

An-Najah National University

Faculty of Graduate Studies

**The Effect of Noise Pollution on Arterial Blood Pressure and Pulse
Rate of Workers in the Hospitals of Nablus City-Palestine**

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the Degree of Master of Physics, Faculty of Graduate Studies, An-
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Dedication

This thesis is dedicated to my father and mother, as well as,
to my husband, my daughters Tala and Lamar.

With respect and love.

Acknowledgement

A lot of appreciation to my supervisors 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.

Declaration

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

The Effect of Noise Pollution on Arterial Blood Pressure and Pulse Rate of Workers in the Hospitals of Nablus City-Palestine

أقر بأن ما اشتملت عليه هذه الرسالة، إنما هي نتاج جهدي الخاص، باستثناء ما تمت 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.

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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List of Abbreviations

AAP	The American Academy of Pediatrics
ANOVA	Analysis of Variance
Al-Ittihad Hospital	Arab Woman Union Hospital
Al-Injeeli Hospital	The Anglican St. Lukes Hospital
Al-Watani Hospital	The National Hospital
COR	Hospital corridors
dB(A)	A-Weighted Decibel
DBP	Diastolic Blood Pressure
Fig.	Figure
hr	Hour(s)
HPR	Heart Pulse Rate
Hz	Hertz
ICU	Intensive Care Unit
kHz	Kilohertz
L ₁₀	The Noise Level Exceeded at 10% of the

XII
measured time.

L_{90} The Noise Level Exceeded at 90% of the
measured time.

L_{eq} Equivalent Sound Level

L_{NP} Noise Pollution Level

NICU Neonatal Intensive Care Unit

OR Operation Rooms

OSHA Occupational Safety and Health
Administration

Pa Pascal

P_{ref} The threshold of Hearing Pressure

P-value Probability

R Pearson Correlation Coefficient

SBP Systolic Blood Pressure

Sec. Section

SPL Sound pressure level

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Abstract

This study analyzes the association of noise pollution level with systolic and diastolic blood pressure and heart pulse rate of workers in hospitals in the operating rooms (OR), neonatal intensive care units (NICU) and intensive care units (ICU). 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 arterial blood pressure (Systolic and Diastolic) and heart pulse rate were measured for 95 workers (55 males and 40 females) which is the sample of workers in hospitals in Nablus city. The ages of workers are ranged from 20 to 73 yr. The duration of employment of those workers in the current job is ranged from 1 to 47 yr. In this study 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 SBP, DBP and HPR in all selected hospitals are ranged from 0.546 to 0.906 of SBP, from 0.617 to 0.799 of DBP and from 0.658 to 0.869 of HPR. Moreover, this study showed that there are significant shifts

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in mean values of SBP, DBP and HPR before work and after 5 hours at least in all selected hospitals. Significant correlation was found between mean values of SBP, DBP and HPR with the duration of employment and age. Whereas the difference between means of SBP, DBP and HPR before and after work are 6.335 (mmHg) of SBP, 5.108 (mmHg) of DBP and 5.305 of HPR (beat\min).

Preface

The 20th century witnessed the emergence of a number of problems related to noise pollution. Compared to other types of pollution, noise pollution was in general ignored. In the Middle East in particular, this problem is considered to be much worse especially, in places such as, schools, educational institutions, hospitals, medical care centers, center of cities and in main streets.

Due to their vital services as they are considered places for healing people, hospitals probably represent one of the most important environments which need full attention when it comes to noise pollution. This is why several developed countries have taken serious considerations of the noise pollution issue in an attempt to reduce the negative impact of noise pollution, not only in hospitals, but in all aspects of daily life.

In our country, there is a serious lack of data on noise pollution in hospitals and its association with auditory and non auditory effects. Therefore, the selection of noise pollution as a topic of research gains great importance because it helps to gain some control on noise pollution in general, and to reduce this phenomenon in hospitals in particular. In addition, the measurements of this research contribute to and further enrich the already established database concerning Palestinian environmental issues.

Chapter One

Introduction

People in general live and communicate in a world of sound. It is well known that excess noise in working places can affect communication and alter human attitude. As a special case, hospitals -the environment in which doctors and nurses work- require special attention to ensure the safety of patients.

1.1 Previous Studies

In recent years, considerable attention has been focused on noise levels generated in the different sectors of hospitals such as operation rooms (OR), neonatal intensive care units (NICU), intensive care units (ICU) and emergency department (ED) (Hui X. *et al.* 2009 and Busch-Vishniac I. *et al.* 2005). For example, the emergency department (ED) in Los Angeles was found to have excessive noise on a regular basis (Tijunelis M. *et al.* 2005). Moreover, studies in operation rooms of hospitals have reported high noise levels (Dascalaki E. *et al.* 2009 and Eugene L. *et al.* 2000). Furthermore, excessive noise has been proved to be harmful to mental efficiency and short-term memory (Murthy V. 1995). Also long-term noise exposure was found to alter the strength and the efficiency of speech-sound system in human body (Brattico E. *et al.* 2005).

