An-Najah National University
Faculty of Graduate Studies

Effects of Noise Pollution on Hearing Threshold, Blood Pressure and Oxygen Concentration in Blood of Workers in the Hospitals in Jenin City-Palestine

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Physics, Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine
2011

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Dedication

This thesis is dedicated to my father and mother, as well as,

to my husband, my brothers and sisters, and my family.

With respect and love.

Acknowledgement

A lot of appreciation to my supervisors Prof. Dr. Issam Rashid and co-supervisor Dr. Zeid Naim Qamhieh, for their helpful effort and continual encouragement throughout this research. Special thanks are addressed to the managers of the hospitals doctors and nurses for their cooperation, whom contributed considerably to the completion of this research.

الإقرار

أنا الموقعة أدناه مقدمة الرسالة التي تحمل العنوان:

Effects of Noise Pollution on Hearing Threshold, Blood Pressure and Oxygen Concentration in Blood of Workers in the Hospitals in Jenin City-Palestine

تأثير الضوضاء على السمع وضغط الدم وتركيز الأكسجين في الدم عند العاملين في المستشفيات في مدينة جنين – فلسطين

اقر بأن ما اشتملت عليه هذه الرسالة، إنما هي نتاج جهدي الخاص، باستثناء ما تمـــت الإشارة إليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

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.

Student's name: **اسم الطالبة:**

Signature: **التوقيع:**

Date: **التاريخ:**

List of Abbreviations

ANOVA	Analysis of Variance
ANSI	American National Standard Institute
ASHA	American Social Health Association
b	Before Exposure to the Noise
D	During Exposure to the Noise
dB	Decible (Unit of Sound Level Using Logarithmic Scale)
dB(A)	Decible (Unit of Sound Level Using Logarithmic Scale) by A Weighting Filter
DBP	Diastolic Blood Pressure
EPA	Environmental Protection Agency
EU	European Union
Fig.	Figure
H. I.	Hearing Impairment
HPR	Heart Pulse Rate
HTL	Hearing Threshold Levels
Hz	Hertz
ICU	Intensive Care Unit
L.E	Left Ear
Leq	Equivalent Continuous Sound Level
LNP	Noise Pollution Level
Lab	Laboratory
NICU	Neonatal Care Unit
NIHL	Noise Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
NPL	Noise Pollution Level
OR	Operation Rooms
OSHA	Occupational Safety and Health Administration
R.E	Right Ear
RMS	Root Mean Square
SBP	Systolic Blood Pressure
SPL	Sound Pressure Level
SpO_2%	Blood Oxygen Saturation.
WHO	World Health Organization

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Abstract

This study analyzes the association of noise pollution level with hearing threshold level, blood oxygen concentration, heart pulse rate, systolic and diastolic blood pressure on workers in six departments in Jenin hospitals. The six departments are the intensive care units (ICU), neonatal care units (NICU), operating rooms (OR), laboratory (Lab), emergency and outpatient clinic. The sound pressure level (SPL) values in all studied hospitals are high compared with the recommended value which is 45.0 dB(A) in the daytime.

The hearing threshold level, blood oxygen concentration, heart pulse rate and blood pressure (Systolic and Diastolic) were measured for 117 workers (61 males and 56 females) which is the sample of workers in hospitals in Jenin city. The ages of workers are ranged from 20 to 65 yr. The duration of employment of those workers in the current job is ranged from 1 to 38 yr. In this study HTL, SpO_2%, SBP, DBP and HPR are correlated positively (p-value < 0.050) with the occupational noise levels in all studied hospitals. Whereas the Pearson coefficient correlation R value of HTL, SpO_2%, SBP, DBP and HPR in all selected hospitals are ranged

from 0.857 to o.938 of HTL, from 0.405 to 0.861 of SpO_2%, from 0.754 to 0.983 of SBP, from 0.703 to 0.837 of DBP and from 0.496 to 0.938 for HPR.

Chapter One

Introduction

Chapter One
Introduction

1.1. Introduction

Noise is disturbing uncomfortable waves which has great negative effects on health. It has become a very important "stress factor" in the environment of human being as a result of technological and industrial progress. However the most common sources of noise pollution are factories and modern transportation of all forms (cars, trains, planes, trucks and buses). Other sources include the noise in workplace or even the noise of simultaneous conversations.

As a result of the many sources of noise, many health problems appeared. For example, physiological effects of noise pollution were found to cause sudden changes in triggering muscular reflexes such as eye blinks, facial grimaces and inward bending of arms and knees. These reflexes prepare the body for defensive action against the source of the noise which might interfere with other tasks and sometimes may cause accidents (Elizabeth Scott, 2007).

Due to the importance of this subject, noise pollution has suddenly moved up the international health organizations agenda, in an attempt to reduce the health effects of noise pollution. Several organization such as World Health Organization (WHO), International Labour Organization (ILO) and Occupational Safety and Health Administration (OSHA)) started to setup new standards for noise and take appropriate actions against their

sources. As a result of the continuous hard work, standards for noise pollution level in various work places during various times were developed and some are shown in table (1.1).

Table (1.1): Some noise standards developed by WHO, ILO and OSHA organizations. Day time means 6:00 a.m. to 10:00 p.m. and night time is 10:00 p.m. to 6:00 a.m.

Area Code	Category of Area/Zone	Limits of Leq dB(A)	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note: Leq : The equivalent continues sound level.

1.2. Previous Studies

Measurement and analysis of noise levels are powerful diagnostic tool in noise reduction programs from airports, factories, highways and machines in different institutions. Therefore, they can be considered as tools that permit the improvement of quality of human life. However noise pollution is a problem that started with the industrial revolution. Since then, many studies have been done worldwide to find out the negative effects of noise. In factories where workers are exposed to regular high levels of noise, some symptom including nausea, headaches, changes in mood and anxiety were noticed on them (Crook M. A., 1974). Particularly in industrial places, the exposure to continuous noise level between 85 to 90 dB(A), can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity (Kryter K. D., 1985).

In hospitals, as a result of technological progress, the noise levels may be harmful (Pereira R. P., 2003). Both patients and staff workers noted that noise levels in the intensive care unit (ICU) is high, and studies confirmed this observation (Christensen M., 2007). For instance, in a study by Petterson, night time sound pressure levels were found to be greater than 50 dB(A) and peak levels were between 80 and 86 dB(A) (Petterson M., 2000). Busch-Vishniac studies showed that the spectra at a pediatric Intensive Care Unit (ICU) were over 63 Hz to 2 kHz, with higher sound levels at lower frequencies, and a gradual roll off above 2 kHz (Busch-Vishniac, 2005). Livera and colleagues, analyzed the spectrum of equipment and activity noises in the neonatal ICU, showing that the noise was predominant in the range of 1 to 8 kHz (Ryherd E. E., 2008). In Taiwan, measurements of sound level in hospitals were carried out. Results showed that the daily average sound levels measured inside those hospitals during daytime were between 52.6 dB(A) and 64.6 dB(A) (Juang D. F., 2010). However noise levels in hospitals should not exceed 35 - 40 dB(A) during the daytime and 30 - 40 dB(A) in the evening time (WHO, 2010).

Various studies have found long-term effects of noise exposure on cardiovascular function. Hypertension or heart pulse rate were found to increase when people were exposed to audio-taped in critical care unit (CCU) noise such as an abrupt noise or staff conversation (Snyder-Helpern 1985). Cardiovascular rates of patients were raised by noise levels greater than 70 dB(A) (Falk and Woods, 1974). Although several studies have been done in hospitals, still a lot of work has to be performed due to the

systematic increase in the average noise levels inside hospitals by an amount of 0.38 dB(A) (day) and 0.42 dB(A) (night) per year (Busch-Vishniac, 2005).

In Palestine, it was shown that the noise measurements permit precise and scientific analysis of annoying noise and give clear indications when sound may cause hearing damages, increase blood pressure and affect heart pulse rate (Abdel-Raziq, 2000). Some studies in industrial factories in Nablus city found that blood pressure was raised as a result of exposure to the occupational noise (Abdel Raziq I. R., 2003). A study of the effect of noise pollution on young children attending nursery schools in high traffic areas have shown that those children have higher mean systolic blood pressures and lower mean heart pulse rates compared to those in quiet areas (Recova V., 1995).

1.3. Objectives of this Study

Due to the increasing sources of noise in Palestine, the impact of noise pollution on human health is getting more crucial. Hospitals are good example of places which are adversely affected by noise. The lack of studies in this field was the motivator to measure the noise levels and their health effects on humans.

This study is focused on studying the impact of noise on workers in four hospitals in Jenin city in Palestine. More precisely, the following

factors has been measured on some workers in these hospitals in order to check the way they are affected by noise:

1- Noise level pressure.

2- Hearing threshold level.

3- Systolic and diastolic blood pressure.

4- Heart pulse rate.

5- Oxygen concentration in blood.

Chapter Two

Theoretical Background

Chapter Two
Theoretical Background

This chapter consists of four sections including explanation of some basic information about calculation and the units of sound pressure levels (sec. 2.1). It also illustrates the threshold of hearing (sec. 2.2) and the sensitivity of the human ear (sec. 2.3). Finally, this chapter show the effects of sound pressure levels (sec. 2.4) on blood pressure (sec. 2.4.1) and oxygen concentration in the blood (sec. 2.4.2).

2.1. Sound Pressure Level

Sound pressure level (SPL) or sound level (L_p), measured in decibels, is a logarithmic measure of the energy of a particular noise relative to a reference noise source of sound pressure p_0 = 20 μPa which represents the normal threshold of human hearing at 1,000 Hz.

The Sound Pressure Level (L_p) is given by the following relation (Stumpf, 1980):

$L_p = 20\text{Log}_{10} (p/p_0)$.

Where p is the measured root-mean-square (rms) sound pressure. Fig. (2.1) compares sound pressures in pascals (Pa) and sound pressure levels in decibels (dB). The zero of the decibel scale (0 dB) to which all other sound pressures are compared on the dB-scale is the sound pressure p_0 equivalent to 20 μPa.

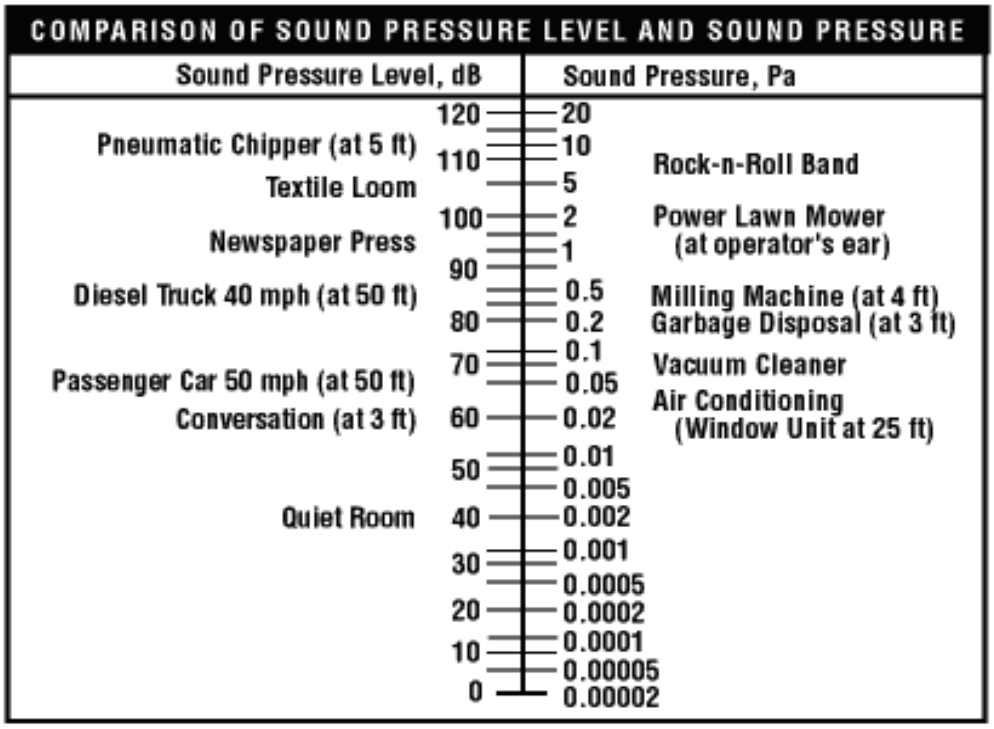


Figure (2.1): Sound pressure levels (SPL) in decibels (dB) and pascals (Pa) unit (Purdom P. W., 1980).

2.2. Threshold of Hearing

The threshold of hearing is the minimum sound level that a person can hear when no other sounds are present. This point will vary from person to person, usually the sound pressure of 20 micropascals or 2×10^{-4} dynes per square centimeter - that equals 0 dB SPL. This behavior of hearing threshold is presented in Fig. (2.2) which is taken from reference (Robert, 2010).

The threshold of pain is the point at which pain begins to be felt. The values of the threshold of pain in normal human is shown in Fig. (2.2). It is an entirely subjective phenomenon. The pressure at which sound begins to feel painful is the pain threshold pressure. It starts with 20 pascals or 120 dB to be painful (Anthonyhcole, 2011).

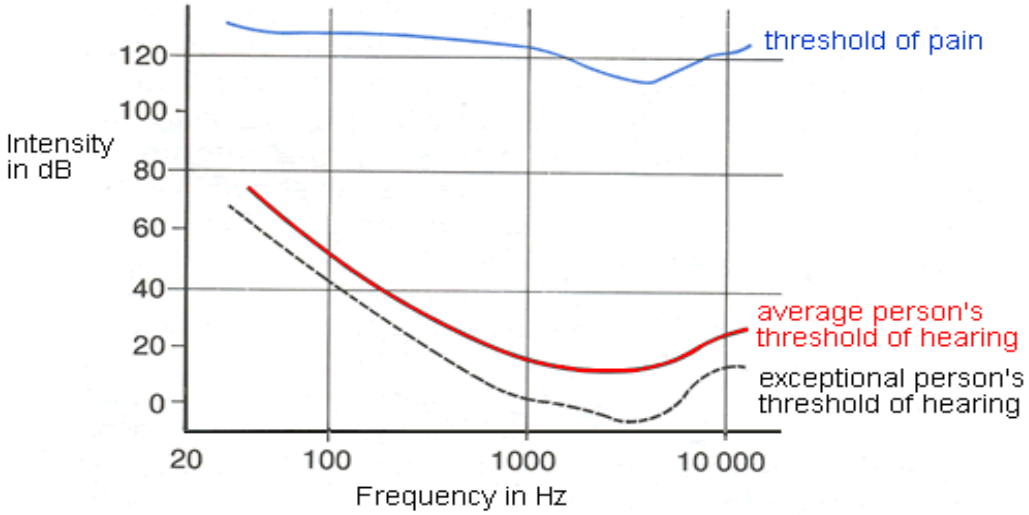


Figure (2.2): The relation of the intensity of sound as a function of frequency where exceptional persons threshold of hearing means the persons who can hear less than the degree of hearing (< 0 dB(A)), (Robert, 2010).

2.3. Sensitivity of Human Ear

The ear contains three sections, the outer, middle, and inner ears. Hearing is a complex process depends on a series of events that change sound waves in air to the electric signal. The auditory nerve have to carry these signals to the brain through a complex series of steps. The human ear can respond to minute pressure variations in the air if they are in the audible frequency range from 20Hz to 20000 Hz (Arnold, 1995).

2.4. The Effect of Noise on Humans

Several physiological and health effects of noise on humans were observed. This study, will focus on two of them, the change of blood pressure (sec. 2.4.1) and the oxygen concentration in blood (sec. 2.4.2).

2.4.1. Blood Pressure

Blood pressure is defined as the force of the blood pushing against the walls of the arteries. Each time the heart beats, it pumps blood into the arteries. Blood pressure is measured by the systolic and diastolic pressures. The systolic pressure represents the pressure in the arteries as the heart contracts and pumps blood, while the diastolic pressure, represents the pressure in the arteries as the heart relaxes. Normal blood pressure is considered below 120/70 mmHg. The value, 120 mmHg being the systolic pressure while 80 mmHg being the diastolic pressure. Most doctors use a cutoff of 140/80 mmHg for diagnosing high blood pressure. Blood pressure varies during the day. It is lowest when one is sleeping and rises when one gets up. It also rises when one is excited, nervous or active. High blood pressure or hypertension means high pressure in the arteries. Blood pressure of 140/90 mmHg or above is considered as high blood pressure. In high blood pressure, the heart works harder, and your chances of a stroke or heart attack are greater. Studies show that stress and high blood pressure play a major role in causing strokes. Experts believe that people who report high levels of stress in their lives are twice as likely to suffer from a fatal stroke, than compared to people who report low stress levels. Having a stressful job may also be raised blood pressure in human (Wesothelioma, 2007).

2.4.2. Oxygen Concentration in the Blood

Every living organism requires oxygen for its survival. Healthy blood oxygen levels are essential for proper functioning of the body. Less amount of oxygen flowing through the blood or oxygen deprivation can lead to organ failure. Since lungs are involved in breathing, low oxygen levels suggest lung conditions. Other health conditions can also cause low oxygen levels in blood. Oxygen in blood is measured by performing a blood test. For this, blood sample is taken from an artery. The level can also be measured with the help of a 'pulse oximeter' attached to a finger. A '95-100% level' is considered as normal or healthy while 80-94% oxygen is considered as 'low blood oxygen' or 'hypoxemia'. In children, 97% oxygen level (at least 97% of the bloodstream should be oxygen saturated) is considered as normal. Very low levels of oxygen (less than 80%) can lead to serious symptoms. As blood that contains oxygen is circulated to the cells and tissues, a healthy level of oxygen in the arteries can keep the organs functioning. 'Hyperoxia' is a condition caused by very high levels of oxygen in the blood. Breathing high concentrations of oxygen can lead to hyperoxia which is an equally serious condition. It can result in cell death and serious damage, especially to the central nervous system, eye and lungs (Leena, 2011).

Oxygen saturation is defined as the ratio of oxyhemoglobin to the total concentration of hemoglobin present in the blood. A hemoglobin molecule carry a maximum of four oxygen molecules. 100 haemoglobin

molecules can carry a maximum of 400 oxygen molecules; if they together were carrying 360 oxygen molecules, then the oxygen saturation level would be (360/400)*100 or 90% (Houston, 1982).

Pulse oximater: A pulse oximater is a device intended for the non-invasive measurement of arterial blood oxygen saturation and pulse rate. Typically it uses two LEDs (light-emitting diodes) generating red and infrared lights through a translucent part of the body (Houston, 1982).

Chapter Three

Methodology

Chapter Three
Methodology

This study measured the threshold of hearing level, blood oxygen concentration, heart pulse rate and blood pressure (SBP & DBP), on the workers (doctors and nurses) in the hospitals in Jenin city, as a result of sound pressure level effects.

3.1 Sample Size

The sample of this study consists of 117 workers, 61 male and 56 female. The workers ages were between 20 to 65 years. This sample was chosen randomly from several sections in four hospitals in Jenin city (including: intensive Care Unit (ICU), neonatal intensive care unit (NICU), operation room (OR), Emergency, Laboratory, and Outpatient).

The sample size was chosen according to the formula (1) (Cochran, 1977), as shown below:

$$n = Z^2 P q/\alpha^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Where:

n is sample size according to Cochran's formula

Z is value for selected alpha level of 0.025 in each tail (Z = 1.96)

(p)(q) is estimate of variance where q = 1- p, p = 0.9 and q = 0.1

α is acceptable margin of error for proportion being estimated (α = 0.055)

The minimum sample size from this formula is calculated to be 114.30. Accordingly, the sample size of this study was 117.

The four hospitals are:

1- Governmental Hospital.

2- Al-Razi Hospital.

3- Al-Amal Hospital.

4- Al-SHifa Hospital.

The table (3. 1) below shows the selected of this sample in these hospitals.

Table (3.1): The selected sample in the four studied hospitals.

Hospital Name	Sample size	The number of male	The number of female
Governmental	51	27	24
Al-Razi	36	21	15
Al-Amal	23	11	12
Al-SHifa	7	2	5

3.2 Measurement

In this study several factors are measured which affect the workers in Jenin hospitals. These factors are:

- The sound pressure levels in different times and locations in hospitals are measured using sound level meter. Sound level meter was in a fixed place in every section in hospitals and taking readings every minute, starting from (7:00 o'clock) to (17:00 o'clock) and then taking

the average of these readings. The data were analyzed by SPSS and Microsoft excel program.

- The threshold of hearing of the workers levels are measured at different frequencies. The results of right and left ears are measured using the audiometer.

- The systolic and diastolic blood pressure and heart pulse rate of the workers are measured by automatic digital electronic wrist blood pressure monitor. The measurements are taken twice for each worker before working and twice after the work. The average is taken for each case.

- The blood oxygen concentration of the workers are measured using the pulse oximeter.

3.3 Timetable of the Study

The collected data at hospitals were carried out during morning (7:00 o'clock) before the work and evening hours (17:00 o'clock) after they have finished their shift work. These measurements were carried out in February and March, 2011. In this time the weather was winter and raining.

3.4 Experimental Apparatus

- Digital Sound Level Meter (Quest Technologies U.S.A, Model 2900 type 2) with accuracy of ±0.5 dBA at 25 degree centigrade, was used to measure the sound pressure levels.

Figure (3.1): The Sound Level Meter.

