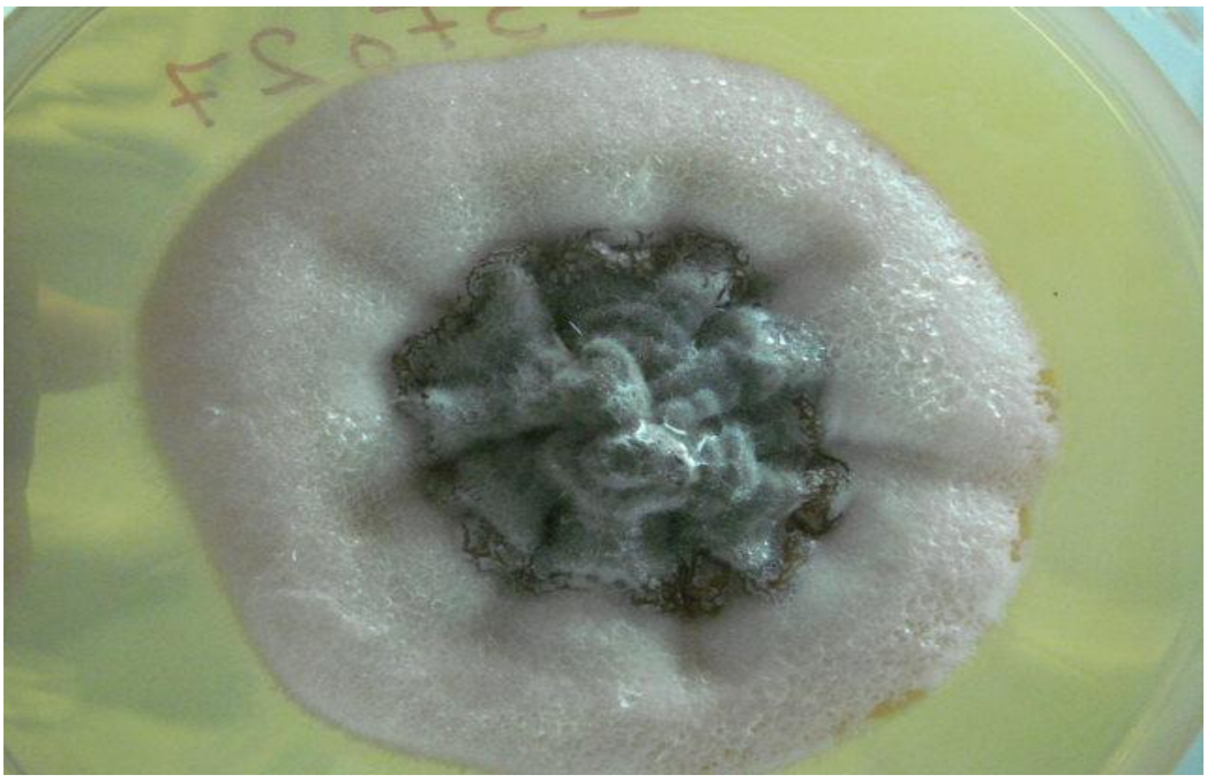


plate (4.9) colony of Curvularia spp on corn meal agar from outdoor air of sector 3 taken at May (sample E3Fo)

Discussion

Household ventilation is a function of both climate and development. Ideally, such ventilation is appropriate to the surrounding environment, with reduced ventilation rates in colder climates/seasons and increased rates in more temperate climates/seasons. Ventilation tends to be better controlled with increased economic development. While exposure assessment can be used to estimate exposures experienced by the "average" individual, it is often used to address populations most likely to be at risk. This includes populations likely to experience the highest exposures, as well as those most susceptible to these exposures. Host factors, such as activity, lifestyle, behavior and susceptibility, must be taken into consideration. Susceptible populations include young children, the elderly *(50)*.

This study shows that (81.6 %) of the families have 3 – 5 rooms in their houses with both types of ventilation (80%), supported with three windows in each room (83%), with family size ranged between 5 to 10 (71.6%). That means there is enough spaces which is well ventilated but there are some factors that might affect the indoor air quality, such as existing of animals in the homes 55% , plants 81.7% and insects 70% .

Air pollution can affect our health in many ways with both short-term and long-term effects. Many ordinary activities such as cooking, heating, cooling, cleaning, and redecorating can cause the release and spread of indoor pollutants at home (1). The study shows that 75% do activities such as cleaning 63% and cooking 6.7%.

Different groups of individuals are affected by air pollution in different ways. Some individuals are much more sensitive to pollutants than are others. Young children and elderly people often suffer more from the effects of air pollution. In this study the number of children under 15 years range between 1to 3 (41.7%), 4to6 (26.6%). Sixty percent of the families complain from respiratory tract infection with common signs of watery eyes, running nose, sneezing, coughing, wheezing, difficult breathing, headache and fatigue. Also 1 to 4 persons are suffering from asthma (29.3%) most of them are young children and elderly people (table 4.20).

