إقــــرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

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DECLARATION

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

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نتيجة الحكم على أطروحة ماجستير

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تقييم جودة الهواء الداخلي في أقسام العناية المركزة لحديثي الولادة في المستشفيات الحكومية بقطاع غزة – فلسطين

Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

وبعد المناقشة العلنية التي تمت اليوم الأربعاء 29 رجب 1435هـ، الموافق 2014/05/28 الساعة الواحدة ظهراً بمبنى القدس، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق ،،،

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بسم الله الرحمن الرحيم

﴿ وَلَوْ أَنَّمَا فِي الْأَرْضِ مِنْ شَجَرَةٍ أَقْلَامٌ وَالْبَحْرُ يَمُدُّهُ مِنْ بَعْدِهِ سَبْعَةُ أَبْحُرٍ

مَا نَفِدَتْ كَلِمَاتُ اللَّهِ ۗ إِنَّ اللَّهَ عَزِيزٌ حَكِيمٌ ﴾

(لقمان: 27)

Dedication

This thesis is dedicated to my parents to whom I owe everything since I was born, as well as, to my wife who supported and encouraged me at all stages of my study. Finally, this thesis is dedicated to my sons, daughters, brothers, sisters, friends and all those who live and work for Palestine.

With respect and love.

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Abstract

The indoor air quality is considered one of the most important factors that affect the residents of indoors, and hospitals - especially the closed units such as the neonatal intensive care units - places that most prone to poor ventilation. The aim of this study was to assess of indoor air quality in three neonatal intensive care units, which were chosen geographically to represent the Gaza strip.

The study adopted two methods to gather information, firstly: field work, by measuring carbon dioxide, carbon monoxide, temperature, relative humidity and suspended particles using special devices, and secondly: a questionnaire exploring views of the staff (doctors and nurses) about indoor air quality and the impact of these elements on them. The study was conducted on 4 March until 22 March 2013, where 108 questionnaires have been filled out in parallel with measurements. 41% of the sample are doctors, 59% nurses, 68% males, 32%females, 56% have bachelor degrees, and 55% have more than five year experience. 43% of the sample were in the NICU of the Shifa Hospital, 35% in the NICU of the Gaza European Hospital, and 22% in the NICU of the Al-Aqsa Martyrs Hospital.

The study showed that the average concentrations of carbon dioxide were often close to the maximum standard of the United States Environmental Protection Agency, and sometimes exceed the limit, especially in the NICU of Shifa Hospital. While the concentrations of carbon monoxide are consistent with the standards recommended by the Environmental Protection Agency in all places of study. As well, the study showed that the temperature was in all places of the study on normal rates, but sometimes it was at Shifa Hospital very close to the limit. While the degree of relative humidity complied with the American standard. For concentrations of suspended particles, it has also complied with the standard of the United States Agency for Environmental Protection.

The study also showed that 60% of employees suffer from the sick building syndrome, where 83% suffer from tired and fatigue, while76% suffer from headache, 78% of them believe that these symptoms are related to their workplace, and 71% of them disappear the symptoms after they leave work.

The results of the statistical analysis (ANOVA) indicated the existence of a statistical significance when compared to the results of the variables for each hospital separately.

Also showed the existence of a statistical significance when comparing the average results for each variable with time in the European Gaza Hospital, while at Shifa Hospital, there were statistical significance with humidity, carbon dioxide and carbon monoxide variables. At Al-Aqsa Hospital there was statistical significance only with variable temperature and carbon dioxide. In contrast, there are no statistical significance in the differences between the response of the questionnaire with some variables such as age and sex.

Consequently, the study suggested some recommendations, especially for officials and decision-makers at the Ministry of Health, and the need to give this issue more attention. And that the environmental awareness and its impact needs to be strengthened among the employees.

Key words: indoor air quality, neonatal intensive care unit, carbon monoxide, carbon dioxide, particulate matter.

Abstract in Arabic

ملخص الدراسة

تعتبر جودة الهواء الداخلي من أهم العوامل التي تؤثر على المقيمين في الأماكن المغلقة، والمستشفيات – خاصة الأقسام المغلقة مثل العناية المكثفة لحديثي الولادة– أكثر الأماكن عرضة لسوء التهوية. وتهدف هذه الدراسة لتقييم جودة الهواء الداخلي في ثلاث وحدات عناية مكثفة لحديثي الولادة اختيرت جغرافيا لتمثل قطاع غزة، عمدت الدراسة إلى طريقتين لجمع المعلومات، الطريقة الأولى: ميداني، عن طريق قياس ثاني أكسيد الكربون، أول أكسيد الكربون، الحرارة، الرطوبة النسبية والجسيمات المعلقة باستخدام أجهزة خاصة للقياس، والطريقة الثانية: إعداد استبانه تستطلع آراء الموظفين (أطباء و ممرضين) حول جودة الهواء الداخلي ومدى أثر هذه العناصر عليهم. أجريت الدراسة في 4 مارس وحتى 22 مارس 2013م ، وقد تم تعبئة الاستبانه بالتوازي مع إجراء القياسات، تم تعبئة 108 استبانه للموظفين، كان منهم 41% طبيب و59% ممرض، 68% ذكور و 32% إناث، 56% يحملون شهادات البكالوريوس، و55% لهم خبرة أكثر من خمس سنوات. 43% من العينة كانت في حضانة مستشفى الشفاء، 35% في حضانة مستشفى غزة الأوروبي و 22% في حضانة مستشفى شهداء الأقصى.

وقد أظهرت الدراسة أن متوسط تركيز ثاني أكسيد الكربون كانت غالبا قريبة من الحد الأقصى لمعيار الوكالة الأمريكية لحماية البيئة، وأحيانا يتجاوز الحد المسموح به خصوصا في حضانة مستشفى الشفاء. بينما كانت تركيز أول أكسيد الكربون تنسجم مع المعايير الموصى بها لوكالة حماية البيئة في جميع أماكن الدراسة. كذلك أظهرت الدراسة أن درجة الحرارة كانت في جميع أماكن الدراسة حول المعدلات الطبيعية، غير أنها في مستشفى الشفاء أحيانا كانت قريبة جدا من الحد الأعلى المسموح به. بينما درجة الرطوبة النسبية امتثلت للمعيار الأمريكي. وأما بالنسبة لتركيز الجسيمات المعلقة فقد امتثلت أيضا لمعيار الوكالة الأمريكية لحماية البيئة.

وأظهرت الدراسة أيضا أن 60% من الموظفين يعانون من أعراض متلازمة المباني، حيث أن 83% يعانون من الإرهاق والتعب، بينما 76% يعانون من الصداع، 78% منهم يعتقدون أن هذه الأعراض لها علاقة بأماكن عملهم، و 71% تختفي عندهم الأعراض بعد مغادرتهم العمل.

أظهرت نتائج التحليل الإحصائي (ANOVA) بوجود دلالة إحصائية عند مقارنة نتائج المتغيرات لكل مستشفى على حده. كما أظهرت أيضا بوجود دلالة إحصائية عند مقارنة متوسط النتائج لكل متغير مع الوقت في مستشفى غزة الأوروبي. بينما في مستشفى الشفاء كانت هناك دلالة إحصائية مع متغير الرطوبة النسبية، ثاني أكسيد الكربون و أول أكسيد الكربون. وفي مستشفى الأقصى كانت دلالة إحصائية فقط مع متغير الحرارة و ثاني أكسيد الكربون. في المقابل، لا توجد دلالة إحصائية في الفروق بين الاستجابة للاستبيان مع بعض المتغيرات مثل العمر والجنس.

واقترحت الدراسة بعض التوصيات وخصوصا للمسئولين وصناع القرار بوزارة الصحة، وضرورة إعطاء هذا الموضوع مزيدا من الاهتمام. وأن الوعي البيئي لهذه العوامل ومدى تأثيرها بحاجة إلى تعزيز لدى الموظفين.

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List of abbreviation

am	In the morning
ANOVA	analysis of variance
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
C°	Celsius
CDC	Center for Disease Control and Prevention
CO	Carbon monoxide
CO_2	Carbon Dioxide
DOSH	department of occupational safety and health
EPA	Environmental Protection Agency
EUROVEN	European Committee of Air Handling and Refrigeration
HVAC	Heating, Ventilation, and Air Conditioning
IAQ	Indoor air quality
IAQMG	Indoor Air Quality Management Group
IDPH	Illinois Department of Public Health
IEQ	Indoor Environmental Quality
MOH	Ministry Of Health
NAAQS	National Ambient Air Quality Standards
NICU	Neonatal intensive care unit
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PCBS	Palestinian central bureau of statistics
pm	In the evening
PM	Particulate Matter
PM_{10}	Particle matter that 10 Micrometer in diameter
$PM_{2.5}$	Particle matter that 2.5 Micrometer in diameter
ppm	parts per million
P-value	Probability
RH%	Relative Humidity
SBS	Sick Building Syndrome

SPSS	Statistical Package for the Social Sciences
Temp	Temperature
UFP	Ultra-fine particles
VOC	Volatile organic compound
WHO	World Health Organization
µm	Micrometer
µg/m3	Microgram per Cubic Meter

Chapter 1: Introduction

1.1 Background of the study

Fresh air is a basic requirement of life; the quality of air inside homes, offices, schools, day care centers, public buildings, health care facilities or other private and public buildings where people spend a large part of their life is an essential determinant of healthy life and people's well-being. Hazardous substances emitted from buildings, construction materials and indoor equipment or due to human activities indoors, such as combustion of fuels for cooking or heating, lead to a broad range of health problems and may even be fatal (WHO, 2010).

Air pollution is a concentration of outdoor matter in the air that adversely affects the health and welfare of people. Air pollutants can be liquid, solid, gaseous, radioactive, or microbial chemicals suspended in the air that are caused by different human activities related to industry, construction, transportation, or natural resources. Such pollutants cause harmful effects to humans, animals, and plants (Karaeen, 2012).

Most of our time is spent in indoor environments, such as hospitals, offices, schools, and homes, so the quality of indoor air becomes important for human health and well-being. Indoor air quality (IAQ) in neonatal wards is a significant factor with respect to both the health of employees and the treatment of neonates. Poor indoor air quality at work decreases employees' comfort and work efficiency and may also cause some work-related symptoms and diseases (Lahtinen et al., 2004).
Furthermore, indoor air problems have been associated with a decrease in work productivity (Niemela et al., 2002).

Human exposure occurs when a person comes into contact with a pollutant of a certain concentration during a certain period of time (Ott et al., 2007). This means that exposure requires both the pollutant and the person to be present. Many studies are being conducted on indoor air pollution, because most people spend a lot of their time indoors, living, working, and studying (Lee et al., 2001).

Sick building syndrome (SBS) is a commonly used term for symptoms resulting from problems with IAQ. Complaints common to SBS include allergic rhinitis, headaches, flu-like symptoms, watering of eyes and difficulty in breathing (Mishra et al., 1992). The first official study about SBS that examined more than one structure was published in 1984 (Finnigan et al., 1984). In confined environments indoor air quality can be related to several causes both chemical (carbon oxides, carbon monoxide (CO) and carbon dioxide (CO_2), environmental tobacco smoke, formaldehyde, and volatile organic compounds) (Dales et al., 2008) and physical (ventilation rate, dampness, temperature, and non-ionizing and ionizing radiation) (Bakke et al., 2008).

Studies developed by some environmental agencies, such as Health Canada and US Environmental Protection Agency (USEPA), indicate that levels of indoor pollutants may be significantly higher than outdoor levels. Since most people spend approximately 90% of their time inside a building, indoor air pollution is a significant concern. Each indoor micro-environment is uniquely distinguished, as determined by the local outdoor air, specific building characteristics, and indoor activities (Godoi et al., 2009).

1.2 Significance of the study

The intensive care units for newborn babies is one of indoor places, where the workers feel of symptoms that may feel as working in an enclosed area due to lack of ventilation and poor indoor air quality, and as we know that there is no database and information helps us to know what it is develop IAQ, and where there is a lack of knowledge about IAQ of the staff and even decision-makers about this subject. This study will help us to see the existing status and to contribute to the development of solutions and provide helpful suggestions to the decision-makers. To the best of our knowledge, there is no previous study about this subject in neonatal intensive care units.

1.3 Objective of the study

Research of indoor air quality and its effects on human being are rare in our country. Therefore, IAQ standards and guidelines have not yet been formulated. In order to fill this gap, several measurements are still to be performed through the country. However, the objectives of this study can be summarized as follows:

1.3.1 General objective

The purpose of this study is to assess indoor air quality in neonatal intensive care units (NICUs) in selected governmental hospitals in Gaza strip.

1.3.2 Specific objectives

The objectives of this research were:

- To assess the air quality {carbon monoxide (CO), carbon dioxide (CO_2), and particulate matter (PM_{10} , $PM_{2.5}$)}in NICUs.
- To identify the thermal comfort {temperature (Temp) and relative humidity (RH %)} in NICUs.
- To investigate the effects of IAQ on the employees' health.
- To provide the decision makers with a healthful suggestions and recommendations about the IAQ.

1.4 research questions

Q1: What is the level of IAQ in the NICUs?

Q2: What is the impact of the elements of the IAQ on the employees?

Q3: What is the impact of the IAQ on the professional performance for employees?

Q4: What are the most common symptoms of SBS suffered by employees?

1.5 Demographic context

The complete area of historical Palestine is about 27,027 km^2; Palestine stretches from Ras Al- Nakoura in the north to Rafah in the south. Palestine is boarded by Lebanon in the north, the Gulf of Aqaba in the south, Syria and Jordan in the east and by Egypt and Mediterranean Sea in the west (Palestinian Ministry of Health, 2005).

The Palestinian territories consist of two politically separated areas West Bank and Gaza Strip. Gaza strip is a narrow zone of land bounded of the south by Egypt, on the west by the Mediterranean Sea, and on the east and north by the occupied territories in 1948. Gaza strip is very crowded place with 46 kilometers long and 5 –12 kilo-meters wide and with a total area of 365 km^2. Gaza strip is administratively divided into five governorates: North, Gaza, Mid-zone, Khan- Younes and Rafah. It consists of four cities, fourteen villages and eight refugees' camps.

1.6 Gaza strip

Gaza Strip has a population of 1,701,437 people. Population density is 4,661 inhabitants per sq. km^2. Gaza Strip has an extremely high population growth rate of over 3.3%, and as a result some 44.2% of the population is under the age of 15 (Palestinian central bureau of statistics (PCBS), 2013).

1.7 Ministry of health hospitals and hospitals beds

The number of hospitals in the Gaza Strip are 29 hospitals (13 government hospital), furnished with 2769 beds (1936 government beds) and Most of the beds are stationed in three big hospital (El Shifa Hospital, Nasser Hospital and European Gaza Hospital), (PMOH, 2010).

1.8 Operational Definition

Employees (Nurse and Doctor)

Nurse

Professional human who had knowledge, skills and self-confidence, that help to work on variety of health units and has multiple rules to apply it (Spakhi, 1999).

Doctor

Medical doctor is a professional who practices medicine, which is concerned with promoting, maintaining or restoring human health through the study, diagnosis, and treatment of disease, injury, and other physical and mental impairments. They may focus their practice on certain disease categories, types of patients, or methods of treatment – known as specialist medical practitioners – or assume responsibility for the provision of continuing and comprehensive medical care to individuals, families and communities (WHO, 2010).

Neonatal Intensive Care Unit (NICU)

An intensive care unit designed with special equipment to care for premature or seriously ill newborn (Mosby's Medical Dictionary, 2009).

Indoor air

Its define as air within a building occupied for at least one hour by people of varying states of health. This can include the office, classroom, transport facility, shopping centre, hospital and home. Indoor air quality can be defined as the totality of attributes of indoor air that affect a person's health and well being. The National Health and Medical Research Council (NHMRC, 2013).

Indoor environmental quality(IEQ)

Refers to the quality of the air in an office or other building environments (center for disease control and prevention (CDC, 2012).

Sick Building Syndrome (SBS)

It is defined as situations in which building occupants experience discomfort and acute health effects that appear to be linked to time spent in building (USEPA, 1991).

Chapter 2: Literature review

Clean air is essential for good health, and this is especially true when it comes to indoor air. U.S. EPA has ranked indoor air pollution among the top five environmental risks. This is because indoor concentrations of some pollutants may be many times higher than their levels outdoors and people spend up to 90% of their time indoors, at home, at work and in recreational environments, therefore, indoor air pollution may pose a greater health threat than outside pollution.

2.1 Indoor environment

Indoor environmental quality is a generic term used to describe the attributes of enclosed spaces, including the thermal, acoustic and visual environment, as well as IAQ. Both physical (measurable) and perceptual (human comfort) factors play a key role in defining IEQ. The IEQ in a building may have an influence on health, wellbeing and comfort of building occupants, which in turn may impact on their productivity at work (Paevere, et al., 2008). The key components of IEQ can be divided into (Paevere, et al., 2008):

Indoor air quality, thermal comfort, acoustic environment quality, and luminous and visual environmental quality.

Each indoor microenvironment is uniquely characterized, and is determined by local outdoor air, specific building characteristics and indoor activities (Stranger, et al., 2007). IEQ has also been defined as anything of the built environment that impacts the health and/or comfort of the building occupants (California Integrated Waste Management Board, 2007).

Indoor air quality refers to the totality of attributes of indoor air that affect a person's health, well-being and comfort. According to the American Association of School Administrators IAQ in schools involves all aspects of the environment from temperature, humidity and ventilation to the chemical and biological elements that exist inside schools (American Association of School Administrators, 2008). The USEPA has ranked IAQ among the top five environmental risks to public health (USEPA, 1999). The IAQ is characterized by (Paevere, et al., 2008):

Physical factors, such as ambient temperature, humidity and ventilation rate, air pollutant factors, such as pollutant levels and exposure times, human factors, such as occupant health status, individual sensitivity and personal control.

The indoor air can be affected by the inflow of polluted outdoor air through windows or other openings, evaporation of substances from water, and in some locations, infiltration of radon and other gases into building from underlying soil and bedrock (Harrison, 2002). Other factors that may contribute to poor IAQ include poor cleaning practices, poor moisture control (e.g. water leaks or persistent damp surfaces), human occupancy (e.g. odors) and poor building maintenance (Paevere, et al., 2008). From previous studies it is apparent that indoor- outdoor ratios can alter considerably from one day to the next, even when building conditions (ventilation, window and door use etc.) remain the same (Li and Harrison, 1990). Major contributors to poor IAQ can be summarized into (Paevere, et al., 2008):

New building materials, new furniture, office equipment, heating, ventilation, and air conditioning (HVAC) system performance and maintenance, and Poor outside air quality.

It has been suggested that modern buildings with better insulation may result in warmer, more humid houses with a poorer availability of fresh air (Jones, 1998). Poor ventilation has been associated with several health outcomes including SBS, perceived air quality and respiratory allergies and asthma (Seppanen, 1999). Building dampness, due to high indoor humidity causing condensation, poor building design or structure deficiencies, has been defined as a potential problem for respiratory health, by being a breeding ground for molds, fungi, bacteria and dust mites (Ooi, et al., 1998).

Luoma and Batterman showed in 2001 that in indoor environments, where there is no specific source of pollution (such as smoking and the combustion of fuel for heating and/or cooking), occupant related activities may represent a principal source of dust (composed of cloth fibers, hair fragments, soil particles, skin cells, re-suspended of various origin by walking, and emissions from materials handled, such as paper, fungi spores, and fibers, etc.) (Luoma and Batterman, 2001).

2.2 Carbon dioxide (CO_2)

It is a standard method to use levels of CO_2 as an indicator of human emissions. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) ventilation standard has a recommendation for indoor CO_2 levels at a maximum 1000 ppm (parts per million) (ASHRAE, 1999).

The degree of contamination of IAQ can be evaluated by measuring CO_2 levels. If the indoor CO_2 level is high, the risk of SBS rises (Gupta et al., 2007).

A recent article concludes that SBS decreased when CO_2 is reduced down to 800 ppm (Norback, 2009). CO_2 is generally not found at hazardous levels in an indoor environment, yet it is often measured when trying to determine the indoor air quality of a building. The reason is that it is a good surrogate measure of how well the ventilation system is working in relation to the number of occupants. CO_2 transfers into a certain room through the breathing of those who are in the room. The level of CO_2 depends on the original level of CO_2 , room volume, number of persons in the room, individual's age (weight), their activities, air-exchange rate and the time spent in the room. CO_2 can also results from burning, for example candles or from fireplaces (Health Authority of Kjos, 2002). The air we exhale has the level of carbon dioxide is around 40.000 ppm and the levels in outdoor air is 350-450 ppm. When levels of CO_2 are between 500-1000 ppm, people starts to feel discomfort (Minnesota Department of Health, 2008).

Seppanen and Fisk concluded that beneficial health effects could be achieved by reducing CO_2 down to 800 ppm (Seppanen and Fisk, 2004). Another review for European Committee of Air Handling and Refrigeration (EUROVEN) concluded that a low ventilation rate is associated with bad health effects and decreased performance in offices (Wargocki et al., 2002).