Investigations throughout the world have shown that the level of noise in the intensive care units (ICU) exceeds the acceptable

standards (Gabor J. *et al.* 2003). Some studies have found that staff conversation in particular is a major source of loud noises in hospital sectors (Allaouchiche B. *et al.* 2002). In addition, Douglas K. *et al.* (1998) identified 12 individual causes of noise in ICU that contribute to the high peak sound levels. According to his study the mean peak sound levels for those noises ranged from 74.8 to 84.6 dB(A), where television and talking noise were the most prominent. In (ICU) in India hospitals, Vinodhkumaradithyaa A. *et al.* (2008) have measured the mean equivalent sound pressure levels (L_{eq}) during the morning and evening hours to be 70.4 and 64.5 dB(A), respectively. A number of studies have found that the environment in the intensive care units (ICU) has negative effects on patients and staff including sleep disturbance and annoyance (Hagerman I. *et al.* 2005 and Freedman N. *et al.* 2001).

The American Academy of Pediatrics (AAP) suggests that sound pressure levels (SPL) inside incubators in neonatal intensive care units (NICU) should not exceed 45.0 dB(A) (American Academy of Pediatrics 1997). Failure to maintain noise level under the recommended levels may result in many adverse health effects such as hearing loss (Tomoyuki K. 2004 and Dimitris A. 1982) and hypoxemia [Lack of oxygen in blood] (Long J. G. *et al.* 1980) on the staff and on the new born babies. Moreover, loud noise in neonatal intensive care unit (NICU) has several impacts on infants such as brain and nervous effects (Perlman J. 2001), sleep disorders

(Muzet A. 2007) and the growth and the development of premature infants (The American Academy of Pediatrics 1997). In addition, loud noise causes stress, annoyance (Rylander R. 2004), and fluctuation of blood pressure (Iyawe V. I., 2000).

The sound noise level and therefore, their health effects can be reduced by considering some precautions. For example in neonatal intensive care units (NICU), and by using sound absorbing panel (SAP), the sound pressure level (SPL) inside the NICU incubator was decreased from 56.0 to 47.0 dB(A), the SPL of the temperature alarm was decreased from 82.0 to 72.0 dB(A), the SPL of monitor alarm was decreased from 64.0 to 56.0 dB(A), and the SPL of baby crying was decreased from 79.0 to 69.0 dB(A) (Altuncu E. *et al.* 2009). In order to minimize noise, Smykowski L. *et al.* (2008) designed new patient care units (PACU) at Memorial Sloan Kettering Cancer Center in New York City based on creating rooms with four patient beds, each separated by hard isolating walls.

In Palestine, some studies were conducted on noise pollution. For example, strong positive correlation between occupational noise pollution levels and heart pulse rate, systolic blood pressure, diastolic blood pressure and hearing threshold levels at several frequencies were found (Abdel-Raziq I. *et al.* 2003 and Hanini N. *et al.* 2002). In addition, Abdel-Ali M. *et al.* (2003) studied noise pollution in factories in Nablus city. The average value of (L_{eq}) in 38 factories was 85.5 dB(A), and the L_{eq} values for 40% of the

selected factories were higher than the adopted international standards (OSHA, 1981). Also, the problem of noise has been studied in Arraba region by Qamhieh Z. N. *et al.* (2000). The equivalent noise level values (L_{eq}) for 60% of 20 locations spread over the area of the town were measured to be 65.0 dB(A) or higher. Hence, Arraba town is considered as an unacceptable living area.

Finally, in a household environmental survey on exposure to noise in Palestine, it was indicated that 14.3% in West Bank and 18.5% in Gaza strip were sometimes exposed to noise, whereas 16.9% of households in Palestine were very often exposed to noise. The survey also showed that road traffic and the construction work were the most important sources of noise (Palestinian central Bureau of statistics 1998). However, no work was ever done concerning noise in local hospitals in Palestine. Therefore, this study has been done to focus on noise pollution problems in the hospitals of Nablus city.

1.2 Objectives of This Study

When visiting some hospitals in Nablus city, one can easily tell that there are three major factors which contribute to raising the noise pollution of the environment of the patients, workers and visitors.

The three factors can be summarized as:

1. The internal noise sources due to telephones, air conditions, ventilators, alarms, televisions, intercoms, beepers, doors, food carts and unnecessary conversation.

2. The fact that the surfaces in hospitals (walls, floors, and ceilings) tend to be sound reflecting rather than sound absorbing.