- Am 232 Manual Audiometer (Welch Ally Inc, U.S.A), with accuracy ±3%, at operating temperatures 15 degree centigrade to 40 degree centigrade was used to measure the threshold of hearing levels.

Figure (3.2): Manual Audiometer.

- Automatic Digital Electronic Wrist Blood Pressure Monitor (Nihon Seimitsu Sokki Co, Japan Model WS-300) with accuracy ±3mmHg cuff (pressure), and ±10 degree centigrade to ±40 degree centigrade, was used to measure the systolic and diastolic blood pressure.

Figure (3.3): Automatic Digital Blood Pressure Monitor.

- Pulse Oximeter LM-800 (Finger Oximeter), was used to measure the concentration of the oxygen in the blood.

Figure (3.4): The Pulse Oximeter.

3.5 Statistical Analysis

Data are analyzed statistically by using the SPSS and Microsoft excel program to find the association between noise level and dependent variables: heart pulse rate, blood pressure, oxygen concentration in the blood and threshold of hearing level.

This data analyzed by using Paired Sample T-test and One-Way ANOVA test to calculate the probability value (p-value) and the Pearson's correlation coefficient (R) for all workers in all studied hospitals.

The probability value (p-value) of a statistical hypothesis test is the probability of getting a value of the test statistic. The p-value is compared with the actual significance level of our test and, if it is smaller, the result is significant.

The Pearson correlation coefficient (R) is a number between +1 and -1. This number tells about the magnitude and direction of the association between two variables. If the Pearson correlation is +1 in the case of a perfect positive (increasing) linear relationship (correlation). If (R) is −1 in the case of a perfect decreasing (negative) linear relationship (anticorrelation). The value between −1 and +1 in all other cases is indicate the degree of linear dependence between the variables. If (R) approaches zero the relationship is closer to uncorrelated or the variables are independent. The closer the coefficient is to either −1 or 1 indicate the stronger of the correlation between the variables.

Chapter Four

Results

Chapter Four
Results

This chapter includes the measured data and results, conducted on the sample workers in the hospitals in Jenin city. The following factors have been studied and measured in these hospitals:

1- Sound pressure level (SPL)

2- Hearing threshold level (HTL)

3- Systolic (SBP) and diastolic (DBP) blood pressure

4- Heart pulse rate (HPR)

5- Blood oxygen concentration

However, the first factor (SPL) was taken every minute in each sample hospital starting from (7:00 o'clock) to (17:00 o'clock). While the other factors (2, 3, 4 & 5) were taken twice a day just before work (at 7:00 o'clock) and six hours after starting the work (at 13:00 o'clock). The sample was composed of 117 workers, 61 males and 56 females. The workers ages were between 20 to 65 years and the serving periods were from 1 to 38 year. The test sample in the four selected hospitals was distributed according to gender; it was about 52% males and about 48% females (Fig. 4.1).

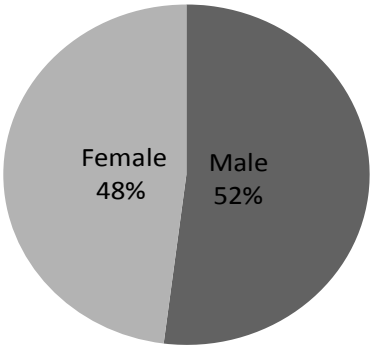
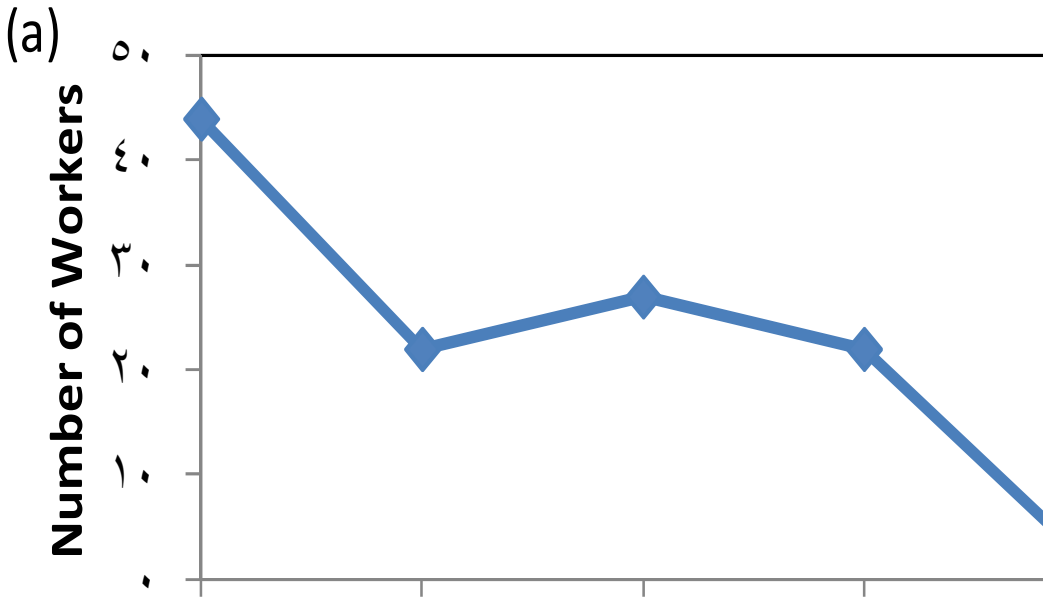


Figure (4.1): Gender distribution of selected workers in the four sample hospitals.

The number of workers in all hospitals as a function of their ages and as a function of their serving periods of the workers are shown in Fig. (4.2). It is obvious that most chosen sample were less than 50 years old and with serving periods less than 30 years.



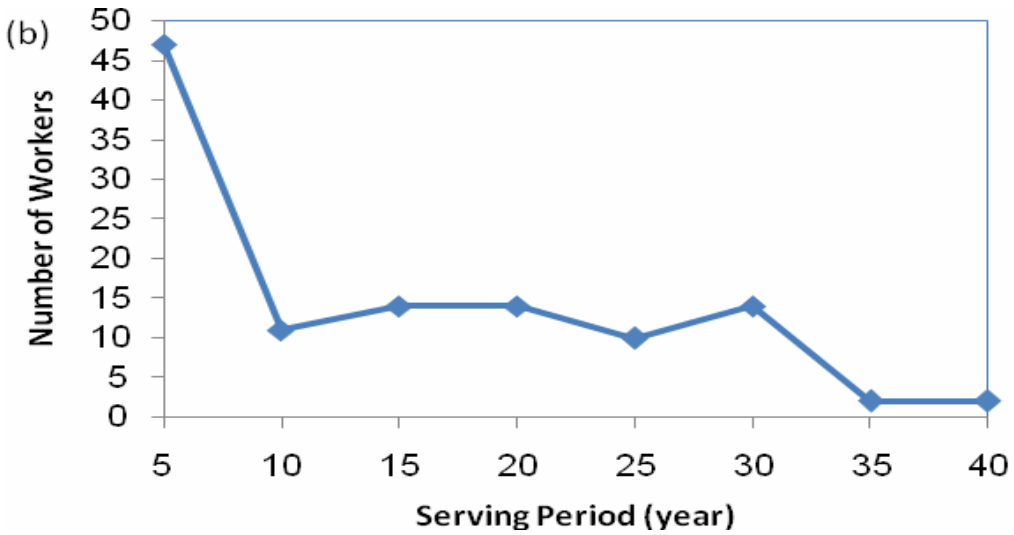


Figure (4.2): Relation between the number of the selected workers in the four hospitals as a function of (a) ages and (b) serving period in years.

The tested sample was distributed in the selected hospitals as follows: (43% Governmental, 31% Al-Razi, 20% Al-Amal and 6% Al-Shifa) as shown schematically in Fig. (4.3.a). The distribution of the same sample workers according to the departments in which they work is as follows: (8% ICU, 8% NICU, 27% OR, 21% LAB, 18% Emergency and 18% Outpatient Clinic) as in Fig. (4.3.b).

(a) (b)

Figure (4.3): Distribution of the sample workers according to their (a) hospitals and (b) departments in which they work.

4.1. Sound Pressure Level (SPL)

The sound pressure levels (SPL) were measured in the four hospitals in Jenin city. The results of these measurements are discussed for Governmental hospital in (sec. 4.1.1), for Al-Razi hospital in (sec. 4.1.2), for Al-Amal hospital in (sec. 4.1.3) and for Al-Shifa hospital in (sec. 4.1.4).

4.1.1. Governmental Hospital

The governmental hospital was established in 1961, with an area of 11000 m^2. The hospital is located just 350 m away from the center of Jenin city. The hospital consists of 13 departments with a capacity of 123 beds and about 350 workers.

The sound pressure levels (SPL) in this hospital were measured in six departments (NICU, ICU, OR, Lab, Emergency and Outpatient Clinic). The data carried out every minute, starting from (7:00 o'clock) to (17:00 o'clock). The results of those measurements in the six departments are shown in Fig. (4.4.a) and their average is shown in Fig. (4.4.b).

The detailed measurements SPL as a function of time in each department of ICU, NICU, OR, Emergency, Lab and Outpatient clinic are shown in Appendix (A-1).

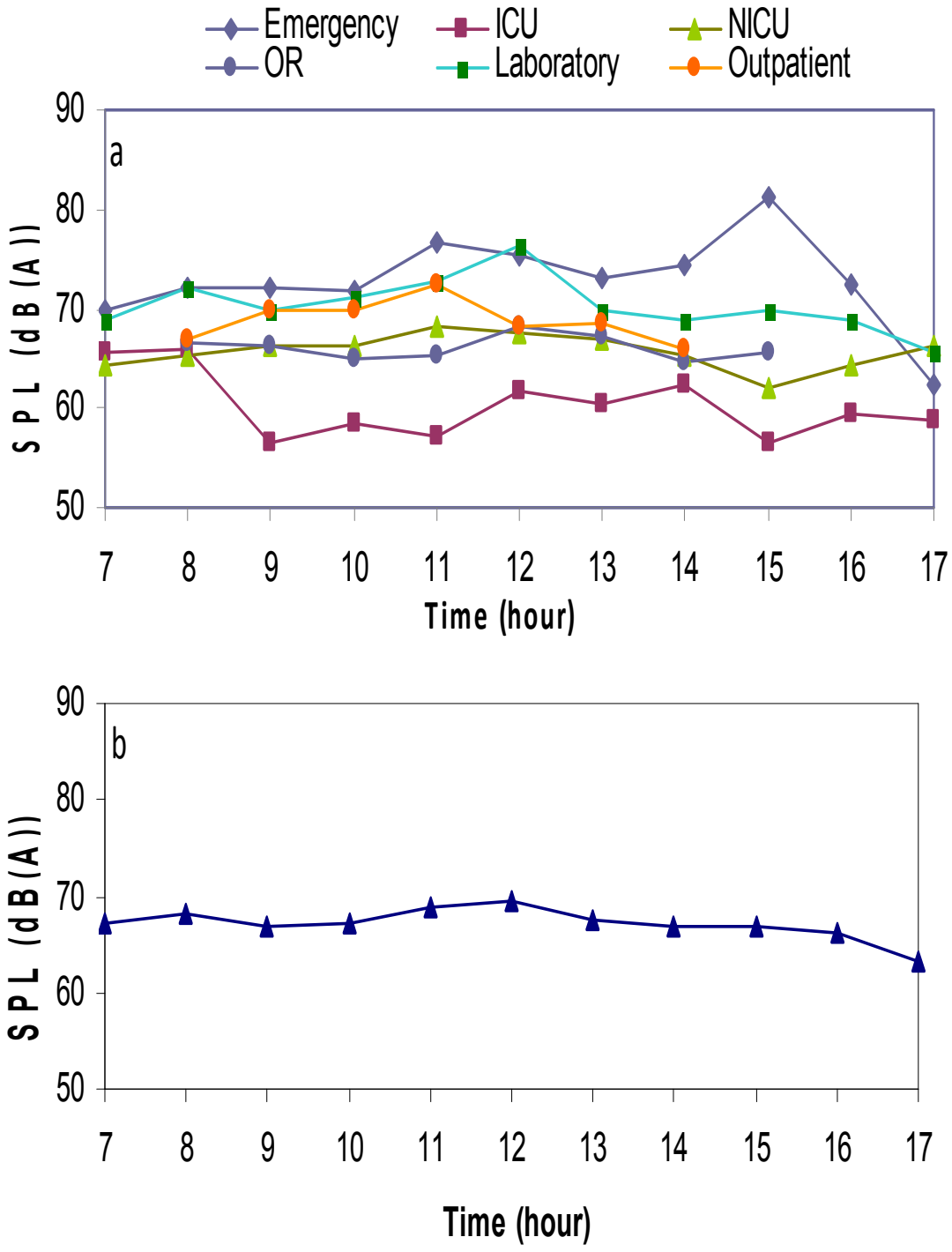


Figure (4.4): (a) SPL in the six departments (b) Average of SPL in all six departments in Governmental hospital as a function of time.

Fig. (4.4.a) shows that the ICU department has the least SPL while the Emergency department has the highest. Another remark is that the

average of SPL in all departments shows a peak around 12:00 o'clock, which is time to visit patients. However, all average SPL values vary around the value 67 dB(A) as in Fig. (4.4.b).

4.1.2. Al-Razi Hospital

Al-Razi hospital was found in 1991. The hospital is located in a side street just 500 m far from the center of Jenin city with an area of 4200 m^2. The hospital consists of 8 sections with 90 beds and 150 employees.

Similar to the governmental hospital, the SPL values were measured every minute, starting from (7:00 o'clock) to (17:00 o'clock).

The results of those measurements in the six departments are shown in Fig. (4.5.a) and their average is shown in Fig. (4.5.b).

The detailed measurements SPL as a function of time in each department of ICU, NICU, OR, Emergency, Lab and Outpatient clinic are shown in Appendix (A-2).

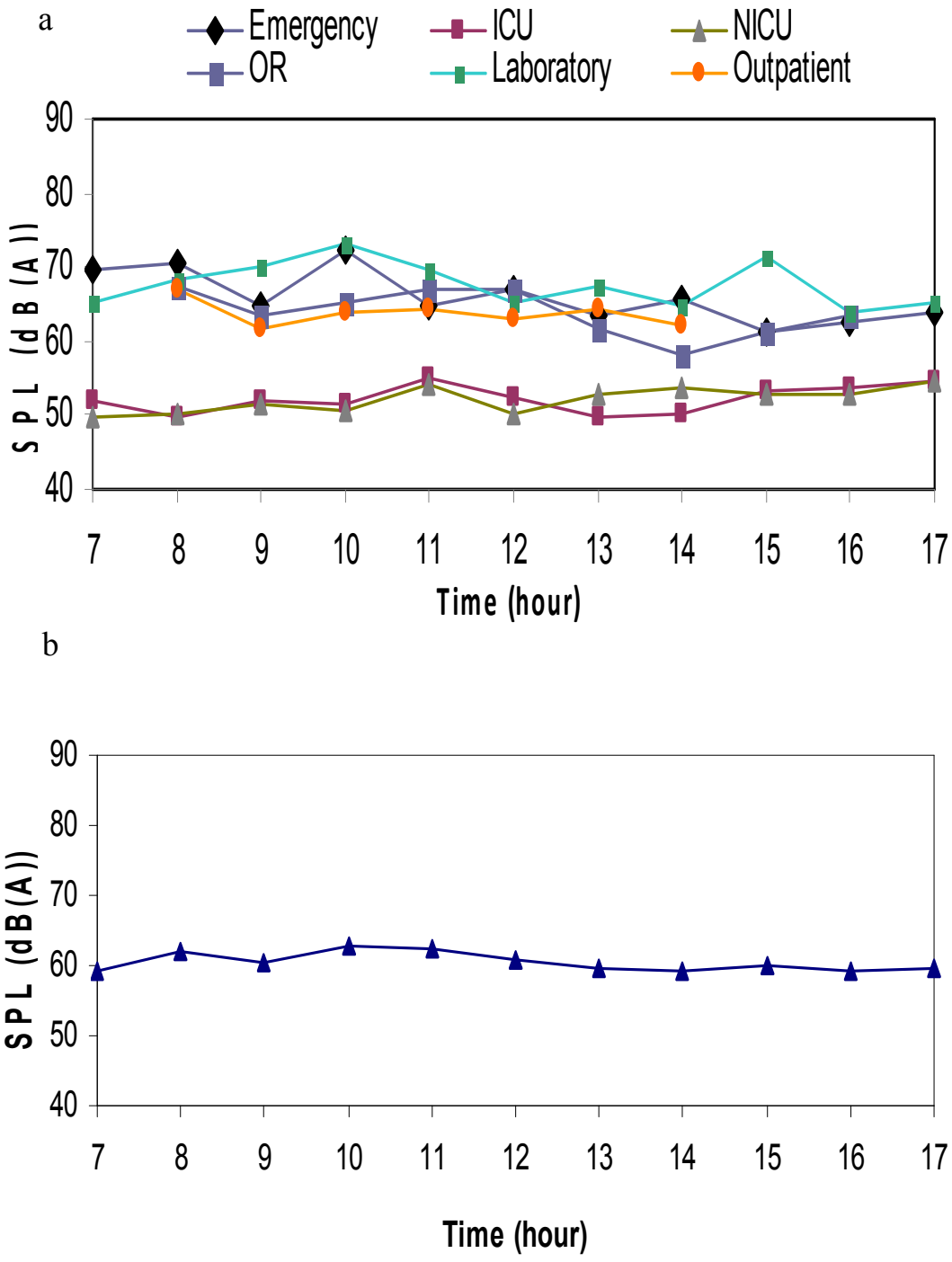


Figure (4.5): (a) SPL in the six departments (b) Average of SPL in all six departments in Al-Razi hospital as a function of time.

Fig. (4.5.a) shows that the ICU and NICU departments has the least SPL while the Laboratory department has the highest. Another remark is that the average of SPL in all departments shows a peak between (10:00

and 11:00) o'clock, which is the start time of surgery, where increasing number of escorts for patients and start to outpatient clinics and this leads to increase the number of medical tests.

Although this hospital is quite big with 150 workers, it has relatively low SPL of about 61 dB(A) compared to other sample hospitals.

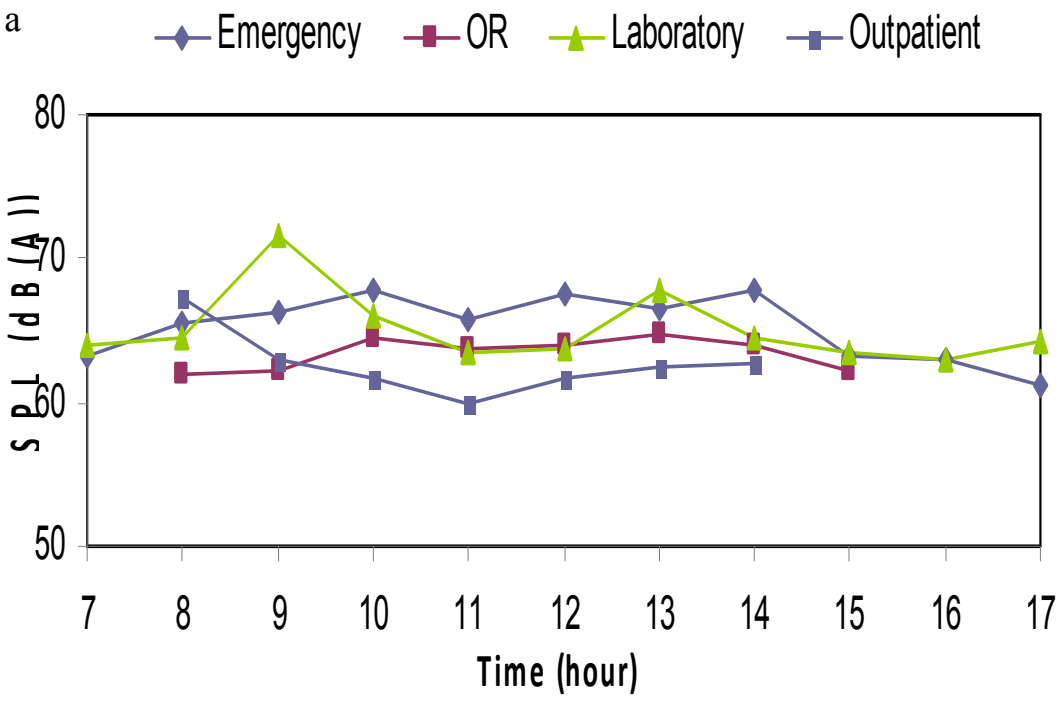
4.1.3. Al-Amal Hospital

Al-Amal hospital found in 2001, is located near the government hospital, about 200 m far from the center of Jenin city. The hospital consists of 7 sections, with 12 employees. The SPL values were measured every minute, starting from (7:00 o'clock) to (17:00 o'clock).

The results of those measurements in the four departments are shown in Fig. (4.6.a) and their average is shown in Fig. (4.6.b).