CO_2 could be used as an indicator of human emissions. In the ventilation standard in Sweden it is recommended that indoor CO_2 levels should be below 1,000 ppm (National Swedish Board of Occupational Safety and Health, 2000).

A study done on the concentration and number of particles in 64 classrooms in Germany, identified that increased concentrations of PM correlated significantly with increased level of CO_2 (as cited in: Stranger, et al., 2008). It is very easy and inexpensive to measure CO_2 and thus it is commonly used as preliminary test weather a ventilation system is adequate.

2.3 Carbon monoxide (CO)

Carbon Monoxide is an odorless, tasteless, colorless gas. CO is an un-reactive gas and readily penetrates from outdoors without undergoing significant depletion by physical and chemical processes other than by dilution through air exchange. Once it is present in the indoor air, whether from outdoor or indoor sources, it can be removed exchange with fresh, CO-free air. Its stability often makes it useful as an indoor tracer for air exchange determinations (Janse, 2000).

Carbon Monoxide exposure usually occurs in a combination of combustion products, many of which have distinctive odors. The most common sources for CO in non-industrial environments include automobile exhaust fumes from indoor garages, inappropriately placed air intakes, and smoking. Improperly vented gas or oil furnaces, fireplaces, wood stoves and environmental tobacco smoke are some of the indoor sources of this gas (Hellsing, 2009).

Many studies have been carried out to measure CO in several types of indoor environments using a variety of monitoring techniques. CO has been measured in homes, office and public buildings, and automobiles. Monitoring techniques have included fixed point monitors and small portable samplers, used at fixed points or as personal exposure monitors. The data based on CO studies is fairly extensive, and continues to grow (Janse, 2000).

The greatest numbers of studies have focused on the most ubiquitous source of CO, i.e. motor vehicle exhaust. The studies inside vehicles most frequently used personal exposure monitors based on electrochemical principles. Concentrations within the vehicles were dependent on both the density and speed of surrounding traffic and, to a lesser extent, on the type of vehicle being studied. Reported concentrations were generally in the 10 to 30 ppm range, with some peaks as high as 44 to 45 ppm (Yocom and McCarthy, 1995).

CO concentrations in buildings have been measured with both fixed monitors such as nondispersive infrared sensor and personal exposure monitors. It has been founded that both changes proximity to traffic and seasonal influence the indoor CO levels. Indoor concentrations are less than outdoor concentrations, with variations attributed to source and ventilation variables. Measured levels in commercial office buildings range from 1 to 10 ppm. Parking garages and other "indoor" vehicle areas can be two to three times higher (Hellsing, 2009).

The third type of study focused on CO levels related to unvented indoor combustion appliances. Studies have been conducted field settings, as well as in controlled laboratory test chambers. In homes, concentrations are highest in the room with the combustion appliance. Depending on the type of home and appliance, concentrations in the range of 6 to 10 ppm are common. The trend in indoor research on CO is to focus on monitoring exposures of sensitive subpopulations and relating these exposures to possible health effects (Yocom and McCarthy, 1995).

2.4 Particulate Matter (PM)

Particulate matter (PM) is a name for a wide range of particles that are small enough to be carried by the air and therefore can be breathed in by people (Health Canada, 2008). Particles can come in almost any shape or size, and can be solid particles or liquid droplets. The particles can travel hundreds to thousands of kilometers, depending on their size (WHO, 2005).

Ambient PM has been classified in three size distributions (Hind, 1999). PM_{10}, which consists of particles <10 µm in aerodynamic diameter, are able to reach the respiratory tract below the larynx. In comparison, the average size of a human hair is 70 µm.

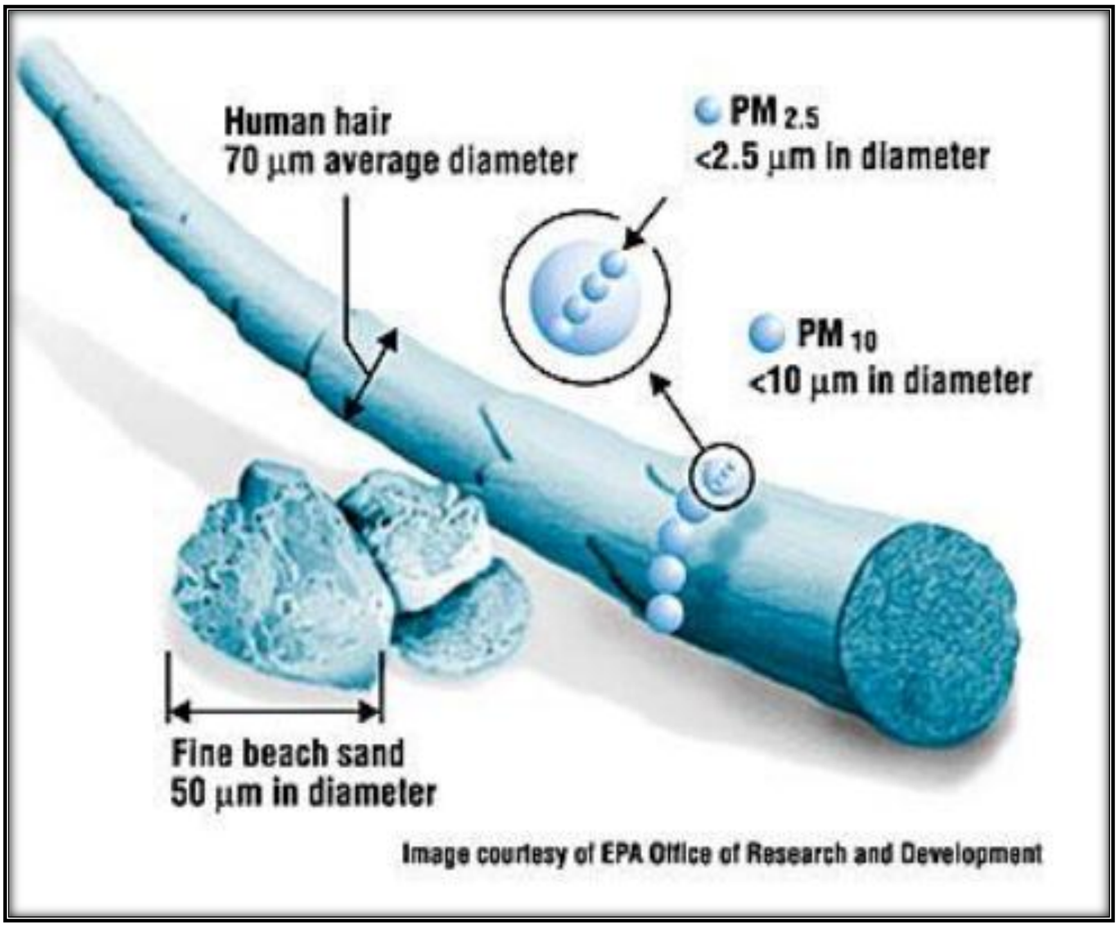

Figure (2.1): Comparison of particulate matter (PM) to average human hair. (Source: EPA website)

Particles smaller than 2.5 µm ($PM_{2.5}$) can penetrate into the gas-exchange region (alveoli) of the lung. In urban or industrialized areas $PM_{2.5}$ comprises 60-70% of the PM_{10} fraction and consist of a high degree of elemental carbon derived from stationary or mobile combustion sources. Ultra-fine particles (UFP) are approximately less than 100 nm in diameter ($PM_{0.1}$) and are component of air pollution, derived mainly from primary combustion sources (Hind, 1999).

It is generally accepted that indoor concentrations of particles derive from two sources: indoor and outdoor. However, the significance of both sources depends on a number of variables, e.g., air-exchange rate, outdoor air pollution, type of indoor activities, aerodynamic diameter of particles emitted, etc. (Monn, 2001).

The dominating source for particle fraction with diameters < 1µm is outdoor air, but indoor activities for particle fraction > 1µm (Jansson, 2000).

Indoor particulate matter is a mixture of substances such as:

Carbon (soot) emitted by combustion sources, Tiny liquid or solid particles in aerosols, Fungal spores, Pollen, and A toxin present in bacteria (endotoxin) (Health Canada, 2008).

The main source of the airborne particulate matter in the majority of homes is the outdoor air. Some homes, however, do have other significant sources of indoor particulate matter, such as: (Health Canada, 2008).

Cigarette smoking, cooking, indoor pet allergens, non-vented combustion appliances such as gas stoves,wood-burning appliances, and mold growth.

According to (Xiaojiang et al., 2010) a field study was carried out in Shanghai metro stations to gather and evaluate information about the real environment. The thermal environment and particulate matter levels were monitored in this study. The mean thermal sensation vote in metro stations was 0.91, and the mean thermal neutral temperature was 20.6℃. Although 92.1% of subjects voted that the thermal environment was acceptable, the condition of air quality in Shanghai metro stations was not good. The mean levels of $PM_{1.0}$, $PM_{2.5}$, and PM_{10} were 0.231±0.152, 0.287±0.177, and 0.366±0.193 mg/m^3, respectively. The contribution of $PM_{1.0}$ to $PM_{2.5}$ and $PM_{2.5}$ to PM_{10} was up to 79% and 76%, respectively. This means that fine particles or ultrafine particles constituted the preponderant part of metro station particulate matter.

Children's health is particularly vulnerable to environmental pollution, because their lungs are still in development and are, therefore, more susceptible to hazardous pollutants. Pearson, et al., (2000), reported, for instance, that exposure to air pollutants emitted from cars is closely associated with childhood leukemia as well as other typical childhood cancers. A quantitative and comprehensive health impact assessment for ambient air particles is extremely complex and suffers from a considerable lack of knowledge on particle composition and airway deposition data for various particle size fractions. Most reported studies related to the quality of air in schools were carried out in Europe, the USA and to some extent Asia (Peng and Lin , 2007).

Several studies indicated smoking as the most important source of indoor PM, CO and a significant source of trace elements and toxic organic compounds, many of which are carcinogenic, toxic, or irritating (Kwangsam et al., 2004). Although numerous measurements of air and particulate pollutants in the outside environment have been conducted, only few data on indoor air pollution are available (Poupard et al., 2005).

Outdoor particles are brought indoor via ventilation or, on the contrary, indoor sources might be present. The indoor sources are numerous and can be ascribed to different processes such as room heating, soil dust, dust from visitors, human bio-effluent, cleaning materials, deterioration of the walls, etc. One of the main problems caused by indoor aerosols is soiling, i.e., particle deposition on surfaces (Owen and Ensor, 1992) or the chemical damage (Nazaroff et al., 1990) depending on their size and chemical composition. PM in the indoor atmosphere can also be generated by photo-oxidative processes. $PM_{2.5}$, i.e., particles with aerodynamic diameter smaller than 2.5 µm (Seinfeld and Pandis,1998)

2.5 Relative humidity (RH%) and Temperature (Temp)

It has been demonstrated that the environmental parameters temperature and relative humidity are critical for organic material preservation. When organic material-based objects—like paper and parchment—release humidity, they become fragile and the fibers are easily broken (Pavlogeorgatos, 2003). In contrast, high temperature and relative humidity favor microbial growth. Actually, as with other objects, documentary heritage is susceptible to biological damage (Cappitelli and Sorlini, 2005).

There is no temperature that is suitable for all building occupants, but temperature between 20-24°C has been seen as suitable for every-day wellness and creativity, but it has to be taken into account that factors like personal activity and clothing may affect personal comfort. Even so studies have indicated that the temperature should rather be lower than higher and that if the temperature goes above 24°C it can reduce people's ability to perform subjective tasks (Gunnarsdottir, et al., 1990). As the indoor air temperature rises, so does the vaporization of chemicals from furniture, fittings and building materials (Gunnarsdottir, et al., 1990). Numerous factors that can affect room temperature, for example large windows that can also increase thermal problems during warmer parts of the year (Norback and Nordstrom, 2008).

Relative air humidity (RH%) is defined as the ratio of the amount of water vapor in the air at a specific temperature to the maximum amount that the air could hold at that temperature and is expressed as a percentage (The American Heritage Medical Dictionary, 2007). The dominating factor affecting indoor air humidity is air temperature, because when cold air with high air humidity warms up indoors, the air humidity drops considerably, unless there are some sources for indoor humidity. Sources for indoor humidity can for example be from the respiratory tract, plants or other sources like bathrooms or kitchens (Health Authority of Kjos, 2002).

There is no "ideal" humidity level, but according to the American Society of ASHRAE acceptable relative humidity levels should range from 30-60% to achieve maximum occupant comfort (ASHRAE, 1999). Levels less than 20% in the winter and greater than 60% percent in the summer should be considered unacceptable. If relative air humidity goes under 20% it is more likely that dust will stay in the air. Low relative air humidity can also result in higher static electricity and more vaporization of chemicals from furniture, fittings and building materials. Elevated relative air humidity can also promote the growth of mold, bacteria, and dust mites, which can aggravate allergies and asthma (Illinois Department of Public Health (IDPH), 2008).

The subject of air humidification is always discussed when constructing or reconstructing a building due to the fact that the most commonly reported discomfort indoor is the perception that the air is to dry (Skoog, 2006).

There have been few studies on perceived indoor climate in hospital wards, where the relative air humidity is, but one variable affecting the climate. The indoor climate is therefore important in an area where the patients are ill. According to (Berglund, 2002) low air humidity affects comfort and health. He also says that in wintertime when the relative air humidity indoors drops respiratory problems increase.

Another study (Reinikainen, 1991) found that there were fewer complaints of dry skin and nose and throat irritation in the humidified part of a building than in a non-humidified part. The use of humidification has both advantages and disadvantages. One disadvantage is an increasingly complex HVAC system design, but the great advantage is there can be fewer adverse health symptoms and a more positive perception of the overall indoor environment. In study of relative air humidity in hospital wards in a Swedish hospital by (skoog, 2006) conducted in a hospital ward, measurements and questionnaire distribution to nursing staff and patients were carried out under both summer and winter conditions. The results showed that during summer and winter the relative air humidity and the humidity ratio indoors were low, and that both staff and patients perceived the air as dry during those seasons. In order to change these conditions the indoor air has to be humidified.

2.6 Health Effects

Clean air is essential for good health, and this is especially true when it comes to indoor air. U.S. EPA has ranked indoor air pollution among the top five environmental risks. This is because indoor concentrations of some pollutants may be many times higher than their levels outdoors and people spend up to 90% of their time indoors, at home, at work and in recreational environments, therefore, indoor air pollution may pose a greater health threat than outside pollution (Heach and Lee, 2003). Most people, however, are unaware of the effects that poor indoor air quality can have on their health.

2.6.1 Health effects of indoor air

According to the CDC, health risks like asthma, which are triggered by IAQ problems, have increased by 42% between 1982 and 1992 (Wilson and Malin, 1996). Furthermore, a study by Fisk and Rosenfeld (1998) cited the annual cost of IAQ related problems at $100 billion. These costs are incurred due to problems like SBS, building related illness, absenteeism, and operation and maintenance cost of problematic buildings.

Discomfort or diseases that are related to buildings have been divided into three categories (Gunnarsdottir, et al., 1990). First, illness or discomfort that is related to houses and the cause is known, such as allergies, contagious diseases and discomfort due to known pollution for example from chemicals. Second discomfort that is related to houses and the causes are unclear or unknown, often called SBS. SBS was once seen as a mass psychogenic illness, but today is it accepted as a certain phenomenon, due to unknown reasons (Gunnarsdottir, et al., 1990). In cases of SBS it is common that people complain about irritation in eyes, nose, throat, airway, skin problems, undiagnosed allergies, tiredness, nausea and/or dizziness while staying in the building. The discomfort often increases, as the time spent in the building gets longer, but disappears or decreases when people leave the building. The reason for SBS is unknown, but it is a widely held opinion that the cause is more than one environmental factor and therefore the cause can even be different between buildings. Psychological reasons like stress are not seen as causing the discomfort, but can be a stimulating factor. In cases of such discomfort the employees can get unhappy, less productive and cause increased sick leaves among employees (Gunnarsdottir, et al., 1990).

Third illnesses can be caused by pollution that people get exposed to indoors, without realizing it. In this case it is an illness that develops over a long time, such as cancer due to secondary smoking or pollution from chemicals that can cause mutation in genes (Health Authority of Kjos, 2002).

In 1990 the Administration of Occupational Saftey and Health in Iceland published a report on indoor air and peoples wellness. In the report, factors that are often related to people’s wellness in buildings are divided into four categories. Three categories with environmental factors, and one with a social or psychological factor.

The following table (2.1), illustrates these factors and two factors that were added by Davidsson, the author of a study on indoor air in schools and day-care centers in Iceland (Health Authority of Kjos, 2002).

Table (2.1): Factors that can affect people's health indoors.

Physical	Chemical	Biological	Psychological
Temperature	Smoking	dust mites	Stress
Humidity	Formaldehyde	Mold	Social status
Ventilation	VOC	Pets	Imagination
Air ions	Microbiology Poison	Other arthropods (insects)	
Static electricity	Other gases		
Particles and threads	Odor		

Resource, 1. (Gunnarsdottir, et al., 1990). and 2. (Health Authority of Kjos, 2002)

2.6.2 Sick building syndrome

The SBS is used to describe a situation in which building occupants experience acute health and comfort effects that appear to be linked to time spent in the building, but no specific illness or cause can be identified. The complaints may be localized in particular room or zone, or may be widespread throughout the building (U.S.EPA, 2008).

According to U.S.EPA, SBS is strongly suspected when the following circumstances are present:

Symptoms are temporally related to time spent in a particular building or part of building, symptoms resolve when the individual is not in the building, symptoms recur seasonally (heating, cooling), and Co-workers, peers have noted similar complaints.

A recent study by Norback (2009), concluded that SBS is related to personal and environmental risk factors. In the office environment, SBS may have important economic implications affecting productivity. Also that more focus is needed on the indoor environment in schools, day care centers, hospitals and nursing homes for the elderly, because children, hospital patients and the elderly are sensitive subgroups (Norback, 2009).

Seppanen et al., (1999) reviewed available literature for the association between both ventilation rates and CO_2 concentrations and health. The authors were not able to determine a clear threshold value for CO_2 below which further reductions in concentration were not associated with further decreases in SBS symptoms. However, 7 of the 16 studies reviewed suggested that the risk of SBS symptoms continued to decrease with decreasing CO_2 concentrations below 800 ppm (Pegas et al., 2011).

According to Fisk (2000), the U S can save from $6 to $14 billion from respiratory illness, $1 to $4 billion reduced allergies and asthma, $10 to $30 billion from reduced SBS, $20 to 160 Billion from worker performance and productivity gains.

A study by Wargocki, et al., (2000) suggested that increased ventilation effectiveness can help decrease the intensity of SBS symptoms, improving the perceived air quality and productivity of the occupants. More and more people today are paying attention to indoor environmental quality, and numerous indoor environmental studies have been carried out in various countries (Ye et al., 2005). Most of them focused on office or residential buildings (Huang et al., 2005).

Several studies suggested that a high concentration of microbial air contamination, combined with other non-biological factors, could induce adverse health effects, such as infectious diseases, allergic and irritant responses, respiratory problems, and hypersensitivity reactions or even the SBS, correlated with work environmental stress and characterized by symptoms of unclear etiology, including irritation of eyes, nose, throat, and skin, headache, and tiredness (Tsaiand and Macher 2005).

2.6.3 Health effect of CO_2, RH% and Temp

CO_2 is generally not found at hazardous levels in indoor environments, they are extremely rare in non-industrial workplaces. Even so occupants may experience health effects in buildings where levels of CO_2 are elevated, like headaches, dizziness, restlessness, tiredness and so forth. Most of these symptoms are usually due to the other contaminants in the air that also build up as a result of insufficient ventilation. The CO_2 itself can cause headache, dizziness, nausea and other symptoms when exposed to levels above 5000 ppm for many hours (Minnesota Department of Health, 2008).

High or low RH% can cause discomfort among occupants. According to Berglund low air humidity affect comfort and health and in wintertime, when the relative air humidity indoor drops, respiratory problems increase (Berglund, 2002). High relative air humidity may contribute to water condensation and microbial growth, indirectly causing SBS (Norback, 2009).

Low relative air humidity or dry air, has also been shown to cause dry and itchy skin, fatigue, feeling of illness and sickness. The risk of bacteria and virus attacks is normally higher in environments with a high RH% (Gertis, 1999), but with particles (dust) in the air, even dry environments may represent a health hazard. The dry particle mass may cause an imbalance in the mucous membrane humidity, with resulting irritation (Holmberg and Chen, 2003). Keeping the body at the normal temperature is important for comfort and health. Generally speaking, a healthy person feels most comfortable in an environment where the body can easily maintain a thermal balance with the surrounding air (Mc Quiston et al., 2005).