Relative humidity and temperature have some effect on indoor environment, such as moisture, dampness and growth of molds and bacteria, which might harm individuals' health. The study shows that 55% of the homes have maximum relative humidity (51.4%) combined with low dry bulb temperature 23 -30 degree centigrade indoor, compared with maximum relative humidity (50.1%) combined with low dry bulb temperature 23 -30 degree centigrade outdoor (tables 4.25&4.26). This is different when combined with low wet bulb temperature 23 -30 degree centigrade. In this study ,for indoor environment, relative humidity is ranked as highly significant followed by air velocity, then the average cooling time, the site and the sampling time (table 4.29), compared with relative humidity followed by the average cooling time, then the sampling time, the site and the air velocity outdoor(table 4.30).

In a building two sources need to be taken into account, an exogenous source which penetrates into the building via ventilation systems or via the occupants; and an endogenous source which is related to the survival and development of micro-organisms inside the building. Aerial dissemination takes place in various modes. It can be continuous or discontinuous. Speaking, coughing, and sneezing cause large numbers of microbial droplets to be expelled which, after very fast evaporation, give rise to small biological particles that are isolated or in clusters. These particles are aerosols which are easily dispersed and capable of covering long distances. In addition, the skin scales continuously released by the keratinized layer of the epidermis also contaminate the atmosphere with bacteria. The quality of air inside buildings is a growing concern for hygiene and public health, it can cause various pathologies, immuno-allergic disorders of bacterial and fungal origin and severe ailments in humans and animals. Building practices for commercial and public structures as well as residences have changed markedly in the past three decades, making many buildings more prone to moisture problems that lead to higher levels of microbial contaminants. Poor understanding of moisture dynamics and careless building design and construction lead to structures that are more susceptible to water intrusion. Also, lack of good maintenance practices in some buildings can lead to moisture buildups that, when left alone, can result in microbial contamination and higher levels of bioaerosols. (1)

Mechanical disturbance of a contaminated water environment or of a biofilm colonizing a surface, and handling of a contaminated material or substance also release micro-organisms. The formation of biological aerosols can thus be facilitated by certain humidifier systems, cooling towers, and when cleaning a contaminated surface without taking any particular precautions. Moisture is the principal determinant of mold growth indoors. Different levels of moisture are needed for growth of different molds. For instance, *Aspergillus* and *Penicillium* require little available moisture and often are found along drier areas of water damaged materials. Other molds that require higher levels of moisture include *Stachybotrys* and *Chaetomium*. In this study molds are detected both indoor and outdoor, (table 4.38). In contrast to viruses, bacteria and fungi will grow, often to an alarming extent, on building materials if moisture is available. Background levels of airborne bacteria and fungi change frequently inside buildings as a result of human activity, especially operation of mechanical air handling systems. Indeed, building conditions that allow excessive growth of bacteria or fungi can lead to occupants developing various specific medical symptoms or other complaints. (1)

Many people spend large portion of time indoors - as much as 80-90% of their lives. We work, study, eat, drink and sleep in enclosed environments where air circulation may be restricted. For these reasons, some experts feel that more people suffer from the effects of indoor air pollution than outdoor pollution. (1)

In a recent report, the Institute of Medicine (IOM) concluded that "there is sufficient evidence of an association between exposure to a damp indoor environment and asthma symptoms in sensitized asthmatic people" and that "there is a sufficient evidence of an association between the presences of 'mold' (otherwise unspecified) in a damp indoor environment and asthma symptoms in sensitized asthmatic people."(1)

In this study different species of bacteria and molds were found with variable frequency in all sectors during the whole months of the year. Two groups of bacteria were identified and categorized into Gram +ve & Gram –ve. The most abundant frequent species of Gram –ve were *Pseudomonos aeraginosa 33 , Hafnia alvei 6 , E.coli 6 , Cedecea davicae 4 , Providincia rettgeri 2 and Klebsiella pneumonia 2* (table 4.35). The Gram +ve bacteria include a group of Bacillus species 44 and one Enterococcus species.

The maximum number of species was found during January (9 species) August, September, October, Novmber and December (7 species) . The lowest number of bacterial Species was found in February , March, April and May. The rainy months, i.e. June, July show no growth. However, individual types of bacterial Species exhibited their own maximum and minimum frequency distribution during different months and seasons e.g.

Pseudomonos aeraginosa were found throughout the year; other species showed a more or less seasonal pattern as shown in table (4.36).

Of the total 120 exposed petri dishes fungal spores were collected on only 105.The remaining lacked any fungal spores. Using the subculture method fungal colonies were obtained only on 60 Petri dishes and these colonies were identified up to the species level. They were categorized into 17 species and a group of unidentified elements. Species of *Alternaria, Aspergillus, Curvularia, Fusarium, Penecillium*,*Bipolaris* showed excellent growth on exposed culture media dishes. Several other types of spores were also found in comparatively low numbers. Figure(4.11)

The seasonal and monthly variations of the air-born fungi were studied qualitatively. The most abundant frequent species were *Aspergillus* (25), *Alternaria* (8) ,*Curvularia* (6), *Bipolaris* (5), *Aureobasidium* (3), *Fusarium* (2), *Zygomycotes*(2)and *Penecillium* (1). The maximum number of species was found during January and December (8) February and April(7) March and May (9). The lowest numbers of fungal spores was found in the rainy months, i.e. June, July , August and September. However, individual species of fungal spores exhibited their own maximum and minimum frequency distribution during different months and seasons e.g. *Aspergillus, Altemaria, Curvularia and Bipolaris,*were found , more or less throughout the year,both indoor and outdoor and in all sectors ; other species show a more or less seasonal pattern as shown in tables (4.37,4.38&4.39).