3. The external noise sources such as traffic.

The goal of this research is studying noise pollution effects on the healthcare professionals in Nablus city hospitals, which contains neonatal intensive care units (NICU), intensive care units (ICU) and in operation rooms (OR). The study consists of two major parts:-

1. Measuring the noise levels generated by sources of noise like people and instruments in specific locations in the hospitals in Nablus city. The measurements were conducted in the following sectors at the sample hospitals:-

- In operation rooms (OR)
- In neonatal intensive care units (NICU)
- In intensive care units (ICU)
- In hospital corridors (COR).

1. Assessing some of the physiological effects of noise on staff members in the selected locations of the hospitals. Two major tests were done:-

- Systolic and diastolic blood pressure.
- Heart pulse rate.

Chapter Two

Theory of Noise

Sound is defined as being caused by vibrations in the air or other medium which stimulate a sensation of hearing when they reach the ears. The sound is called noise when it becomes loud over 60dB according to OSHA regulation (OSHA, 1981). The basic quantity of the measured parameter used for community noise measurements is sound pressure level (SPL). As human ear responds to sound pressure, most acoustical instruments are calibrated to measure the sound pressure level (SPL). This chapter includes two sections. Section one clarifies the definition of sound pressure level and section two discusses the audible range of human beings.

2.1 Sound Pressure Level (SPL)

Sound pressure is a measure of air vibrations that makes up sound, when it falls on human ear. Some parameters can be measured to describe whether this sound is considered as noise or not. The equivalent continuous sound pressure level (SPL), or sometimes called (L_{eq}) is the most common quantity used to measure the sound level. Practically this parameter is being measured directly by sound level meters. The equivalent continuous sound pressure level (L_{eq}) can be calculated using the formula (Stumpf F. B.1980).

$$L_{eq} = L_{NP} - (L_{10} - L_{90})$$

Where L_{NP} is the noise pollution level,

L_{10} represents the noise level exceeded at 10% of the measured time.

L_{90} represents the noise level exceeded at 90% of the measured time.

Sound pressure level is typically measured in units called decibels (dB), which is one-tenth of the bel, named after Alexander Graham Bell. Because of the very wide range of sound pressure levels encountered in our acoustic environment, it is more convenient to describe sound pressure levels through a logarithmic scale. The use of a logarithmic scale compresses the range of numbers required to describe the vast range of sound pressure levels. A second reason is that humans judge the relative loudness of two sounds by the ratio of their intensities.

Sound pressure level can be given as the following (Stumpf, 1980):

$$\text{SPL (dB)} = 20 \log \frac{p}{p_{\text{ref}}}$$

Where SPL is the Sound pressure level in dB

P is the measured sound pressure

P_{ref} is the threshold of hearing pressure for human beings which is about 2×10^{-5} Pascal (Pa)

2.2 The Audible Range for Human Beings

Our hearing systems are not equally sensitive to all sound frequencies. Thus, the audible frequency range is from 20(Hz) to 20(kHz). However, hearing sensitivity to higher frequencies decreases with age and with the duration of exposure to noise. The audible range for human beings can be summarized in Fig. (2.1),

which shows the relation between sound pressure level in dB and the frequency in hertz, with reference pressure 2×10^{-5} Pa.