The detailed measurements SPL as a function of time in each departments of OR, Emergency, Lab and Outpatient clinic are shown in Appendix (A-3).

a



b

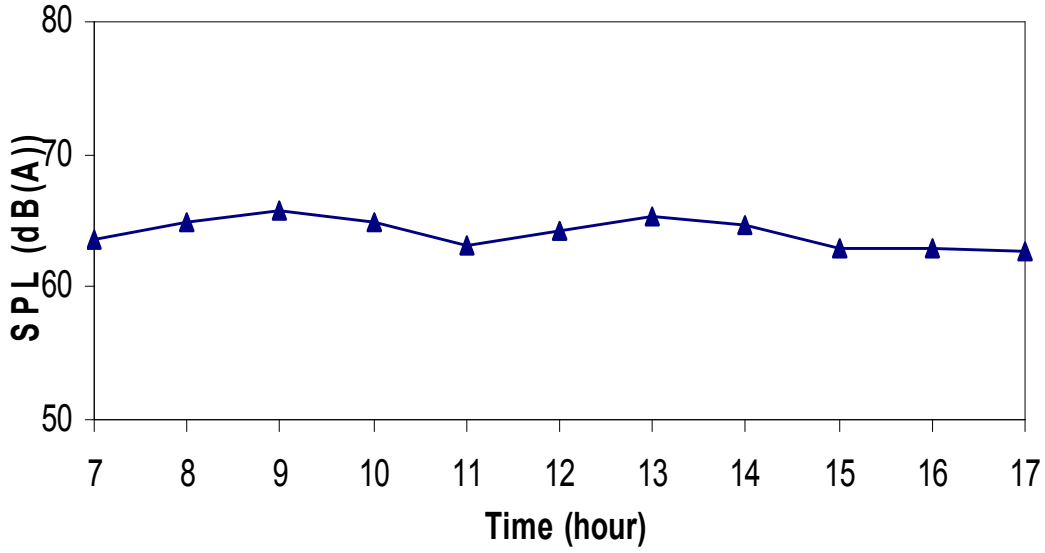


Figure (4.6): (a) SPL in the four departments (b) Average of SPL in all four departments in Al-Amal hospital as a function of time.

Fig. (4.6.a) shows that the Outpatient clinic department has the least SPL while the Laboratory department has the highest. Another remark is that the average of SPL in all departments shows a peak around (9:00 and

13:00) o'clock, which is entry and exit of staff and patients. However, all average SPL values vary around the value 64 dB(A) without significant variation in the value of SPL in different departments as shown in Fig. (4.6.b).

4.1.4. Al-Shifa Hospital

Al-Shifa hospital is a specialist in medicine and surgery of eye and it's located about 150 m far from the center of Jenin city with about 600 m^2 area. The hospital consists of 2 sections, with 10 employees distributed in the only two existing departments, the Operation room (OR) and the screening room (Outpatient Clinic). The SPL values were measured every minute, starting from (8:00 o'clock) to (16:00 o'clock).

The results of those measurements in the two departments are shown in Fig. (4.7.a) and their average is shown in Fig. (4.7.b).

The detailed measurements SPL as a function of time in each departments of OR and Outpatient clinic are shown in Appendix (A-4).

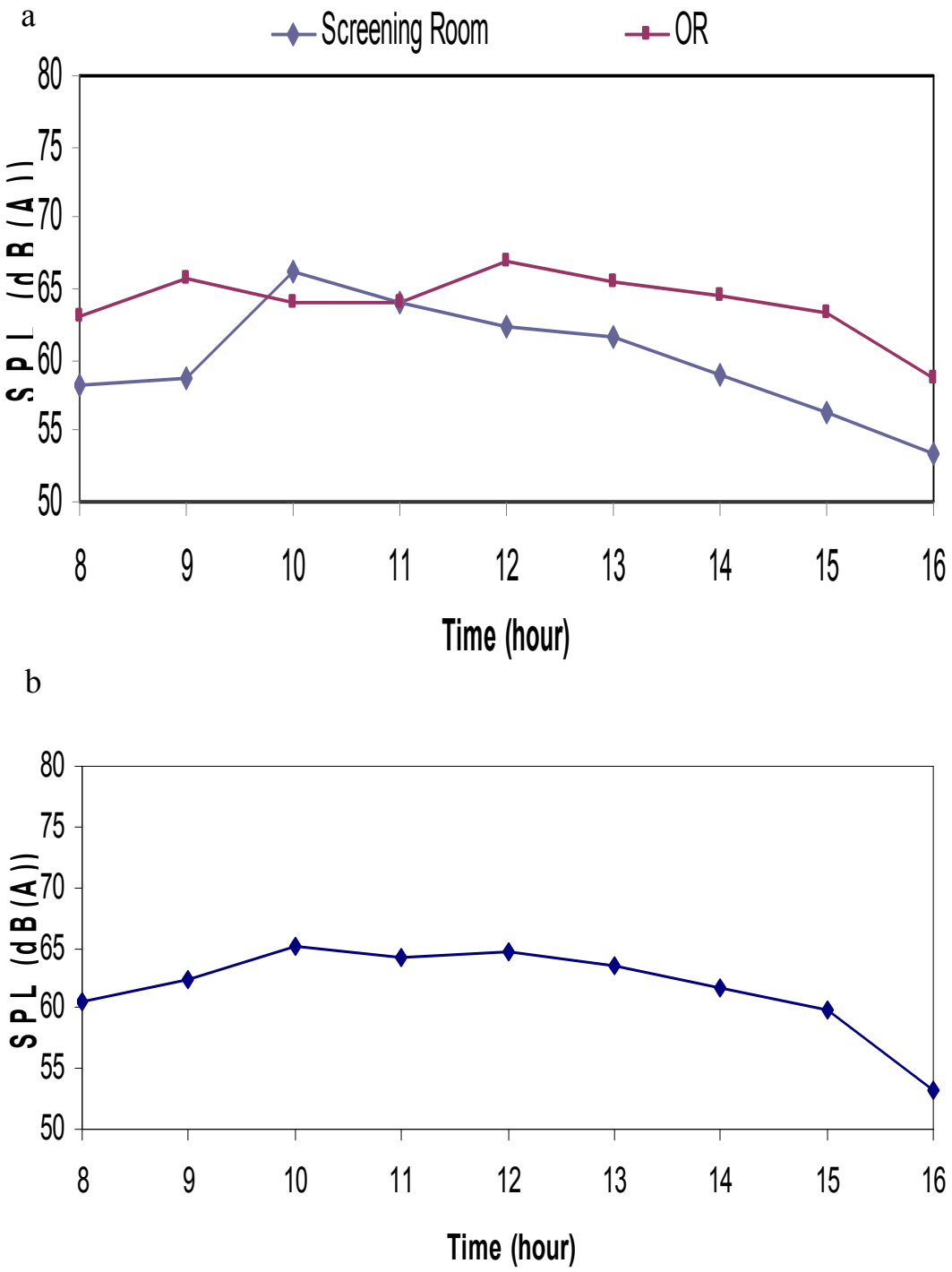


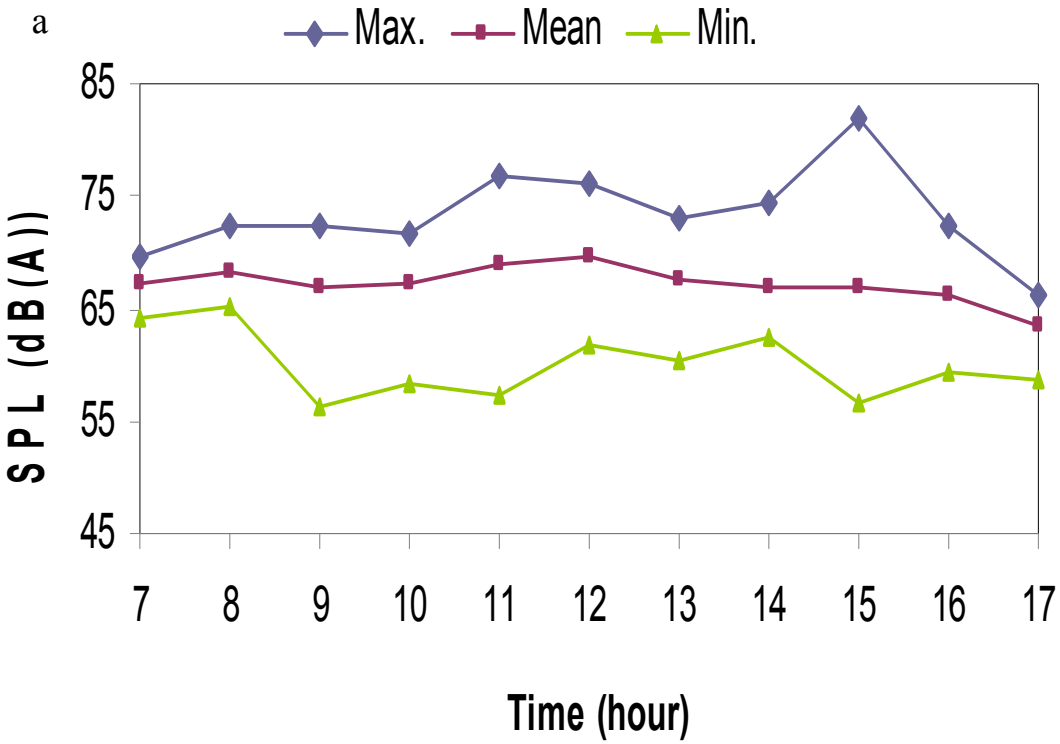
Figure (4.7): (a) SPL in the two departments (b) Average of SPL in the two departments in Al-Shifa hospital as a function of time.

Fig. (4.7.a) shows that the Screening room department (Outpatient Clinic) has the least SPL while the OR department has the highest.

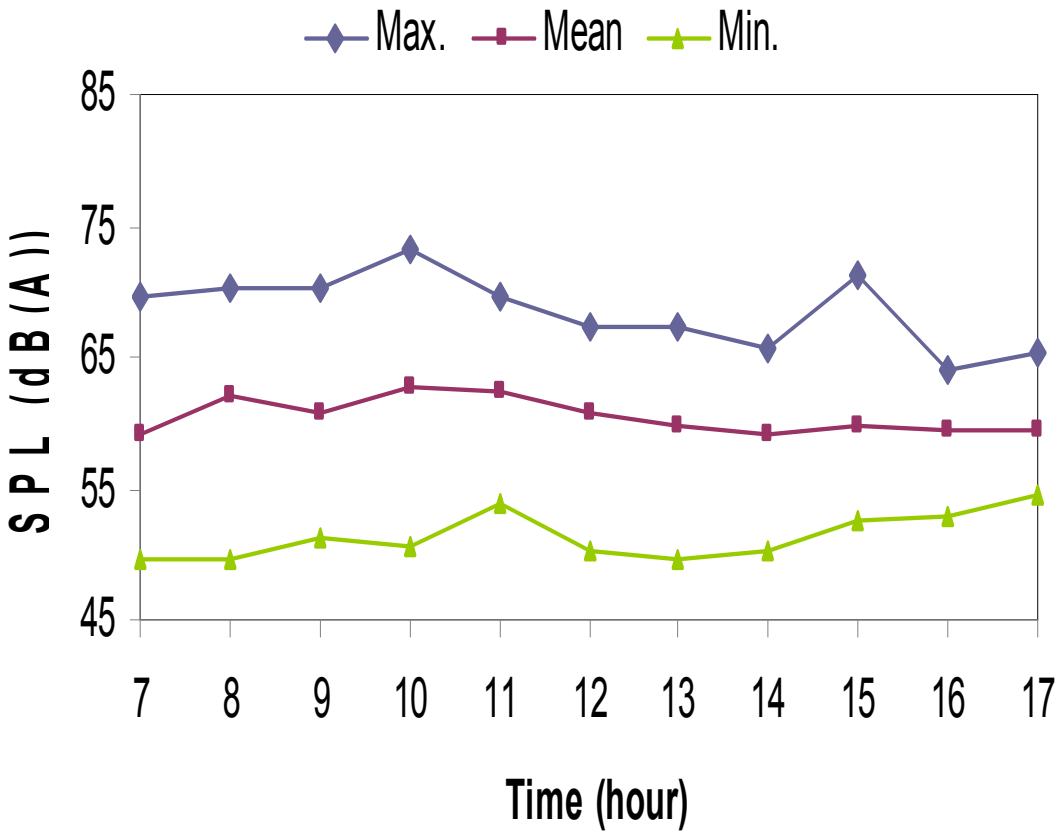
Although this hospital is the closest to the city center which is very busy area with a lot of noise, it has relatively low SPL of about 62 dB(A) compared to other hospitals. This might be due to smaller size and less number of workers.

The hourly average (Mean.), maximum (Max.) and minimum (Min.) values of Sound Pressure Levels (SPL) in each studied hospitals are shown in Fig. (4.8). In addition, the mean SPL values of the four hospitals are shown in Fig. (4.9). From these two figures which one can see that the noise peaks in hospitals where at the morning time between (9:00 – 11:00) o'clock which might be due to shift delivery, sections cleaning, meal time, doctor morning traffic, the medication of the patients and visiting period. On the other hand, the noise is less at afternoon time (12:00 – 14:00) o'clock because of patients break time and finishing the visiting period. The noise peaks increased again (14:00 – 17:00) o'clock because of delivery of shifts and the time of patients visit. The detailed data is presented in Appendix (A-5).

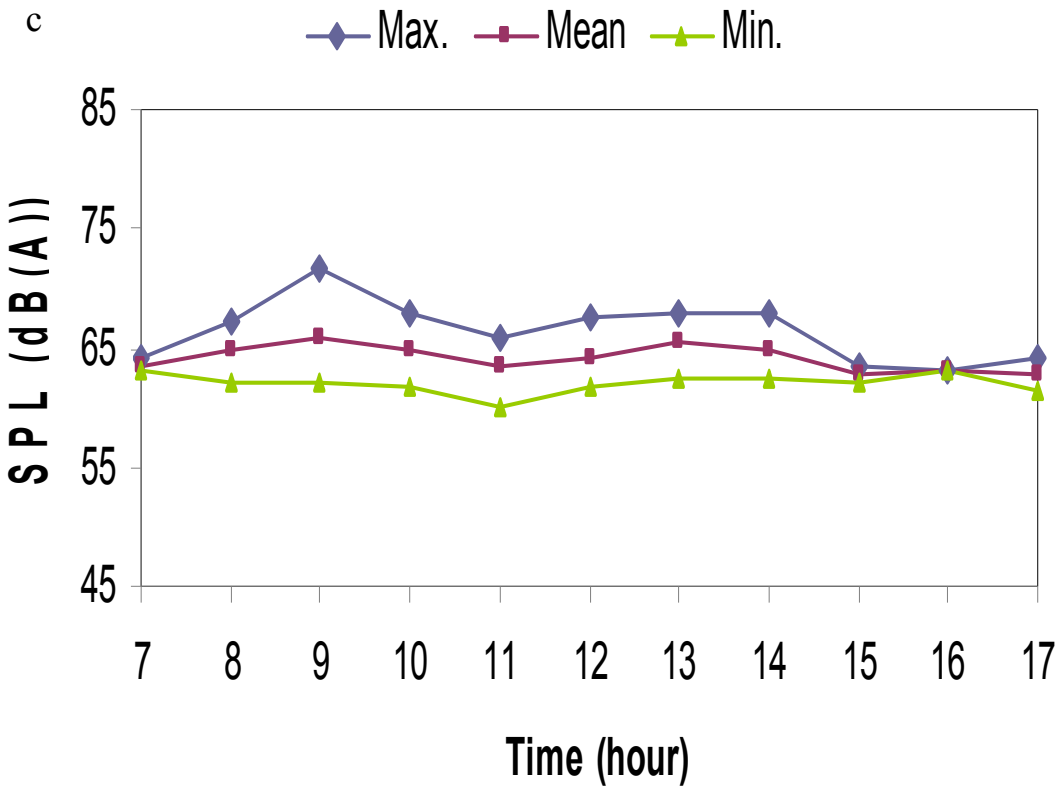
a


Max.
Mean
Min.
85
75
65
55
45
S P L (d B (A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)

b


Max.
Mean
Min.
85
75
65
55
45
S P L (d B (A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)

c



d

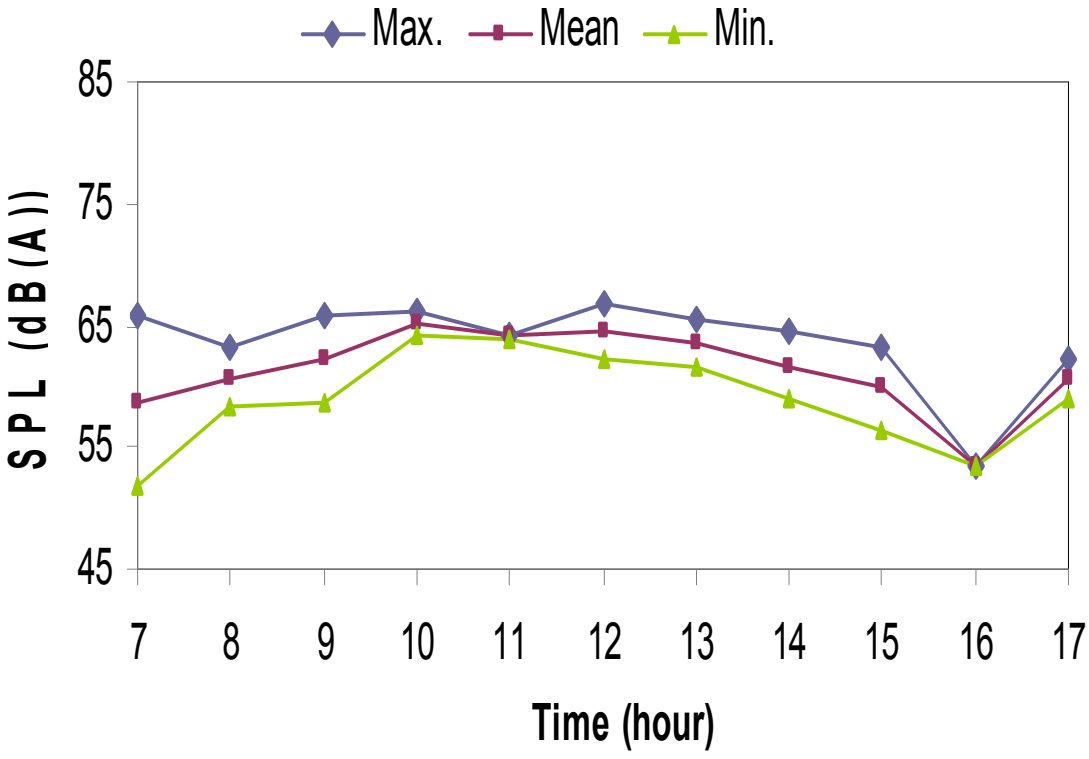
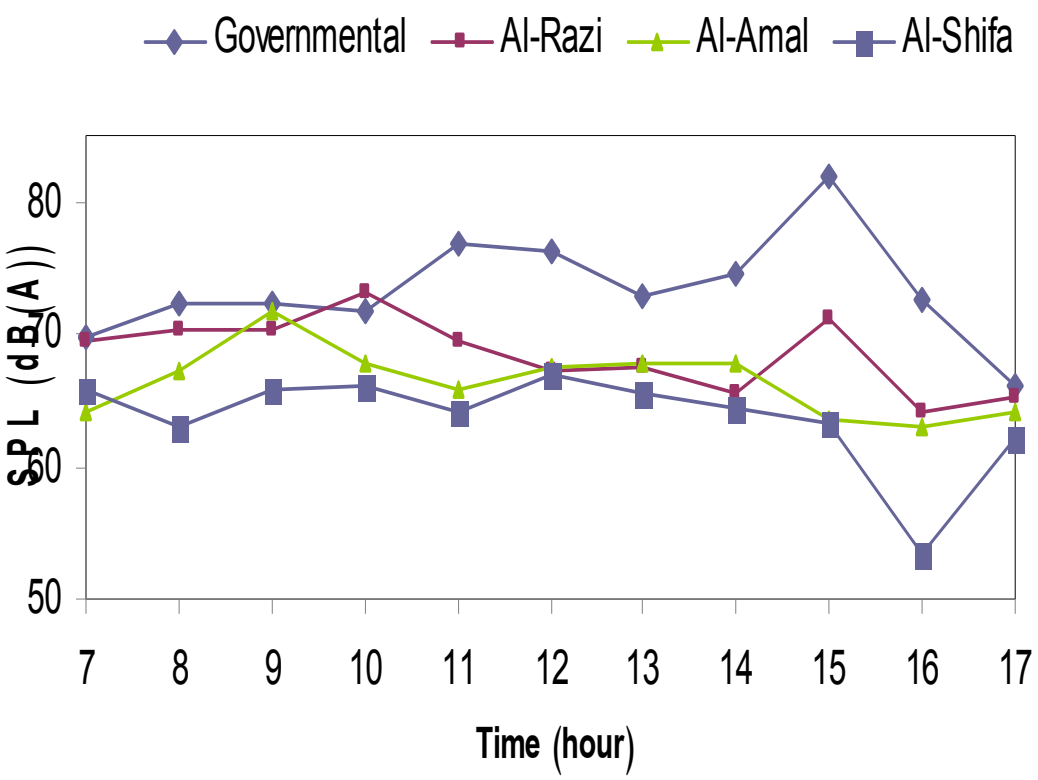
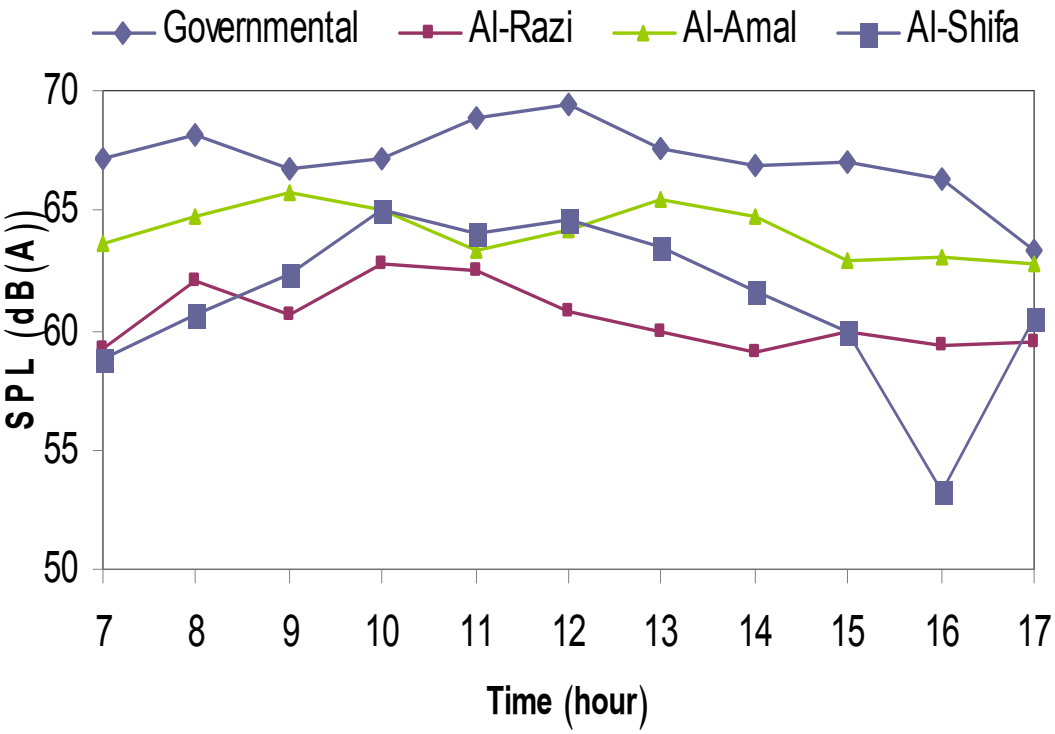