Recently the IOM report stated that “there is sufficient evidence of an association between the presence of mold and bacteria in damp indoor environments and hypersensitivity pneumonitis" in sensitized persons. The IOM also referred to a possible association between exposure to damp environments, the presence of molds, and an increased risk of lower respiratory tract illnesses in otherwise healthy children.(1)

Exposure to high levels of indoor moisture is associated with upper respiratory symptoms, including higher incidence of coughing, wheezing, and asthma in sensitized persons, according to several large epidemiological studies cited by the IOM.

Health care professionals face the challenge that these symptoms are common and are associated with many different disorders. Medical conditions associated with exposure to viruses, bacteria, or fungi include infectious diseases, respiratory disorders such as bronchitis and asthma, and other allergic, inflammatory, and toxic responses. In some cases, evidence links these disorders to exposure to bioaerosols. The study shows that the spread of infections indoors, allergic reactions may be the most common health problem with indoor air quality in homes. They are often connected with animal dander (mostly from cats and dogs); in this study cats and dogs are in 28.3% of the studied houses.

The substances that cause allergic diseases in people are known as allergens, these allergens can get into our body in several ways one of them is Inhalation into the nose and the lungs. Examples are airborne pollens of certain trees, grasses and weeds; house dust that include dust mite particles, mold spores, cat and dog dander and latex dust. The study shows that inhalation is a known way for getting allergens into the body 88.3% (table

4.11) and that the allergens are pollen grain 46.7%, microorganism 21.7% and animals1.7% (table 4.12).

The prevalence of allergic diseases such as Allergic Rhinitis (AR) and atopic dermatitis has risen substantially in recent decades (2, 3). Of all the allergic disorders, AR probably has the greatest impact on productivity, because it tends to be a lifelong condition, because the causative allergens are usually difficult or impossible to avoid, and because of its pathophysiologic relationship to asthma. Although AR often begins in childhood, its highest prevalence is between the ages of 18 and 49 years. (7).The study implies that rhinitis (hay fever) is the common allergy 38.3% then asthma11.7% (table 4.13).

In general, the types and concentrations of mold that affect Indoor Air Quality (IAQ) are similar to those found in outdoor air. However, background mold numbers may shift whenever water accumulates in buildings. Damage caused by floods, plumbing leaks, or roof and window leaks, and even climate and air conditioning related condensation can lead to long term water related damage indoors. Once water accumulates in building materials and furnishings, it takes less than 72 hours for mold to begin growing on those dampened surfaces.

Qualitative and/or secondary data sources, such as data on traffic characteristics, the distance of the home from a busy street, traffic intensity on the street of residence, energy consumption and information on indoor sources, can be used to indicate potential exposure.

Seasonal patterns are extremely location-specific, and may vary substantially from year to year. The impact of seasonal patterns on the relationship between indoor and outdoor concentrations needs to be carefully evaluated. In some places, extremes of temperature are often addressed by controlling indoor temperatures in ways that limit ventilation (such as with increased use of air conditioning or heating). In other places, however, increases in temperature may increase the air exchange rate of housing, owing to resulting changes in physical exchange processes as well as changes in human activity (such as opening windows and doors more frequently in warmer weather). The impact of these changes on human exposure will depend on the location of pollution sources (indoors or outdoors) as well as any changes in activity patterns attributable to the season.

In this study, for indoor environment, relative humidity is ranked as highly significant followed by air velocity, then the average cooling time, the site and the sampling time (table 4.29), compared with relative humidity followed by the average cooling time, then the sampling time, the site and the air velocity outdoor (table 4.30).The amount of air pollution penetrating from outdoors to indoors depends on the penetration coefficient, the ventilation rate and the decay rate *(32)*.

Aerobiocontamination measures taken in indoor environments up until now have not made it possible to show a clear relationship of cause and effect between inhaling airborne biological particles and the appearance of symptoms of various degrees of seriousness and of specificity.

Allergies from airborne particles are caused by certain tree, weed and grass pollen as well as fungal spores. Fungal spores are also found in high numbers at certain times of the year, many of these are not the source of human, animal or plant disease but many of them are. Airborne dust and its particles, which include mold spores, animal dander, mites, and other allergens in indoor air are a major source of allergic reactions. Those that produce spores and get airborne are called aeroallergens. An example is *Penicillium*. Fungi are found in decaying materials, such as leaves and trees, on fences, in soil, water, air and also food.

The field of Aerobiology deals with those that are found in the air. Some fungi are considered opportunistic and usually cause disease in people who have abnormal immune systems. These fungi, usually do not cause serious infections in the immunocompetent host but can cause serious illness in immuno-compromised patients. In contrast dimorphic fungi are those that are capable of causing disease in people with normal immune systems.