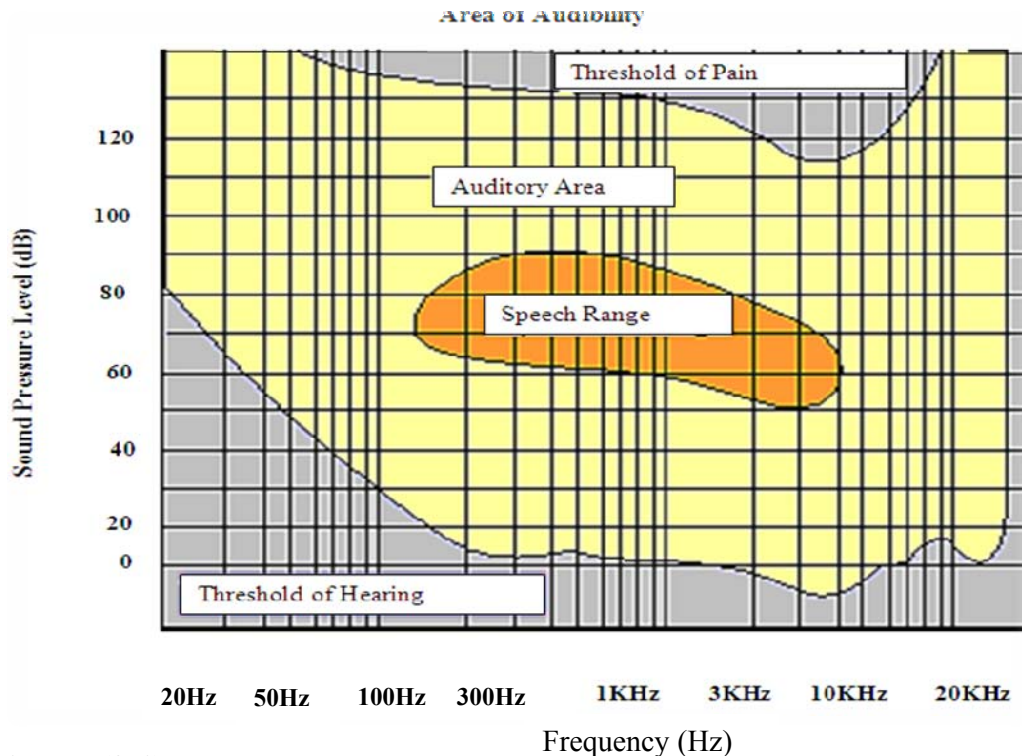


Figure (2.1): Sound pressure level in dB as a function of frequency in Hz, of the audible frequency range for human beings (Purdom P. W., 1980)

The threshold of hearing is defined as the sound pressure level of the weakest sound at which human ear can detect. As the response of the ear is very dependent on the frequency content of the sound, the threshold of hearing is different for sounds of different frequencies. The value of the threshold of hearing and the threshold of pain depend on the frequency. The lowest curve on the chart gives the threshold of hearing at various frequencies. The threshold of pain is defined as the sound pressure level of the sound at which the ear starts to feel pain. As the response of the ear is very dependent on the frequency content of the sound, the threshold of

pain is different for sounds of different frequencies. The uppermost curve on the chart (Fig.2.1) gives the threshold of pain at various frequencies.

Human beings are much more sensitive to sounds in the frequency range about 1 kHz to 4 kHz (speech range) than to very low or high frequency sounds. For this reason, sound meters are usually fitted with a filter whose response to frequency is a bit like that of the human ear. There is A, B, C and Z filters. If the "A weighting filter" is used in the measurement system, the sound pressure level is given in units of dB(A) instead of dB. The range of frequency in B, C and Z filters is less than the frequency range in A filter. Sound pressure level on the dB(A) scale is easy to measure and is therefore widely used (Purdom P. W., 1980). In the current study, all measured noise levels are reported in dB(A) or A-weighted decibels. Common sound pressure level in dB(A) for some sources of sound are shown in Fig. (2.2).

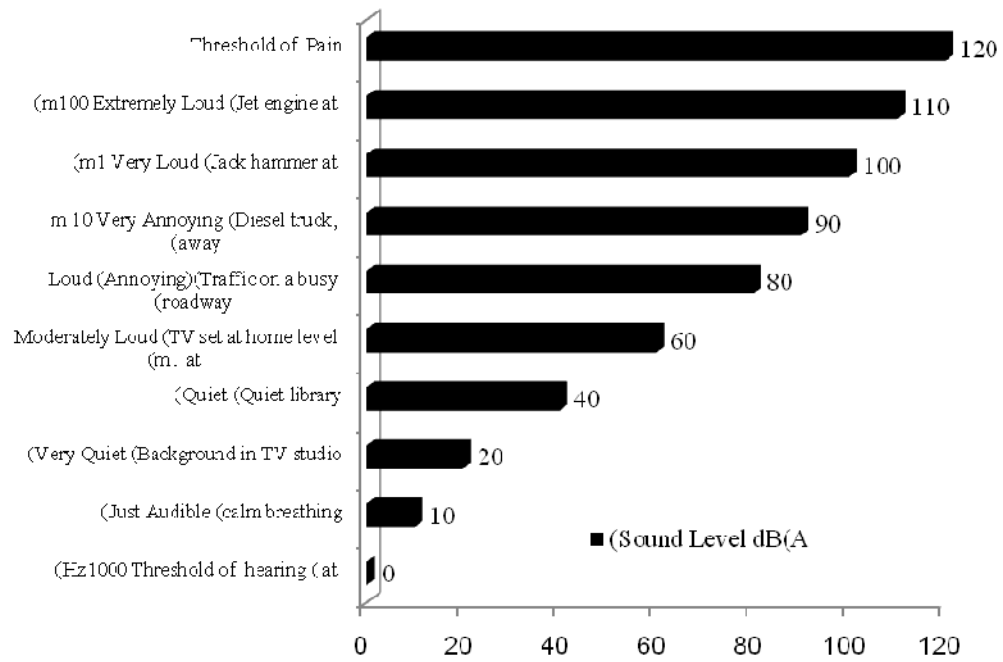


Figure (2.2): The acceptable range of sound pressure level for some sources of sound (The reference pressure is 2×10^{-5} Pascal).

Chapter Three

Methodology

This work focuses on measuring the sound levels in the hospitals of Nablus city and on studying the effects of noise on human health inside those hospitals. Nablus city was chosen because it is a commercial and industrial city. For that, several sample hospitals were chosen as study fields in Nablus city. This chapter is composed of three sections. Section 1 contains a description of all study samples and the strategy of all experimental measurements. Section 2 shows the instruments used in this research. Finally, section 3 indicates the programs used for statistical analysis.