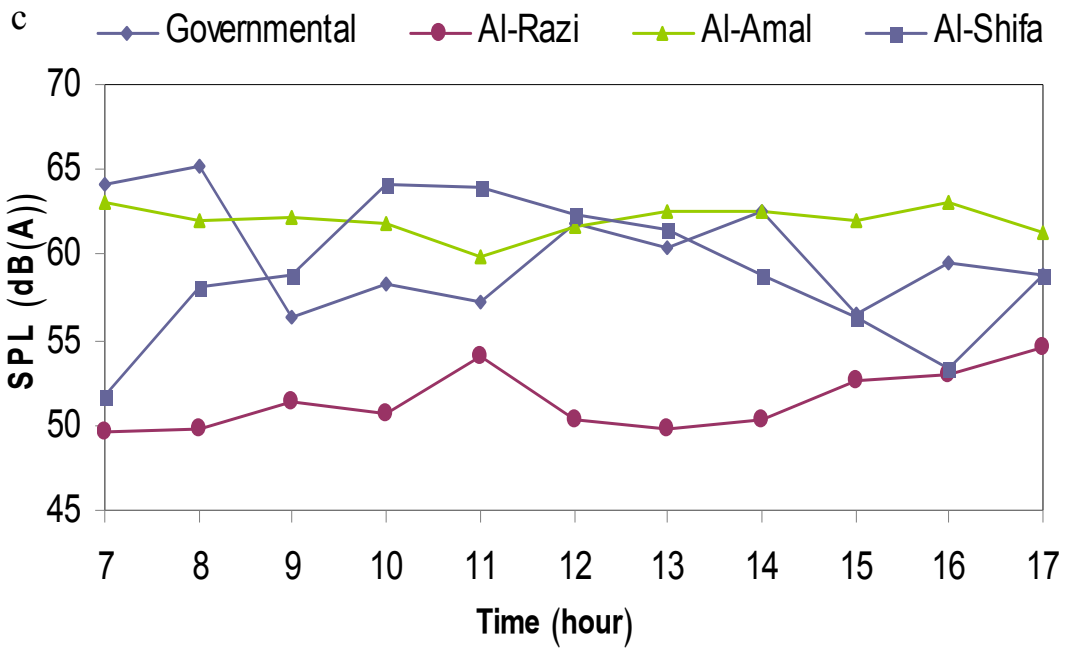
Figure (4.8): Maximum (Max.), Average (Mean) and Minimum (Min.) values of SPL as a function of time in (a) Governmental (b) Al-Razi (c) Al-Amal (d) Al-Shifa hospital.

a


Governmental
Al-Razi
Al-Amal
Al-Shifa
80
70
60
50
SPL (dB(A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)

b


Governmental
Al-Razi
Al-Amal
Al-Shifa
70
65
60
55
50
SPL (dB(A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)



Figure(4.9): (a) Maximum(Max.), (b)Average(Mean) and (c) Minimum(Min.) values of SPL as a function of time in Governmental, Al-Razi, Al-Amal and Al-Shifa hospital.

4.2. Hearing Threshold Levels

The threshold of hearing is the minimum sound level that a person can hear when no other sounds are present while hearing impairment is a broad term used to describe the loss of hearing in one or both ears. Many organizations study the hearing impairment (H. I.) phenomenon and classified it according to certain criteria. The criteria of each organization is shown below:

a. American National Standard Institute (ANSI (1969)) has the degrees of hearing impairment as follows:

1. Normal: for ear that can hear between -10 dB(A) and 26 dB(A).

2. Mild: for ear that can't hear less than 27 dB(A) and it can hear between 27 dB(A) and 40 dB(A).

3. Moderate: for ear that can't hear less than 41 dB(A) and it can hear between 41 dB(A) and 55 dB(A).

4. Moderately severe: for ear that can't hear less than 56 dB(A) and it can hear between 56 dB(A) and 70 dB(A).

5. Severe: for ear that can't hear less than 71 dB(A) and it can hear between 71dB(A) and 90 dB(A).

6. Profound: for ear that can't hear less than 91 dB(A).

b. Occupational Safety and Health Administration (OSHA**)** has the degrees of hearing impairment as following:

The average of hearing threshold levels in either one or both ears exceeds 25 at 1000, 2000 and 3000Hz.

c. National Institute for Occupational Safety and Health **(**NIOSH) has the degree of hearing impairment as follows:

The average of hearing threshold levels in either one or both ears exceeds 25 at 1000, 2000,3000 and 4000Hz.

d. American Social Health Association **(**ASHA) has the same criteria of the previous organization (NIOSH**).**

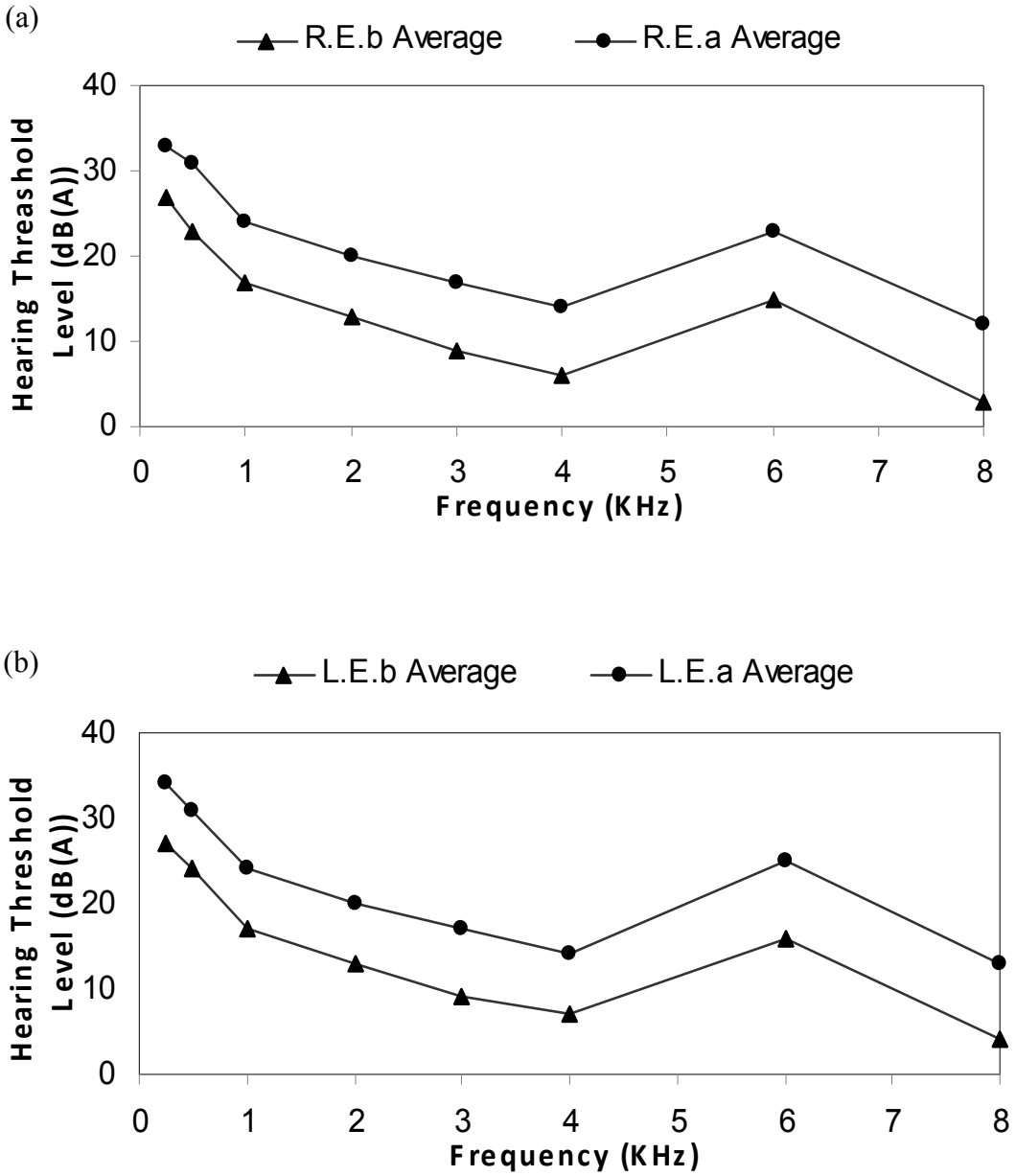
e. Environmental Protection Agency (EPA) has the degrees of hearing impairment as following:

The average of hearing threshold levels in either one or both ears exceeds 25 at 500, 1000 and 2000Hz.

In this section the hearing impairment phenomenon is discussed based on the classification these organizations. The Percentage of degrees of hearing impairment in right and left ears after exposure (denoted by a) and before exposure (denoted by b) to occupational noise in the studied sample also presented in table (4.1) to table (4.4).

4.2.1. Governmental Hospital

The hearing threshold levels were measured for the left and right ears of 51 workers in the six departments in Governmental hospital. The dependence of hearing threshold levels on sound frequency for these workers is shown in Fig. (4.10).



Figure(4.10): The average of hearing threshold level for (a) the right earbefore (R.E.b) and after (R.E.a) (b) the left ear before (L.E.b) and after (L.E.a) working in all sixdepartments in Governmental hospital as a function offrequency.

The hearing impairment phenomenon were studied in six departments in the governmental hospital. The Percentage of the degree of hearing impairment at different sound frequencies was measured for the right and the

left ears before and after working hours. The results of such measurements are classified according to ANSI (1969) criteria and are shown in table (4.1).

Table (4.1): Percentage of degrees of hearing impairment at different sound frequencies in Governmental hospital sample on the right and the left ears before and after work

Degrees of H.I.*	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
1	87.99	65.44	86.28	66.67
2	11.03	30.39	12.99	28.43
3	0.74	3.19	0.74	4.41
4	0	0.98	0	0.25
5	0	0	0	0.25
6	0	0	0	0
Total	**100**	**100**	**100**	**100**

***H. I.: Hearing Impairment.**

The results of the first degree of H. I. criteria [normal: -10 dB(A) to 26 dB(A)] for the right and the left ears before the work are 87.99% and 86.26%, respectively while the H. I. results for the right and the left ears after the work are 65.44% and 66.67%, respectively.

The results of the second degree of H. I. criteria [mild: 27 dB(A) to 40 dB(A)] for the right and the left ears before the work are 11.03% and 12.99%, respectively while the H. I. results for the right and the left ears after the work are 30.39% and 28.43%, respectively.

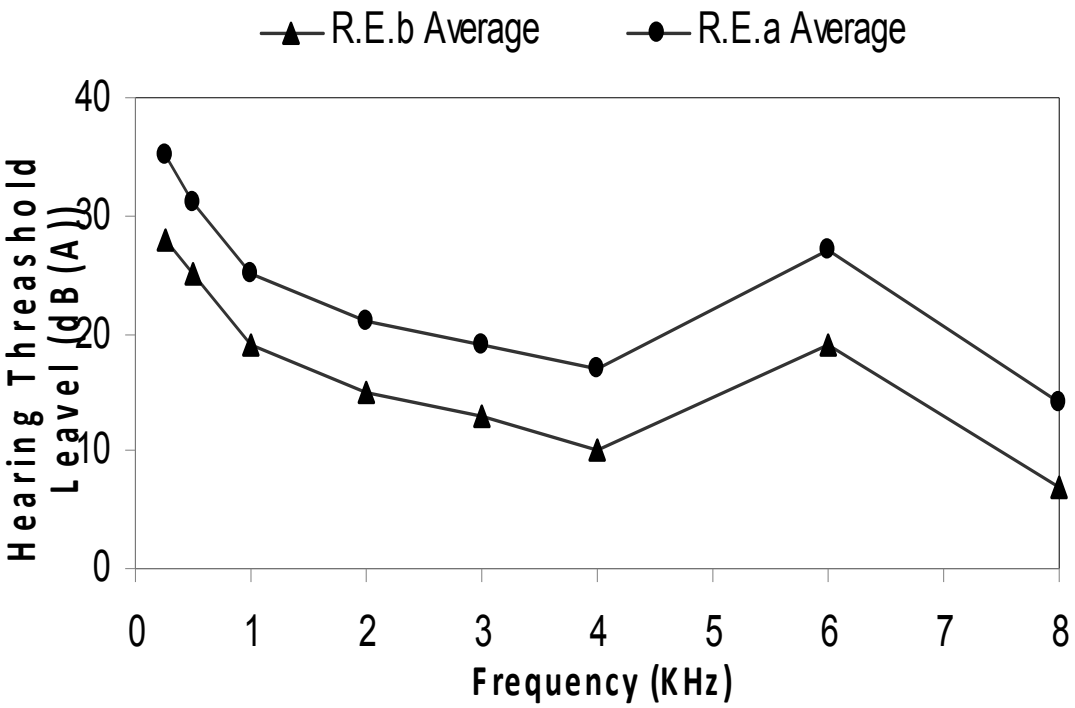
The results of the third degree of H. I. criteria [moderate: 41 dB(A) to 55 dB(A)] for the right and the left ears before the work are 0. 74% and 0.74%, respectively while the H. I. results for the right and the left ears after the work are 3.19% and 4.41%, respectively.

Finally, for the rest of the degree of H. I. [fourth degree (moderately severe): 56 dB(A) to 70 dB(A), fifth degree (sever): 71 dB(A) to 90 dB(A) and sixth degree (profound): 90+ dB(A)] for the right and the left ears before the work are 0% and 0%, respectively while the H. I. results for the right and the left ears after the work are 0.98% and 0.25%, respectively at the fourth degree and 0% and 0.25% at the fifth degree and 0% and 0% at the sixth degree. Therefore we can conclude that the SPL is high and the degrees of hearing degrees (normal degree) which means increasing in hearing impairments according to increases of noise pollution which mean that the noise pollution affected on the hearing level.

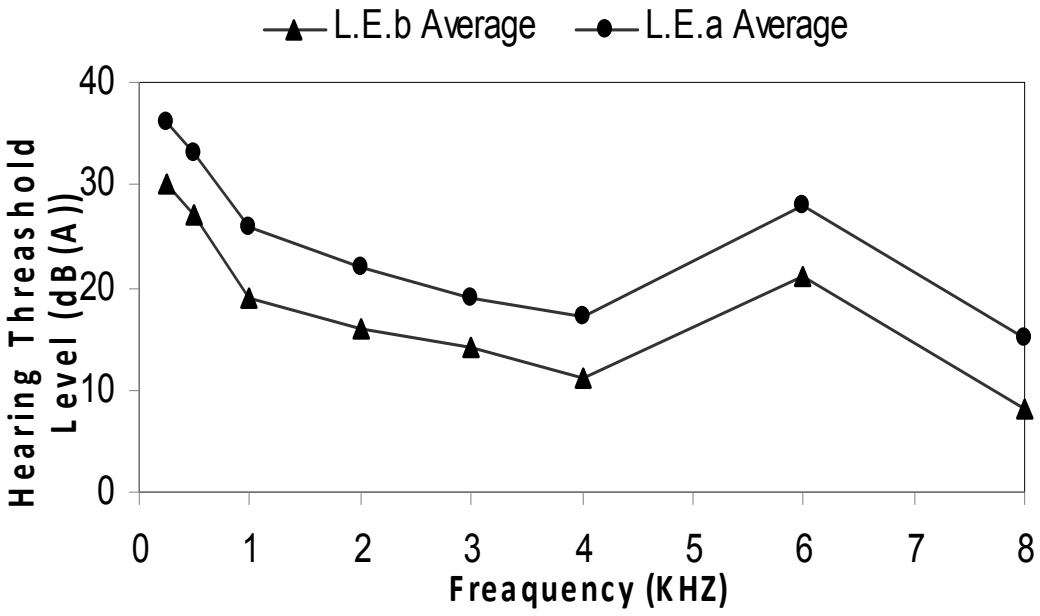
4. 2. 2. Al-Razi Hospital

The hearing threshold levels were measured for the left and right ears of 36 workers in the six departments in Al-Razi hospital. The dependence of hearing threshold levels on sound frequency for these workers is shown in Fig. (4.11).

(a)



(b)



Figure(4.11): The average of hearing threshold level for (a) the right ear before (R.E.b) and after (R.E.a) (b) the left ear before (L.E.b) and after (L.E.a) working in all six departments in Al-Razi hospital as a function of frequency.

The hearing impairment phenomenon were studied in six departments in Al-Razi hospital. The Percentage of the degree of hearing impairment at different sound frequencies was measured for the right and the left ears before and after working hours. The results of such measurements are classified according to ANSI (1969) criteria and are shown in table (4.2).

Table (4.2): Percentage of degrees of hearing impairment at different sound frequencies in Al-Razi hospital sample on the right and the left ears before and after the work.

Degrees of H.I.*	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
1	79.86	62.15	79.86	60.76
2	17.71	32.99	14.93	31.25
3	2.43	3.82	4.17	5.21
4	0	0	1.04	2.43
5	0	1.04	0	0.35
6	0	0	0	0
Total	**100**	**100**	**100**	**100**

***H. I.: Hearing Impairment.**

The results of the first degree of H. I. criteria [normal: -10 dB(A) to 26 dB(A)] for the right and the left ears before the work are 79.86% and 79.86%, respectively while the H. I. results for the right and the left ears after the work are 62.15% and 60.76%, respectively.

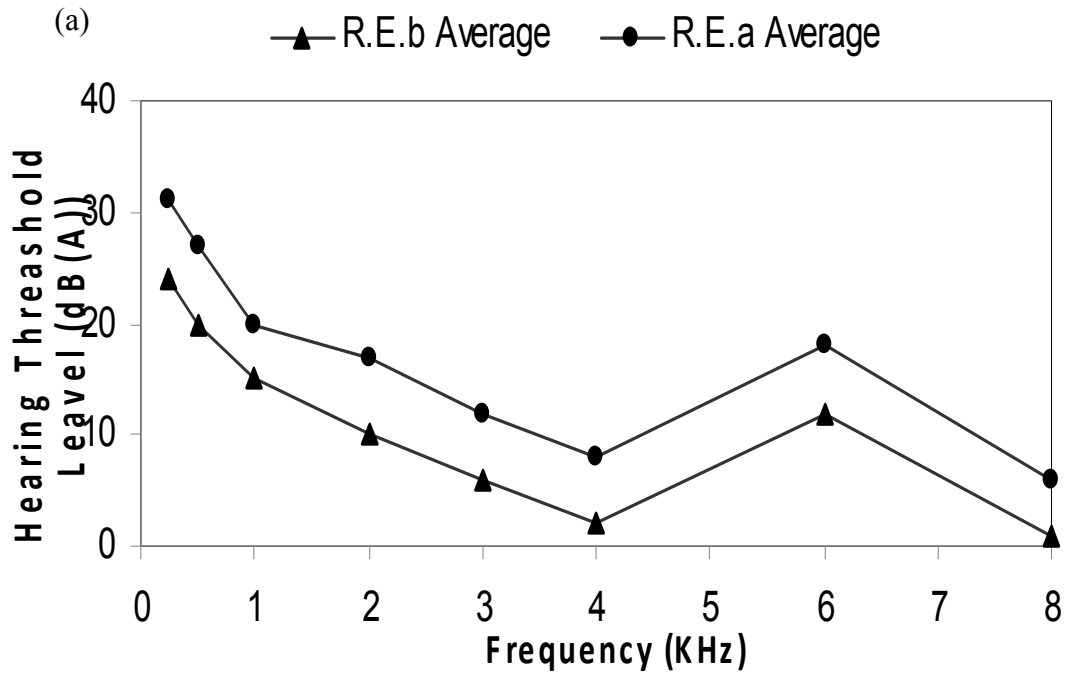
The results of the second degree of H. I. criteria [mild: 27 dB(A) to 40 dB(A)] for the right and the left ears before the work are 17.71% and 14.93%, respectively while the H. I. results for the right and the left ears after the work are 32.99% and 31.25%, respectively.