In the present study large numbers of fungal propagates, small round spores and smut spores are of common occurrence. The frequency distribution of these fungal spores varies from month to month, and season to season. The maximum number of species was found during January, February, March, April, May and December. The lowest number of fungal spores was found in the rainy months, i.e. June, July , August and September. However, individual species of fungal spores exhibited their own maximum and minimum frequency distribution during different months and seasons for example *Aspergillus, Altemaria, Curvularia and Bipolaris,*were found in many months of the year; other species show a more or less seasonal pattern. The occurrence of many of these spores is related to their production, and to rain, temperature and wind velocity in the locality. Large numbers of plants and plant debris act as boost for the commonly occurring fungi. In the rainy months the fungal population decreases because most of the atmospheric microbes are washed down by rain. Most of the exposed clean Petri dishes without spores came from rainy months (July and August), only a few from hot summer and severe winter. Following this period in the clear weather the spores are carried to and from with the air currents resulting in good quantity and quality. Due to lower temperature in winter, the fungal population decreases and again the optimum temperature favors the aerobiotic population during February to April. Then the concentration again starts decreasing due to high temperature.

There are thousands of spores found in the air that we breathe but only a few of them can cause human disease. Table (4.39) reveal that sector 1 and sector 2 are exhibit similar behavior, probably as a result of their geographic proximity and their overall climates. These two sampling sites present a slightly similar annual variation pattern, with two main seasons in which the existence of *Aspergillus* is higher than during the rest of the year. The existence is low in winter, rise significantly in summer, fall during the autumn and rise again in the late autumn. Variation patterns for the other sectors (3, 4 and 5) are not so markedly seasonal. In fact, they exhibit a single period of increased existence, the existence increase during May and Des, peak in the summer and then fall in late autumn, remaining at low levels during the winter.

Some of the found fungal spores are similar in appearance (small round spores) did not identified up to the generic level from the slides. Many of these were, however, identifiable to the specific level in the culture media (the plates). Similarly, many of the spores found on the slides did not grow well in the culture media, e.g. *Exserohilium* sp., *Bactrodesium* sp., *Phaeosclera* sp., *Pseudoallscheria* sp, *Cladosporium* sp*, Absidia* sp, *Chactomium* sp and Ascotrchia sp. Thus the present results support the necessity of combining the methods.

The air borne fungal spores at corn meal agar show great richness qualitatively as well as quantitatively as compared to the studies conducted at Kanpur, Saugar and Delhi. Though every locality represents its own aerobiota.

Though many of the spores in the air showed variations with respect to weather conditions, however smut spores did not exhibit marked seasonal variations and occurred in the air in many months of the year, probably due to their wide range of availability in the locality. Thus, the seasonal periodicity of fungal spores with respect to variation in weather resembles the general principles.

Considering the fungal spores as a whole, in the present study, little is known about the structural aspects of atmospheric spores. Most of the spores abounding in the air are small in size, produced on a large scale and have a comparatively simple structure.

CONCLUSIONS

The study enabled the following conclusions to be drawn:

- The study shows that (81.6 %) of the families have 3 – 5 rooms in their houses with both types of ventilation (80%) supported with windows, three in each room.
- The study shows the existence of different types of animals in the homes 55%, plants 81.7% and insects 70% .
- 60% of the families complain from respiratory tract infection and the common signs and symptoms are watery eyes, running nose, sneezing, coughing, wheezing, difficult breathing, headache and fatigue.
- The study shows that 75% do activities such as cleaning 63% and cooking 6.7%).
- Also 1 to 4 persons are suffering from asthma (29.3%), most of them are young children and elderly people.
- In this study ,for indoor environment, relative humidity is ranked as highly significant followed by air velocity, then the average cooling time, the site and the sampling time, compared with relative humidity followed by the average cooling time, then the sampling time, the site and the air velocity in outdoor environment .

- In this study *Pseudomonos aeraginosa* , *Hafnia alvei* , *E.coli* , *Cedecea davicae* , *Providincia rettgeri* and *Klebsiella pneumoniae* are the most found bacteria .
- The fungal Species of *Aspergillus, Alternaria, Curvularia, Fusarium, Penecillium*, *Bipolaris* showed excellent growth on exposed culture media. Several other types of spores were also found in comparatively low numbers.
- The most abundant frequent types were *Aspergillus* sp (25), *Alternaria* sp (8) ,*Curvularia* sp (6), *Bipolaris* sp(5), *Aureobasidium* sp(3), *Fusarium* sp(2), *Zygomycotes* sp(2) and *Penecillium* sp(1).
- The maximum frequency of fungal Species was found during December (8) February , March, April and May (7).
- The lowest numbers of fungal spores was found in the rainy months, i.e. June, July , August and September.
- However, individual types of fungal spores exhibited their own maximum and minimum frequency distribution during different months and seasons.
- The study demonstrates the following categories of the fungal spores in the air:

  (i) Occurring almost throughout the year: *Altemaria and Aspergillus* spp.

  (ii) Those common during February to May: *Altemaria tenuis, Aspergillus niger, Curvularia clavata, Bipolaris* sp, *Fusarium* sp and *Penecillium* spp.