Both over-cooled and over-heated indoor temperatures will bring adverse health effects to occupants. SBS is a common illness associated with the work place environment. SBS symptoms are observed when occupants find the temperature too warm or too cold (Godish, 1995).But in western countries, most studies are related to heating (too warm). As the work place in Hong Kong is usually air-conditioned, SBS sometimes is simplified and renamed "air-conditioning syndrome" in Chinese (Indoor Air Quality Management Group (IAQMG, 2003).The indoor temperature affects several human responses, including thermal comfort, perceived air quality, SBS and work performance. The indoor temperature has also been shown to effect people's productivity (Seppanen et al., 2004).

2.6.4 Health effect of Carbon monoxide (CO)

CO is an asphyxiant that converts hemoglobin to carboxyhemoglobin, thus decreasing the amount of oxygen transported to tissues and resulting in tissue hypoxia. Exposure results in fatigue, shortness of breath, headache, nausea and at high levels, death. Carboxyhemoglobin levels above 4 - 5% can exacerbate symptoms of cardiovascular disease. Extreme altitudes may exacerbate the detrimental effects of CO on persons with this disease. Health effects of low-level CO exposure resulting in less than 3% bound hemoglobin are not well established, but probably include effects on the heart and brain. In general, when CO exposure levels do not exceed 25 ppm, the carboxyhemoglobin levels in the non-smoking population are in the range of 0.3 - 0.7 %, while for smokers this is 2 - 3% (DiNardi, 1997).

Carbon monoxide can among other health effects cause irreversible brain damage, coma and even death (at high concentrations). This gas can elicit symptoms that range from mild (headaches, nausea, breathlessness) to severe (visual disturbances, cyanosis, angina). (Janse, 2000).

2.6.5 Health effect of particle pollution

People with heart or lung diseases, older adults, and children are considered at greater risk from particle matter than other people (EPA, 2003). It has been shown that long-term PM exposure is associated with elevated, cardiovascular and infant mortality and morbidity of respiratory symptoms, lung growth and function of the immune system. Particles may be carriers of carcinogenic, allergic and irritant substances (Indoor Environment and Health, 1999). A large quantity of specific allergens and many organic particles can increase of allergic and other hypersensitivity reactions (Holmberg and Chen, 2003).

Long-term PM exposure has been associated with elevated total, cardiovascular and infant mortality and elevated morbidity of respiratory symptoms, lung growth and function of immune system. Short-term exposure has been consistently associated with mortality or morbidity especially in patients with asthma or respiratory diseases (Kappos, 2004). UFP are considered important for adverse health aspects since they can be transported and deposited in the lungs. Because of high deposition efficiency, they can migrate from the lungs into the systemic circulation and to the heart (Penn, 2005).

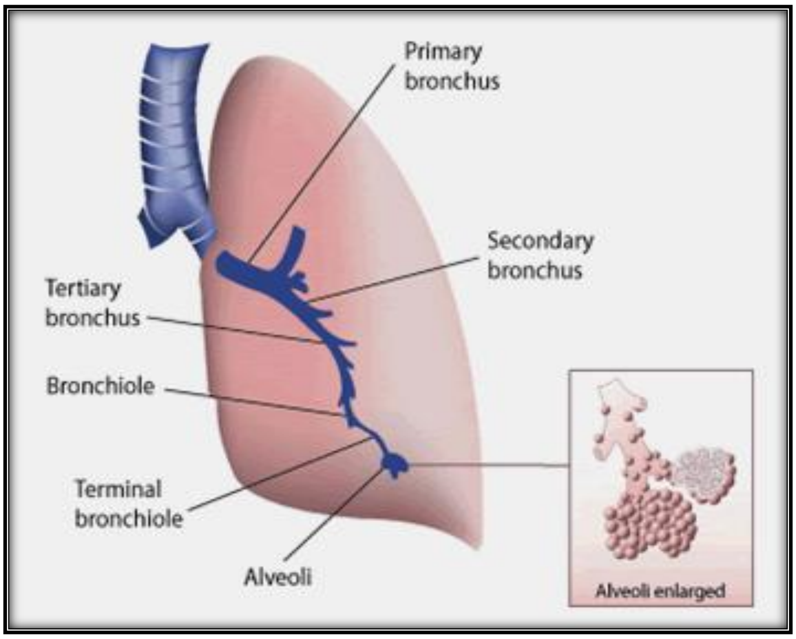

Figure (2.2): Particle Pollution in Lung. Resource: EPA website

The health effect of particle pollution largely depends on the size of the particles. Healthy people can get rid of particles that are larger than 5 µm by sneezing and coughing, but some particles that are 2,5-5 µm can transmit down into the lungs and cause irritation. Elderly, asthmatics and people with lung diseases like bronchitis can have difficulties getting rid of the bigger particles. Bigger particles can, by irritation and bristle of the mucous membrane, clear the way for infections. The particles don't only irritate and clear the way for infections, but they can also transmit unwanted chemicals that dissolve in the mucous membrane and have a clear way into the body's circulatory system. The smallest particles 0-2.5µm are considered to be the most health threatening, because they transmit down the lungs and settle in the alveoli (Hellsing, 2009) .

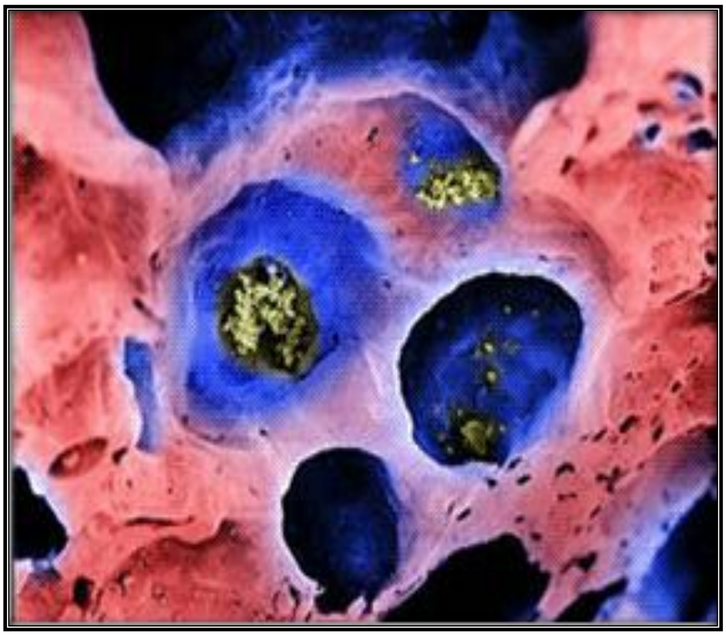

Figure (2.3): Particulate matter from diesel engines, in the alveoli. (Source: Lennart Nilsson).

Outdoor air in Scandinavia contains around 10 µg /m^3 particles (PM_{10}). Higher concentrations, up to 50 µg/m^3, cause increased risk for sensitive individuals, 100 µg/m3 can result in hospital care for respiratory problems and over 100 µg/m^3 represents an increased mortality risk (Ahmansson et al., 1996).

2.7 Indoor air quality in hospitals

Most of us spend major portion of our time indoors in homes, schools, the workplace, shopping malls or hospitals. The average person will use typically 15kg of air a day through breathing compared with 1 kg of food and 2 kg of water (Ramaswamy et al., 2010).

Air quality at hospitals needs special precautions during design and maintenance stage to prevent infections from spreading. It is reported that 5% of all patients who go to hospitals for treatment will develop an infection while they are there (O'Neal, 2000). The levels of some hazardous pollutants in indoor air at some places have been found to be up to 70 times greater than in outdoor air. Besides the complex hospital environment requires special attention to ensure healthful indoor air quality to protect patients and health care workers against nosocomial infections and occupational diseases. According to WHO, bad indoor air quality is a real health hazard and can have significant impact on the shortening of life expectancy. Children and the elderly are especially affected by polluted indoor air. Researchers from Hong Kong university carried out a detail study about the role of ventilation in airborne transmission of infectious agent in health care units and concluded that there is a strong and sufficient evidence to demonstrate the association between ventilation, air movements in buildings and the transmission spread of infectious diseases such as measles, tuberculosis, chickenpox, influenza, and sars etc. (Ignatius, 2004).

Nordstrom and his team from Sweden investigated IAQ in hospitals in relation to building dampness and type of construction. They analyzed four hospital buildings of different age and design and concluded that building dampness in the floor construction may increase the sensation of air dryness and stuffy air (Nordstrom, 1998).

An interesting study was carried out by researchers from Greece about the indoor air conditions in 20 numbers of hospital operating rooms in major hospitals in Greece and listed out the commonly encountered problems such as insufficient indoor air change, bad space ergonomics, poor maintenance etc. (Balaras, 2007).

A study shows a direct relationship between certain concentrations of air pollutants with internal health problems, such as: allergies, asthma, bronchitis, pneumonia, lung cancer etc. (Deloach, 2004).

2.7.1 Indoor air quality in neonatal intensive care unit

Few studies have examined the quality of indoor air in hospitals, especially in NICUs, Prazad et al., (2008) were studied the air borne concentrations of volatile organic compounds in neonatal incubators, concluded that the emission pattern of 2-heptanone and n-butyl acetate, were found at elevated concentrations inside the incubators compared with ambient room air samples and background measurements indicate that they originate inside the incubator. There is evidence that exposure to some VOCs may adversely impact the fetal and developing infants' health. Currently, as there is no definitive information available on the effects of acute or chronic low-level exposure to these compounds in neonates, future studies evaluating the health effects of neonatal exposure to these VOCs are needed.

Chapter 3: Materials and Methods

This chapter describes the methodology that was used in this research. The adopted methodology to accomplish this study uses the following techniques:

3.1 Research phases

The first phase of the research thesis proposal included identifying and defining the problems and establishment objectives of the study and development research plan.

The second phase of the research included a summary of the comprehensive literature review . literatures on claim management was reviewed.

The third phase of the research included a field survey which was conducted with the assessment of indoor air quality in NICUs in governmental hospital in Gaza strip, by measure the mentioned parameters by mentioned instrument .

The fourth phase of the research focused on the modification of the questionnaire design, through distributing the questionnaire to pilot study. The purpose of the pilot study was to test and prove that the questionnaire questions are clear to be answered in a way that help to achieve the target of the study. The questionnaire was modified based on the results of the pilot study.

The fifth phase of the research focused on distributing questionnaire. This questionnaire used to collect the required data in order to achieve the research objective.

One hundred and twenty questionnaires were distributed to the research population and one handred and eight questionnaire were received.

The sixth phase of the research was data analysis and discussion. Statistical package for the social sciences, (SPSS) was used to perform the required analysis.

The final phase includes the conclusions and recommendations.

Figure (3.1) shows the methodology flowchart, which leads to achieve the research objective.

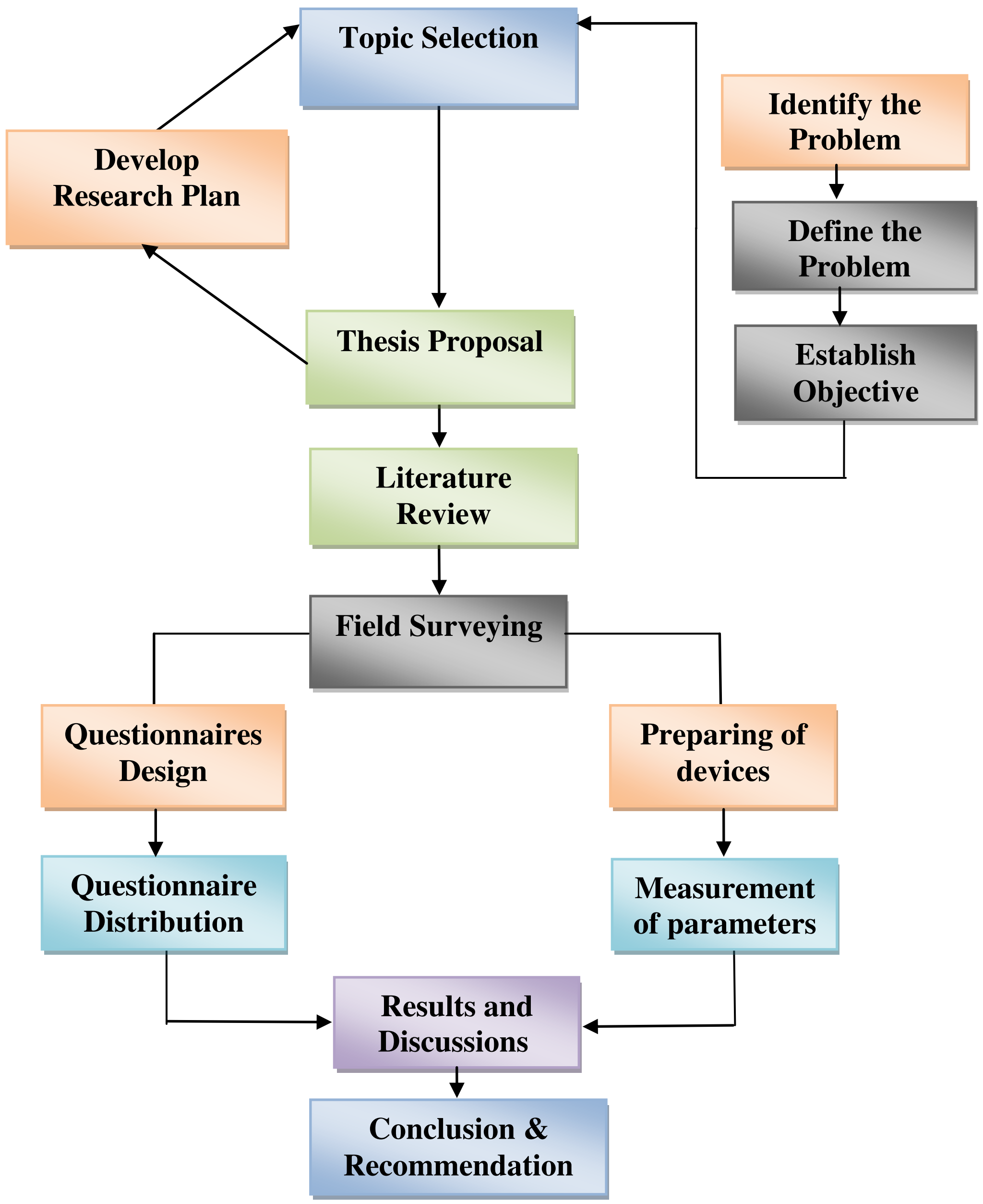

Figure (3.1) Illustrates the methodology flow chart.

3.2 Study design

Cross sectional analytical design was used in this study. Cross analytical design is conducted at the same time or over a short period of time. Measurement parameters and the distribution of the questionnaire was in parallel**.**

3.3 Study population and sample

In the Gaza strip there are five NICUs distributed over the following hospitals: (Al Shifa Hospital, Al Nasser Pediatric Hospital, European Hospital, Naser Hospital and finally Al Aqsa Hospital).

In this study three units were selected geograghically to represent the Gaza strip which is Al Shifa Hospital, European Hospital and Al Aqsa Hospital.

Table (3.1) number of employees and incubators for each hospital

No.	Name of hospital	No. of incubators	No. of doctors	No. of nurses
1.	Al Shifa Hospital	34	15	48
2.	European Hospital	13	9	24
3.	Al Aqsa Hospital	11	8	14

Study population in this research consist of all doctors and nurses in NICUs in three governmental hospitals at Gaza strip, (Al Shifa Hospital, European Hospital, and Al Aqsa Hospital).

3.4 Study Sitting

The study performed at NICUs in three governmental hospitals at Gaza strip, (Al Shifa Hospital, European Hospital, and Al Aqsa Hospital).

1) AL-Shifa hospital: Al-Shifa is the largest medical health institution within the Gaza Strip. This Medical complex includes three hospitals: Medical Hospital, Surgery Hospital and Obstetrics and Gynecology Hospital, with a capacity 744 bed and about 2100 employees until 2013. Shifa Hospital was established in 1946 and was built on an area of 42 thousand square meters. It's located on the western side of central Gaza city, at a crossroads of the intersection of Izz al- Din al-Qassam on Al Wahda Street.

2) European Hospital: This hospital is in the southern Gaza Strip and offers services for surgery, medical and children. The total clinical capacity has 335 beds. The hospital is located in the south-eastern region of Khan Younis city, Fokhari area, crossing Street.

The hospital was established in1987 on an area of 65,000 m^2. The numbers of hospital staff in all specialties are about 750 employees.

3) Al-Aqsa Martyrs Hospital: General hospital offers surgery, medical services, children, women and Obstetrics. The overall clinical capacity for hospital 125 bed, and is located in the central governorate in Deir al-Balah. The Hospital was established in 2001 on an area of 4000 m^2. The number of hospital employees in all specialties are about 448 employees.

3.5 Period of the study

Samples were collected on March 4th, 2013, till March 22ed, 2013, as samples were collected for five days per unit (Monday, Tuesday, Wednesday, Thursday, and Friday) distributed on three shifts as follows: day shift from 7:30 am to 13:30 pm, evening shift from 13:30 pm to 19:30 pm, and night shift from 19:30 pm to 7:30 am.

3.6 Experimental Devices and Tools

Devices were put in the middle of the hall, one meter away from the nursing station and one meter high from the ground. Devices were used randomly in every half an hour and take measurment every five minutes, in the day shift 18 records were taken, in the evening shift 12 records were taken and in the night shift 20 records were taken. The mean were calculated for all records in every shift for all units.

Table (3.2) Shows the parameters that were measured and the devices, which were used.

Table (3.2) Parameters and devices used in the study:

No.	Parameter	The device were used
1.	CO_2	Kanomax IAQ Monitor 2211
2.	CO	Kanomax IAQ Monitor 2211
3.	Temp	Mastech MS8209
4.	RH%	Mastech MS8209
5.	PM_{10}	HAL-HPC300 Handheld Laser Particle Counter
6.	$PM_{2.5}$	HAL-HPC300 Handheld Laser Particle Counter

3.6.1 IAQ Monitor Models 2211

The Kanomax IAQ Monitor 2211 features quick start-up and high accuracy was used in measuring CO_2 and CO concentration levels in the environment. Temperature and humidity RH% are also simultaneously measured in a handy lightweight design.

The device runs under the following instructions:

- Before turning the device on, it should be left the probe in open air for at least 20 minutes before start a measurement.

- After turning a power on, sensor circuit requires 5 minutes to warm-up. For an accurate measurement result.

- It is recommended to placing the probe on the provided probe stand, it place the probe on the horizontal and stabilized stand.

- Keep the sensor away from expiratory air, exhaled air contain more than 10,000ppm of CO_2.

- Device was programmed to take a reading every five minutes then repeats it twice then calculates the average.

Figure (3.2) IAQ Monitor Models 2211

Table (3.3): IAQ Monitor Model 2211 Specifications (Kanomax website)

CO	Range	0 – 500 ppm
	Accuracy	+/-3% of reading or 3ppm whichever is greater
CO_2	Range	0 – 5000 ppm
	Accuracy	+/-3% of reading or +/-50 ppm whichever is greater

3.6.2 Handheld Particle Counter HAL-HPC300

The Hal Technology HAL-HPC300 Handheld Laser Particle Counter was used to measure particles suspended in the air and their distributions in clean environment applications such as microelectronics, fine mechanics, optics, pharmaceutical, medical device, food processing and aerospace.

The HAL-HPC300 can simultaneously measure three channels that are arbitrarily configured or set by the users. The data are recorded in the embedded flash memory and can be downloaded with supplied software through either USB or RS232 interface. The user can also upgrade the firmware through USB or RS232 interface.

The HAL-HPC300 was designed in USA and is in compliance with the international standards (JIS B 9925:1997 and ISO14644-1). All of its key components are made from USA, Germany and Japan. Slim and lightweight in design, the HAL-HPC300 features high sensitivity, multiple functional capabilities, and is user-friendly.

Figure (3.3) Handheld Particle Counter HAL-HPC300

To use the Handheld Particle Counter HAL-HPC300 in the field, the following instruction must be applied:

- After turning the device on, it be ready to measure pollutants directly.
- Keep the sensor away from expiratory air, direct air stream and the large amount of dust which the measurement process fails.
- The device was programmed to take a reading every minutes during 15 minutes, the results represent the number of particles in a unit volume under the accumulative situation.
- The results represent as cumulative mode counts per cubic meter Counts /m3.), Microgram per Cubic Meter µg/cum .

3.6.3 Digital Multimeter MASTECH MS8209

Figure (3.4) shows fantastic Mastech MS8209 5 in 1 Auto Ranging BACKLIT DMM combines a high accuracy TRUE RMS 4 1/2 digits Digital Multi Meter with a TEMPERATURE sensor complete with a K-Type Thermo Probe, a SOUND LEVEL (decibels) function with a built in SENSOR, a LIGHT LEVEL (LUX) function with a built in SENSOR and a HUMIDITY function with a built in SENSOR.