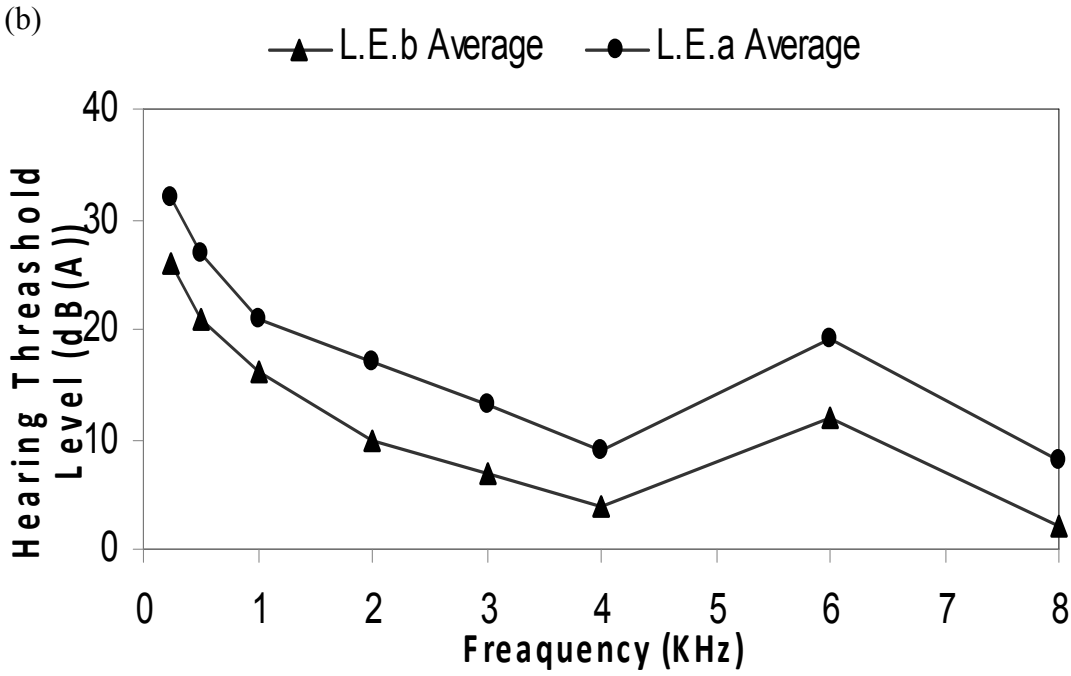
The results of the third degree of H. I. criteria [moderate: 41 dB(A) to 55 dB(A)] for the right and the left ears before the work are 2.43% and 4.17%, respectively while the H. I. results for the right and the left ears after the work are 3.82% and 5.21%, respectively.

Finally, for the rest of the degree of H. I. [fourth degree (moderately severe): 56 dB(A) to 70 dB(A)), fifth degree (sever): 71 dB(A) to 90 dB(A) and sixth degree (profound): 90+dB(A)] for the right and the left ears before the work are 0% and 0%, respectively except at fourth degree are 0% and 1.04% while the H. I. results for the right and the left ears after the work are 0% and 2.43%, respectively at the fourth degree and 1.04% and 0.35% at the fifth degree and 0% and 0% at the sixth degree. Therefore we can conclude that the SPL is high and the degrees of hearing degrees (normal degree) which means increasing in hearing impairments according to increases of noise pollution which mean that the noise pollution affected on the hearing level.

4. 2. 3. Al-Amal Hospital

The hearing threshold levels were measured for the left and right ears of 23 workers in the four departments in Al-Amal hospital. The dependence of hearing threshold levels on sound frequency for these workers is shown in Fig. (4.12).





Figure(4.12): The average of hearing threshold level for (a) the right ear before (R.E.b) and after (R.E.a) (b) the left ear before (L.E.b) and after (L.E.a) working in all four departments in Al-Amal hospital as a function of frequency.

The hearing impairment phenomenon were studied in four departments in Al-Amal hospital. The Percentage of the degree of hearing impairment at different sound frequencies was measured for the right and the left ears before and after working hours. The results of such measurements are classified according to ANSI (1969) criteria and are shown in table (4.3).

Table (4.3): Percentage of degrees of hearing impairment at different sound frequencies in Al-Amal hospital sample on the right and the left ears before and after the work.

Degess of H.I.*	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
1	98.37	81.52	90.76	78.26
2	1.63	17.39	8.15	17.39
3	0	1.09	1.09	3.8
4	0	0	0	17.94
5	0	0	0	0
6	0	0	0	0
Total	**100**	**100**	**100**	**100**

***H. I.: Hearing Impairment.**

The results of the first degree of H. I. criteria [normal: -10 dB(A) to 26 dB(A)] for the right and the left ears before the work are 98.37% and 90.76%, respectively while the H. I. results for the right and the left ears after the work are 81.52% and 78.26%, respectively.

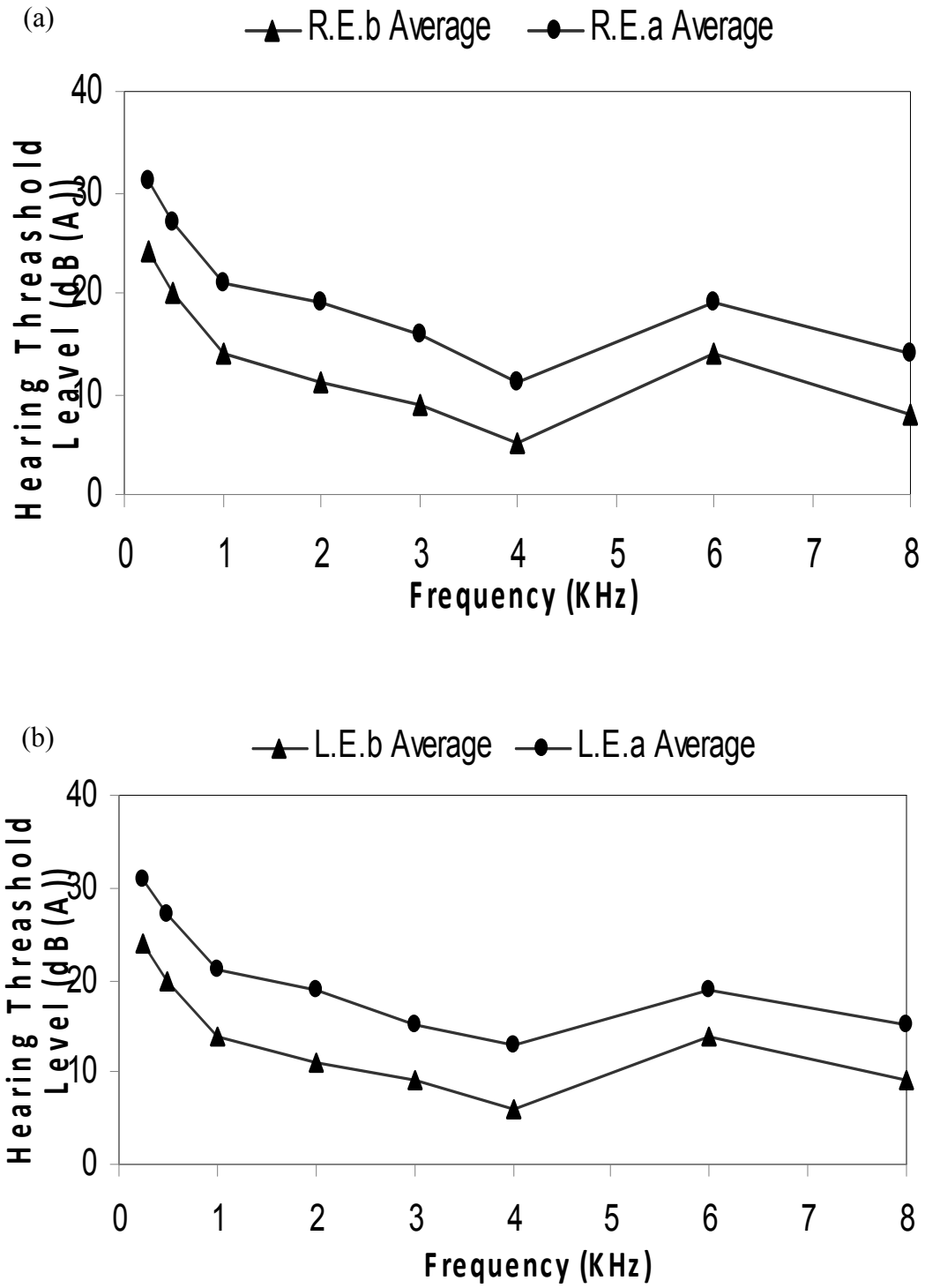
The results of the second degree of H. I. criteria [mild: 27 dB(A) to 40 dB(A)] for the right and the left ears before the work are 1.63% and 8.15%, respectively while the H. I. results for the right and the left ears after the work are 17.39% and 17.39%, respectively.

The results of the third degree of H. I. criteria [moderate: 41 dB(A) to 55 dB(A)] for the right and the left ears before the work are 0% and 1.09%, respectively while the H. I. results for the right and the left ears after the work are 1.09% and 3.8%, respectively.

Finally, for the rest of the degree of H. I. [fourth degree (moderately severe): 56 dB(A) to 70 dB(A), fifth degree (sever): 71 dB(A) to 90 dB(A) and sixth degree (profound): 90+dB(A)] for the right and the left ears before the work are 0% and 0%, respectively while the H. I. results for the right and the left ears after the work are 0% and 0%, respectively except at the fourth degree are 0% and 17.94%, respectively. Therefore one can conclude that the SPL is high and the degrees of hearing degrees (normal degree) which means increasing in hearing impairments according to increases of noise pollution which mean that the noise pollution affected on the hearing level.

4. 2. 4. Al-Shifa Hospital

The hearing threshold levels were measured for the left and right ears of 7 workers in the two departments in Al-Shifa hospital. The dependence of hearing threshold levels on sound frequency for these workers is shown in Fig. (4.13).



Figure(4.13): The average of hearing threshold level for (a) the right ear before (R.E.b) and after (R.E.a) (b) the left ear before (L.E.b) and after (L.E.a) working in the two departments in Al-Shifa hospital as a function of frequency.

The hearing impairment phenomenon were studied in two departments in al-shifa hospital. The Percentage of the degree of hearing

impairment at different sound frequencies was measured for the right and the left ears before and after working hours. The results of such measurements are classified according to ANSI (1969) criteria and are shown in table (4.4).

Table (4.4): Percentage of degrees of hearing impairment at different sound frequencies in Al-Shifa hospital sample on the right and the left ears before and after the work.

Degess of H.I.*	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
1	91.07	75	91.07	71.43
2	8.93	25	8.93	25
3	0	0	0	3.57
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
Total	**100**	**100**	**100**	**100**

***H. I.: Hearing Impairment.**

The results of the first degree of H. I. criteria [normal: -10 dB(A) to 26 dB(A)] for the right and the left ears before the work are 91.07% and 91.07%, respectively while the H. I. results for the right and the left ears after the work are 75% and 71.43, respectively.

The results of the second degree of H. I. criteria [mild: 27 dB(A) to 40 dB(A)] for the right and the left ears before the work are 8.93% and 8.93%, respectively while the H. I. results for the right and the left ears after the work are 25% and 25%, respectively.

The results of the third degree of H. I. criteria [moderate: 41 dB(A) to 55 dB(A)] for the right and the left ears before the work are 0% and 0%,

respectively while the H. I. results for the right and the left ears after the work are 0% and 3.57%, respectively.

Finally, for the rest of the degree of H. I. [fourth degree (moderately severe): 56 dB(A) to 70 dB(A), fifth degree (sever): 71 dB(A) to 90 dB(A) and sixth degree (profound): 90+dB(A)] for the right and the left ears before the work are 0% and 0%, respectively while the H. I. results for the right and the left ears after the work are 0% and 0%, respectively. Ttherefore we can conclude that the SPL is high and the degrees of hearing degrees (normal degree) which means increasing in hearing impairments according to increases of noise pollution which mean that the noise pollution affected on the hearing level.

The percentage of degrees of hearing impairment according to OSHA, NIOSH & ASHA, EPA's definitions in each hospitals is presented in tables (4.5), (4.6) and (4.7).

Table (4.5): Percentage of degrees of hearing impairment on the right and the left ears before and after the work in each studied hospitals [according to OSHA definition of hearing impairment]. The number between the brackets represent the percentage of the number of workers who suffer to the total number of sample workers.

Hospitals	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
Governmental	3.9 (2/51)	15.7 (8/51)	5.9 (3/51)	19.6 (10/51)
Al-Razi	8.3 (3/36)	22.2 (8/36)	8.3 (3/36)	25 (9/36)
Al-Amal	0 (0/23)	4.4 (1/23)	4.4 (1/23)	8.7 (2/23)
Al-Shifa	0 (0/7)	14.3 (1/7)	0 (0/7)	14.3 (1/7)
Total	**12.2 (5/117)**	**56.6 (18/117)**	**18.6 (7/117)**	**67.6 (22/117)**

Table (4.6): Percentage of degrees of hearing impairment on the right and the left ears before and after the work in each studied hospitals [according to NIOSH and ASHA definition of hearing impairment]. The number between the brackets represent the percentage of the number of workers who suffer to the total number of sample workers.

Hospitals	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
Governmental	3.9 (2/51)	13.7 (7/51)	5.9 (3/51)	17.7 (9/51)
Al-Razi	8.3 (3/36)	22.2 (8/36)	8.3 (3/36)	22.2 (8/36)
Al-Amal	0 (0/23)	4.4 (1/23)	4.4 (1/23)	8.7 (2/23)
Al-Shifa	0 (0/7)	14.3 (1/7)	0 (0/7)	14.3 (1/7)
Total	**12.2 (5/117)**	**54.6 (17/117)**	**18.6 (7/117)**	**62.9 (20/117)**

Table (4.7): Percentage of degrees of hearing impairment on the right and the left ears before and after the work in each studied hospitals [according to EPA definition of hearing impairment]. The number between the brackets represent the percentage of the number of workers who suffer to the total number of sample workers.

Hospitals	Right ear (b) %	Right ear (a) %	Left ear (b) %	Left ear (a) %
Governmental	3.9 (7/51)	39.2 (20/51)	15.7 (8/51)	41.2 (21/51)
Al-Razi	16.7 (6/36)	47.2 (17/36)	19.4 (7/36)	47.2 (17/36)
Al-Amal	4.4 (1/23)	21.7 (5/23)	8.7 (2/23)	26.1 (6/23)
Al-Shifa	0 (0/7)	42.9 (3/7)	0 (0/7)	42.9 (3/7)
Total	**25 (14/117)**	**151 (45/117)**	**43.8 (17/117)**	**157.4 (47/117)**

The effect of noise pollution on hearing impairment according to different organization criteria can be compared between the sample of workers in the four hospitals as shown in previous tables.

The percentage of hearing impairment of 51 workers on right and left ears, respectively in Governmental hospital according to OSHA criteria are 3.9% (2 from 51) and 5.9% (3 from 51) before the work and 15.7% (8 from 51), 19.6% (10 from 51) after the work. The percentage of hearing impairments in the same hospital according to NIOSH and ASHA

organizations are 3.9% (2 from 51) and 5.9% (3 from 51) on right and left ears, respectively before the work and 13.7% (7 from 51), 17.7% (9 from 51) after the work. In addition, in the Governmental hospital. The percentage of hearing impairments according to EPA organization are 3.9% (7 from 51) and 41.2% (21 from 51) on right and left ears, respectively before the work and 39.2% (20 from 51), 41.2% (21 from 51) after the work.

The percentage of hearing impairment of 36 workers on right and left ears, respectively in Al-Razi hospital according to OSHA criteria are 8.3% (3 from 36) and 8.3% (3 from 36) before the work and 22.2% (8 from 36), 25% (9 from 36) after the work. The percentage of hearing impairments in the same hospital according to NIOSH and ASHA organizations are 8.3% (3 from 36) and 8.3% (3 from 36) on right and left ears, respectively before the work and 22.2% (8 from 36), 22.2% (8 from 36) after the work. In addition, in Al-Razi hospital. The percentage of hearing impairments according to EPA organization are 16.7% (6 from 36) and 19.4% (7 from 36) on right and left ears, respectively before the work and 47.2% (17 from 36), 47.2% (17 from 36) after the work.

The percentage of hearing impairment of 23 workers on right and left ears, respectively in Al-Amal hospital according to OSHA are 0% (0 from 23) and 4.4% (1 from 23) before the work and 4.4% (1 from 23), 8.7% (2 from 23) after the work. The percentage of hearing impairments in the same hospital according to NIOSH and ASHA organizations are 0% (0

from 23) and 4.4% (1 from 23) on right and left ears, respectively before the work and 4.4% (1 from 23), 8.7% (2 from 23) after the work. In addition, in Al-Amal hospital. The percentage of hearing impairments according to EPA organization are 4.4% (1 from 23) and 8.7% (2 from 23) on right and left ears, respectively before the work and 21.7% (5 from 23), 26.1% (6 from 23) after the work.

The percentage of hearing impairment of 7 workers on both ears in Al-Shifa hospital according to OSHA criteria are 0% (0 from 7) before the work and 14.3% (1 from 7) after the work. The percentage of hearing impairments in the same hospital according to NIOSH and ASHA organizations are 0% (0 from 7) on both ears before the work and 14.3% (1 from 7) after the work. In addition, in Al-Shifa hospital. The percentage of hearing impairments according to EPA organization are 0% (0 from 7) on both ears before the work and 42.9% (3 from 7) on both ears after the work.

The comparison found that the percentage of hearing impairments at different frequency are increases according to increase of noise pollution in these hospitals.

The tables (4.5), (4.6) and (4.7) shown a big similarities between the results of table (4.5) and table (4.6) except for after work in Governmental and Al-Razi hospitals. This is because the criteria of the two organizations (OSHA, NIOSH and ASHA) as shown in (sec. 4.2) are very similar. However, the results of Al-Amal and Al-Shifa hospitals do not show some behavior because the sample is less. On the other hand, the results in table

(4.7) are obviously different from those of table (4.5) and table (4.6) because there is a big different in the criteria of EPA organization compared to the (OSHA, NIOSH and ASHA) as presented in (sec. 4.2).

4.3. Blood Oxygen Concentration

The concentration of oxygen in the blood was measured on the selected sample of workers in the four hospitals. The measurements were done twice for each worker, before and after working.

The results of such measurements are shown in the following table according to the gender of workers in these hospitals.

Table (4.8) shows the changes of the blood oxygen concentration (SpO_2%) before and after working in all sample hospitals.

Table (4.8): Min., Max. and Mean of SpO_2% before (b) and after working (a)in Governmental, AlRazi, Al-Amal and Al-Shifa hospitals.

Hospital	SpO_2% before exposure						SpO_2% after exposure					
	Male			Female			Male			Female		
	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.
Governmental	99	98	96	99	99	98	99	97	91	98	97	94
Al-Razi	99	98	97	99	99	98	98	96	92	98	97	96
Al-Amal	99	99	98	99	98	98	98	97	96	99	98	96
Al-Shifa	98	98	98	99	98	98	97	96	95	98	97	96

The table (4.8) shows that the blood oxygen concentration of all workers in all sample hospitals was decreased. Although of this decreased, the average of SpO_2% was in the normal range for all workers sample but the SpO_2% was very low for some of each workers alone. However, the

SpO_2% in males is more affected compared to female. This might be that the most male workers are smokers that affects the SpO_2% very strongly.

The average of blood oxygen concentration (SpO_2%) in the blood for the workers (before and after working) in the four hospitals are shown in Fig. (4.14).

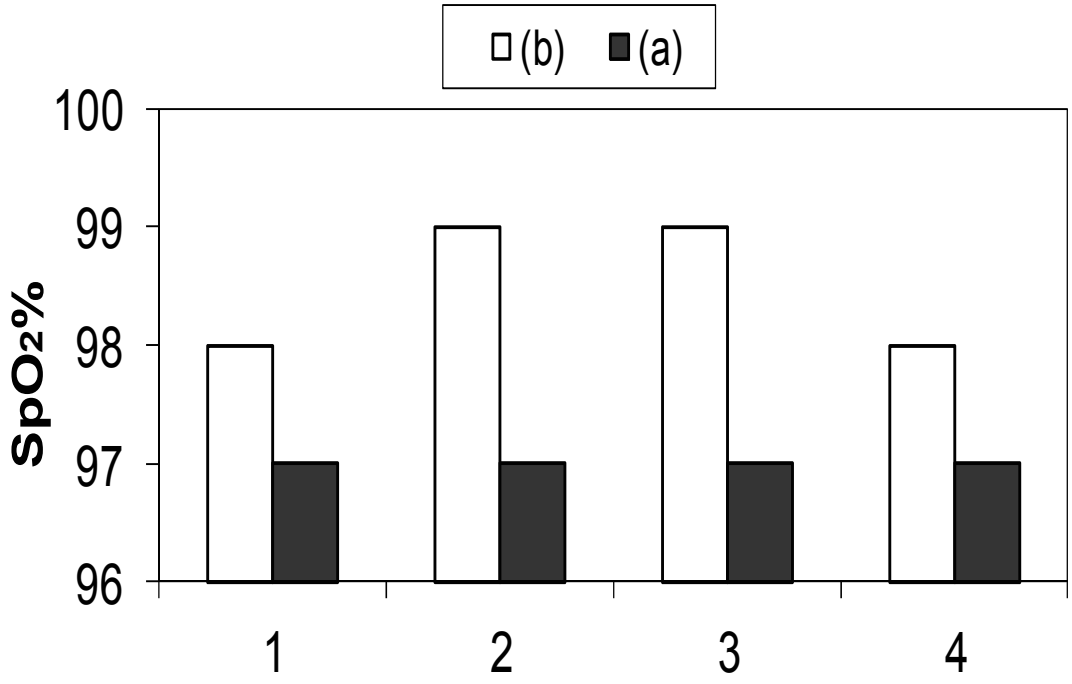


Figure (4.14): The average of blood oxygen saturation (SpO_2%) of the workers (before and after working) in the four hospitals (where: 1 is Governmental (SPL= 67.1 dB(A)), 2 is Al-Razi (SPL= 60.5 dB(A)), 3 is Al-Amal (SPL= 64.1 dB(A)) and 4 is Al-Shifa hospital (SPL= 61.7 dB(A)).