(iii) Those having high concentration during December to April: *Aspergillus niger, Altemaria tenuis, Fusarium spp.*

(iv) Those having their peak abundance during May to August: *Aspergillus spp .*

RECOMMONDATIONS

1) A comprehensive study, of indoor air biological species, should be done by the Sudanese Standards &Metrology Organization (SSMO) in order to establish Standards for biological allergens.

2) Shendi university should help in establishing well developed and improved methodologies, for better detection of bioaerosols.

3) Parents, teachers and health care providers should work together to help preventing and treating childhood allergies.

4) The allergens to which children are sensitized are primarily those which can be inhaled thus Shendi locality should take steps to avoid or eliminate these allergens by monitoring the classrooms for plants, pets or other items that may carry allergens.

5) Indoor moisture must be controlled by the households because moisture control is the key to mold control.

6) The best way to prevent allergy symptoms is to avoid allergens as much as possible and to eliminate the source of allergens from homes and other environments. Thus the students of faculty of public health should take a part in raising the public awareness.

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Appendix I

Questionnaire to assess the biological allergens impact on human health in Shendi town

1- Date………………………………………….   (   )

2- Sheet No ……………………………………. (   )   .

3- Block No…………………………………….. (   )

4- Plot No ……………………………………….. (   )

5- What is the area of the house? .... (   )

6- What is the number of rooms?

a. one………………………………………(   )

b. two……………………………………....... (   )

c. three…………………………………..   (   )

d. four…………………………………   (   )

e. five & more …………………………… (   )

7- What is the type of ventilation?

a. artificial ……………………………………....... (   )

b. natural …………………………………….. (   )

c. artificial & natural .... (   )

8- Number of windows per room?

a. no ………………………………………….. (   )

b. one ………………………………………... (   )

c. two ……………………………………….. (   )

d. three …………………………….,…….. (   )

e. four ………………………………………... (   )

9- Animal in the house?

a. goats ………………………………….   (   )

b. cows ………………………………….   (   )

c. cats ……………………………………   (   )

d. dogs ……………………………………   (   )

e. others ………………………………….   (   )

10- Insect in the house?

a. flies …………………………………..   (   )

b. mosquitoes ……………………………..   (   )

c. spiders …………………………………..   (   )

d. cockroaches ……………………………. (   )

e. others ………………………………… (   )

11- Plants in the house?

a. trees ……………………………………… (   )

b. grass …………………………………… (   )

c. weeds …………………………………. (   )

d. all …. …………………………………. (   )

e. none …………………………………….. (   )

12- What is the size of the family?

a. 2 – 4 …………………………………….. (   )

b. 5 – 7 ……………………………………. (   )

c. 8 – 10 …………………………………….. (   )

d. 11 – 13 …………………………………. (   )

e. 14 & more………………………………. (   )

13- What is the number of children under 15 years?

a. 0 – 2 ………………………………………. ( )

b. 3 – 5 ………………………………………. ( )

c. 6 - 8 ………………………………………. ( )

d. 9 – 11 ………………………………………. ( )

e. 12 – 14 ………………………………………. ( )

14- Number of males under 15 years?

a. 0 – 2 ………………………………………. ( )

b. 3 – 5 ………………………………………. ( )

c. 6 - 8 ………………………………………. ( )

d. 9 – 11 ………………………………………. ( )

e. 12 – 14 ………………………………………. ( )

15- Number of females under 15 years?

a. 0 – 2 ………………………………………. ( )

b. 3 – 5 ………………………………………. ( )

c. 6 - 8 ………………………………………. ( )

d. 9 – 11 ………………………………………. ( )

e. 12 – 14 ………………………………………. ( )

16- What is the pattern of diseases in your house?

a. respiratory tract infections ………………. (   )

b. GIT diseases …………………………….. (   )

c. ENT diseases ……………………………. (   )

d. eye diseases ……………………………… (   )

e. skin diseases ……………………………… (   )

17- Common signs & symptoms?

a. watery eyes ……………………………… (   )

b. runny nose & sneezing …………………… (   )

c. coughing ………………………………… (   )

d. wheezing & difficulty breathing ………… (   )

e. headache & fatigue ……………………… (   )

18- What are the common allergies?

a. rhinitis (hay fever) ……………………… (   )

b. asthma …………………………………… (   ) .

c. food allergy …………………………….... (   )

d. drug allergy ……………………………… (   )

e. skin allergy ………………………………. (   )

19- What is asthma?

a. chronic lung disease ……………………….... ( )

b. airway hypersensitivity …………………… ( )

c. bronchitis ………………………………..... ( )

d. viral associated wheezing ………………….. ( )

e. difficult breathing ………………………….. ( )

20- What cause allergies?

a. pollen ………………………………….. ( )

b. food ……………………………………. ( )

c. drug ……………………………………. ( )

d. animal ………………………………… ( )

e. microorganism …………………………… ( )

21- How allergens get into our body?

a. inhalation ……………………………… ( )

b. ingestion ……………………………… ( )

c. injection .... ( )

d. absorption .... ( )

e. do not know …………………………… ( )

22- What is the impact of allergic diseases?