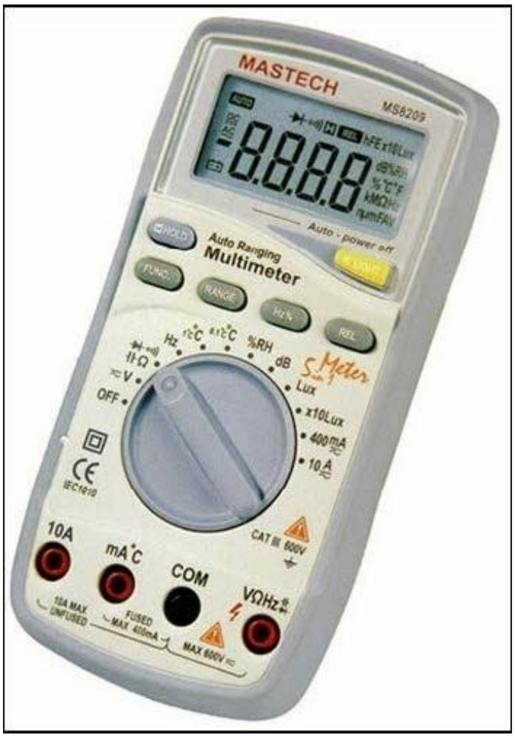

Figure (3.4) Digital Multimeter MASTECH MS8209

3.6.4 Questionnaire

About 120 self-administered questionnaires were distributed in the NICUs. One hundred and eight questionnaires were received, with response rate of 108/120 (90%). The questionnaire was sent to a specialist in environment, health and to specialist in English language. A questionnaire was provided with a covering letter explaining the purpose of the study, the way of responding, the aim of the research and the security of the information in order to encourage a high response.

To ensure the validity of questionnaire, it was submitted to panel of experts to evaluate its faced contents validity. To ensure reliability of the questionnaire Crombach Alpha and correlation coefficient were done. Small scale reliability test (pilot study) was done to have an idea about length and ambiguity of the questionnaire. An English revision is attached in (Annex A).

3.6.5 Validity of Questionnaire

Validity refers to the degree to which an instrument measures what it is supposed to be measuring. Validity has a number of different aspects and assessment approaches. Statistical validity is used to evaluate instrument validity, which include internal validity and structure validity.

3.6.5.1 Internal Validity

Internal validity of the questionnaire is the first statistical test that used to test the validity of the questionnaire. It is measured by a scouting sample, which consisted of 30 questionnaires through measuring the correlation coefficients between each paragraph in one field and the whole field, the correlation coefficients for each paragraph were presented in Appendix (C).

3.6.5.2 Structure Validity of the Questionnaire

Structure validity is the second statistical test that used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the fields of the questionnaire that have the same level of liker scale.The correlation coefficient was presented in Appendix (D).

3.7 Statistical analysis Tools

In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is/are an appropriate method/s that can be applied and not others. In this research, ordinal scales were used. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the important (1,2,3,4,5) do not indicate that the interval between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels. Based on Likert scale we have the following:

Item	*Strongly agree*	*Agree*	*Do not Know*	*Disagree*	*Strongly Disagree*
Scale	5	4	3	2	1

The researcher would use data analysis both qualitative and quantitative data analysis methods. The Data analysis will be made utilizing SPSS 20. The researcher would utilize the following statistical tools:

1) Spearman correlation coefficient for Validity.
2) Cronbach's Alpha for Reliability Statistics.
3) Frequency and Descriptive analysis.
4) Nonparametric Tests (Sign test, Mann-Whitney test and Kruskal-Wallis test).
5) The one-way analysis of variance (ANOVA) was used to mean Comparisons for each variable by Hospital and time.

Sign test is used to determine if the mean of a paragraph is significantly different from a hypothesized value 3 (Middle value of Likert scale). If the P-value (Sig.) is smaller than or equal to the level of significance, $\alpha = 0.05$, then the mean of a paragraph is significantly different from a hypothesized value 3. The sign of the Test value indicates whether the mean is significantly greater or smaller than hypothesized value 3. On the other hand, if the P-value (Sig.) is greater than the level of significance $\alpha = 0.05$, then the mean a paragraph is insignificantly different from a hypothesized value 3.

Mann-Whitney test is used to examine if there is a statistical significant difference between two means among the respondents toward the assessment of indoor air quality in neonatal intensive care units in government hospitals in Gaza Strip, Palestine due to (gender, How long have you been at your current job and occupation).

Kruskal-Wallis test is used to examine if there is a statistical significant difference between several means among the assessment of indoor air quality in neonatal intensive care units in government hospitals in Gaza Strip, Palestine due to (Age, Hospital and qualification).

3.8 Ethical consideration

Approval of Dean of postgraduate studies and research affairs, Approval of Ministry of Health and Consent of the employees were obtained. Every participant in the study received a complete explanation about the research purposes and confidentiality. All the ethical consideration observed, respect for people and human rights and respect for truth. Confidentiality was given and maintained.

Chapter 4: Results and Discussion

4.1 Introduction

This chapter includes the measured data and questionnaire results, conducted on the sample NICUs in Gaza strip and discusses the results of the collected data and analyses. The statistical package SPSS was used for statistical analysis and Excel was used to draw some charts which will be presented at this chapter. The following parameters have been studied and measured in NICUs:

1- Temperature (Temp).
2- Relative Humidity (RH %) .
3- Carbon Dioxide (CO_2).
4- Carbon Monoxide (CO).
5- Particulate Matter 10 micrometer (PM_{10}).
6- Particulate Matter 2.5 micrometer ($PM_{2.5}$).

4.2 Normal range of indoor air quality

Table (4.1) Normal range of indoor air quality indicators (Temp, RH%, CO_2, CO, PM_{10} and $PM_{2.5}$)

Variable	Normal range
Temp ℃	In Winter 20-24℃ In Summer 23-26℃ (ASHRAE Standard 55) WHO, 2003
RH%	30% - 60% (ASHRAE Standard 55) WHO, 2003
CO_2 ppm	not exceed 1000 ppm , <800 (ASHRAE 62.1 (2004).)
CO ppm	Short term (1 hr.) 25 ppm Long term (24 hr.) 10 ppm (ASHRAE 62.1 (2004).)
PM_{10} µg / m^3	20 µg / m^3 annual mean . 50 µg / m^3 24hr. mean .(NAAQS and USEPA 2012)
$PM_{2.5}$ µg / m^3	10 µg / m^3 annual mean 25 µg / m^3 24hr. mean . (NAAQS and USEPA 2012)

4.3 The result and discussion of parameters

4.3.1 The mean results of temperature

Figure (4.1) shows mean results of Temp in AL Aqsa hospital in the morning, evening and night shifts were 25.8 ℃, 25.9 ℃, and 26.9 ℃, respectively. And the mean results of Temp in European hospital in the morning, evening and night shifts were 24.6 ℃, 24.4°C, and 26.2 °C, respectively. While the mean results of Temp in AL Shifa hospital in the morning, evening and night shifts were 26.5 °C, 26.3°C, and 26.7 °C, respectively. The recommended range for acceptable IAQ is 23.0 °C to 26.0 °C for Temp from ASHRAE, (2007). Figure (4.1) shows that the majority of the results in all the hospitals were on the upper limit of the recommended value, Some readings were slightly higher than the recommended value such as AL Shifa hospital because it contains the largest NICU where the number of incubators and employees. This is because the NICUs contain many of the devices, which produce heat such as incubators to warm newborns.

These reading are compatible with the study of Pickett and Bell, (2011) which investigated the air quality of infants' homes in the New England area of the U.S.

These results were also consistent with the study of Ismail et al., (2010b) which studied IAQ in non-industrial work place.

In contrast, the results were the opposite in the study of Skoog, (2006) which studied IAQ in a hospital ward in Sweden, where the readings were very close to the lower limit of the recommended value. Perhaps because of this study were in the open sections of the hospital such as the orthopedic department.

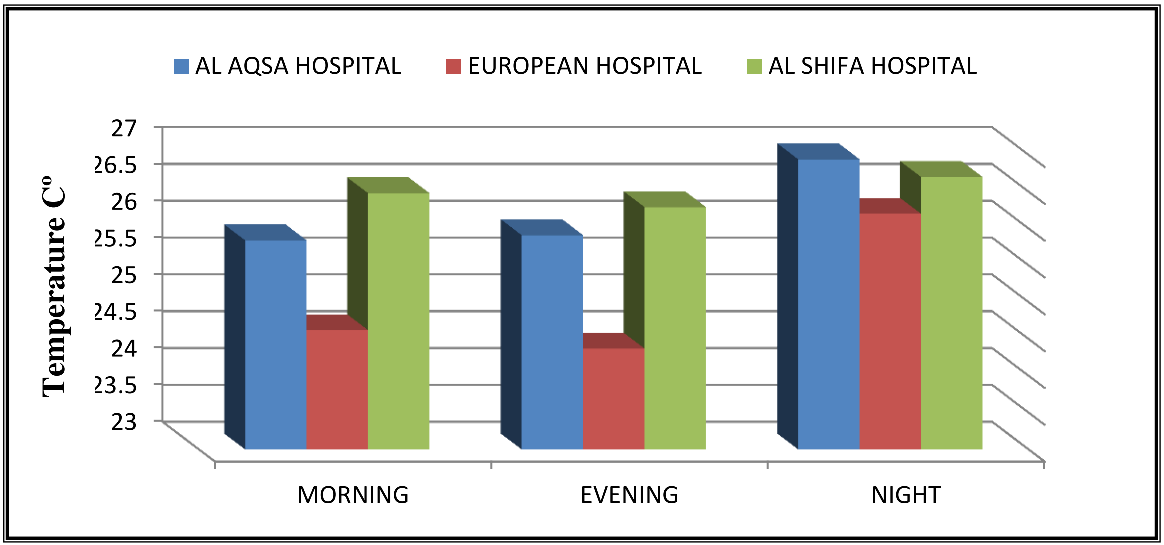

Figure (4.1): Mean results of temperature in all hospitals.

4.3.2 The mean results of RH%

Figure (4.2) shows mean results of RH% in AL Aqsa hospital in the morning, evening and night shifts were 45.9%, 44.3%, and 42.1%, respectively. And the mean results of RH% in European hospital in the morning, evening and night shifts were 44.8%, 41.2%, and 51.0%, respectively. While the mean results of RH% in AL Shifa hospital in the morning, evening and night shifts were 44.9%, 39.7%, and 41.7%, respectively. The recommended range for acceptable indoor air quality is 30% to 65% for RH% from (ASHRAE, 2007). Figure (4.2) shows that all the results in all the hospitals were in the normal range of the recommended value. This is because the humidity in the outdoor influence is somewhat on the indoor.

These results were consistent with the study of Pegas, et al., (2011), which addressed the IAQ in schools in Lisbon, in the spring.

These results were also consistent with the study of Capitelli et al., (2009), who studied the physical measurement in historical Archive in Milan.

But the results were different in the study of Pickett and Bell, (2011), which investigated the air quality of infants' homes in the New England area of the U.S., where it was slightly higher than the recommended value in most of the readings.

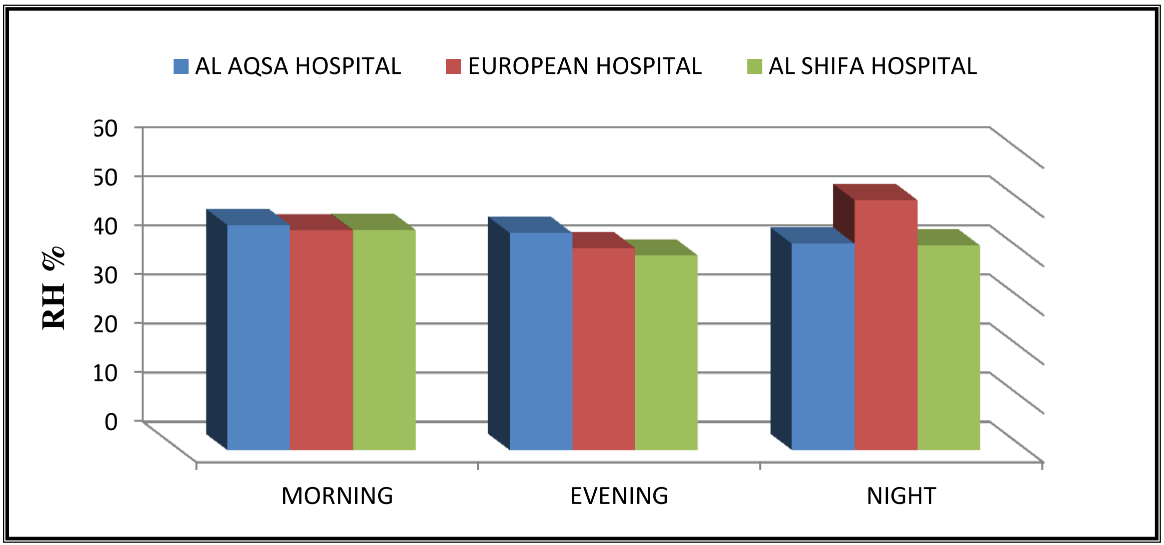

Figure (4.2): Mean results of RH% in all hospitals.

4.3.3 The mean results of CO_2

The recommended values of exposure for CO_2 should not exceed 1000 ppm for an 8 hour period as indicated by Malaysian Code of Practice (department of occupational safety and health (DOSH), 2005) and ASHRAE standards. Figure (4.3) shows mean results of CO_2 in AL Aqsa hospital in the morning, evening and night shifts were 878 ppm, 876 ppm, and 689 ppm, respectively. And the mean results of CO_2 in European hospital in the morning, evening and night shifts were 742 ppm, 606 ppm, and 536 ppm, respectively. While the mean results of CO_2 in AL Shifa hospital in the morning, evening and night shifts were 1143 ppm, 850 ppm, and 806 ppm, respectively. Its noted that most of the readings were consistent with the recommended value other than Shifa Hospital readings were very close to the upper limit of the recommended value and sometimes slightly exceed the upper limit, especially in the morning because it is the most crowded shift.

Seppanen et al., (1999) reviewed available literature for the association between both ventilation rates and CO_2 concentrations and health. The authors were not able to determine a clear threshold value for CO_2 below which further reductions in concentration were not associated with further decreases in SBS symptoms. However, 7 out of the 16 studies reviewed suggested that the risk of SBS symptoms continued to decrease with decreasing CO_2 concentrations below 800 ppm.

This study largely compatible with the study that dealt with some of IAQ of schools in Malaysia. (Ismail et al., 2010a).

These results were also consistent with the study of Khan and Budaiwi, (2002) which conducted in some commercial buildings in Saudi Arabia.

Clear association seen between elevated of indoor CO_2 levels and increases in certain SBS symptoms. The reduction of CO_2 could come through large increases in ventilation rates, improved effectiveness in providing fresh air to the occupants' breathing zone (Seppanen et al., 1999), or through identification of the symptom-causing agents in the indoor air and control of their sources. The ventilation that inadequate and insufficient fresh air intake can contribute to high level of CO_2 in certain area in the building (Ooi et al., 1998).

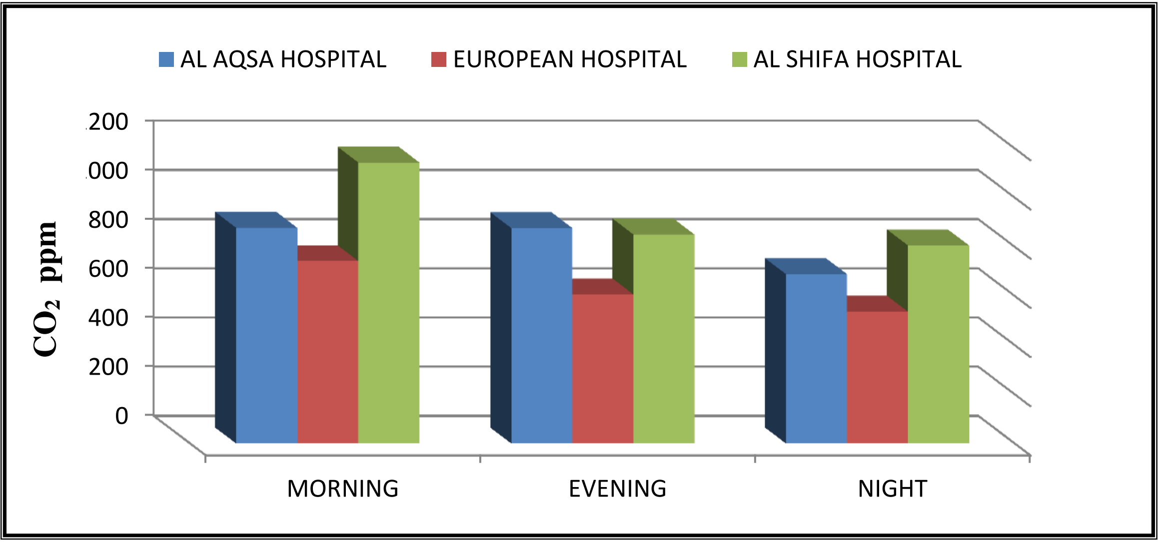

Figure (4.3): Mean results of CO_2 in all hospitals.

4.3.4 The mean results of CO

The Malaysian Code of Practice (DOSH, 2005) recommended value of 10 ppm for an 8-hour period exposure. Figure (4.4) shows mean results of CO in AL Aqsa hospital in the morning, evening and night shifts were 3.2 ppm, 3.1 ppm, and 3.2 ppm, respectively. And the mean results of CO in European hospital in the morning, evening and night shifts were 3.1 ppm, 3.1 ppm, and 2.7 ppm, respectively. While the mean results of CO in AL Shifa hospital in the morning, evening and night shifts were 7.9 ppm, 8.1 ppm, and 6.8 ppm, respectively. This results within normal range of recommended value, Perhaps this is due to no origin of CO in NICU.

CO is produced as a by-product of incomplete combustion of organic materials. In the human body, CO is produced endogenously by the class of enzymes known collectively as heme oxygenase (Mines, 1997). CO is detectable in small quantities in the exhaled air of healthy people (Zayasu et al., 1997).

This study compatible with the study that measure CO in pollution in homes with infants (Pickett and Bell, 2011).

These results were also consistent with the study of Ismail et al., (2010a), who studied that dealt with some of the IAQ of schools in Malaysia.

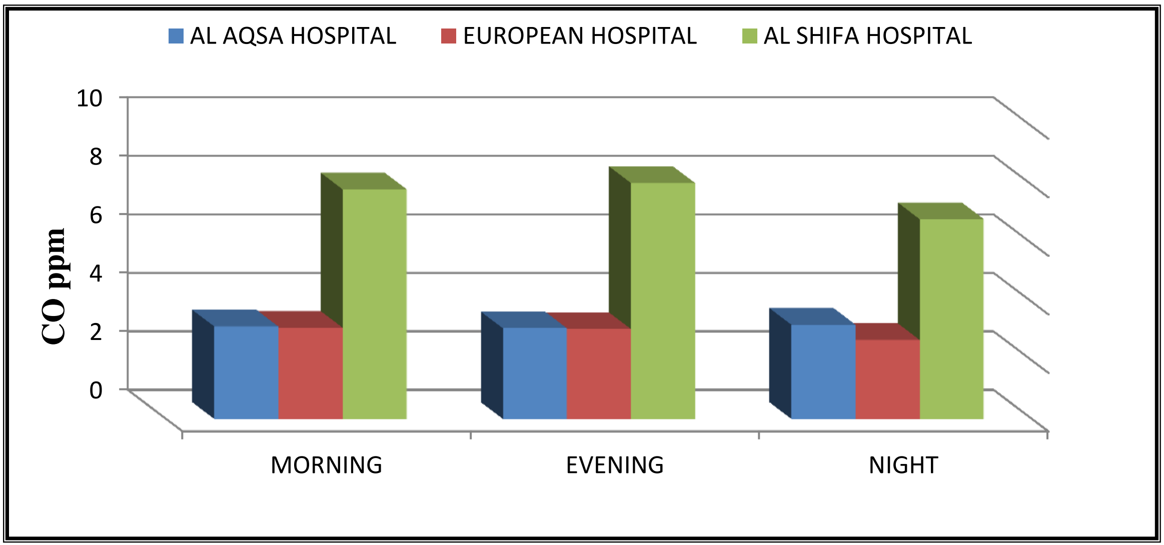

Figure (4.4): Mean results of CO in all hospitals.

4.3.5 The mean results of PM

The recommended threshold level for an 24-hour period exposure for PM_{10} and $PM_{2.5}$ are 50 µg / m^3 , and 25 µg / m^3 , respectively. (National Ambient Air Quality Standards (NAAQS) and USEPA, 2012**).** Figure (4.5) shows mean results of PM_{10} and $PM_{2.5}$ in AL Aqsa hospital in the morning, evening and night shifts were 4 µg / m^3, 3.5 µg / m^3, 3 µg / m^3, and 1 µg / m^3, 1 µg / m^3, 0.5 µg / m^3 , respectively. And the mean results of PM_{10} and $PM_{2.5}$ in European hospital in the morning, evening and night shifts were 1.5 µg / m^3, 0.5 µg / m^3, 4.5 µg / m^3, and 0.2 µg / m^3, 0.0 µg / m^3, 1 µg / m^3 , respectively. While the mean results of PM_{10} and $PM_{2.5}$ in AL Shifa hospital in the morning, evening and night shifts were 5.5 µg / m^3, 4.2 µg / m^3, 5 µg / m^3, and 1 µg / m^3, 1 µg / m^3, 1 µg / m^3 , respectively. All results of PM were below the standerd value. We note that although the results of AL Shifa hospital below the recommended value, but it is a little more than other hospitals, possibly because AL Shifa hospital contains the largest NICU where the number of incubators and employees. The combined effects of high occupancy and insufficient ventilation seem to be the main reason for the high PM_{10} concentrations.