4.4. Blood Pressure and Heart Pulse Rate

The systolic and diastolic blood pressures (SBP & DBP) and heart pulse rate (HPR) were measured for 117 workers in the four hospitals. The results of the average of SBP and DBP for the workers in the four hospitals before and after working hours as a function of SPL are increasing as a

result of increasing in noise pollution in these hospitals. The Fig. (4.15) below show this results.

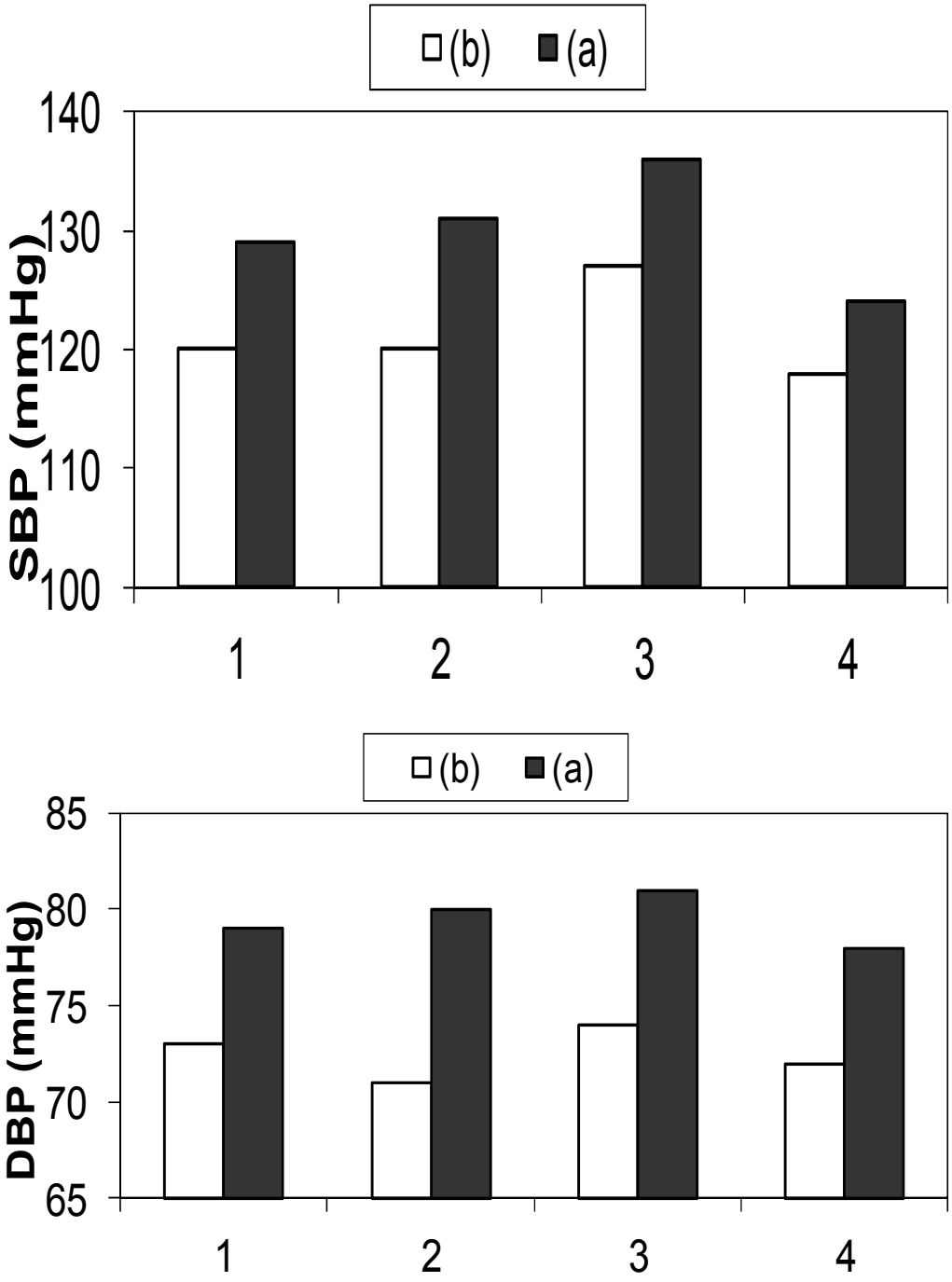


Figure (4.15): The average of (a) SBP and (b) DBP of the 117 workers in the four hospitals before and after working (where: 1 is Governmental (SPL= 67.1 dB(A)), 2 is Al-Razi (SPL= 60.5 dB(A)), 3 is Al-Amal (SPL= 64.1 dB(A)), and 4 is Al-Shifa hospital (SPL= 61.7 dB(A)).

The results of the average of HPR as a function of SPL in the four hospitals are increasing (normally for all workers sample, but up normal for some of each workers alone) according to increasing in SPL. This relation is shown in Fig. (4.16).

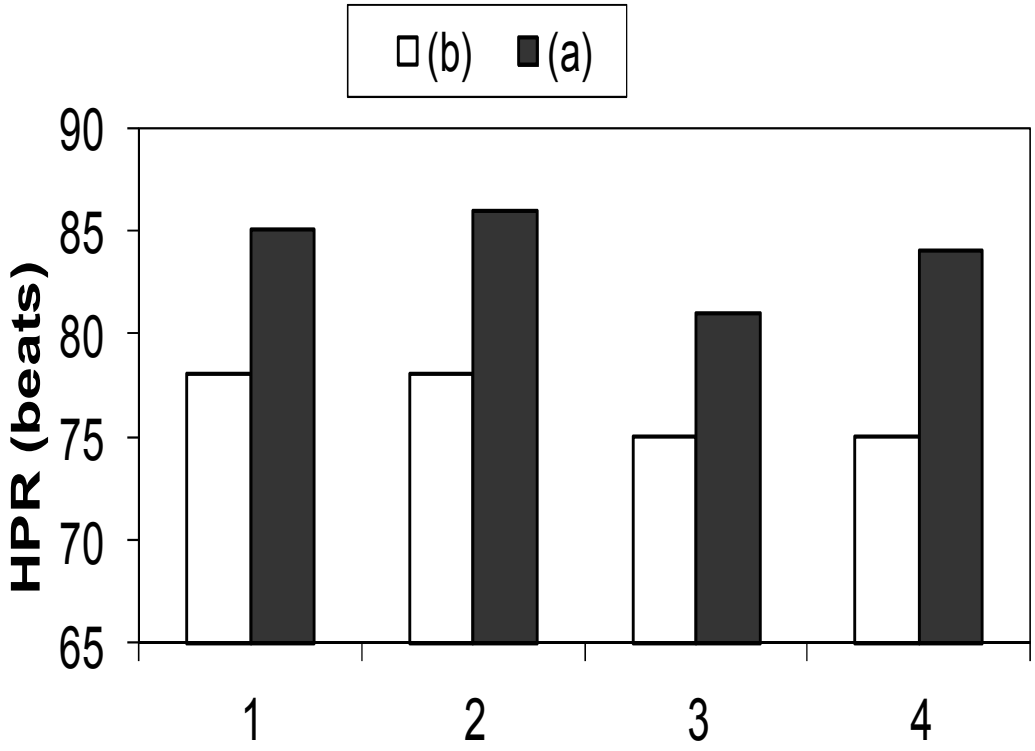


Figure (4.16): The average of HPR of 117 workers in the four hospitals before and after works (where: 1 is Governmental (SPL= 67.1 dB(A)), 2 is Al-Razi (SPL= 60.5 dB(A)), 3 is Al-Amal (SPL= 64.1 dB(A)) and 4 is Al-Shifa hospital (SPL= 61.7 dB(A)).

In general, several parameters concerning the workers and their health condition were collected and measured for the 117 sample workers of the four selected hospitals. These parameters are summarized and presented in table (4.9)

Table (4.9): Gender, serving period, age, weight, SBP, DBP, HPR for the sample workers in all studied hospitals.

Variables	Governmental Hospital						Al-Razi Hospital						Al-Amal Hospital						Al-Shifa Hospital					
	Male			Female			Male			Female			Male			Female			Male			Female		
	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.
Serving period (years)	30	13	1	30	8	1	36	16	1	19	8	1	38	18	1	28	18	3	32	31	30	30	12	1
Age (years)	55	37	20	59	32	20	59	41	21	42	32	23	65	43	22	54	42	27	56	55	54	53	39	21
Weight (kg)	111	79	55	95	66	43	97	77	62	85	67	47	98	81	66	87	73	49	93	89	84	65	56	48
SBP (b) (mmHg)	137	125	108	131	115	95	156	126	102	135	111	90	142	130	110	140	123	100	128	126	124	126	114	99
SBP (a) (mmHg)	146	132	118	146	125	104	174	137	120	146	124	96	164	140	120	146	132	115	134	133	132	129	120	109
DBP (b) (mmHg)	85	75	63	82	70	59	88	71	55	76	69	55	85	71	60	88	77	64	72	71	70	82	72	62
DBP (a) (mmHg)	92	81	68	91	77	63	93	80	67	87	80	68	88	78	71	93	83	74	78	78	77	85	77	68
HPR (b) (beats/min)	86	76	61	103	81	67	91	78	62	87	79	67	86	74	63	86	76	69	82	77	71	81	75	67
HPR (a) (beats/min)	105	83	66	106	87	75	98	85	65	93	86	73	90	78	68	106	83	71	88	84	79	87	84	82

The table (4.9) shows the different between the measurement values for all workers (before and after the work) according to their gender (male and female). These results indicates that the SBP and DBP in males are more affected compared to females. Although of this, the HPR for females is more affected compared to males. In addition, the weight is effect on SBP, DBP and HPR.

Chapter Five

Discussion, Recommendations and Conclusions

Chapter Five

Discussion, Recommendations and Conclusions

5.1. Statistical Analysis

The data of hearing threshold levels, blood oxygen concentration (SpO_2%), blood pressure (SBP & DBP) and heart pulse rate (HPR) are analyzed and discussion in this section**.**

Table (5.1) shows mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables in all studied hospitals.

Table (5.1): Mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables in all studied hospitals.

Hospitals	N	Dependent variables	Mean value of dependent variables		The difference between means	p-value (Sig.)	R
			Before work	After work			
Governmental	51	SpO_2%	98.37	96.76	1.61	0.000	0.707
		SBP(mmHg)	120.29	128.6	8.38	0.000	0.798
		DBP(mmHg)	72.53	78.86	6.33	0.000	0.786
		HPR(beat\min)	78.16	85.06	6.9	0.000	0.842
Al-Razi	36	SpO_2%	98.58	96.61	1.97	0.000	0.749
		SBP(mmHg)	119.50	131.1	11.64	0.000	0.856
		DBP(mmHg)	70.75	79.75	9	0.000	0.762
		HPR(beat\min)	78.39	85.97	7.58	0.000	0.938
Al-Amal	23	SpO_2%	98.70	97.39	1.31	0.055	0.405
		SBP(mmHg)	126.65	135.7	9.09	0.000	0.754
		DBP(mmHg)	74.17	80.48	6.31	0.000	0.703
		HPR(beat\min)	74.65	80.48	5.83	0.000	0.817
Al-Shifa	7	SpO2%	98.29	96.57	1.72	0.013	0.861
		SBP(mmHg)	117.57	123.8	6.29	0.000	0.983
		DBP(mmHg)	71.71	77.57	5.86	0.019	0.837
		HPR(beat\min)	75.43	84.14	8.71	0.258	0.496

The average value of R is 0.768. This result indicate there is strong correlation for SpO_2%, SPB, DBP and HPR for all workers.

The finding of this study conforms to the results of other reports of noise-induced blood pressure elevation and higher incidence of hypertension which were detected in field studies in subjects who exposed to high levels of noise (Green et al., 1991, Regecova & Kellerova, 1995, Wu et al., 1998).

Table (5.2) shows mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables for the gender in all hospitals.

Table (5.2): Mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables for the gender in all hospitals.

Total Number	Gender	Number	Dependent variables	Mean value of dependent variables		The difference between means	P value (Sig.)	R
				Before work	After work			
117	Male	61						
			SpO_2%	98.36	96.49	1.87	0.000	0.711
			SBP(mmHg)	126.13	134.69	8.56	0.000	0.833
			DBP(mmHg)	72.98	79.66	6.68	0.000	0.861
			HPR(beat\min)	76.18	83.16	6.98	0.000	0.909
	Female	56						
			SpO_2%	98.64	97.20	1.44	0.000	0.568
			SBP(mmHg)	115.70	126.00	10.3	0.000	0.756
			DBP(mmHg)	71.46	79.07	7.61	0.000	0.629
			HPR(beat\min)	78.68	85.71	7.03	0.000	0.789

The average value of R is 0.829 for male and 0.686 for female. These results indicates there is strong correlation for SpO_2%, SPB, DBP

and HPR for all workers for male and female. While this correlation for male is more stronger than female. The p-values are 0.000 for all workers.

Table (5.3) shows mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables in OR, ICU, NICU, Lab., Emergency and Outpatients Clinic in all studied hospitals.

Table (5.3): Mean values of SpO_2%, SBP, DBP and HPR for all workers and p-values and Pearson correlation coefficients R of the studied variables in OR, ICU, NICU, Lab., Emergency and Outpatients Clinic in all studied hospitals.

Department	N	Dependent variables	Mean value of dependent variables		The difference between means	P-value (Sig.)	R
			Before work	After work			
OR	32	SpO_2%	98.41	96.69	1.72	0.000	0.672
		SBP(mmHg)	120.00	127.78	7.78	0.000	0.811
		DBP(mmHg)	73.84	79.84	6	0.000	0.770
		HPR(beat\min)	76.47	82.53	6.06	0.000	0.893
ICU	9	SpO_2%	98.89	97.00	1.89	0.460	0.283
		SBP(mmHg)	115.56	127.78	12.22	0.111	0.568
		DBP(mmHg)	70.56	78.89	8.33	0.155	0.516
		HPR(beat\min)	74.67	82.33	7.66	0.000	0.966
NICU	9	SpO_2%	98.56	97.44	1.12	0.010	0.800
		SBP(mmHg)	109.11	125.67	16.56	0.384	0.331
		DBP(mmHg)	64.44	75.44	11	0.245	0.433
		HPR(beat\min)	81.11	88.67	7.56	0.002	0.881
Lab.	25	SpO2%	98.48	96.72	1.76	0.011	0.498
		SBP(mmHg)	119.84	129.96	10.12	0.000	0.895
		DBP(mmHg)	72.60	80.24	7.64	0.000	0.658
		HPR(beat\min)	80.72	88.08	7.36	0.005	0.545
Emergency	21	SpO_2%	98.29	96.43	1.86	0.000	0.750
		SBP(mmHg)	126.10	134.67	8.57	0.000	0.913
		DBP(mmHg)	74.38	81.10	6.72	0.000	0.856
		HPR(beat\min)	78.33	85.67	7.34	0.000	0.889
Outpatients Clinic	21	SpO2%	98.67	97.24	1.43	0.000	0.776
		SBP(mmHg)	127.00	134.52	7.52	0.000	0.848
		DBP(mmHg)	71.38	77.81	6.43	0.000	0.890
		HPR(beat\min)	73.38	80.57	7.19	0.000	0.890

The average value of R is 0.722. This result indicate there is strong correlation for SpO_2%, SPB, DBP and HPR for all workers in these departments.

The findings of this study support the hypothesis that exposure to high industrial noise levels may risk factor for cardiovascular disease via increased systolic and diastolic blood blood pressure, and pulse rate(Melamed & Ribak, 1997, Regecova & Kellerova, 1995, WHO, 1999).

Table (5.4) shows p-values and Pearson correlation coefficients R of threshold levels for all workers in all studied hospitals.

Table (5.4): p-values and Pearson correlation coefficients R of threshold levels for all workers in all studied hospitals.

Dependent variables	P-value (Sig.)	R.
R 250 HZ (b) & R 250 HZ (a)	0.000	0.922
L 250 HZ (b) & L 250 HZ (a)	0.000	0.935
R 500 HZ (b) & R 500 HZ (a)	0.000	0.913
L 500 HZ (b) & L 500 HZ (a)	0.000	0.927
R 1000 HZ (b) & R 1000 HZ (a)	0.000	0.938
L 1000 HZ (b) & L 1000 HZ (a)	0.000	0.931
R 2000 HZ (b) & R 2000 HZ (a)	0.000	0.918
L 2000 HZ (b) & L 2000 HZ (a)	0.000	0.922
R 3000 HZ (b) & R 3000 HZ (a)	0.000	0.890
L 3000 HZ (b) & L 3000 HZ (a)	0.000	0.912
R 4000 HZ (b) & R 4000 HZ (a)	0.000	0.857
L 4000 HZ (b) & L 4000 HZ (a)	0.000	0.869
R 6000 HZ (b) & R 6000 HZ (a)	0.000	0.929
L 6000 HZ (b) & L 6000 HZ (a)	0.000	0.930
R 8000 HZ (b) & R 8000 HZ (a)	0.000	0.883
L 8000 HZ (b) & L 8000 HZ (a)	0.000	0.903

The average value of R is 0.911. This result indicate there is strong correlation for HTL before and after the work for all workers in all hospitals. While the P-values are 0.000 (< 0.05) for all workers.

Table (5.5) shows p-values and Pearson correlation coefficients R of threshold levels for all workers in each studied hospitals.

Table (5.5): p-values and Pearson correlation coefficients R of threshold levels for all workers in each studied hospitals.

Dependent variables	Governmental Hospital		Al-Razi Hospital		Al-Amal Hospital		Al-Shifa Hospital	
	p-value (Sig.)	R	p-value (Sig.)	R	p-value (Sig.)	R	p-value (Sig.)	R
R 250 HZ (b) & R 250 HZ (a)	0.000	0.925	0.000	0.921	0.000	0.906	0.000	0.965
L 250 HZ (b) & L 250 HZ (a)	0.000	0.918	0.000	0.936	0.000	0.943	0.000	0.971
R 500 HZ (b) & R 500 HZ (a)	0.000	0.893	0.000	0.932	0.000	0.940	0.003	0.924
L 500 HZ (b) & L 500 HZ (a)	0.000	0.895	0.000	0.950	0.000	0.930	0.003	0.924
R 1000 HZ (b) & R 1000 HZ (a)	0.000	0.934	0.000	0.938	0.000	0.967	0.002	0.934
L 1000 HZ (b) & L 1000 HZ (a)	0.000	0.926	0.000	0.930	0.000	0.980	0.013	0.858
R 2000 HZ (b) & R 2000 HZ (a)	0.000	0.864	0.000	0.984	0.000	0.886	0.001	0.943
L 2000 HZ (b) & L 2000 HZ (a)	0.000	0.869	0.000	0.973	0.000	0.914	0.001	0.943
R 3000 HZ (b) & R 3000 HZ (a)	0.000	0.808	0.000	0.946	0.000	0.888	0.002	0.934
L 3000 HZ (b) & L 3000 HZ (a)	0.000	0.821	0.000	0.972	0.000	0.976	0.010	0.876
R 4000 HZ (b) & R 4000 HZ (a)	0.000	0.707	0.000	0.933	0.000	0.969	0.002	0.939
L 4000 HZ (b) & L 4000 HZ (a)	0.000	0.705	0.000	0.961	0.000	0.970	0.004	0.915
R 6000 HZ (b) & R 6000 HZ (a)	0.000	0.898	0.000	0.947	0.000	0.937	*	*
L 6000 HZ (b) & L 6000 HZ (a)	0.000	0.875	0.000	0.971	0.000	0.978	*	*
R 8000 HZ (b) & R 8000 HZ (a)	0.000	0.771	0.000	0.965	0.000	0.951	0.000	0.984
L 8000 HZ (b) & L 8000 HZ (a)	0.000	0.800	0.000	0.965	0.000	0.978	0.000	0.987

***The paired samples correlation table is not produced.**

The average value of R is 0.851 in Governmental hospital. This result indicate there is strong correlation for HTL before and after the work for all workers. While the p-values are 0.000 (< 0.05) for all workers in this hospital. In addition, the average value of R is 0.952 in Al-Razi hospital. This result indicate there is strong correlation for HTL before and after the work for all workers. While the p-values are 0.000 (< 0.05) for all workers in this hospital. The average value of R is 0.945 in Al-Amal hospital so that there is strong correlation for HTL before and after the work for all workers. While the p-values are 0.000 (< 0.05) for all workers in this hospital. Finally, in Al-Shifa hospital the average value of R is 0.819. This mean that there is strong correlation for HTL before and after the work for all workers. While the p-value range from 0.000 to 0.013 (< 0.05) for all workers in this hospital.