a. low productivity ………………………….. (   )

b. role limitation …………………………….. (   )

c. mental disorders ………………………….. (   )

d. health effects …………………………….. (   )

e. death …………………………………… (   )

23- What is the number of people with asthma in your home?

a. 0 – 1 …………………………………… (   )

b. 2 – 3 …………………………………… (   )

c. 4 – 5 …………………………………… (   )

d. 6 – 7 …………………………………… (   )

e. 8 – 9 …………………………………… (   )

24- What is the age of asthmatic people in your home?

a. under 15 ………………………………. (   )

b. 16 – 25 ………………………………… (   )

c. 26 – 35 ………………………………… (   )

d. 36 – 45 ………………………………… (   )

e. 46 – 55 ………………………………… (   )

25- How long does allergy last?

a. minutes ………………………………… ( )

b. hours …………………………………… ( )

c. days ……………………………………. ( )

d. weeks …………………………………… ( )

e. months ………………………………….. ( )

26- How is it diagnosed?

a. by the sign ………………………………. ( )

b. skin test ………………………………… ( )

c. blood test ……………………………….. ( )

d. air sampling …………………………….. ( )

e. dust sampling ………………………........ ( )

27- How is it treated?

a. by its own ………………………………. ( )

b. by changing the place ……………………. ( )

c. by changing the work ……………………. ( )

d. by changing the environment …………… ( )

e. by treatment ……………………………. ( )

28- How can it be prevented?

a. by knowing the allergens ………………… ( )

b. by knowing the history of the family ……. ( )

c. by keeping your home clean …………….. ( )

d. by increasing the ventilation rate ………. ... ( )

e. by controlling temp &humidity …………. ( )

29- What are the activities which can play a part?

a. cooking …………………………………. ( )

b. heating ……………………………………. ( )

c. cooling ……………………………………. ( )

d. cleaning ………………………………….. ( )

e. redecorating ………………………………. ( )

30- What is the time spending at home?

a. 24 hours ………………………………. ( )

b. 12 hours ………………………………. ( )

c. 8 hours ……………………………….. ( )

d. 6 hours ………………………………. ( )

e. 3 hours ………………………………. ( )

31- What is the time spending at work?

a. 24 hours ………………………………. ( )

b. 12 hours ………………………………. ( )

c. 8 hours ……………………………….. ( )

d. 6 hours ……………………………….. ( )

e. 3 hours ……………………………….. ( )

Appendix II

Time, activities survey (Check list)

1. Does anyone in the family have frequent headaches, fevers, itchy watery eyes, a stuffy nose, dry throat, or a cough

    a. YES ……………………………………………… (   )

    b. NO ……………………………………………….. (   )

2. Does anyone complain of feeling tired or dizzy all the time?

    a. YES ……………………………………………… (   )

    b. NO ……………………………………………….. (   )

3. Is anyone wheezing or having difficulties breathing on a regular basis?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

4. Did these symptoms appear after you moved to a new or different place?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

5. Do the symptoms disappear when you go to school or the office or go away on a trip, and return when you come back?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

6. Have you recently remodeled your home or done any energy conservation work, such as installing insulation, storm windows, or weather stripping?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

7. Did your symptoms occur during or after these activities?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

8. Does your home feel humid?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

9. Can you see moisture on the windows or on other surfaces, such as walls and ceilings?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

10. What is the usual temperature in your home? Is it very hot

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

11. Have you recently had water damage?

a. YES …………………………………………… ( )

b. NO ……………………………………………. ( )

12. Is your basement wet or damp?

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

13. Does any part of your home have a musty or moldy odor?

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

14. Is the air stale?

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

15. Do you have pets?

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

16. Do your house plants show signs of mold?

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

17. Do you have air conditioners or humidifiers that have not been properly cleaned?

a. YES ……………………………………………… ( )

b. NO ……………………………………………… ( )

18. Does your home have cockroaches or rodents?

a. YES ……………………………………………… ( )

b. NO ……………………………………………… ( )

19. There is dust and construction materials, such as wood, wallboard, and insulation

a. YES ……………………………………………… ( )

b. NO ……………………………………………… ( )

20. Appliances such as humidifiers, kerosene and gas heaters, and gas stoves add moisture to the air

a. YES ……………………………………………… ( )

b. NO ……………………………………………… ( )

21. There is musty odor, moisture, or even water stains on hard surfaces

a. YES ……………………………………………… ( )

b. NO ………………………………………………. (   )

22. Fix leaks and seepage. If water is entering the house from the outside,

a. YES ……………………………………………. (   )

b. NO ………………………………………………. (   )

23. Put a plastic cover over dirt in crawlspaces to prevent moisture from coming in from the ground

a. YES ……………………………………………. (   )

b. NO ………………………………………………. (   )

24. Use exhaust fans in bathrooms and kitchens to remove moisture to the outside

a. YES ……………………………………………. (   )

b. NO ………………………………………………. (   )

25. Use dehumidifiers and air conditioners, especially in hot, humid climates, to reduce moisture in the air,

a. YES ……………………………………………. (   )

b. NO ………………………………………………. (   )