PM is an indicator which directly contributes to the IAQ problem at workplace. Code of Practice on IAQ published by Department of Occupational Safety and Health Malaysia has set the maximum standard for the particulate at 0.15 mg/m³ for 8-hours. All results detected were less than the Code of Practice limit less than 0.15 mg/m³.This can be related to the practice within work place itself (Ismail et al., 2010a).

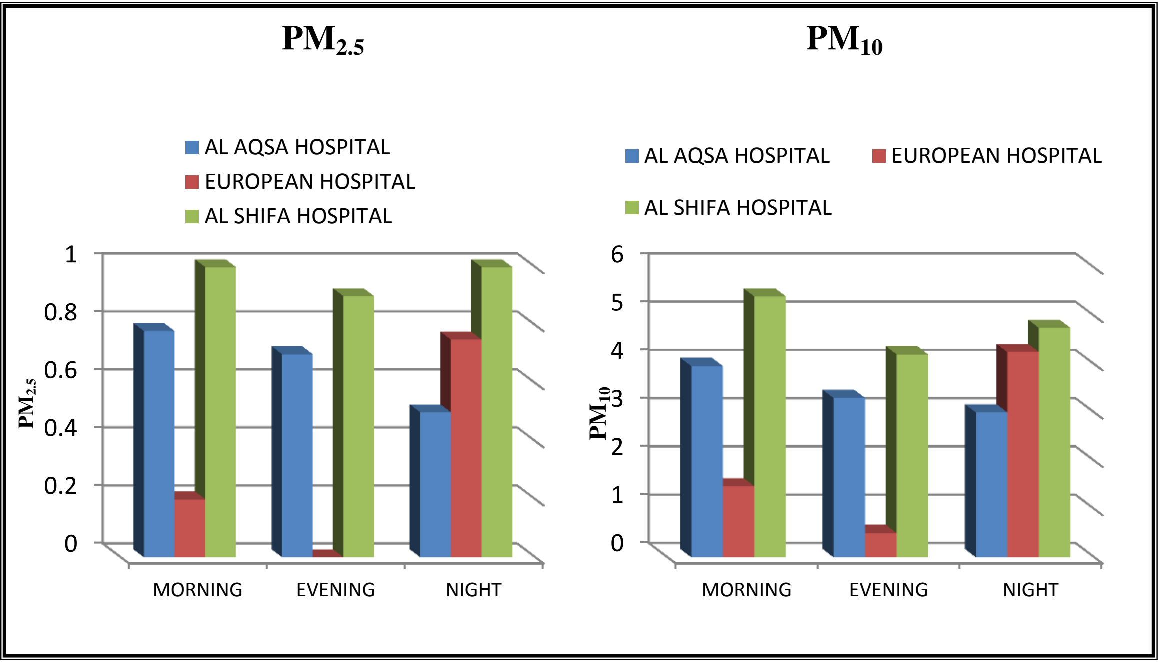

Figure (4.5): Mean results of PM in all hospitals.

4.4 Mean Comparisons for each variable by Time

4.4.1 Al Aqsa Martyrs Hospital

The NICU in this hospital has a small area containing 8 incubators with 5 patients on Monday, 5 patients on Tuesday, 3 patients on Wednesday, 4 patients on Thursday and 3 patient on Friday. During morning shift, the number of employees in NICU is at least 7 employees, 4 employees in evening shift and 4 employees in night shift.

Table (4.2) shows ANOVA test for each variable with respect to time hospitals for Al Aqsa Hospital.

4.4.1.1 For the variable " Temp "

The mean for the variable **" Temp "** in the morning period equals 25.84 with SD 1.36. For evening period, the mean equals 25.91 with SD 0.49 and for night period, the mean equals 26.94 with SD 0.30. The value of the ANOVA-test equals 11.306, with p-value equals 0.000, which is smaller than the level of significance 0.05. This means that there is significant difference in the mean of variable **" Temp "** among the three different periods. The result shows the mean of the variable **" Temp "** in the night period has the largest value among the other periods. This is because the team turn off their air conditioning at night shift.

4.4.1.2 For the variable " CO_2"

The mean for the variable **" CO_2"** in the morning period equals 877.50 with SD 145.84. For evening period, the mean equals 876.25 with SD 170.30 and for night period, the mean equals 688.92 with SD 49.20. The value of the ANOVA-test equals 17.100, with p-value equals 0.000, which is smaller than the level of significance 0.05. This shows that there is significant difference in the mean of variable **" CO_2"** among the three different periods. The result shows the mean of the variable **" CO_2"** in the morning period has the largest value among the other periods. Because the presence of the largest number of the team, whether doctors or nurses in the morning shift, also the doctors round and preparing the treatments , so in the morning shift, the unit is crowded. See Appendix (E).

For the other variables the p-value is greater than the level of significance 0.05. This clarifies that there is insignificant difference in the mean of these variables among the three different times.

Table (4.2): ANOVA for each variable by time for Al Aqsa Hospital

Variable	Time	Mean	Std. Deviation	ANOVA Test	P-value
Temp	Morning	25.84	1.36	11.306	0.000*
	Evening	25.91	0.49		
	Night	26.94	0.30		
RH%	Morning	45.90	10.01	2.184	0.116
	Evening	44.27	6.75		
	Night	42.07	3.67		
CO_2	Morning	877.50	145.84	17.100	0.000*
	Evening	876.25	170.30		
	Night	688.92	49.20		
CO	Morning	3.16	0.51	0.522	0.595
	Evening	3.10	0.53		
	Night	3.22	0.43		
PM_{10}	Morning	3.96	1.48	1.042	0.366
	Evening	3.30	0.82		
	Night	3.00	2.45		
$PM_{2.5}$	Morning	0.78	0.41	0.590	0.561
	Evening	0.70	0.48		
	Night	0.50	0.58		

* The mean difference is significant at 0.05 level

4.4.2 European Hospital

The NICU in this hospital has area about 6×10 m^2 containing 11 incubators with 8 patients on Monday, 6 patients on Tuesday, 6 patients on Wednesday, 9 patients on Thursday and 7 patient on Friday. During morning shift, the number of employees in NICU is at least 9 employees, 5 employees in evening shift and 5 employees in night shift. The nurse station in the NICU is in the center of this department.

Table (4.3) shows ANOVA test for each variable with respect to time hospitals for European Hospital.

4.4.2.1 For the variable " Temp "

The mean for the variable **" Temp "** in the morning period equals 24.62 with SD 1.00. For evening period, the mean equals 24.37 with SD 0.85 and for night period, the mean equals 26.20 with SD 0.20. The value of the ANOVA-test equals 39.231, with p-value equals 0.000, which is smaller than the level of significance 0.05. This indicates that there is significant difference in the mean of variable **" Temp "** among the three different periods. The result shows the mean of the variable **" Temp "** in the night period has the largest value among the other periods. This is because the team turn off their air conditioning at night shift.

4.4.2.2 For the variable " RH% "

The mean for the variable " RH% " in the morning period equals 44.79 with SD 41.20. For evening period, the mean equals 41.20 with SD 7.44 and for night period, the mean equals 50.97 with SD 0.36. The value of the ANOVA-test equals 15.413, with p-value equals 0.000, which is smaller than the level of significance 0.05. This implies that there is significant difference in the mean of variable " RH% " among the three different periods. The result shows the mean of the variable " RH%" in the night period has the largest value among the other periods. I think that this is in line with the result of temperature.

4.4.2.3 For the variable " CO_2"

The mean for the variable " CO_2" in the morning period equals 741.83 with SD 130.51. For evening period, the mean equals 606.33 with SD 77.21 and for night period, the mean equals 536.33 with SD 49.13. The value of the ANOVA-test equals 50.443, with p-value equals 0.000, which is smaller than the level of significance 0.05. This implies that there is significant difference in the mean of variable " CO_2" among the three different periods. The result shows the mean of the variable " CO_2" in the morning period has the largest value among the other periods. This, as we have said previously that the morning shift are more crowded than other shifts.

4.4.2.4 For the variable " CO "

The mean for the variable " **CO** " in the morning period equals 3.12 with SD 0.32. For evening period, the mean equals 3.07 with SD 0.28 and for night period, the mean equals 2.70 with SD 0.17. The value of the ANOVA-test equals 19.749, with p-value equals 0.000, which is smaller than the level of significance 0.05. This shows that there is significant difference in the mean of variable " **CO** " among the three different periods. The result shows the mean of the variable " **CO**" in the morning period has the largest value among the other periods. But the difference in the results largely limited.

4.4.2.5 For the variable " PM_{10}"

The mean for the variable " PM_{10}" in the morning period equals 1.60 with SD 1.19. For evening period, the mean equals 0.50 with SD 0.35 and for night period, the mean equals 4.50. The value of the ANOVA-test equals 8.93, with p-value equals 0.009, which is smaller than the level of significance 0.05. This clarifies that there is significant difference in the mean of variable " PM_{10}" among the three different periods. The result shows the mean of the variable " PM_{10}" in the night period has the largest value among the other periods. But the difference in the results largely limited.

4.4.2.6 For the variable " $PM_{2.5}$"

The mean for the variable " $PM_{2.5}$" in the morning period equals 0.20 with SD 0.41. For evening period, the mean equals 0.00 with SD 0.00 and for night period, the mean equals 0.75 with SD 0.50. The value of the ANOVA-test equals 6.639, with p-value equals 0.005, which is smaller than the level of significance 0.05. This means that there is significant difference in the mean of variable " $PM_{2.5}$" among the three different periods. The result shows the mean of the variable " $PM_{2.5}$" in the night period has the largest value among the other periods. But the difference in the results largely limited. See Appendix (E).

Table (4.3): ANOVA for each variable by time for European Hospital

Variable	Time	Mean	Std. Deviation	ANOVA Test	P-value
Temp	Morning	24.62	1.00	39.231	0.000*
	Evening	24.37	0.85		
	Night	26.20	0.20		
RH%	Morning	44.79	8.18	15.413	0.000*
	Evening	41.20	7.44		
	Night	50.97	0.36		
CO_2	Morning	741.83	130.51	50.443	0.000*
	Evening	606.33	77.21		
	Night	536.33	49.13		
CO	Morning	3.12	0.32	19.749	0.000*
	Evening	3.07	0.28		
	Night	2.70	0.17		
PM_{10}	Morning	1.47	1.25	14.960	0.000*
	Evening	0.50	0.53		
	Night	4.25	1.89		
$PM_{2.5}$	Morning	0.20	0.41	6.639	0.005*
	Evening	0.00	0.00		
	Night	0.75	0.50		

* The mean difference is significant at 0.05 level

4.4.3 Al Shifa Hospital

The NICU in this hospital has large area about 12×10 m^2 containing 32 incubators with 22 patients on Monday, 19 patients on Tuesday, 23 patients on Wednesday, 22 patients on Thursday and 19 patient on Friday. During morning shift, the number of employees in NICU is at least 13 employees, 7 employees in evening shift and 7 employees in night shift. The nurse station in the NICU is in the center of this department.

Table (4.4) shows ANOVA test for each variable with respect to time hospitals for AL Shifa Hospital.

4.4.3.1 For the variable "RH%"

The mean for the variable " **RH%** " in the morning period equals 44.89 with SD 5.96. For evening period, the mean equals 39.68 with SD 3.81 and for night period, the mean equals 41.68 with SD 4.30. The value of the ANOVA-test equals 19.309, with p-value equals 0.000, which is smaller than the level of significance 0.05. This indicates that there is significant difference in the mean of variable " **RH%** " among the three different periods. The result shows the mean of the variable " **RH%**" in the morning period has the largest value among the other periods. But all the results were in the normal range.

4.4.3.2 For the variable " CO_2 "

The mean for the variable " **CO_2** " in the morning period equals 1,142.74 with SD 243.02. For evening period, the mean equals 850.18 with SD 219.93 and for night period, the mean equals 805.75 with SD 130.43. The value of the ANOVA-test equals 41.058, with p-value equals 0.000, which is smaller than the level of significance 0.05. This proves that there is significant difference in the mean of variable " **CO_2** " among the three different periods. The result shows the mean of the variable " **CO_2** " in the morning period has the largest value among the other periods. We also note that the results were very close to the upper limit of the recommended value and sometimes slightly exceed the upper limit, especially in the morning because it is the most crowded shift.

4.4.3.3 For the variable " CO "

The mean for the variable " **CO** " in the morning period equals 7.85 with SD 1.81. For evening period, the mean equals 8.06 with SD 1.36 and for night period, the mean equals 6.83 with SD 0.67. The value of the ANOVA-test equals 5.605, with p-value equals 0.004, which is smaller than the level of significance 0.05. This implies that there is significant difference in the mean of variable " **CO** " among the three different periods. The result shows the mean of the variable " **CO**" in the evening period has the largest value among the other periods. But the difference in the results largely limited. See Appendix (E).

For the other variables the p-value is greater than the level of significance 0.05. This implies that there is insignificant difference in the mean of these variables among the three different times.

Table (4.4): ANOVA for each variable by time for Al Shifa Hospital

Variable	Time	Mean	Std. Deviation	ANOVA Test	P-value
Temp	Morning	26.48	1.22	1.294	0.277
	Evening	26.29	1.00		
	Night	26.70	0.79		
RH%	Morning	44.89	5.96	19.309	0.000*
	Evening	39.68	3.81		
	Night	41.68	4.30		
CO_2	Morning	1,142.74	243.02	41.058	0.000*
	Evening	850.18	219.93		
	Night	805.75	130.43		
CO	Morning	7.85	1.81	5.605	0.004*
	Evening	8.06	1.36		
	Night	6.83	0.67		
PM_{10}	Morning	5.40	3.27	0.693	0.509
	Evening	4.20	1.14		
	Night	4.75	0.96		
$PM_{2.5}$	Morning	1.00	0.65	0.123	0.884
	Evening	0.90	0.32		
	Night	1.00	0.00		

* The mean difference is significant at 0.05 level

4.5 Mean Comparisons for each variable by Hospital

Table (4.5) shows ANOVA test for each variable with respect to the hospitals (Al Aqsa Hospital, European Hospital, and Al Shifa Hospital).

4.5.1 For the variable " Temp "

The mean for the variable **" Temp "** for Al Aqsa Hospital equals 26.02 with SD 1.09. For European Hospital, the mean equals 24.75 with SD 1.06 and for Al Shifa Hospital, the mean equals 26.44 with SD 1.10. The value of the ANOVA-test equals 114.860, with p-value equals 0.000, which is smaller than the level of significance 0.05. This explains that there is significant difference in the mean of variable **" Temp "** among the three hospitals. The result shows the mean of the variable **" Temp "** in Al Shifa Hospital has the largest value among the other hospitals. This due to large number of team and incubators in NICU in AL Shifa Hospital so it is the most crowded unit.

4.5.2 For the variable "RH%"

The mean for the variable "RH%" for Al Aqsa Hospital equals 44.81 with SD 8.41. For European Hospital, the mean equals 44.40 with SD 7.93 and for Al Shifa Hosptal, the mean equals 42.65 with SD 5.61. The value of the ANOVA-test equals 4.168, with p-value equals 0.016, which is smaller than the level of significance 0.05. This proves that there is significant difference in the mean of variable " RH%" among the three hospitals. The result shows the mean of the variable " RH%" in **AL AQSA HOSPITAL** has the largest value among the other hospitals. But it is within normal range.

4.5.3 For the variable " CO_2"

The mean for the variable **" CO_2"** for Al Aqsa Hospital equals 851.06 with SD 159.33. For European Hospital, the mean equals 666.76 with SD 132.95 and for Al Shifa Hospital, the mean equals 995.38 with SD 269.70. The value of the ANOVA-test equals 122.297, with p-value equals 0.000, which is smaller than the level of significance 0.05. This explains that there is significant difference in the mean of variable **" CO_2"** among the three hospitals. The result shows the mean of the variable **" CO_2"** in AL SHIFA HOSPITAL has the largest value among the other hospitals. And this is also due to the large number of the team in NICU in AL Shifa hospital.

4.5.4 For the variable " CO"

The mean for the variable **" CO"** for Al Aqsa Hospital equals 3.15 with SD 0.51. For European Hospital, the mean equals 3.05 with SD 0.32 and for Al Shifa Hospital, the mean equals 7.78 with SD 1.59. The value of the ANOVA-test equals 1,316.211, with p-value equals 0.000, which is smaller than the level of significance 0.05. This shows that there is significant difference in the mean of variable **" CO"** among the three hospitals. The result shows the mean of the variable **" CO"** in Al Shifa Hospital has the largest value among the other hospitals.

4.5.5 For the variable " PM_{10}"

The mean for the variable **" PM_{10}"** for Al Aqsa Hospital equals 3.61 with SD 1.46. For European Hospital, the mean equals 1.52 with SD 1.64 and for Al Shifa Hospital, the mean equals 4.90 with SD 2.48. The value of the ANOVA-test equals 23.191, with p-value equals 0.000, which is smaller than the level of significance 0.05. This indicates that there is significant difference in the mean of variable **" PM_{10}"** among the three hospitals. The result shows the mean of the variable **" PM_{10}"** in Al Shifa Hospital has the largest value among the other hospitals. But the difference in the results largely limited.

4.5.6 For the variable " $PM_{2.5}$"

The mean for the variable **" $PM_{2.5}$"** for Al Aqsa Hospital equals 0.71 with SD 0.45. For European Hospital, the mean equals 0.21 with SD 0.41 and for Al Shifa Hospital, the mean equals 0.97 with SD 0.50. The value of the ANOVA-test equals 20.916, with p-value equals 0.000, which is smaller than the level of significance 0.05. This implies that there is significant difference in the mean of variable **" $PM_{2.5}$"** among the three hospitals. The result shows the mean of the variable **" $PM_{2.5}$"** in Al Shifa Hospital has the largest value among the other hospitals. But also the difference in the results is limited. See Appendix (E).

Table (4.5): ANOVA for each variable by Hospital

Variable	Hospital	Mean	Std. Deviation	ANOVA Test	P-value
Temp	Al Aqsa Hospital	26.02	1.09	114.860	0.000*
	European Hospital	24.75	1.06		
	Al Shifa Hospital	26.44	1.10		
RH%	Al Aqsa Hospital	44.81	8.41	4.168	0.016*
	European Hospital	44.40	7.93		
	Al Shifa Hospital	42.65	5.61		
CO_2	Al Aqsa Hospital	851.06	159.33	122.297	0.000*
	European Hospital	666.76	132.95		
	Al Shifa Hospital	995.38	269.70		
CO	Al Aqsa Hospital	3.15	0.51	1,316.211	0.000*
	European Hospital	3.05	0.32		
	Al Shifa Hospital	7.78	1.59		
PM_{10}	Al Aqsa Hospital	3.61	1.46	23.191	0.000*
	European Hospital	1.52	1.64		
	Al Shifa Hospital	4.90	2.48		
$PM_{2.5}$	Al Aqsa Hospital	0.71	0.45	20.916	0.000*
	European Hospital	0.21	0.41		
	Al Shifa Hospital	0.97	0.50		

* The mean difference is significant at 0.05 level

4.6 Result and discussion of questionnaire

4.6.1 Basic information: (Employees data)

Figure (4.6) shows that 44.4% of the sample are " 20 –30 years " , 30.6% of the sample are of "31 – 40 years ", 21.3% of the sample are of "41-50 year " and 3.7% of the sample are of "51 and older ". This is due to that NICUs need effort and work load is greater than the other sections so these units need young age.

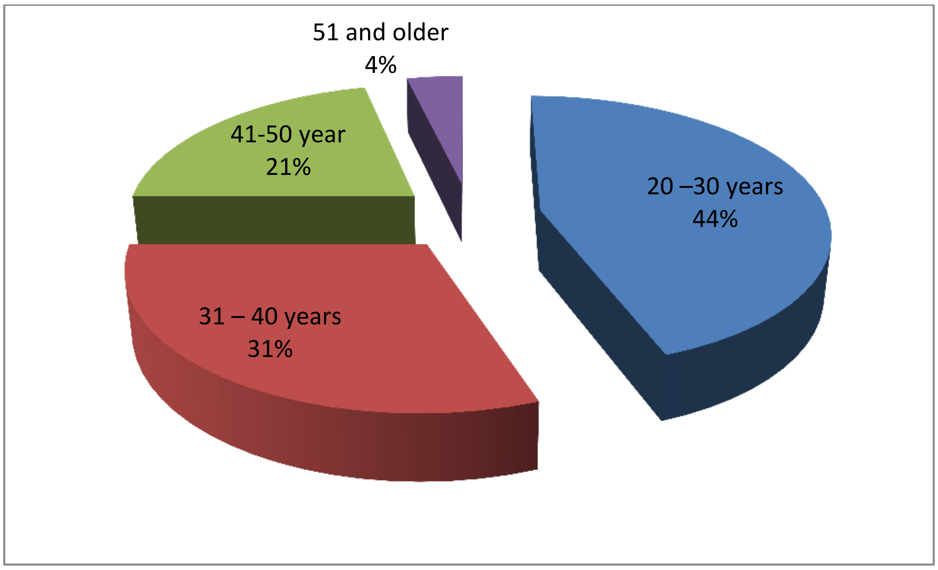

Figure (4.6): Age of all studied employees in all hospitals.