3.1 Study Population

For the purposes of this study noise level measurements were carried out in five public and private hospitals in Nablus city. The hospitals are: Al-Watani Hospital (public), Rafidya Hospital (public), Nablus Speciality Hospital (private), AL-Injeeli Hospital (private), and Al-Ittihad Hospital (private). All hospitals have three departments, Neonatal Intensive Care Units (NICU), Intensive Care Units (ICU) and the Operation Rooms (OR) except Al-Watani Hospital which doesn't have operation rooms.

The noise level measurements were carried out for two days in each ward throughout February (winter) and July (summer) of 2009. The readings of sound pressure levels were taken during the day from

7:00 o'clock to 18:00 o'clock. The measurements were done in different departments of each hospital including the neonatal intensive care units (NICU), the intensive care units (ICU), the operation rooms (OR) and hospital corridors (COR). The readings of SPL in all sample hospitals were taken during two days, in Feb. 2009 and in Jul.2009. One reading of sound pressure levels was taken every 10 minutes using sound level meter with A-weighting. These measurements were taken inside the hospitals (indoors) for the mentioned period, during which, the sound level meter was placed at a specific fixed place (front of the department).

The measurements of sound pressure levels were analyzed statistically using the SPSS and Microsoft excel program. Different types of analysis were conducted, which involved comparison of sound pressure levels between different wards in the same hospital then between similar wards in different hospitals.

The Systolic and diastolic blood pressure and pulse rate were taken for workers male and female aged from 20-75 years with a minimum of 3 month employment duration in all wards in the five hospitals. Each of the selected workers in the hospitals works at least for 8 hours, and all tested workers had no history of heart diseases.

The systolic and diastolic blood pressures and heart pulse rate were measured for each selected doctor and nurse twice a day, the

readings were taken before work and after at least five hours from the beginning of work.

3.2 Instrumentations

A. Sound Level Meter: The sound level meter (SLM) is the basic measuring instrument for noise exposures. The noise levels were measured using the Quest Technologies, U.S.A, model 2900, type 2, integrating and logging sound level meter, in (dB) units with an accuracy of ± 0.5 dB(A) and its precision is 0.1 dB(A) (Instruction for Sound Level Meter, 1998).



Figure (3.1): The Sound Level Meter

B. Blood Pressure Monitor:

Arterial blood pressure (systolic and diastolic) and pulse rate were measured using Automatic Blood Pressure Monitor (microlife AG, Mod no. BP 2BHO, size: (162 X 106 X 61.5 mm), Measuring range: (30 – 280 mmHg) with accuracy of ± 3 mmHg and 5% of the heart pulse rate reading (Instruction for the Automatic Blood Pressure Monitor, 2009).



Figure (3.2): Automatic Blood Pressure Monitor

3.3 Statistical Analysis

The obtained results were tabulated and statistically analyzed. The statistical package SPSS was used for statistical analysis. The minimum, the maximum and the mean of each studied variable were expressed. Average values were expressed as means. Analysis of variance (ANOVA) test (one way ANOVA and T-test) was used to determine significant differences between occupational noise pollution levels and heart pulse rate, systolic and diastolic blood pressure.

Pearson correlation factor (R) and the P-value were used as a measure of the strength of the correlation between occupational noise pollution levels and the dependent variables (William L. Carlson, 2007). Results of sound pressure levels were tabulated against time using Microsoft Excel.

Chapter Four

Measurements and Results

In the following sections, the results of all measurements which were carried out in the sample hospitals in Nablus city are presented. The collected and the measured data in all hospitals include the following:

- 1.** Measurements of sound pressure levels (SPL)
- 2.** Measurements of systolic (SBP) and diastolic (DBP) blood pressure.
- 3.** Measurements of heart pulse rate(HPR)

The arterial blood pressure (Systolic and Diastolic) and heart pulse rate were measured for 95 workers (55 males and 40 females) twice a day, the readings were taken just before work and after at least 5 hours from the beginning of the work. The ages of workers ranged from 20 to 73 year. The duration of employment of those workers in the current job ranged from 1 to 47 year. The number of workers as a function of the ages and the duration of employment in the current job of the selected workers in all hospitals is shown in Fig. (4.1. a&b) in which the number of workers is taken in a collective manner every 5 years.