26. Raise the temperature of cold surfaces where moisture condenses by Open doors between rooms to increase circulation.

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

27. moving furniture from wall corners to promote air and heat circulation

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

28. Pay special attention to carpet on concrete floors to prevent a moisture problem.

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

29. Moisture problems and their solutions differ from one climate to another.

a. YES ……………………………………………… (   )

b. NO ……………………………………………. (   )

30. Have major appliances, such as air conditioners, inspected and cleaned regularly by a professional, especially before seasonal use

a. YES ……………………………………………… (   )

b. NO ………………………………………………. (   )

31. Have window or wall air-conditioning units cleaned and serviced regularly by a professional, especially before the cooling season.

a. YES …………………………………………….. ( )

b. NO ……………………………………………... ( )

32. Clean refrigerator drip pans regularly according to manufacturer's instructions.

a. YES …………………………………………….. ( )

b. NO ……………………………………………... ( )

33. Clean mold surfaces, such as showers and kitchen counters.

a. YES …………………………………………….. ( )

b. NO ……………………………………………... ( )

34. Remove meld from walls, ceilings, floors, and paneling.

a. YES …………………………………………….. ( )

b. NO ……………………………………………... ( )

35. Replace moldy shower curtains, or remove them and scrub well with a household cleaner and rinse before re-hanging them.

a. YES …………………………………………….. ( )

b. NO ………………………………………………. (   )

36. Always wash bedding in hot water

a. YES ………………………………………………. (   )

b. NO ………………………………………………. (   )

37. Launder bedding at least every 7 to 10 days.

a. YES ………………………………………………. (   )

b. NO ………………………………………………. (   )

38. Clean rooms and closets well; dust and vacuum often to remove surface dust.

a. YES ………………………………………………. (   )

b. NO ………………………………………………. (   )

39. wear a mask when vacuuming or dusting

a. YES ………………………………………………. (   )

b. NO ………………………………………………. (   )

40. have exhaust fans in bathrooms and kitchens.

a. YES ………………………………………………. (   )

b. NO ……………………………………………….. ( )

41. If there are no vents, do the kitchen and bathrooms have at least one window apiece?

a. YES ……………………………………………… ( )

b. NO ……………………………………………….. ( )

42. Does the cook top have a hood vented outside?

a. YES ……………………………………………… ( )

b. NO ……………………………………………….. ( )

43. Does the clothes dryer vent outside?

a. YES ……………………………………………… ( )

b. NO ……………………………………………….. ( )

44. Are all vents to the outside of the building, not into attics or crawlspaces?

a. YES ……………………………………………… ( )

b. NO ……………………………………………….. ( )

45. There is obvious mold growth throughout the house,

a. YES ……………………………………………… ( )

b. NO ……………………………………………….. (   )

46. there are plants close to the house, particularly they are damp and rotting.

a. YES ………………………………………………. (   )

b. NO ……………………………………………….. (   )

47. There are stains on the walls, floor or carpet

a. YES ………………………………………………. (   )

b. NO ……………………………………………….. (   )

48. Is there moisture on windows and surfaces?

a. YES ………………………………………………. (   )

b. NO ……………………………………………….. (   )

49. There are rotted building materials which may suggest moisture or water d.

a. YES ………………………………………………. (   )

b. NO ……………………………………………….. (   )

50. There are signs of cockroaches.

a. YES …………( ) b. NO …………… ( )

Appendix III samples result

sample	type	Species	comments
A1Fi			**unknown**
A1Fo	**mould**	*Fusarium*	
A2Fi	**mould**	*Aspergillus flams*	
A2Fo	**mould**	*Aspergillus spp*	
A3Fi	**mould**	*Curvlaria spp*	
A3Fo	**mould**	*Curvlaria clavata*	
A4Fi			**unknown**

A4Fo	**-ve**	**-ve**	
A5Fi	**mould**	*Aspergillus nidulaus*	
A5Fo	**-ve**	**-ve**	

sample	Type	species	Comments
B1Fi	**Mould**	*Bipolaris spp*	
B1Fo	**Mould**	*Alternaria spp*	
B2Fi	**Mould**	*Alternaria spp*	
B2Fo	**-ve**	**-ve**	

B_{3Fi}	**-ve**	**-ve**	
B_{3Fo}	**Mould**	*Penicillium spp*	
B_{4Fi}	**-ve**	**-ve**	
B_{4Fo}	**Mould**	*Aspergillus nigar*	
B_{5Fi}	**Mould**	*Aspergillus nigar*	
B_{5Fo}	**Mould**	*Aspergillus nigar*	

sample	**Type**	**species**	**Comments**

C1Fi	**Mould**	*Aspergillus nidulaus*	
C1Fo	**Mould**	*Curvlaria spp*	
C2Fi	**Mould**	*Bipolaris spp*	
C2Fo	**Mould**	*Exserohilium spp*	
C3Fi	**Mould**	*Aspergillus spp*	
C3Fo			**unknown**
C4Fi	**Mould**	*Aspergillus spp*	
C4Fo	**Moist**	*Bacteria*	