Figure (4.7) Shows that 67.6% of the sample are Males and 32.4% of the sample are Females. This is due to that NICUs need effort and work load is greater than the other sections so these units need males more than females.

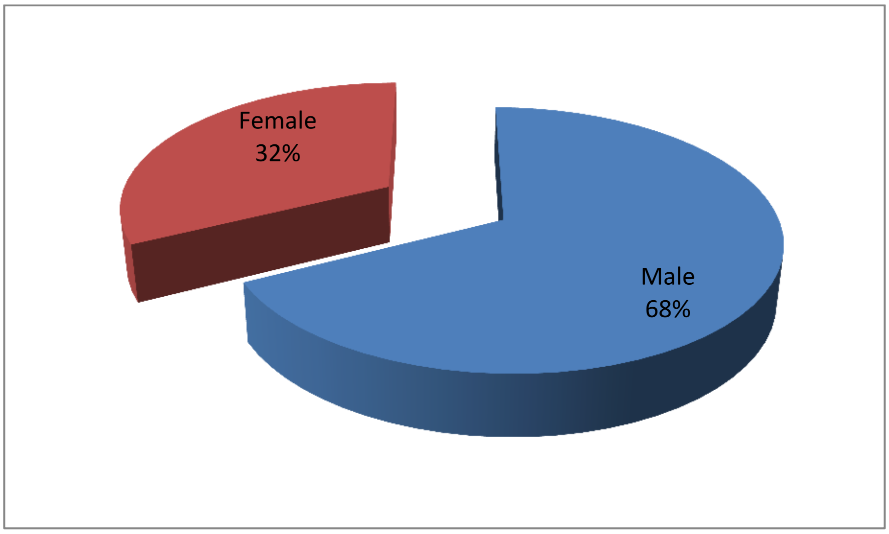

Figure (4.7): Gender distribution of selected employees in the three NICUs.

Moreover, the sample can be classified according to their job as two groups. Doctors of about 41% of the sample and nurses of about 59% (Fig.4.8). Not surprising to find the number of nurses is greater than the number of doctors, this is due to the biggest burden of nursing in working environment.

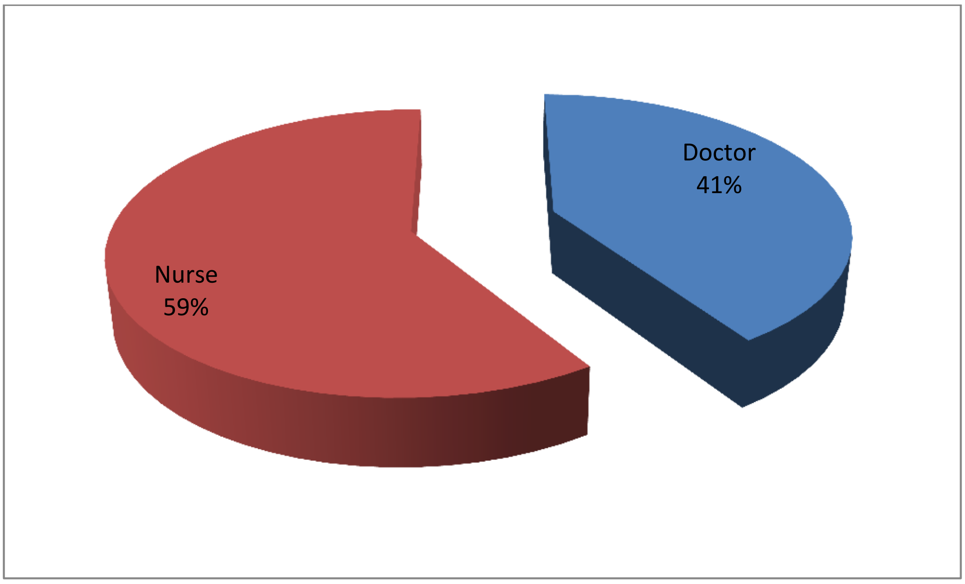

Figure (4.8): Job distribution of selected employees in the three NICUs.

Figure (4.9) indicates that most of the sample from the campaign Bachelor and two years Diploma, because the nursing colleges in the Gaza Strip is only granted this certification, which is mostly in the sample. And most doctors have a bachelor's degree.

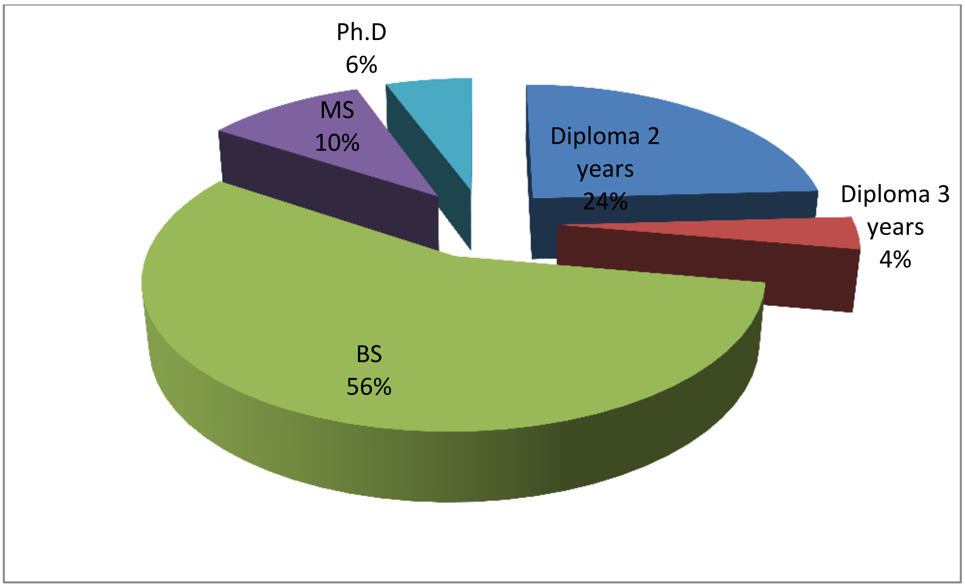

Figure (4.9): Qualification of selected employees in the three NICUs.

Figure (4.10) shows that the highest percentage of sample was in AL Shifa NICU (43%) and the lowest percentage of sample was in AL Aqsa NICU (22%). This is because the number of employees in AL-Shifa NICU was more than other NICUs, in addition to having the largest number of patients as receiving critical cases of all specialties from Gaza strip, so you need large number of staff to provide them with medical care but AL Aqsa NICU receives very small number of patients so it needs few number of employees.

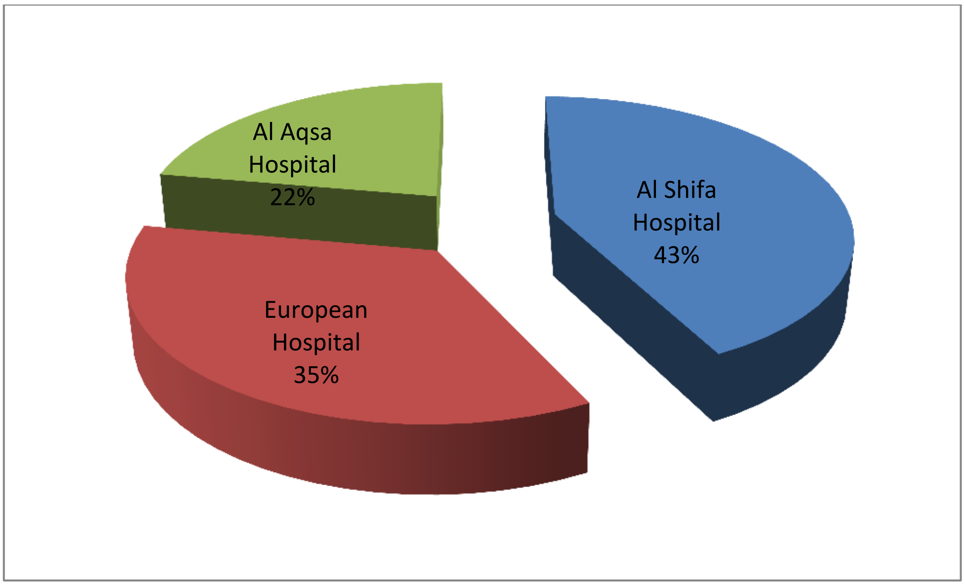

Figure (4.10): Percentage of all studied employees in all hospitals.

Figure (4.11) shows that 55% of the sample had experienced staff who have more than five years. This is because NICUs receives critical cases of patients are needed to experienced staff.

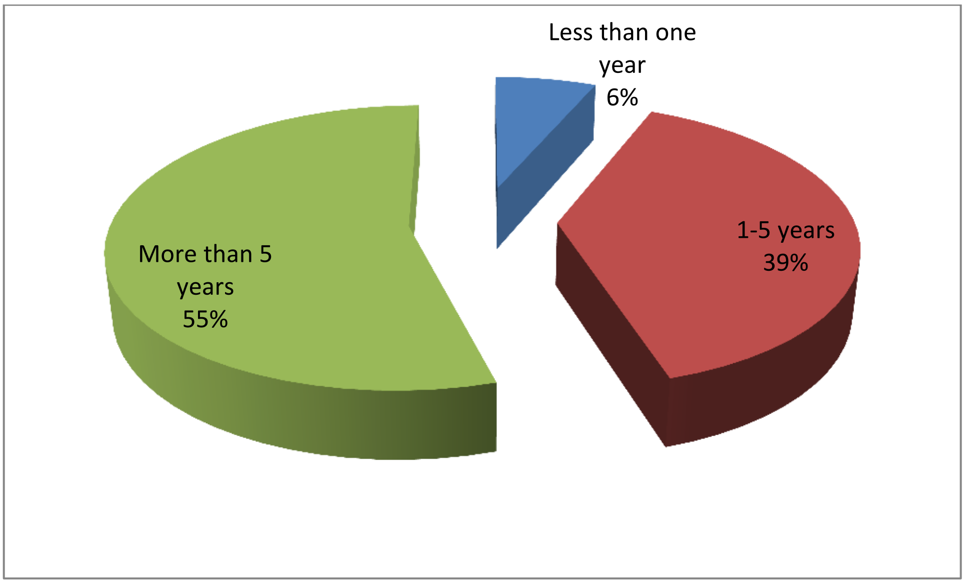

Figure (4.11): Percentage of employment period in years.

4.6.2 Working conditions

Table (4.6) shows the following results:

The mean of paragraph #5 "I don't practice any other work other than my original one" equals 4.05 (80.94%), Test-value = 7.11, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significant. We understand that the respondents agreed to this paragraph.

The mean of paragraph #2 "I don't feel crowded in the area of my work" equals 1.82 (36.48%), Test-value = -7.76, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. This shows that the respondents disagreed to this paragraph.

The mean of the field "**Working conditions**" in table (4.6), equals 2.82 (56.49%), Test-value = -3.02, and P-value=0.001 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this field is significant. This indicates that the respondents disagreed to field of "**Working conditions** ".

That because of the difficult and inappropriate working conditions in many cases and places, where the presence of traffic in NICUs in terms of number of beds or staff and the size of the existing work in these units.

Table (4.6): Means and Test values for "Working conditions"

	Item	Mean	Proportional mean (%)	Test value	P-value (Sig.)	Rank
1.	Are you satisfied of the area of your work	2.03	40.56	-7.10	0.000*	4
2.	I don't feel crowded in the area of my work	1.82	36.48	-7.76	0.000*	5
3.	I don't feel boring of the length of work period	2.86	57.22	-1.08	0.139	3
4.	I don't have the ability to change work conditions	3.43	68.57	3.15	0.001*	2
5.	I don't practice any other work other than my original one	4.05	80.94	7.11	0.000*	1
	All paragraphs of the field	2.82	56.49	-3.02	0.001*	

* The mean is significantly different from 3

4.6.3 Current symptoms

Table (4.7) shows the following results:

The mean of paragraph #2 "Fatigue" equals 4.13 (82.59%), Test-value = 8.78 and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significant. This clarifies that the respondents agreed to this paragraph.

The mean of paragraph #9 "Breathing difficulty" equals 2.25 (44.90%), Test-value = -6.08, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. This clarifies that the respondents disagreed to this paragraph.

The mean of the field "**Current symptoms**" in table (4.7), equals 2.98 (59.58%), Test-value = -0.29, and P-value=0.384 which is greater than the level of significance $\alpha = 0.05$. The mean of this field is insignificant. This shows that the respondents (Do not know, neutral) to field of "**Current symptoms** ".

Table (4.7): Means and Test values for "Current symptoms"

	Item	**Mean**	**Proportional mean (%)**	**Test value**	**P-value (Sig.)**	**Rank**
1.	Headache	3.80	75.93	5.63	0.000*	2
2.	Fatigue	4.13	82.59	8.78	0.000*	1
3.	Dryness or irritation of the skin	2.68	53.65	-2.19	0.014*	10
4.	Nausea	2.48	49.62	-3.90	0.000*	11
5.	Eye irritation	2.78	55.62	-1.03	0.152	7
6.	Difficulty of concentrating	2.99	59.81	0.00	0.500	4
7.	Dizziness	2.73	54.62	-1.66	0.049*	9
8.	Nasal congestion	2.75	55.10	-1.45	0.073	8
9.	Breathing difficulty	2.25	44.90	-6.08	0.000*	13
10.	Chest tightness	2.41	48.16	-4.50	0.000*	12
11.	Throat dryness	2.82	56.47	-1.64	0.051	5
12.	Joints pain	3.38	67.50	2.37	0.009*	3
13.	Sneezing, coughing	2.82	56.47	-1.08	0.139	6
	All paragraphs of the field	2.98	59.58	-0.29	0.384	

* The mean is significantly different from 3

In figure (4.12) the study showed that fatigue and headache were the most present symptoms at the staff, This agree with the study of Khan and Budaiwi, (2002) conducted in some commercial buildings in Saudi Arabia, and the study of Norback and Nordstrom, (2008) who studied the relationship between SBS and IAQ in university computer classrooms in Sweden, which concluded that the main symptoms were fatigue and headache.

The study was also agreed with AL Momani and Ali, (2008) study conducted in Jordan on some residential buildings in the cities of Irbid, Amman, and Zarqa, where headache was ranked the first.

While the noise was the most present symptoms according to the study of Wong, et al.,(2009) which was conducted in residential buildings in Hong Kong.

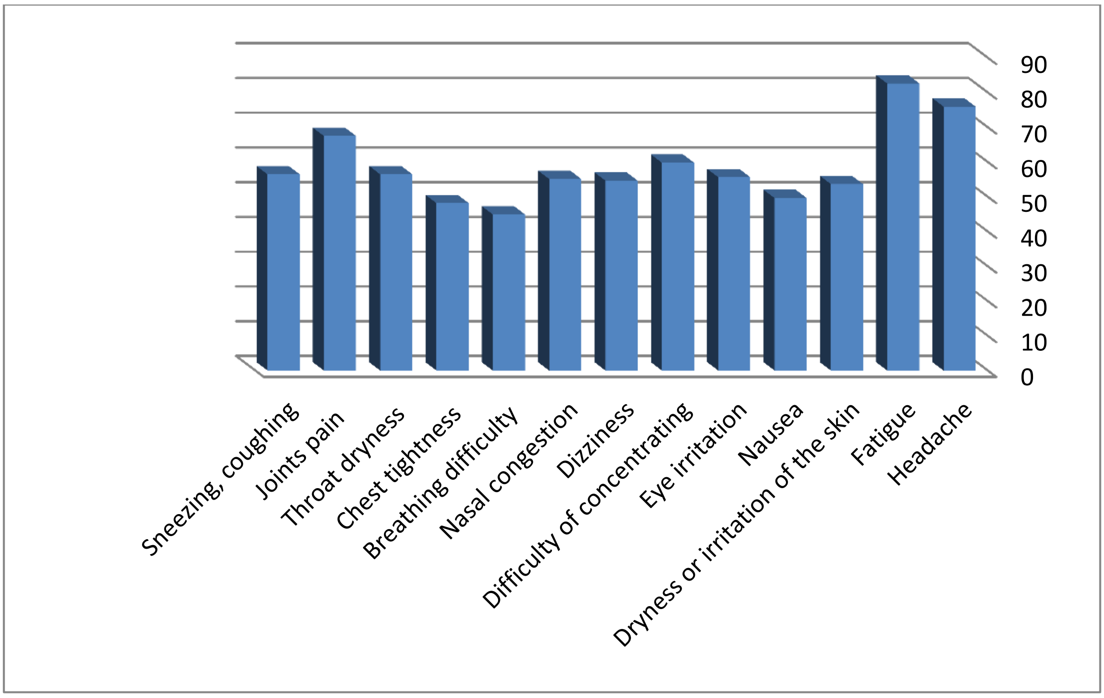

Figure (4.12): Proportional mean (%) for "Current symptoms" for All Hospitals.

4.6.4 Questions related to developed symptoms

Table (4.8) shows the following results:

The mean of paragraph #1 "Do you think it is related to your workplace" equals 3.98 (79.60%), Test-value = 6.84, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significant. We understand that the respondents agreed to this paragraph.

The mean of paragraph #5 "Do these symptoms appear in a specific time of the year" equals 2.66 (53.20%), Test-value = -3.65, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. We realize that the respondents disagreed to this paragraph.

The mean of the field "Questions related to developed symptoms" in table (4.8), equals 3.20 (64.02%), Test-value = 3.69, and P-value=0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this field is significant. We conclude that the respondents agreed to field of "Questions related to developed symptoms ".

This shows that symptoms that appear on the workers in NICUs has a relation to air quality, which is related to the work environment.

Table (4.8): Means and Test values for "Questions related to developed symptoms"

	Item	Mean	Proportional Mean (%)	Test value	P-value (Sig.)	Rank
1.	Do you think it is related to your workplace	3.98	79.60	6.84	0.000*	1
2.	Are these symptoms disappear after leaving work	3.56	71.20	4.67	0.000*	2
3.	Do you have any idea of the cause of these symptoms in your workplace	3.22	64.33	2.03	0.021*	3
4.	Do these symptoms appear at a specific time of the day	3.00	60.00	0.00	0.500	4
5.	Do these symptoms appear in a specific time of the year	2.66	53.20	-3.65	0.000*	6
6.	Are these symptoms occur since a long time	2.68	53.60	-2.80	0.003*	5
	All paragraphs of the field	3.20	64.02	3.69	0.000*	

* The mean is significantly different from 3

4.6.5 Air Quality

Table (4.9) shows the following results:

The mean of paragraph #6 "Do you think that air quality is important to your health" equals 4.75 (95.00%), Test-value = 10.05, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significant. We conclude that the respondents agreed to this paragraph.

The mean of paragraph #5 "I don’t think that bad ventilation affects my performance" equals 1.69 (33.70%), Test-value = -9.07, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. We understand that the respondents disagreed to this paragraph.

The mean of the field "**Air Quality**" in table (4.9), equals 2.65 (53.06%), Test-value = -6.50, and P-value=0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this field is significant. We realize that the respondents disagreed to field of "**Air Quality** ".

The statistical analysis of the air quality in table (4.9), showed dissatisfaction of workers for the indoor air quality in NICU in which they work, and also the means of improving air quality are inadequate and inappropriate, as they believe that poor ventilation affects their performance at work, where they feel bad ventilation and unpleasant odors although there are openings for the renewal of air, and no periodic examination of the air quality in these places.

Table (4.9): Means and Test values for "Air Quality"

	Item	Mean	Proportional mean (%)	Test value	P-value (Sig.)	Rank
1.	Are you satisfied of the air quality in your workplace generally	2.24	44.81	-5.76	0.000*	5
2.	Do you think that means of improving air quality in your workplace is adequate	2.18	43.52	-6.57	0.000*	6
3.	Are means of improving air quality suitable for work place	2.44	48.89	-4.37	0.000*	4
4.	I don’t use fans in my work place	3.56	71.21	3.10	0.001*	2
5.	I don’t think that bad ventilation affects my performance	1.69	33.70	-9.07	0.000*	10
6.	Do you think that air quality is important to your health	4.75	95.00	10.05	0.000*	1
7.	There is almost no bad smelling in my work place	2.03	40.56	-7.45	0.000*	7
8.	I don’t feel bad ventilation in my work place	2.03	40.56	-7.67	0.000*	8
9.	Are there vents for air renewal in your workplace	3.38	67.55	3.95	0.000*	3
10.	Is checking air quality periodically occur in your workplace	1.81	36.11	-8.18	0.000*	9
	All paragraphs of the field	2.65	53.06	-6.50	0.000*	

* The mean is significantly different from 3

4.6.6 Temperature

Table (4.10) shows the following results:

The mean of paragraph #3 "Do you think that means of improving temperature are suitable for your workplace" equals 3.00 (60.00%), Test-value = 0.84, and P-value = 0.201 which is greater than the level of significance $\alpha = 0.05$. Then the mean of this paragraph is insignificant. This explains that the respondents (Do not know, neutral) to this paragraph.