These findings conform to the results of other studies that showed the relationship between progression of hearing loss with continuous exposure (Gallo & Glorig, 1964, Nguyen et al., 1998, Wu et al.,1998).

5.2. Recommendations

Noise in hospitals is a large and growing problem, because of the high noise levels that could contribute to increase efforts, anxiety and fatigue on patients and staff. In addition this can adversely affect on speech and communication between workers which is leading to increase the number of medical errors.

The study of noise pollution in hospitals is one of the interesting issues in modern era due to the increasing high levels of noise. All applied standards of noise in hospitals have shown that the problem of noise pollution in hospitals is a global problem.

Most of the reasons of noise pollution in hospitals are noticed to be due to medical devices, sounds from patients, administration of medications, mobiles and the sound of visitors.

This study support some of recommendations to reduce the noise levels. These recommendations are:

1- Considering the noise pollution studies by the ministry of Health in wider scale and to encourage more researchers to deal with this problem.

2- Hospital managers should post signs demanding visitors and working in the hospital to reduce their voice as much as possible.

3- Limiting the times of visits in hospital.

4- Reducing the number of escorts for patients as much as possible.

5- Design of the building according to specific criteria which helps to reduce noise levels. Of course, using rough and curved surfaces made of special materials help a lot in reducing the noise effects.

6- Using of sound-insulating material in buildings and on the doors and windows.

7- Reducing the sound level of phone bells and speakers.

8- Increasing the number of workers in the sections as required.

9- Reducing shouting in the sections during the work time.

10- Asking the visitors to stick to noise regulations in hospitals via distributing and hanging special stickers through the different sections of hospitals.

11- Making periodical maintenance of the devices.

12- Making resting places for patients and escorts away from the patients sections.

13- Asking all workers in hospitals to wear special shoes.

14- Reduce the number of alarms and alarm noise levels as much as possible and improving the response to life-critical alarms.

15- Prevent the exchange of visits between the workers inside hospital departments.

16- Organize training times of students in Governmental hospital departments.

17- Prevent the entry of visitors from the emergency door in Governmental hospital and Al-Razi hospital.

18- Make sure to prepare all the necessary tools before the operation, especially in Al-Amal hospital.

19- Reduce the sound of the alarm warning as much as possible in Al-Shifa hospital.

5.3. Conclusions

The results of this study indicate the following points:

- The average values of SPL in all studied hospitals were:
  67.1 dB(A) in Governmental hospital, 64.1 dB(A) in Al-Amal hospital, 61.7 dB(A) in Al-Shifa hospital and 60.5 dB(A) in Al-Razi hospital. These values are too high compared to the international standard (45.0dB(A)) in daytime and (35.0dB(A)) in nighttime (American Academy of Pediatrics, 1997).
- The average values of SPL in ICU departments in all studied hospitals were:
  60.14 dB(A) in Governmental hospital and 52.28 dB(A) in Al-Razi hospital.
- The average values of SPL in NICU departments in all studied hospitals were:
  65.61 dB(A) in Governmental hospital and 51.95 dB(A) in Al-Razi hospital.
- The average values of SPL in OR departments in all studied hospitals were:

66.54 dB(A) in Governmental hospital, 63.31 dB(A) in Al-Razi hospital, 63.82 dB(A) in Al-Amal hospital and 64.62 dB(A) in Al-Shifa hospital.

- The average values of SPL in Lab departments in all studied hospitals were:

  70.81 dB(A) in Governmental hospital, 68.04 dB(A) in Al-Razi hospital and 65.28 dB(A) in Al-Amal hospital.

- The average values of SPL in Emergency departments in all studied hospitals were:

  74.08 dB(A) in Governmental hospital, 65.11 dB(A) in Al-Razi hospital and 64.95 dB(A) in Al-Amal hospital.

- The average values of SPL in Outpatient Clinic departments in all studied hospitals were:

  68.8 dB(A) in Governmental hospital, 63.76 dB(A) in Al-Razi hospital, 62.66 dB(A) in Al-Amal hospital and 59.96 dB(A) in Al-Shifa hospital.

- The SpO_2% in males is more affected compared to females. This might be that the most male workers are smokers.
- The SBP and DBP might be affected by the person's physical, mental and health conditions (Iyawe, 2000).
- The SBP and DBP in males are more affected compared to females.
- The weight is effect on SBP, DBP and HPR.
- The results of this study indicate there is a strong positive correlation between noise and the average of the following factors:

HTL ($P < 0.05$, $0.5 < R < 1$), SpO_2% ($P < 0.05$, $0.5 < R < 1$), SBP ($P < 0.05$, $0.5 < R < 1$), DBP ($P < 0.05$, $0.5 < R < 1$), and HPR ($P < 0.05$, $0.5 < R < 1$), for all workers sample. All the tests show increasing trends of HTL, SpO_2%, SBP, DBP and HPR for all workers in all studied hospitals.

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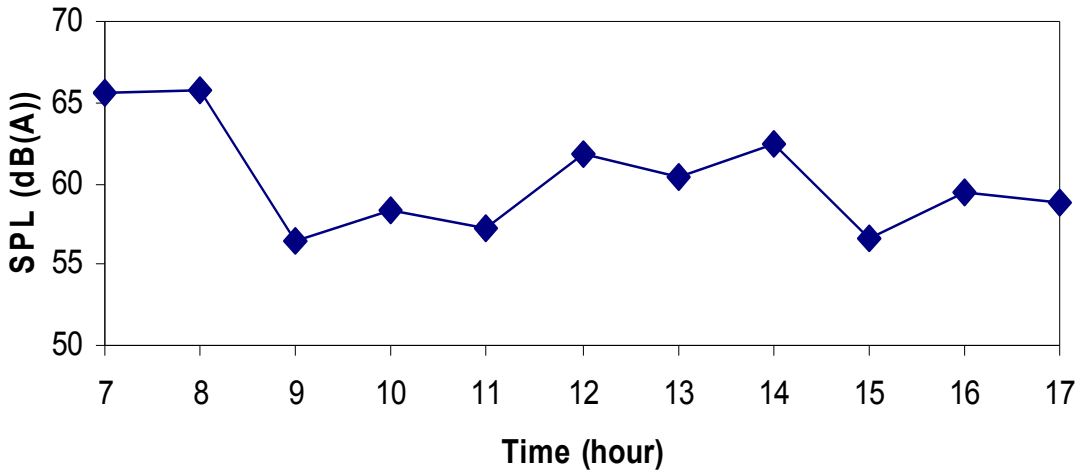
Appendix

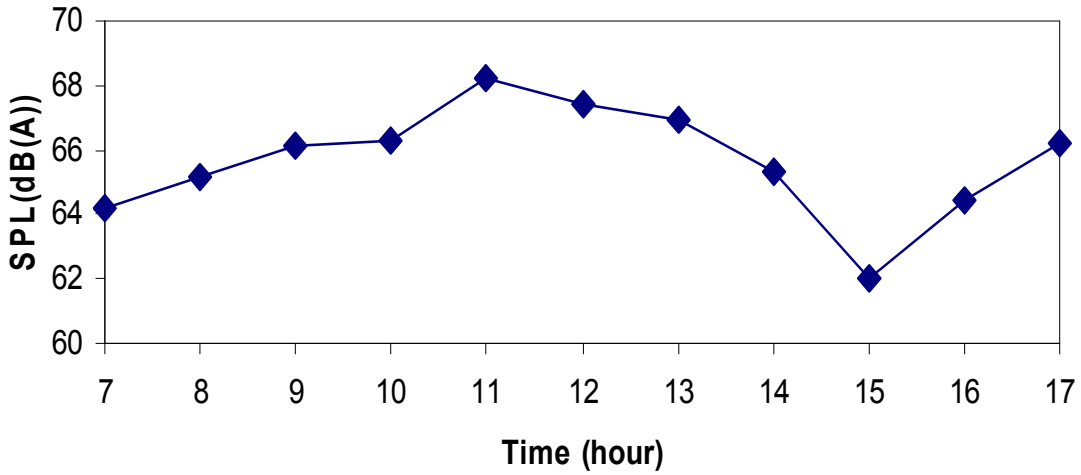
Appendix (A-1)

The following figures below shown the detailed measurements of SPL as a function of time in each department of ICU, NICU, OR, Lab, Emergency and Outpatient Clinic in Governmental hospital.

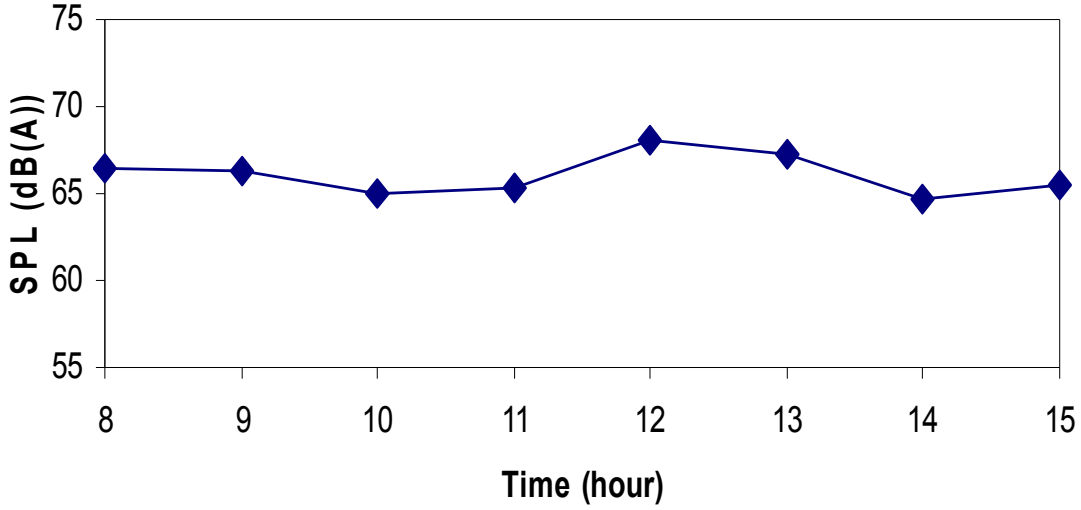
ICU



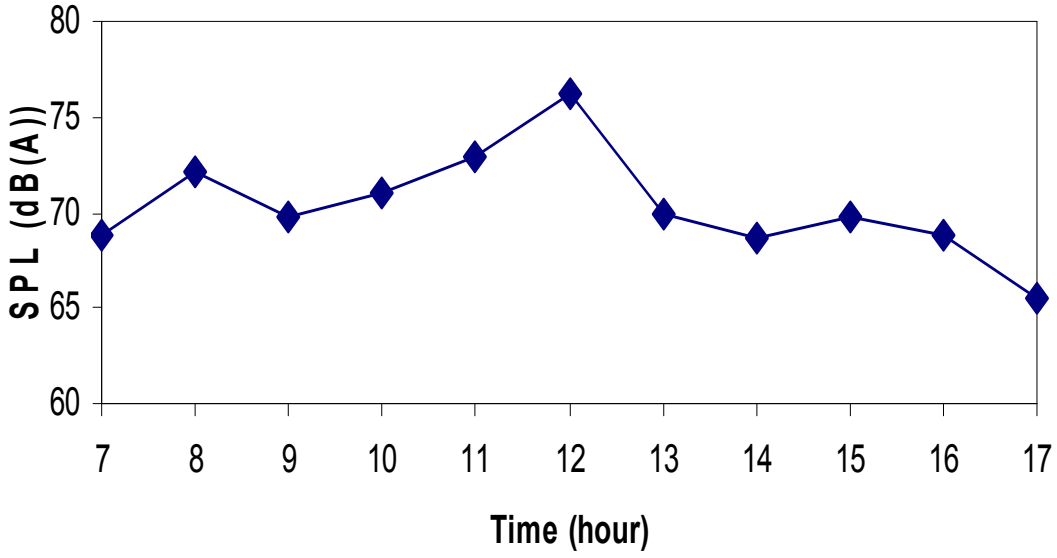
NICU



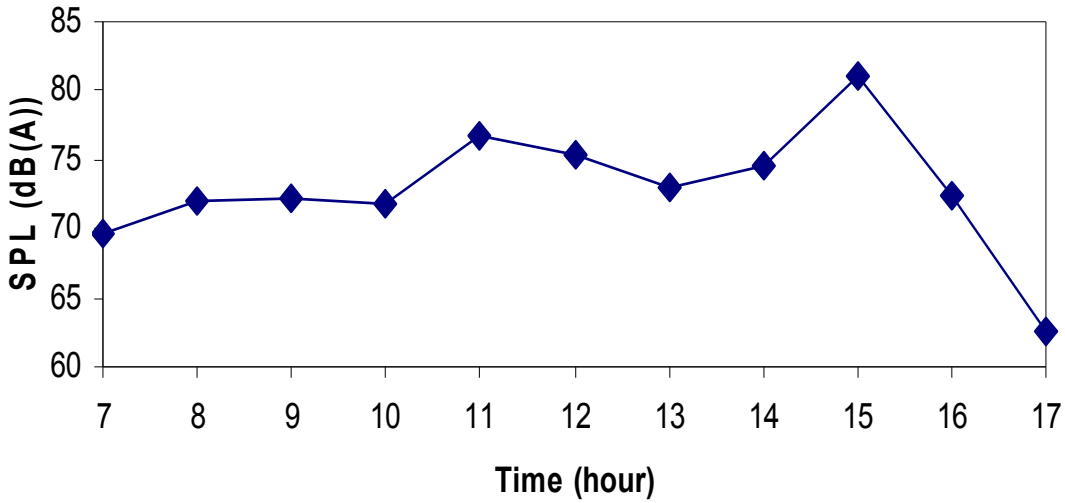
OR


75
70
65
60
55
SPL (dB(A))
8
9
10
11
12
13
14
15
Time (hour)

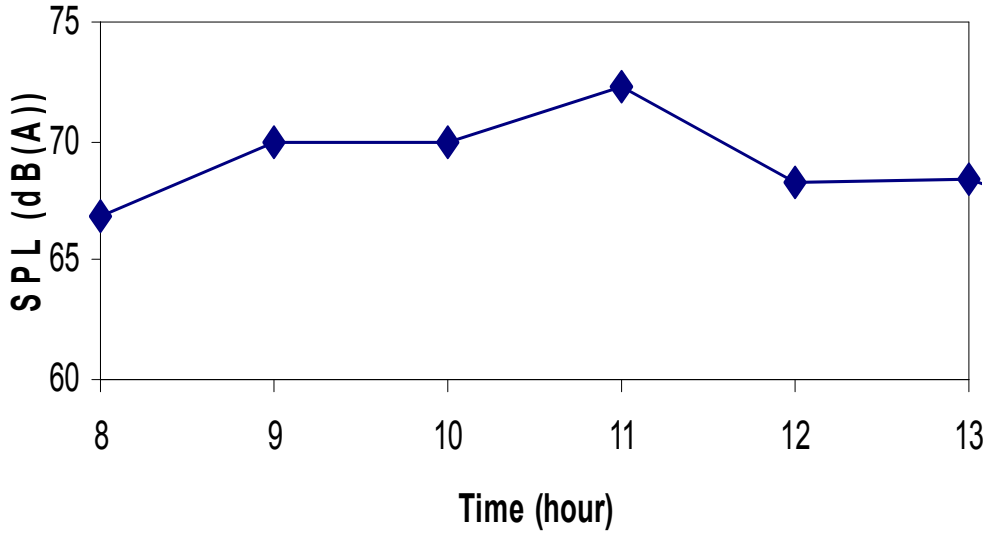
Lab.


80
75
70
65
60
SPL (dB(A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)

Emergency



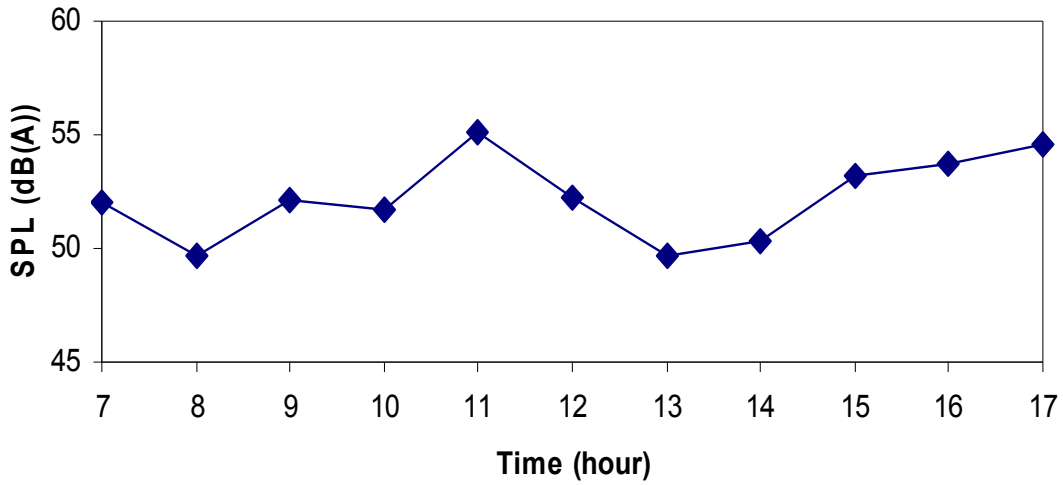
Outpatient Clinic



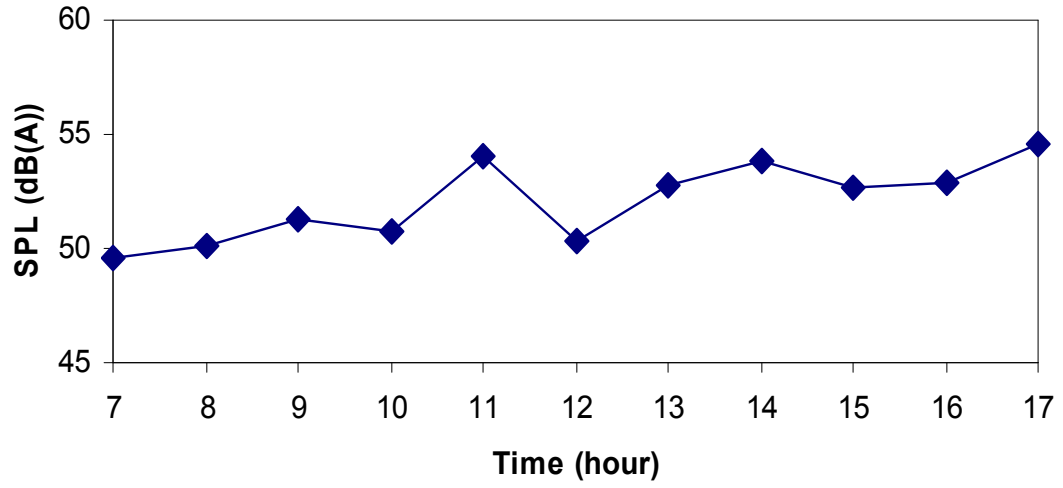
Appendix (A-2)

The following figures below shown the detailed measurements of SPL as a function of time in each department of ICU, NICU, OR, Lab, Emergency and Outpatient Clinic in Al-Razi hospital.