C5Fi	**Mould**	*Alternaria spp*	
C5Fo			**unknown**

sample	Type	species	Comments
D1Fi	**Mould**	*Zygomycotes*	
D1Fo	**Mould**	*Bactrodesium*	
D2Fi	**-ve**	**-ve**	
D2Fo	**Mould**	*Fusarium*	
D3Fi	**-ve**	**-ve**	

D3Fo	**Mould**	*Curvlaria spp*	
D4Fi	**Mould**	*Alternaria spp*	
D4Fo	**Mould**	*Chactomium spp*	
D5Fi	**Mould**	*Ascotrcha*	
D5Fo	**-ve**	**-ve**	

sample	**Type**	**species**	**Comments**
E1Fi	**Mould**	*Aspergillus nigar*	
E1Fo	**Mould**	*Aspergillus nigar*	

E2Fi	**Mould**	*Aspergillus spp*	
E2Fo	**Mould**	*Aspergillus spp*	
E3Fi	**Mould**	*Aspergillus spp*	
E3Fo	**Mould**	*Curvlaria spp*	
E4Fi	**Moist**	*Bacteria*	
E4Fo			**unknown**
E5Fi			**unknown**
E5Fo	**Mould**	*Bipolaris spp*	

sample	Type	species	Comments
F_{1Fi}	**Mould**	*Phaeosclera*	
F_{1Fo}	**-ve**	**-ve**	
F_{2Fi}	**-ve**	**-ve**	
F_{2Fo}	**Mould**	*Curvlaria spp*	
F_{3Fi}	**-ve**	**-ve**	
F_{3Fo}	**-ve**	**-ve**	
F_{4Fi}	**-ve**	**-ve**	

F_{4Fo}	**-ve**	**-ve**	
F_{5Fi}	**Mould**	*Pseudoallscheria*	
F_{5Fo}	**-ve**	**-ve**	

sample	Type	species	Comments
G_{1Fi}	**-ve**	**-ve**	
G_{1Fo}	**-ve**	**-ve**	
G_{2Fi}	**-ve**	**-ve**	
G_{2Fo}	**Mould**	*Aurebasidium spp*	

G_{3Fi}	**-ve**	**-ve**	
G_{3Fo}	**Mould**	*Aurebasidium spp*	
G_{4Fi}	**Moist**	*Bacteria*	
G_{4Fo}	**Mould**	*Aurebasidium spp*	
G_{5Fi}	**-ve**	**-ve**	
G_{5Fo}	**-ve**	**-ve**	

sample	Type	species	Comments
H_{1Fi}	**-ve**	**-ve**	

H1Fo	**Mould**	*Zygomycotes*	
H2Fi	**-ve**	**-ve**	
H2Fo	**Mould**	*Aspergillus nigar*	
H3Fi	**Mould**	*Aspergillus spp*	
H3Fo	**-ve**	**-ve**	
H4Fi	**-ve**	**-ve**	
H4Fo	**-ve**	**-ve**	
H5Fi	**Mould**	*Aspergillus nigar*	

H5Fo	**Mould**	*Bipolaris spp*	

sample	Type	species	Comments
I1Fi	**-ve**	**-ve**	
I1Fo	**-ve**	**-ve**	
I2Fi	**-ve**	**-ve**	
I2Fo	**-ve**	**-ve**	
I3Fi	**-ve**	**-ve**	

I3Fo	**Mould**	*Aspergillus nigar*	
I4Fi	**-ve**	**-ve**	
I4Fo	**Mould**	*Aspergillus nigar*	
I5Fi	**Mould**	*Aspergillus nigar*	
I5Fo	**Mould**	*Bipolaris spp*	

sample	Type	species	Comments
J1Fi	**Moist**	*Bacteria*	
J1Fo	**-ve**	**-ve**	

J2Fi	**Mould**	*Alternaria spp*	
J2Fo	**Moist**	*Bacteria*	
J3Fi	**-ve**	**-ve**	
J3Fo	**-ve**	**-ve**	
J4Fi	**Mould**	*Alternaria spp*	
J4Fo	**-ve**	**-ve**	
J5Fi	**-ve**	**-ve**	
J5Fo	**Mould**	*Alternaria spp*	

sample	type	species	Comments
K_{1Fi}	-ve	-ve	
K_{1Fo}	-ve	-ve	
K_{2Fi}	-ve	-ve	
K_{2Fo}	-ve	-ve	
K_{3Fi}	-ve	-ve	
K_{3Fo}	-ve	-ve	
K_{4Fi}	-ve	-ve	

K4Fo	**-ve**	**-ve**	
K5Fi	**-ve**	**-ve**	
K5Fo	**-ve**	**-ve**	

sample	Type	species	Comments
L1Fi	**Mould**	*Aspergillus nidulaus*	
L1Fo	**-ve**	**-ve**	
L2Fi	**Mould**	*Alternaria spp*	
L2Fo	**-ve**	**-ve**	

L3Fi	**Mould**	*Cladosporium spp*	
L3Fo	**Mould**	*Aspergillus spp*	
L4Fi	**Mould**	*Aspergillus spp*	
L4Fo	**Mould**	*Absidia*	
L5Fi	**Mould**	*Aspergillus nigar*	
L5Fo	**Mould**	*Aspergillus nigar*	