The mean of paragraph #8 "Does this device work regularly" equals 1.94 (38.88%), Test-value = -6.36, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. This shows that the respondents disagreed to this paragraph.

The mean of the field "**Temp**" in table (4.10), equals 2.75 (55.03%), Test-value = -3.07, and P-value=0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this field is significant. We realize that the respondents disagreed to field of "**Temp**".

The results of statistical analysis to paragraph "temperature" in the questionnaire showed dissatisfaction of workers about ways to improve the temperature in NICU in which they work, where temperature is almost unsuitable for the failures in the air conditioning as the incubators produces heat due to the existence of a heating device in each incubator.

Table (4.10): Means and Test values for "Temperature"

	Item	Mean	Proportional Mean (%)	Test value	P-value (Sig.)	Rank
1.	Is there a thermometer over time in your workplace	2.32	46.48	-4.26	0.000*	6
2.	Is the temperature appropriate in your workplace	2.64	52.78	-1.93	0.027*	4
3.	Do you think that means of improving temperature are suitable for your workplace	3.00	60.00	0.84	0.201	1
4.	Are you satisfied with the means of improving temperature in your workplace	2.59	51.85	-2.46	0.007*	5
5.	I don't feel hot in summer in my work place	2.74	54.81	-1.58	0.057	3
6.	I don't feel cold in winter in my work place	2.95	59.07	0.00	0.500	2
7.	Is there an adjusting temperature device in your workplace	2.20	44.07	-4.92	0.000*	7
8.	Does this device work regularly	1.94	38.88	-6.36	0.000*	8
	All paragraphs of the field	2.75	55.03	-3.07	0.001*	

* The mean is significantly different from 3

4.6.7 Humidity

Table (4.11) shows the following results:

The mean of paragraph #7 "Is there air conditioning in the workplace" equals 3.92 (78.32%), Test-value = 7.92, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significant. This indicates that the respondents agreed to this paragraph.

The mean of paragraph #2 "Is humidity measured on a daily basis" equals 1.54 (30.84%), Test-value = -9.60, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. This explains that the respondents disagreed to this paragraph.

The mean of the field "**Humidity**" in table (4.11), equals 2.50 (49.93%), Test-value = -6.77, and P-value=0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this field is significant. We understand that the respondents disagreed to field of "**Humidity** ".

The statistical analysis of the questionnaire to the paragraph "humidity" showed that workers are unssatisfied of the means of improving moisture in their work places, as they believe that the degree of appropriate humidity helps them better perform their work.

Table (4.11): Means and Test values for "Humidity"

	Item	Mean	Proportional mean (%)	Test value	P-value (Sig.)	Rank
1.	Is there a device to measure humidity in your workplace	1.63	32.52	-8.79	0.000*	6
2.	Is humidity measured on a daily basis	1.54	30.84	-9.60	0.000*	7
3.	Humidity in the workplace is generally appropriate	2.11	42.24	-6.22	0.000*	4
4.	Do you think that means of improving humidity suitable for your workplace	2.29	45.85	-5.33	0.000*	3
5.	Are you satisfied with the means of improving humidity in your workplace	2.07	41.50	-7.01	0.000*	5
6.	Do you think that the proper humidity helps in better performing your work	3.91	78.13	5.90	0.000*	2
7.	Is there air conditioning in the workplace	3.92	78.32	7.92	0.000*	1
	All paragraphs of the field	2.50	49.93	-6.77	0.000*	

* The mean is significantly different from 3

4.6.8 Dust

Table (4.12) shows the following results:

The mean of paragraph #1 "My work place far from the main street" equals 2.73 (54.63%), Test-value = -2.28, and P-value = 0.011 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. This proves that the respondents disagreed to this paragraph.

The mean of paragraph #4 "I don't think that dust affects my health" equals 1.52 (30.47%), Test-value = -9.42, and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significant. We conclude that the respondents disagreed to this paragraph.

The mean of the field "**Dust**" in table (4.12), equals 2.71 (54.27%), Test-value = -7.09, and P-value=0.000 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this field is significant. We realize that the respondents disagreed to field of " **Dust**".

Results in paragraph "dust" showed that workers in NICUs believe that the process of hygiene is inadequate and inappropriate. They're sometimes disturbed of dust in their workplace, as they notice dust on the roofs of some of these devices. And they believe that dust significantly affects their health, and there is no periodic measure of the ratio or kind of dust.

Table (4.12): Means and Test values for "Dust"

	Item	Mean	Proportional Mean (%)	Test value	P-value (Sig.)	Rank
1.	My work place far from the main street	2.73	54.63	-2.28	0.011*	1
2.	I don't notice dust on the surfaces of devices and equipment of my work place	2.25	45.05	-5.67	0.000*	4
3.	I don't feel disturbed of dust in my work place	1.80	35.93	-8.67	0.000*	5
4.	I don't think that dust affects my health	1.52	30.47	-9.42	0.000*	8
5.	Do you think that the process of cleaning your workplace enough	2.57	51.40	-3.47	0.000*	2
6.	Do you think that cleaning process is suitable in your workplace	2.46	49.26	-3.98	0.000*	3
7.	Is dust ratio measured periodically	1.55	30.93	-9.14	0.000*	6
8.	Is type of dust tested periodically	1.54	30.74	-9.14	0.000*	7
	All paragraphs of the field	2.71	54.27	-7.09	0.000*	

* The mean is significantly different from 3

4.7 Differences between the responses by some of the variables

4.7.1 Age

Table (4.13) shows that the p-value (Sig.) is greater than the level of significance $\alpha = 0.05$ for each field, then there is insignificant difference in respondents' answers toward each field due to Age. This clarifies that the characteristic of the respondents age has no effect on each field.

Table (4.13): *Kruskal-Wallis* test of the fields and their p-values for Age

No.	Field	Test Value	Sig.	Means		
				20 – 30 years	31 – 40 years	41 and older
1.	Working conditions	-0.096	0.924	2.72	2.98	2.81
2.	Current symptoms	-0.838	0.402	3.06	2.94	2.88
3.	Questions related to developed symptoms	-0.223	0.823	3.26	3.15	3.16
4.	Air Quality	-0.125	0.900	2.78	2.60	2.49
5.	Temperature	-0.404	0.686	2.99	2.66	2.44
6.	Humidity	-1.827	0.068	2.63	2.45	2.32
7.	Dust	-1.372	0.170	2.23	2.23	2.10

4.7.2 Gender

Table (4.14) shows that the p-value (Sig.) is greater than the level of significance $\alpha = 0.05$ for each field, then there is insignificant difference in respondents' answers toward each field due to Gender. This explains that the characteristic of the respondents Gender has no effect on each field. This result is consistent with Norback and Nordstrom, (2008) showed that there was no general trend of more symptoms in females, which is in contrast to most other studies on SBS, where females usually report more medical symptoms than men (Stenberg and Wall, 1995). One explanation could be that the male and female staff had a similar type of education and similar types of work tasks, and all of them are working in the same place.

Table (4.14): *Mann-Whitney* test of the fields and their p-values for Gender

No.	Field	Test Value	Sig.	Means	
				Male	Female
1.	Working conditions	-0.471	0.638	2.83	2.82
2.	Current symptoms	-0.557	0.577	2.95	3.03
3.	Questions related to developed symptoms	-0.131	0.896	3.18	3.24
4.	Air Quality	-1.715	0.086	2.65	2.65
5.	Temperature	-0.541	0.588	2.75	2.75
6.	Humidity	-0.634	0.526	2.43	2.63
7.	Dust	-0.543	0.587	2.16	2.27

4.7.3 Hospital

Table (4.15) shows that the p-value (Sig.) is smaller than the level of significance $\alpha = 0.05$ for the fields "Current symptoms, Air Quality and Temperature", then there is significant difference among the respondents regarding to these fields due to Hospital. We conclude that the respondents' Hospital has significant effect on these fields. Al Shifa Hospital respondents have the higher than other Hospital for field " Current symptoms", but European Hospital respondents have the higher than other Hospital for fields " Air Quality and Temperature".

Table (4.15) shows that the p-value (Sig.) is greater than the level of significance $\alpha = 0.05$ for the other fields, then there is insignificant difference among the respondents regarding to these fields due to Hospital. We understand that the respondents' Hospital has no effect on these fields.

Table (4.15):*Kruskal-Wallis test* of the fields and their p-values for Hospital

No.	Field	Test Value	Sig.	Means		
				Al Shifa Hospital	European Hospital	Al Aqsa Hospital
1.	Working conditions	1.114	0.573	2.80	2.88	2.79
2.	Current symptoms	11.078	0.004*	3.25	2.67	2.95
3.	Questions related to developed symptoms	4.570	0.102	3.33	2.97	3.31
4.	Air Quality	9.293	0.010*	2.68	2.76	2.43
5.	Temperature	22.819	0.000*	2.56	3.26	2.32
6.	Humidity	5.332	0.070	2.39	2.70	2.38
7.	Dust	4.704	0.095	2.10	2.23	2.31

* Means differences are significant at $\alpha = 0.05$

4.7.4 How long have you been at your current job

Table (4.16) shows that the p-value (Sig.) is greater than the level of significance $\alpha = 0.05$ for each field, then there is insignificant difference in respondents' answers toward each field due to How long have you been at your current job. This means that the characteristic of the respondents attended How long have you been at your current job has no effect on each field.

Table (4.16) shows that the p-value (Sig.) is smaller than the level of significance $\alpha = 0.05$ for the field "Air Quality", then this is significant difference among the respondents regarding to this field due to How long have you been at your current job. This proves that the respondents’ How long have you been at your current job has significant effect on these fields. 5 years and Less respondents have the more than More than 5 years.

Table (4.16) shows that the p-value (Sig.) is greater than the level of significance α = 0.05 for the other fields, then there is insignificant difference among the respondents regarding to these fields due to How long have you been at your current job. We conclude that the respondents' How long have you been at your current job has no effect on these fields.

Table (4.16): ***Mann-Whitney test*** **of the fields and their p-values for How long have you been at your current job**

No.	Field	Test Value	Sig.	Means	
				5 years and Less	More than 5 years
1.	Working conditions	-1.012	0.311	2.76	2.87
2.	Current symptoms	-0.210	0.834	2.98	2.98
3.	Questions related to developed symptoms	-0.141	0.888	3.16	3.23
4.	Air Quality	-3.019	0.003*	2.79	2.54
5.	Temperature	-1.724	0.085	2.90	2.63
6.	Humidity	-1.833	0.067	2.62	2.39
7.	Dust	-0.846	0.397	2.16	2.23

* Means differences are significant at α = 0.05

4.7.5 Occupation

Table (4.17) shows that the p-value (Sig.) is smaller than the level of significance α = 0.05 for the field "Air Quality", then this is significant difference among the respondents regarding to this field due to Occupation. We realize that the respondents'

Occupation has significant effect on these fields. Nurse respondents have the more than Doctor respondents.

Table (4.17) shows that the p-value (Sig.) is greater than the level of significance α = 0.05 for the other fields, then there is insignificant difference among the respondents regarding to these fields due to Occupation. This shows that the respondents' Occupation has no effect on these fields.

Table (4.17): *Mann-Whitney test* of the fields and their p-values for Occupation

No.	Field	Test Value	Sig.	Means	
				Doctor	Nurse
1.	Working conditions	-0.815	0.415	2.88	2.79
2.	Current symptoms	-1.011	0.312	2.92	3.02
3.	Questions related to developed symptoms	-1.116	0.264	3.11	3.26
4.	Air Quality	-2.874	0.004*	2.52	2.74
5.	Temperature	-1.092	0.275	2.64	2.83
6.	Humidity	-1.163	0.245	2.42	2.55
7.	Dust	-0.305	0.761	2.18	2.21

* Means differences are significant at α = 0.05

4.7.6 Qualification

Table (4.18) shows that the p-value (Sig.) is smaller than the level of significance α = 0.05 for the field "Current symptoms", then this is significant difference among the respondents regarding to this field due to Qualification. We understand that the respondents' Qualification has significant effect on these fields. Diploma respondents have the higher than other Qualification group.

Table (4.18) shows that the p-value (Sig.) is greater than the level of significance α = 0.05 for the other fields, then there is insignificant difference among the respondents regarding to these fields due to Qualification. We conclude that the respondents' Qualification has no effect on these fields. This result is consistent with wong et.al., (2009) showed that the educational or professional background of respondents did not appear to be significant.

Table (4.18): ***Kruskal-Wallis test*** **of the fields and their p-values for Qualification**

No.	Field	Test Value	Sig.	Means		
				Diploma	BS	MS and more
1.	Working conditions	0.164	0.921	2.83	2.83	2.79
2.	Current symptoms	6.688	0.035*	3.26	2.91	2.73
3.	Questions related to developed symptoms	4.838	0.089	3.38	3.16	2.98
4.	Air Quality	1.168	0.558	2.72	2.62	2.65
5.	Temperature	1.951	0.377	2.88	2.73	2.61
6.	Humidity	1.339	0.512	2.50	2.53	2.36
7.	Dust	1.129	0.569	2.18	2.18	2.28

* Means differences are significant at α = 0.05

Chapter 5: Conclusions and Recommendations

This is the first study done to assess the indoor air quality at the NICUs in government hospitals in Gaza strip. The following conclusions and recommendations were drawn from the results of the research.

5.1 Conclusions

- The study results revealed that the mean of CO_2 in AL Shifa hospital was higher than of other hospitals, especially in the morning shift where it was 1143 ppm which was more than the recommended value (1000 ppm).
- Meanwhile, the mean of Temp in AL Shifa hospital recorded the higher readings where it was very close to the recommended value, and sometimes a little higher than it.
- On the other hand, the average concentration rate of CO complied with recommended value, 10 ppm for an 8hr period exposure.
- While, the mean result of RH% in all hospitals were very compatible with standards, (30% - 65%). This applies to all NICUs.
- Also, all results of particulate matter meet the standards in all NICUs.
- Self-administered questionnaire results revealed that 43% of the sample are from AL Shifa hospital, 35% of the sample are from European hospital, 22% of the sample are from AL Aqsa hospital.
- According to the results of the questionnaire, the study sample consists of : 41% doctors, 59% nurses, 68% male, 32% female, 56% hold a bachelor degree, and 55% have more than five year experience.
- The study showed that about 60% of all respondents suffer from SBS as fatigue and headaches occupied the first and second rank: 83% and 76%, respectively. And in their answers to questions about the symptoms, 78% of them believe that these symptoms are related to the work place, and these symptoms for 71% of them disappear after leaving work.
- The results of the questionnaire showed that about 66% of them believe that poor ventilation affects their performance, while 95% of them believe that air quality is very important for their health. In responding to " Temp ", 47%

showed that it is inappropriate, and for the ways to improve it, 40% showed that it is inappropriate as well for the workplace. But when asked about humidity,78% of them answered that proper humidity helps in better performance.

- Results of the statistical analysis of the differences between the variable (age and sex), showed statistical insignificance. While results by the variable (hospital, occupation, experience, and qualifications) showed the existence of a "statistical significance "in some paragraphs.
- The results of the statistical analysis (ANOVA), when compared to the average results for each variable with time in the European Hospital, shows a statistical significance with all variables, and in Shifa Hospital was a statistical significance with the variables (RH%, CO_2, and CO), while in the Aqsa Hospital, there were a statistical significance with the variables (Temp and CO_2).
- On the other hand, results of the statistical analysis(ANOVA) showed a statistical significance with all the variables when compared with results for each hospital.

5.2 Recommendations

Based on the results and findings of the current research, the researcher recommends the following:

1. Enhance decision maker institutions especially the ministry of health to take the IAQ into consideration.
2. Regular and periodic monitoring of the indoor air parameters should be done.
3. Providing detector equipment of CO_2 gas in the NICUs in which CO_2 measurement exceeds the allowable extent, in order to prevent exposing the employees and neonates to high proportion that may affect their health.
4. Clean air is a basic key to obtain a kind of clean interior air by providing the NICUs with conditioning devices that contain bacterial filter to pumping fresh air.
5. Establishing suitable Palestinian guidelines for IAQ as much as possible, and providing information about air pollution in Palestine, especially indoor air pollutants.

6. Education and information dissemination for the employees and community about the health risks associated with indoor air are very necessary.

5.2.1 Recommendations for further research Studies

1. Similar studies may be performed to check contamination with other indoor air pollutants such as volatile organic compound, and nitrogen oxide.
2. Conducting similar research in other hospitals and comparison between outdoor and indoor air quality.
3. Further research to assess pathogenic microbes culture and number of bacteria in indoor air in hospitals.
4. Study of indoor air quality effects on neonates inside the incubators.

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Appendices

Appendix A: The questionnaire in English

Islamic University-Gaza
Deanship of Graduate studies
Environmental Sciences
Master program
Environmental Health

الجامعة الإسلامية-غزة
كلية الدراسات العليا
برنامج ماجستير العلوم البيئية
تخصص الصحة البيئية

The researcher undermines a study titled:

Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

This study is presented to the Department of Environmental Science , Faculty of Science/Environmental Health, and here is the questionnaire of this study. This questionnaire concerns the quality of indoor air in your workplace which could cause some of the symptoms and the problems you have. Please make sure that this information will be only used for the purposes of scientific research and will not be disclosed for anybody.

Thank you for your cooperation

Researcher

Iyad Mohammed Abu Shamh

✓ Title:

Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

✓ OBJECTIVES:

❖ GENERAL OBGECTIVE:

The purpose of this study is to assess indoor air quality (IAQ) in neonatal intensive care units in governmental hospitals in Gaza strip.