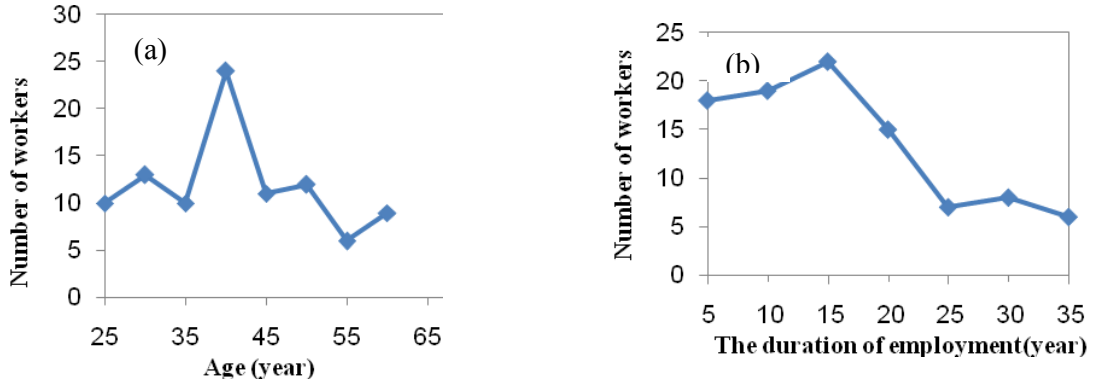


Figure (4. 1): Relationship between the numbers of the selected workers in all selected hospitals as a function of (a) ages and (b) the duration of employment in the current job.

The percentages of workers belonging to each hospital relative to the total test sample are shown in Fig. (4. 2. a). In addition, the percentage of all studied workers in all studied departments (NICU, ICU and OR are shown in Fig.(4.2.b).

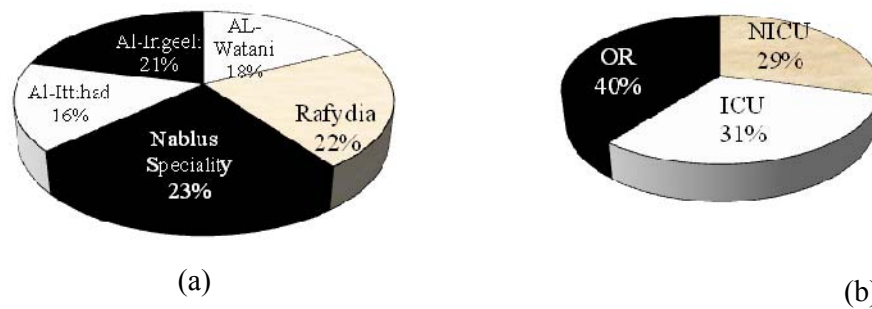


Figure (4.2): (a) Percentage of all studied workers in all hospitals. (b) Percentage of all studied workers in all studied departments (NICU, ICU and OR).

Moreover, the test sample can be classified according to their job as two groups. Doctors of about 33% of the sample and nurses of about 67% (Fig. 4.3.a). However, according to gender the test sample was composed of about 43% females and about 57% males (Fig. 4.3.b).

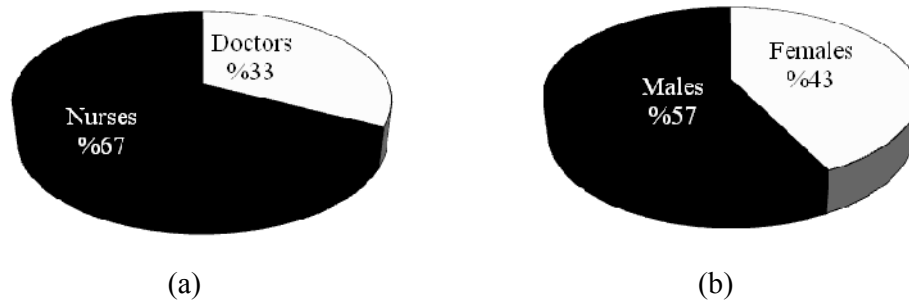


Figure (4.3): Percentage of selected workers in all hospitals are shown as a comparison according to their (a) Job (doctors and nurses) (b) Gender.

Average, maximum and minimum values of sound Pressure levels each hour in NICU, ICU and OR departments in all studied hospitals during the selected two days (one day in Feb. and the other day in Jul. 2009) are presented in tables (4.1, 4.2 and 4.3).

Table 4.1: Average (Mean), Maximum (Max.) and Minimum (Min.) values of SPL in NICU in all studied Hospitals.