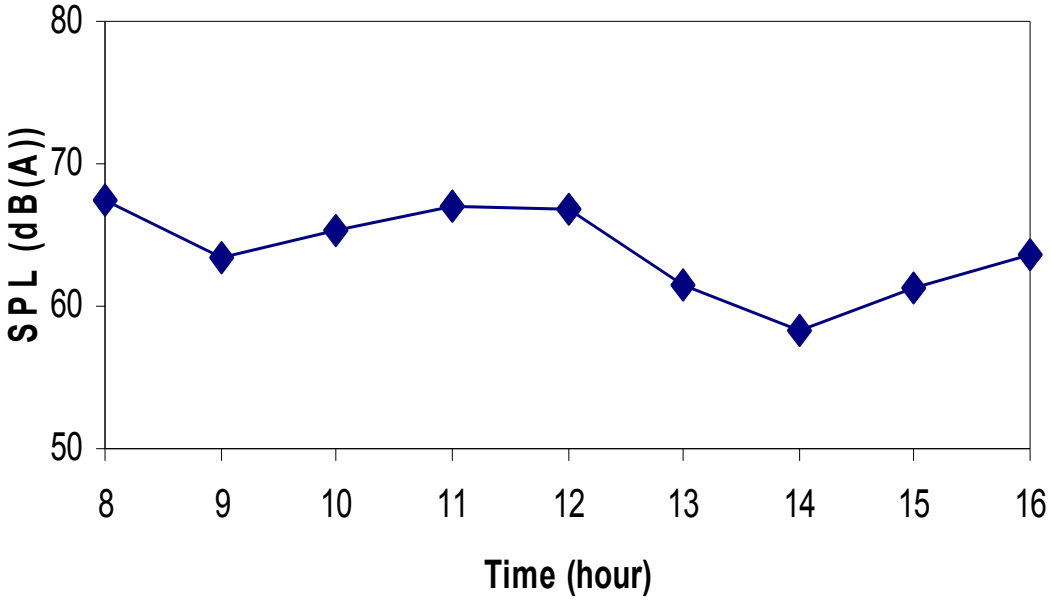
ICU



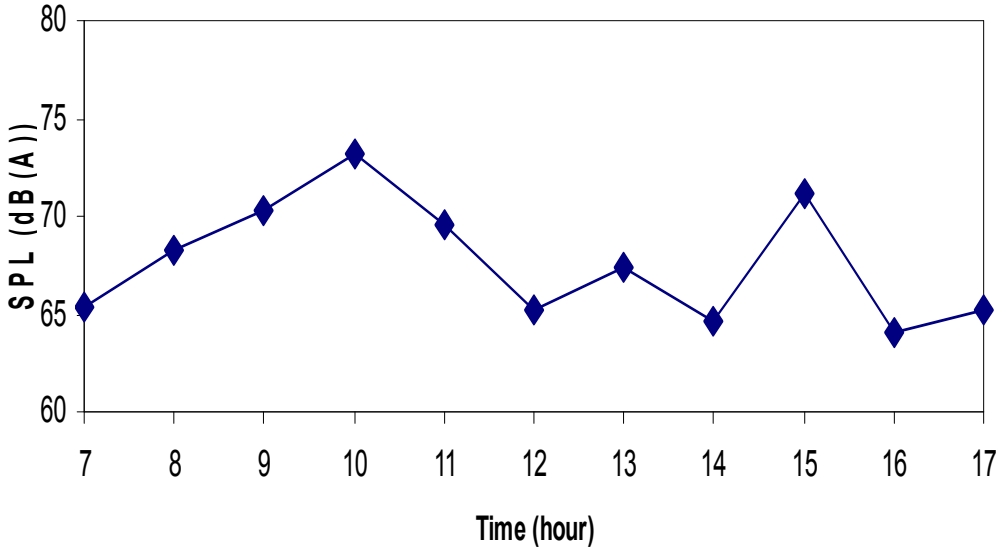
NICU



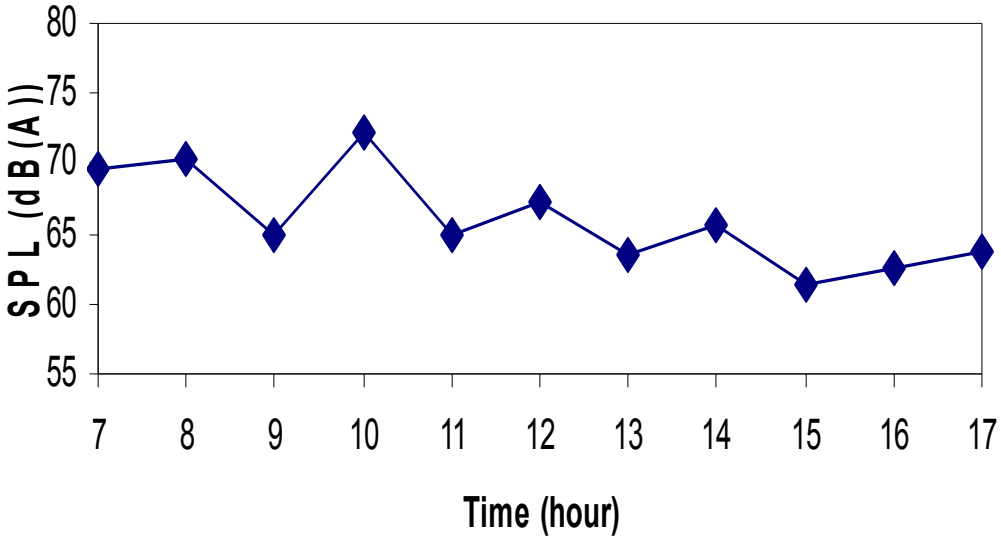
OR


80
70
60
50
SPL (dB(A))
8
9
10
11
12
13
14
15
16
Time (hour)

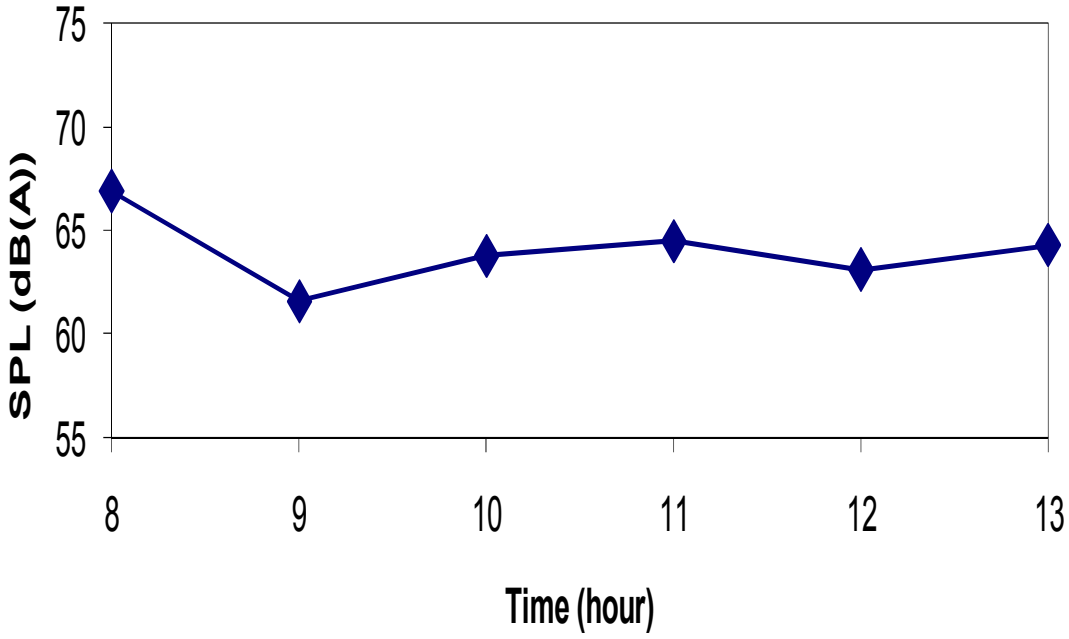
Lab.


80
75
70
65
60
SPL (dB(A))
7
8
9
10
11
12
13
14
15
16
17
Time (hour)

Emergency



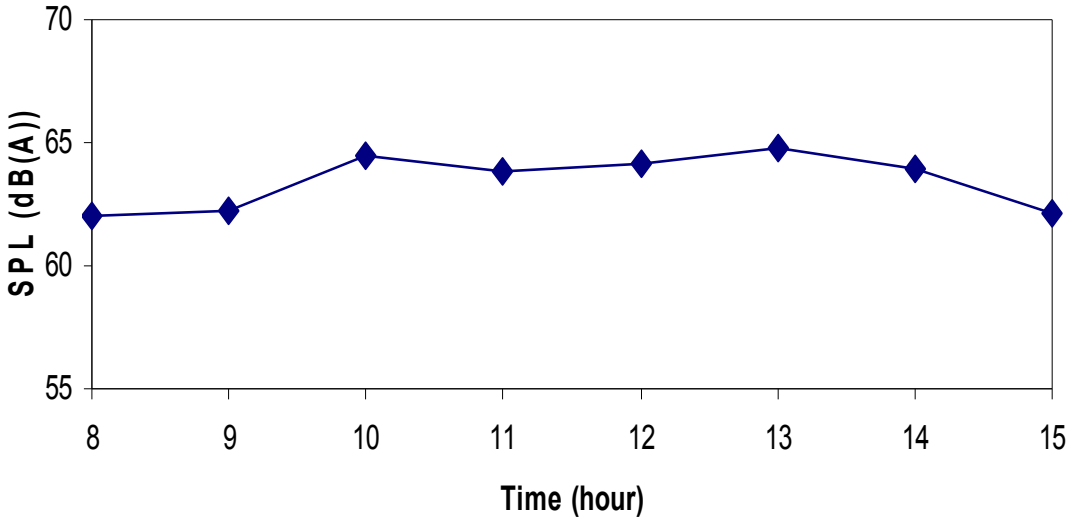
Outpatient Clinic



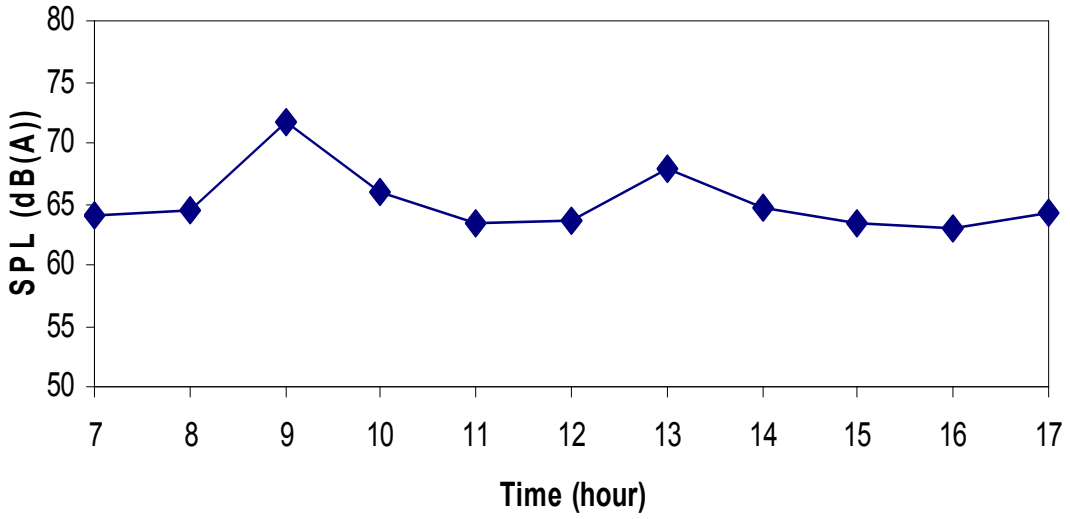
Appendix (A-3)

The following figures below shown the detailed measurements of SPL as a function of time in each department of OR, Lab, Emergency and Outpatient Clinic in Al-Amal hospital.

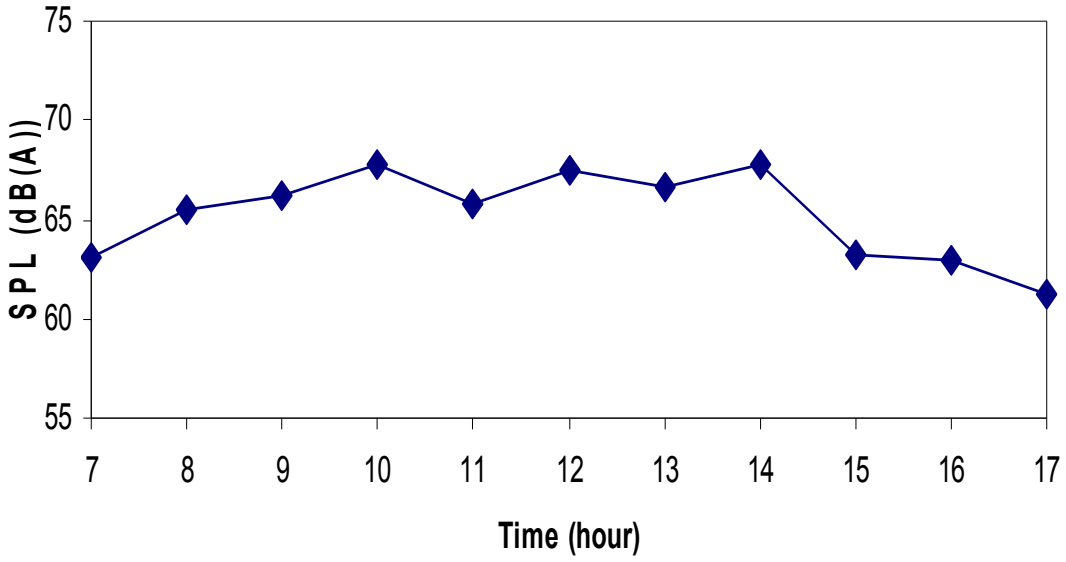
OR



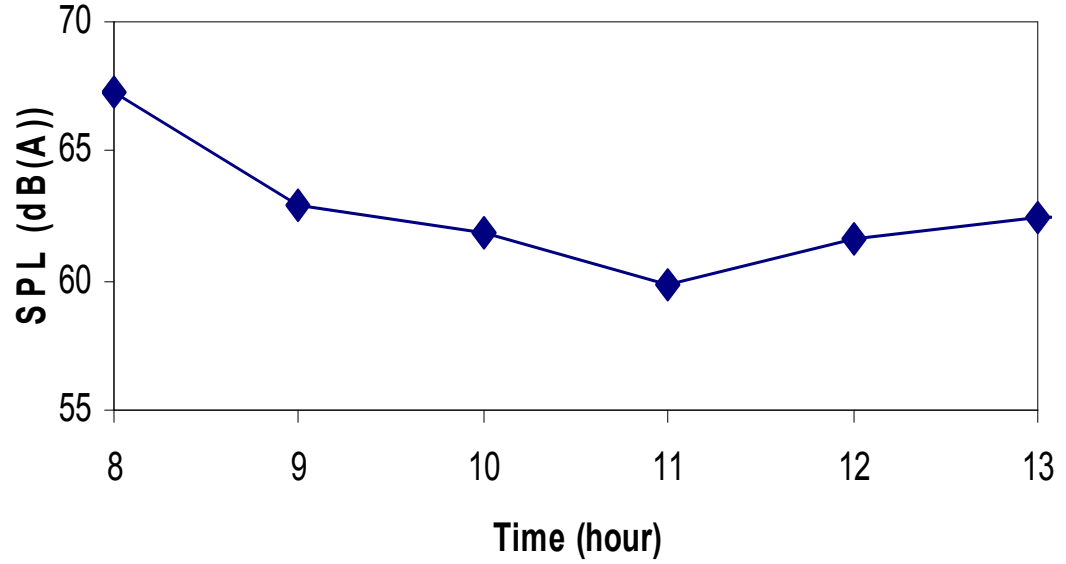
Lab.



Emergency



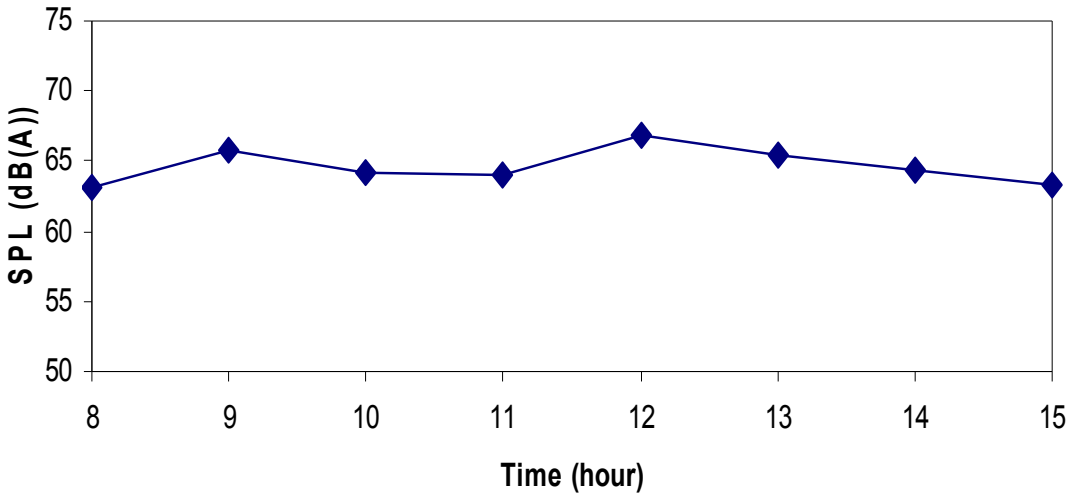
Outpatient Clinic



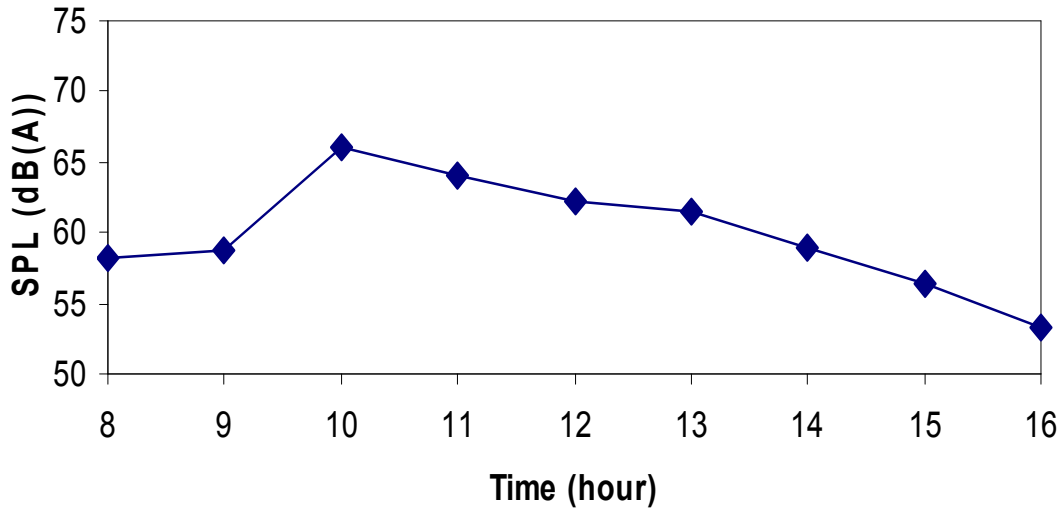
Appendix (A-4)

The following figures below shown the detailed measurements of SPL as a function of time in each department of OR and Outpatient Clinic in Al-Shifa hospital.

OR



Outpatient Clinic



Appendix (A-5)

Average (Mean), Maximum (Max.) and Minimum (Min.) values of SPL in the four studied Hospitals.

Time	Governmental Hospital SPL			Al-Razi Hospital SPL			Al-Amal Hospital SPL			Al-Shifa Hospital SPL		
	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.
7:00	69.7	67.1	64.2	69.6	59.2	49.6	64	63.6	63.1	65.8	58.8	51.8
8:00	72.2	68.1	65.2	70.4	62.1	49.7	67.3	64.8	62	63.1	60.7	58.2
9:00	72.2	66.8	56.4	70.3	60.6	51.3	71.7	65.8	62.2	65.8	62.3	58.8
10:00	71.8	67.1	58.3	73.2	62.8	50.7	67.8	65	61.8	66.1	65.1	64.1
11:00	76.8	68.8	57.3	69.6	62.5	54	65.8	63.3	59.9	64.1	64.1	64
12:00	76.2	69.5	61.8	67.2	60.8	50.3	67.5	64.2	61.6	66.9	64.6	62.3
13:00	73	67.6	60.4	67.4	59.9	49.7	67.9	65.5	62.5	65.5	63.5	61.5
14:00	74.5	66.9	62.5	65.5	59.1	50.3	67.8	64.7	62.6	64.4	61.7	58.9
15:00	81.8	67	56.6	71.2	59.9	52.7	63.5	62.9	62.1	63.3	59.9	56.4
16:00	72.5	66.3	59.5	64.1	59.4	52.9	63	63	63	53.3	53.3	53.3
17:00	66.2	63.3	58.8	65.2	59.5	54.6	64.2	62.8	61.3	62.2	60.5	58.9

جامعة النجاح الوطنية
كلية الدراسات العليا

تأثير الضوضاء على السمع وضغط الدم وتركيز الأكسجين في الدم عند العاملين في المستشفيات في مدينة جنين - فلسطين

إعداد
ربا فوزي خالد أحمد

إشراف
أ. د. عصام راشد عبد الرازق
د. زيد نعيم قمحية

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الفيزياء بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس- فلسطين.

2011م

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أ. د. عصام راشد عبد الرازق

د. زيد نعيم قمحية

الملخص

يعد التلوث الضوضائي في المستشفيات من أهم القضايا المعاصرة، إذ أنه يؤثر بشكل سلبي على درجة السمع وضغط الدم وتركيز الأكسجين في الدم عند العاملين في المستشفيات. لقد ركزت الدراسة على قياس مستويات الصوت في أربعة مستشفيات في مدينة جنين، ثم مقارنتها بالمقاييس العالمية للضجيج. والمستشفيات هي مستشفى جنين الحكومي ومستشفى الرازي ومستشفى الأمل ومستشفى الشفاء للعيون. ولقد تم أخذ القياسات في ستة أقسام هي العناية المكثفة والحضانة وغرف العمليات والمختبرات والطوارئ والعيادات الخارجية.

أوجدت الدراسة أن معدل الضجيج يتراوح بين 60.5 الى67.1 ديسبل في المستشفيات الأربعة، وأن التعرض المستمر لمستويات الضجيج هذه تسبب انخفاضا في درجة السمع، ونقصانا في تركيز الأكسجين في الدم، وارتفاعا في ضغط الدم، وتزايدا في نبضات القلب, حيث كان معامل ارتباط بيرسون قويا بين مستوى الصوت وكل من درجة السمع، وتركيز الأكسجين في الدم، وضغط الدم (الانقباضي والانبساطي)، ونبض القلب. اقترحت هذه الدراسة بعض التوصيات للعاملين في المستشفيات، وللمسؤولين وأصحاب القرار للتقليل من مشكلة التلوث الضوضائي في مستشفيات مدينة جنين.