❖ SPECIFIC OBJECTIVES :

- To assess the air quality {carbon monoxide (CO), carbon dioxide (CO_2), and particulate matter (PM_{10} , $PM_{2.5}$)}in neonatal intensive care units .
- To identify the thermal comfort {temperature (T) and relative humidity (RH%)} in neonatal intensive care units.
- To investigate the effects of indoor air quality (IAQ) on the employees health.
- To provide the decision makers with a healthful suggestions and recommendations about the indoor air quality.

i. basic information: (employee data)

1. Age: ☐ 20-30 years ☐ 31-40 year ☐ 41-50 year ☐ 51 and older
2. Gender: ☐ Male ☐ Female
3. Marital status: ☐ Married ☐ Single ☐ Divorced ☐ widow
4. Address: ☐ North ☐ Gaza ☐ South ☐ Center
5. Occupation: ☐ Doctor ☐ Nurse
6. Qualification : ☐ Diploma 2 years ☐ Diploma 3 years ☐ BS ☐ MS ☐ Ph.D.
7. Hospital: ☐ Al Shifa Hospital ☐ European Hospital ☐ Al Aqsa Hospital
8. How long have you been at your current job

   ☐Less than one year ☐1-5 years ☐More than 5 years

ii. Medical history:

1. Do you suffer from chronic diseases: ☐ Yes ,such as:----------------- ☐ No
2. If the answer is yes:

   Do you suffer from the disease after enrollment in the Department

   ☐Yes ☐No
3. Do you take any medication ☐Yes ☐No
4. Are you smokers ☐ Yes ☐ No
5. If the answer is yes:

   Years of smoking ☐ 0-2 years ☐ 3-5 years ☐ More than 5 years
6. If the answer is no:

   Have you been a smoker before ☐ Yes ☐ No

iii. Working conditions:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Are you satisfied of the area of your work					
2.	I don't feel crowded in the area of my work					
3.	I don't feel boring of the length of work period					
4.	I don't have the ability to change work conditions					
5.	I don't practice any other work other than my original one					

iv. Current symptoms:

1.	**Within your work place do you show any of the following symptoms: (possible to select more than one symptom)**	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a.	Headache					
b.	Fatigue					
c.	Dryness or irritation of the skin					
d.	Nausea					
e.	Eye irritation					
f.	Difficulty of concentrating					
g.	Dizziness					
h.	Nasal congestion					
i.	Breathing difficulty					
j.	Chest tightness					

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
k.	Throat dryness					
l.	Joints pain					
m.	Sneezing, coughing					
n.	Other, specify ------------------					
If there is any of the following symptoms please answer these questions:		**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
2.	Do you think it is related to your workplace					
3.	Are these symptoms disappear after leaving work					
4.	Do you have any idea of the cause of these symptoms in your workplace					
5.	Do these symptoms appear at a specific time of the day					
6.	Do these symptoms appear in a specific time of the year					
7.	Are these symptoms occur since a long time					

v. Air Quality:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Are you satisfied of the air quality in your workplace generally					
2.	Do you think that means of improving air quality in your workplace is adequate					
3.	Are means of improving air quality suitable for work place					
4.	I don’t use fans in my work place					

5.	I don't think that bad ventilation affects my performance					
6.	Do you think that air quality is important to your health					
7.	There is often undesirable odor in my work place					
8.	I don't feel bad ventilation in my work					
9.	Are there vents for air renewal in your workplace					
10.	Is checking air quality periodically occur in your workplace					

vi. Temperature:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Is there is a thermometer over time in your workplace					
2.	Is the temperature appropriate in your workplace					
3.	Do you think that means of improving temperature are suitable for your workplace					
4.	Are you satisfied with the means of improving temperature in your workplace					
5.	I don't feel hot in summer in my work place					
6.	I don't feel cold in winter in my work place					
7.	Is there an adjusting temperature device in your workplace					
8.	Does this device work regularly					

vii. Humidity:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Is there a device to measure humidity in your workplace					
2.	Is humidity measured on a daily basis					
3.	Humidity in the workplace is generally appropriate					
4.	Do you think that means of improving humidity suitable for your workplace					
5.	Are you satisfied with the means of improving humidity in your workplace					
6.	Do you think that the proper humidity helps in better performing your work					
7.	Is there air conditioning in the workplace					

viii. Dust:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Does your workplace close to a main street in the area					
2.	I don't notice dust on the surfaces of devices and equipment of my work place					
3.	I don't feel disturbed of dust in my work place					
4.	I don't think that dust affects my health					
5.	Do you think that the process of cleaning your workplace enough					
6.	Do you think that cleaning process is suitable in your workplace					
7.	Is dust ratio measured periodically					
8.	Is type of dust tested periodically					

Thank you for Filling this questionnaire

Appendix B: Descriptive Statistics of data

For European Hospital

Time		No.	Minimum	Maximum	Mean	Std. Deviation
Morning	**Temp**	90	22.5	26.4	24.62	1.00
	RH%	90	25.1	67.8	44.79	8.18
	CO_2	90	491	1,013	741.83	130.51
	CO	90	2.4	3.8	3.12	0.32
	PM_{10}	15	0	4	1.47	1.25
	$PM_{2.5}$	15	0	1	0.20	0.41
Evening	**Temp**	60	23.1	26.0	24.37	0.85
	RH%	60	25.4	54.5	41.20	7.44
	CO_2	60	496	777	606.33	77.21
	CO	60	2.5	3.6	3.07	0.28
	PM_{10}	10	0	1	0.50	0.53
	$PM_{2.5}$	10	0	0	0.00	0.00
Night	**Temp**	24	25.8	26.6	26.20	0.20
	RH%	24	50.4	51.4	50.97	0.36
	CO_2	24	485	634	536.33	49.13
	CO	24	2.3	3.0	2.70	0.17
	PM_{10}	4	3	7	4.25	1.89
	$PM_{2.5}$	4	0	1	0.75	0.50

For Al Shifa Hospital

Time		No.	Minimum	Maximum	Mean	Std. Deviation
Morning	**Temp**	90	24.0	27.8	26.48	1.22
	RH%	90	35.0	57.0	44.89	5.96
	CO_2	90	692	1,634	1,142.74	243.02
	CO	90	4.7	12.0	7.85	1.81
	PM_{10}	15	3	16	5.40	3.27
	$PM_{2.5}$	15	0	3	1.00	0.65
Evening	**Temp**	60	24.5	27.7	26.29	1.00
	RH%	60	34.5	48.4	39.68	3.81
	CO_2	60	525	1,352	850.18	219.93
	CO	60	5.8	11.2	8.06	1.36
	PM_{10}	10	3	6	4.20	1.14
	$PM_{2.5}$	10	0	1	0.90	0.32
Night	**Temp**	24	25.3	27.5	26.70	0.79
	RH%	24	38.1	49.0	41.68	4.30
	CO_2	24	618	1,043	805.75	130.43
	CO	24	5.1	8.2	6.83	0.67
	PM_{10}	4	4	6	4.75	0.96
	$PM_{2.5}$	4	1	1	1.00	0.00

For Al Aqsa Hospital

Time	Variable	No.	Minimum	Maximum	Mean	Std. Deviation
Morning	**Temp**	90	22.0	35.0	25.84	1.36
	RH%	90	25.5	65.3	45.90	10.01
	CO_2	90	595	1,208	877.50	145.84
	CO	90	2.4	4.9	3.16	0.51
	PM_{10}	16	1	6	3.96	1.48
	$PM_{2.5}$	16	0	1	0.78	0.41
Evening	**Temp**	60	24.9	26.9	25.91	0.49
	RH%	60	30.8	53.1	44.27	6.75
	CO_2	60	620	1,231	876.25	170.30
	CO	60	2.6	5.0	3.10	0.53
	PM_{10}	10	2	4	3.30	0.82
	$PM_{2.5}$	10	0	1	0.70	0.48
Night	**Temp**	24	26.4	27.5	26.94	0.30
	RH%	24	35.8	44.8	42.07	3.67
	CO_2	24	598	742	688.92	49.20
	CO	24	2.3	4.0	3.22	0.43
	PM_{10}	4	1	6	3.00	2.45
	$PM_{2.5}$	4	0	1	0.50	0.58

Appendix C: The correlation coefficients between each paragraph in one field and the whole field

Correlation coefficient of each paragraph of " Working conditions " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Are you satisfied of the area of your work	.487	0.000*
2.	I don't feel crowded in the area of my work	.620	0.000*
3.	I don't feel boring of the length of work period	.449	0.000*
4.	I don't have the ability to change work conditions	.341	0.000*
5.	I don't practice any other work other than my original one	.500	0.000*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Current symptoms " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Headache	.502	0.000*
2.	Fatigue	.378	0.000*
3.	Dryness or irritation of the skin	.691	0.000*
4.	Nausea	.754	0.000*
5.	Eye irritation	.666	0.000*
6.	Difficulty of concentrating	.633	0.000*
7.	Dizziness	.769	0.000*
8.	Nasal congestion	.727	0.000*
9.	Breathing difficulty	.648	0.000*
10.	Chest tightness	.644	0.000*
11.	Throat dryness	.674	0.000*
12.	Joints pain	.497	0.000*
13.	Sneezing, coughing	.580	0.000*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Question related to developed symptoms " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Do you think it is related to your workplace	.608	0.000*
2.	Are these symptoms disappear after leaving work	.614	0.000*
3.	Do you have any idea of the cause of these symptoms in your workplace	.590	0.000*
4.	Do these symptoms appear at a specific time of the day	.742	0.000*
5.	Do these symptoms appear in a specific time of the year	.526	0.000*
6.	Are these symptoms occur since a long time	.613	0.000*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Air Quality " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Are you satisfied of the air quality in your workplace generally	.702	0.000*
2.	Do you think that means of improving air quality in your workplace is adequate	.716	0.000*
3.	Are means of improving air quality suitable for work place	.683	0.000*
4.	I don't use fans in my work place	.167	0.043*
5.	I don't think that bad ventilation affects my performance	.283	0.002*
6.	Do you think that air quality is important to your health	.251	0.004*
7.	There is often undesirable odor in my work place	.565	0.000*
8.	I don't feel bad ventilation in my work	.648	0.000*
9.	Are there vents for air renewal in your workplace	.510	0.000*
10.	Is checking air quality periodically occur in your workplace	.372	0.000*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Temperature " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Is there a thermometer over time in your workplace	.565	0.000*
2.	Is the temperature appropriate in your workplace	.784	0.000*
3.	Do you think that means of improving temperature are suitable for your workplace	.641	0.000*
4.	Are you satisfied with the means of improving temperature in your workplace	.741	0.000*
5.	I don't feel hot in summer in my work place	.470	0.000*
6.	I don't feel cold in winter in my work place	.563	0.000*
7.	Is there an adjusting temperature device in your workplace	.797	0.000*
8.	Does this device work regularly	.735	0.000*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Humidity " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Is there a device to measure humidity in your workplace	.632	0.000*
2.	Is humidity measured on a daily basis	.584	0.000*
3.	Humidity in the workplace is generally appropriate	.665	0.000*
4.	Do you think that means of improving humidity suitable for your workplace	.791	0.000*
5.	Are you satisfied with the means of improving humidity in your workplace	.771	0.000*
6.	Do you think that the proper humidity helps in better performing your work	.220	0.011*
7.	Is there air conditioning in the workplace	.259	0.004*

* Correlation is significant at the 0.05 level

Correlation coefficient of each paragraph of " Dust " and the total of this field

No.	Paragraph	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Does your workplace close to a main street in the area	.447	0.000*
2.	I don't notice dust on the surfaces of devices and equipment of my work place	.622	0.000*
3.	I don't feel disturbed of dust in my work place	.622	0.000*
4.	I don't think that dust affects my health	.446	0.000*
5.	Do you think that the process of cleaning your workplace enough	.371	0.000*
6.	Do you think that cleaning process is suitable in your workplace	.318	0.000*
7.	Is dust ratio measured periodically	.547	0.000*
8.	Is type of dust tested periodically	.582	0.000*

* Correlation is significant at the 0.05 level

Appendix D: Correlation Coefficient of each field and the whole of questionnaire

No.	Field	Spearman Correlation Coefficient	P-Value (Sig.)
1.	Working conditions	.318	0.000*
2.	Current symptoms	.473	0.000*
3.	Question related to developed symptoms	.305	0.001*
4.	Air Quality	.453	0.000*
5.	Temperature	.658	0.000*
6.	Humidity	.528	0.000*
7.	Dust	.450	0.000*

* Correlation is significant at the 0.05 level

Appendix E: Scheffe Test

Multiple Comparisons					
Scheffe					
hospital	Dependent Variable	(I) TIME	(J) TIME	Mean Difference (I-J)	Sig.
AL AQSA HOSPITAL	T	MORNING	EVENING	-0.0639	0.933
			NIGHT	-1.0972(*)	0.000
		EVENING	MORNING	0.0639	0.933
			NIGHT	-1.0333(*)	0.000
		NIGHT	MORNING	1.0972(*)	0.000
			EVENING	1.0333(*)	0.000
	RH%	MORNING	EVENING	1.6317	0.504
			NIGHT	3.8300	0.140
		EVENING	MORNING	-1.6317	0.504
			NIGHT	2.1983	0.553
		NIGHT	MORNING	-3.8300	0.140
			EVENING	-2.1983	0.553
	CO2	MORNING	EVENING	1.250	0.999
			NIGHT	188.583(*)	0.000
		EVENING	MORNING	-1.250	0.999
			NIGHT	187.333(*)	0.000
		NIGHT	MORNING	-188.583(*)	0.000
			EVENING	-187.333(*)	0.000
	CO	MORNING	EVENING	0.0556	0.807
			NIGHT	-0.0653	0.855
		EVENING	MORNING	-0.0556	0.807
			NIGHT	-0.1208	0.617
		NIGHT	MORNING	0.0653	0.855
			EVENING	0.1208	0.617
	PM 5	MORNING	EVENING	0.660	0.538
			NIGHT	0.960	0.507
		EVENING	MORNING	-0.660	0.538
			NIGHT	0.300	0.941
		NIGHT	MORNING	-0.960	0.507
			EVENING	-0.300	0.941
	PM2.5	MORNING	EVENING	0.076	0.919
			NIGHT	0.276	0.565
		EVENING	MORNING	-0.076	0.919
			NIGHT	0.200	0.763
		NIGHT	MORNING	-0.276	0.565
			EVENING	-0.200	0.763

EUROPEAN HOSPITAL	T	MORNING	EVENING	0.2528	0.231
			NIGHT	-1.5831(*)	0.000
		EVENING	MORNING	-0.2528	0.231
			NIGHT	-1.8358(*)	0.000
		NIGHT	MORNING	1.5831(*)	0.000
			EVENING	1.8358(*)	0.000
	RH%	MORNING	EVENING	3.5861(*)	0.015
			NIGHT	-6.1789(*)	0.002
		EVENING	MORNING	-3.5861(*)	0.015
			NIGHT	-9.7650(*)	0.000
		NIGHT	MORNING	6.1789(*)	0.002
			EVENING	9.7650(*)	0.000
	CO2	MORNING	EVENING	135.500(*)	0.000
			NIGHT	205.500(*)	0.000
		EVENING	MORNING	-135.500(*)	0.000
			NIGHT	70.000(*)	0.026
		NIGHT	MORNING	-205.500(*)	0.000
			EVENING	-70.000(*)	0.026
	CO	MORNING	EVENING	0.0550	0.530
			NIGHT	.4192(*)	0.000
		EVENING	MORNING	-0.0550	0.530
			NIGHT	.3642(*)	0.000
		NIGHT	MORNING	-.4192(*)	0.000
			EVENING	-.3642(*)	0.000
	PM 5	MORNING	EVENING	0.967	0.145
			NIGHT	-2.783(*)	0.001
		EVENING	MORNING	-0.967	0.145
			NIGHT	-3.750(*)	0.000
		NIGHT	MORNING	2.783(*)	0.001
			EVENING	3.750(*)	0.000
	PM2.5	MORNING	EVENING	0.200	0.385
			NIGHT	-.550(*)	0.032
		EVENING	MORNING	-0.200	0.385
			NIGHT	-.750(*)	0.005
		NIGHT	MORNING	.550(*)	0.032
			EVENING	.750(*)	0.005
AL SHIFA HOSPITAL	T	MORNING	EVENING	0.1933	0.574
			NIGHT	-0.2158	0.694
		EVENING	MORNING	-0.1933	0.574
			NIGHT	-0.4092	0.307
		NIGHT	MORNING	0.2158	0.694
			EVENING	0.4092	0.307
	RH%	MORNING	EVENING	5.2117(*)	0.000
			NIGHT	3.2117(*)	0.025
		EVENING	MORNING	-5.2117(*)	0.000
			NIGHT	-2.0000	0.270

		NIGHT	MORNING	-3.2117(*)	0.025
			EVENING	2.0000	0.270
	CO2	MORNING	EVENING	292.561(*)	0.000
			NIGHT	336.994(*)	0.000
		EVENING	MORNING	-292.561(*)	0.000
			NIGHT	44.433	0.712
		NIGHT	MORNING	-336.994(*)	0.000
			EVENING	-44.433	0.712
	CO	MORNING	EVENING	-0.2067	0.728
			NIGHT	1.0283(*)	0.017
		EVENING	MORNING	0.2067	0.728
			NIGHT	1.2350(*)	0.005
		NIGHT	MORNING	-1.0283(*)	0.017
			EVENING	-1.2350(*)	0.005
	PM 5	MORNING	EVENING	1.200	0.513
			NIGHT	0.650	0.900
		EVENING	MORNING	-1.200	0.513
			NIGHT	-0.550	0.934
		NIGHT	MORNING	-0.650	0.900
			EVENING	0.550	0.934
	PM2.5	MORNING	EVENING	0.100	0.894
			NIGHT	0.000	1.000
		EVENING	MORNING	-0.100	0.894
			NIGHT	-0.100	0.948
		NIGHT	MORNING	0.000	1.000
			EVENING	0.100	0.948
*. The mean difference is significant at the .05 level.					

Multiple Comparisons

Scheffe

Dependent Variable	(I) TIME	(J) TIME	Mean Difference (I-J)	Sig.	
T	MORNING	EVENING	0.1274	0.571	
		NIGHT	-.9654(*)	0.000	
	EVENING	MORNING	-0.1274	0.571	
		NIGHT	-1.0928(*)	0.000	
	NIGHT	MORNING	.9654(*)	0.000	
		EVENING	1.0928(*)	0.000	
RH%	MORNING	EVENING	3.4765(*)	0.000	
		NIGHT	0.2876	0.957	
	EVENING	MORNING	-3.4765(*)	0.000	
		NIGHT	-3.1889(*)	0.008	
	NIGHT	MORNING	-0.2876	0.957	

		EVENING	3.1889(*)	0.008	
CO2	MORNING	EVENING	143.104(*)	0.000	
		NIGHT	243.693(*)	0.000	
	EVENING	MORNING	-143.104(*)	0.000	
		NIGHT	100.589(*)	0.005	
	NIGHT	MORNING	-243.693(*)	0.000	
		EVENING	-100.589(*)	0.005	
CO	MORNING	EVENING	-0.0320	0.991	
		NIGHT	0.4607	0.357	
	EVENING	MORNING	0.0320	0.991	
		NIGHT	0.4928	0.345	
	NIGHT	MORNING	-0.4607	0.357	
		EVENING	-0.4928	0.345	
PM 5	MORNING	EVENING	0.950	0.223	
		NIGHT	-0.384	0.878	
	EVENING	MORNING	-0.950	0.223	
		NIGHT	-1.333	0.247	
	NIGHT	MORNING	0.384	0.878	
		EVENING	1.333	0.247	
PM2.5	MORNING	EVENING	0.128	0.615	
		NIGHT	-0.089	0.884	
	EVENING	MORNING	-0.128	0.615	
		NIGHT	-0.217	0.518	
	NIGHT	MORNING	0.089	0.884	
		EVENING	0.217	0.518	
*. The mean difference is significant at the .05 level.					

Appendix F: Map for hospitals site that studied.

السلطة الوطنية الفلسطينية
سلطة الأراضي
الإدارة العامة لأملاك الحكومة
قسم نظم المعلومات الجغرافية

الصورة رقم 1 توضح مستشفى دار الشفاء بمدينة غزة

الصورة رقم 2 توضح مستشفى شهداء الأقصى بمدينة دير البلح

الصورة رقم 3 توضح المستشفى الاوروبي بمدينة خانيونس

Appendix G: The NICU in Al Shifa Hospital

Appendix H: Approval of IUG

بسم الله الرحمن الرحيم

الجامعة الإسلامية – غزة
The Islamic University - Gaza
قسم البيئة و علوم الأرض – كلية العلوم – الجامعة الإسلامية – غزة

الرقم: Ref ....
التاريخ: 2012/12/29 :D

السيد الدكتور/ناصر ابو شعبان.. حفظه الله
مدير ادارة تنمية القوى البشرية بوزارة الصحة الفلسطينية
السلام عليكم و رحمة الله و بركاته ،،،

الموضوع : تسهيل مهمة باحث ماجستير

نهديكم في قسم البيئة و علوم الأرض أطيب التحيات و نرجو التكرم بالعلم بأن الطالب / **اياد محمد ابو شمة** يحتاج إلى جمع معلومات و أخذ عينات ضمن رسالة الماجستير الخاصة به و المعنونة بـ

Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip, Palestine

تقييم جودة الهواء الداخلي في أقسام العناية المركزة لحديثي الولادة في المستشفيات الحكومية بقطاع غزة، فلسطين

علما بأن الطالب المذكور أعلا هو طالب في برنامج ماجستير العلوم البيئية شعبة صحة البيئة ، لذا نرجو من سيادتكم مساعدة الطالب المذكور أعلاه من أجل البحث العلمي لا غير.

وتقبلوا فائق الاحترام والتقدير،،،

أ. سمير حرارة
رئيس قسم البيئة و علوم الأرض

P.O. Box 108, Rimal, Gaza, Palestine fax: +970 (8) 286 0800 فاكس Tel: +970 (8) 286 0700 ص.ب 108 الرمال، غزة، فلسطين هاتف
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Appendix I: Approval of MOH

The Palestinian National Authority
Ministry of Health
Directorate General of Human Resources Development

السلطة الوطنية الفلسطينية
وزارة الصحة
الإدارة العامة لتنمية القوى البشرية

التاريخ: 2013/01/13

الأخ/ د. يوسف أبو الريش   المحترم،،،
مدير عام المستشفيات

السلام عليكم ورحمة الله وبركاته،،

الموضوع/ تسهيل مهمة باحث

بخصوص الموضوع أعلاه، يرجى تسهيل مهمة الباحث / إياد محمد أبوشمة الملتحق ببرنامج ماجستير العلوم البيئية شعبة صحة البيئة - كلية العلوم - الجامعة الإسلامية غزة في إجراء بحث بعنوان :-

"Assessment of Indoor Air Quality in Neonatal Intensive Care Units in Government Hospitals in Gaza Strip Palestine "

حيث الباحث بحاجة لتعبئة استبانه من العاملين في وحدات العناية المركزة للأطفال حديثي الولادة في مستشفيات غزه وعمل قياسات للحرارة و الرطوبة وقياسات أخرى في هذه الوحدات، بما لا يتعارض مع مصلحة العمل وضمن أخلاقيات البحث العلمي، و دون تحمل الوزارة أي أعباء أو مسئولية.

وتفضلوا بقبول التحية والتقدير،،،

د. ناصر رأفت أبو شعبان
مدير عام تنمية القوى البشرية

وزارة الصحة
تنمية القوى البشرية

زهير محمود نوفل
Zohair M. Nofal
Director of Nursing Shifa Hospital

Nursing Directorate

11/3/2013

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