Time	SPL in dB(A)	Rafidya		Al-Watani		Nablus Speciality		Al-Ittihad		Al-Ingeeli	
		Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.
8:00	Mean	76.0	75.4	55.1	53.2	59.0	55.8	59.6	61.1	61.3	48.6
	Max.	83.2	82.8	60.2	59.8	63.4	60.3	63.1	63.1	65.5	52.6
	Min.	67.2	69.3	48.1	48.8	55.7	47.9	55.4	58.8	57.7	43.4
9:00	Mean	77.5	80.9	58.5	65.3	61.9	60.2	69.7	64.4	61.5	55.9
	Max.	89.8	85.7	67.1	91.6	76.2	64.9	77.2	73.8	74.6	65.5
	Min.	63.9	76.3	49.7	51.9	46.8	56.4	64.9	59.8	51.6	44.1
10:00	Mean	88.8	92.4	77.3	77.5	76.8	74.0	72.7	73.5	72.2	72.9
	Max.	98.6	98.9	87.3	89.3	87.3	81.2	79.4	89.3	80.1	80.1
	Min.	73.9	84.4	69.7	67.8	57.6	65.7	69.3	65.4	57.9	60.7
11:00	Mean	85.3	86.3	68.7	64.1	75.6	70.5	70.9	72.2	63.9	63.0
	Max.	91.4	94.5	89.2	77.9	81.8	85.4	78.9	82.9	75.2	78.8
	Min.	79.7	79.7	47.8	49.3	68.9	61.7	64.3	64.1	58.9	51.6
12:00	Mean	92.2	94.9	70.3	74.0	62.5	67.4	71.7	72.2	61.2	61.3
	Max.	97.3	98.7	79.3	82.9	75.1	77.1	79.3	79.4	64.7	65.8
	Min.	89.1	88.4	64.4	69.3	55.6	55.7	64.3	66.8	57.6	57.9
13:00	Mean	88.3	84.6	67.9	67.3	62.3	67.5	68.5	71.6	62.2	61.0
	Max.	92.3	91.3	73.8	83.7	71.3	77.6	76.1	75.8	68.6	68.5
	Min.	85.6	78.4	57.3	50.8	56.8	57.9	63.5	68.9	55.8	51.7
14:00	Mean	84.7	85.6	67.2	74.5	72.1	66.9	65.7	68.9	59.2	55.9
	Max.	92.7	91.8	78.3	81.4	88.1	70.6	72.7	72.5	69.1	67.1
	Min.	80.9	78.4	53.3	65.9	61.9	59.6	59.2	63.7	51.3	52.7
15:00	Mean	77.9	73.0	66.6	73.5	58.1	65.3	59.1	61.5	58.9	57.2
	Max.	87.2	77.3	79.0	81.9	63.8	73.8	69.3	71.3	64.3	61.3
	Min.	71.9	67.9	51.6	68.6	52.3	52.8	48.2	49.3	54.3	52.3
16:00	Mean	77.4	87.0	75.4	68.5	59.0	63.5	53.8	56.5	57.8	53.6
	Max.	87.6	93.8	81.8	83.7	70.8	75.4	57.3	59.7	68.2	63.7
	Min.	69.8	75.8	66.9	50.7	51.3	52.8	46.7	51.6	48.3	43.7
17:00	Mean	75.5	84.0	55.5	58.1	58.2	53.3	54.2	55.8	57.4	52.2
	Max.	86.2	95.4	65.9	63.8	62.1	58.7	59.3	62.3	61.7	57.8
	Min.	68.9	76.7	47.1	48.9	55.2	49.1	48.2	51.2	52.8	45.8

Table 4.2: Average (Mean), Maximum (Max.) and Minimum (Min.) values of SPL in ICU in all studied Hospitals.

Time	SPL in dB(A)	Rafidya		Al-Watani		Nablus Speciality		Al-Ittihad		Al-Ingeeli	
		Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.
8:00	Mean	58.6	79.9	64	65.1	57.2	54.8	57.8	65.5	60	67.5
	Max.	71.6	83.1	71.6	73.2	64.9	58.4	64.7	69.3	66.2	73.6
	Min.	49.3	76.2	53.8	56.4	52.2	51.6	52.8	61.1	55.3	59.2
9:00	Mean	61.3	80.1	68.3	63.7	57.6	62.3	66.2	67.6	63.2	59.7
	Max.	82.3	89.4	73.8	71.6	61.7	66.7	73.4	71.8	70.9	64.4
	Min.	50.1	64.8	57.1	54.8	51.6	54.5	52.9	56.8	55.1	56.1
10:00	Mean	71.4	78.7	73.2	73.5	55.5	61.8	58.6	63.8	59.1	65
	Max.	77.8	83.5	77.1	76.7	59.8	67.8	66.8	67.4	67.1	76.8
	Min.	60.8	67.8	69.8	69.8	51.7	52.6	52.8	59.8	53.4	51.6
11:00	Mean	76.2	83.4	74.7	75.7	58.9	58.1	61.1	63.9	67.6	63.8
	Max.	84.9	94.9	84.8	81.4	64.4	61.7	69.2	73.4	79.2	71.3
	Min.	60.8	72.5	69.7	70.8	51.9	53.9	53.2	55.9	53.9	52.9
12:00	Mean	75.9	85.8	79.5	74.2	65.4	63.4	59.8	71.1	62.8	64.2
	Max.	86.6	89.9	89.4	81.6	73.3	71.6	71.8	79.9	75.1	74.2
	Min.	64.8	83.8	69.8	68.1	59.1	58.4	52.1	64.6	55.2	53.8
13:00	Mean	79.9	88.1	79.8	85.6	59	64.8	56	63.8	67.9	66.7
	Max.	91.6	92.7	87.3	89.8	69.9	75.4	59.7	71.6	73.2	78.3
	Min.	68.1	83.4	71.3	80.2	51.7	54.9	51.4	51.3	55.3	53.7
14:00	Mean	80.9	79.3	73.1	78.6	63.1	58.3	59.3	66.1	61.6	62.8
	Max.	94.2	95.7	86.3	93.7	72.3	65.8	65.3	75.7	68.1	70.3
	Min.	61.3	62.2	59.9	55.9	51.8	51.9	51.6	58.7	53.8	56.2
15:00	Mean	72.0	69.6	65.3	58.1	53.6	61.5	72.1	66.7	62.2	64.7
	Max.	77.4	79.4	71.3	63.1	59.3	69.3	79.8	71.2	64.7	68.3
	Min.	66.9	54.8	60.8	53.8	50.8	52.1	67.7	63.8	59.1	61.5
16:00	Mean	66.2	80.9	68.3	63.1	61.2	58.3	64.8	64.7	61.7	60.2
	Max.	75.8	91.4	75.2	73.3	69.3	70.3	70.9	69.8	63.8	64.1
	Min.	58.6	58.2	61.5	54.1	50.9	51.9	60.9	53.5	59.2	58.8
17:00	Mean	75.6	76.4	70.4	74.9	59.3	58.8	65.1	65.8	64.3	64.1
	Max.	79.2	87.3	77.4	79.3	68.2	68.7	69.8	73.8	69.8	69.2
	Min.	71.9	59.2	58.2	68.9	52.9	51.6	59.8	54.8	55.4	51.8

Table 4.3: Average (Mean), Maximum (Max.) and Minimum (Min.) values of SPL in OR in all studied Hospitals.

Time	SPL in dB(A)	Rafidya		Nablus Speciality		Al-Ittihad		Al-Ingeeli	
		Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.
8:00	Mean	80.3	76.3	73.5	70.1	67.8	65.5	72.6	73.0
	Max.	83.2	84.5	77.4	73.8	78.7	69.8	78.3	80.3
	Min.	76.8	63.4	66.8	65.5	55.9	61.1	60.1	67.4
9:00	Mean	84.2	72.3	69.8	66.8	68.8	71.2	71.0	61.4
	Max.	95.8	81.5	75.4	71.2	77.2	79.8	78.6	68.2
	Min.	69.7	62.8	65.3	60.7	57.1	60.6	59.8	56.1
10:00	Mean	80.6	65.5	81.2	81.9	63.2	71.7	77.6	68.0
	Max.	87.4	73.1	84.8	89.3	65.3	77.6	85.3	73.3
	Min.	71.3	53.8	75.9	72.6	58.4	65.4	70.7	60.8
11:00	Mean	74.7	77.0	88.0	81.9	56.5	65.1	82.2	67.3
	Max.	96.9	84.2	97.6	91.4	63.8	73.5	92.4	76.7
	Min.	58.8	62.7	78.6	74.6	50.8	57.1	71.1	62.1
12:00	Mean	66.9	79.6	79.6	83.1	59.3	59.5	79.4	60.9
	Max.	73.4	85.6	87.1	93.9	67.8	67.1	83.2	67.7
	Min.	61.3	70.8	73.9	75.9	50.6	52.6	74.4	56.2
13:00	Mean	72.0	71.6	82.5	79.4	57.6	65.8	73.4	58.5
	Max.	82.7	78.9	95.2	85.9	62.3	72.7	86.3	71.9
	Min.	60.1	61.7	74.8	74.8	51.6	60.9	67.6	49.2
14:00	Mean	69.2	70.3	82.4	77.0	66.8	61.4	78.5	65.5
	Max.	77.1	71.9	97.3	87.3	73.8	69.8	94.1	72.8
	Min.	55.1	66.2	61.7	61.7	56.3	52.1	63.9	55.2
15:00	Mean	60.4	72.7	66.9	65.4	59.2	54.5	68.8	68.3
	Max.	67.4	75.8	77.9	73.3	68.2	62.1	73.2	75.1
	Min.	55.5	68.6	58.3	61.2	51.7	49.9	64.4	61.7
16:00	Mean	71.2	72.9	78.3	66.3	65.9	61.2	65.3	62.4
	Max.	76.3	80.2	85.4	69.1	76.3	70.3	77.8	70.3
	Min.	63.3	68.7	72.2	63.5	50.3	56.1	57.5	53.8
17:00	Mean	71.5	84.7	76.8	67.2	62.1	55.4	67.1	61.2
	Max.	79.4	96.4	82.5	72.5	73.8	65.7	78.4	63.8
	Min.	65.7	74.1	70.5	60.4	53.3	49.5	53.9	59.2

All the measured data of sound pressure level, blood pressure and heart pulse rate are shown and discussed in the following sections.

4.1 Measurements in Al-Watani Hospital

The measurements in Al-Watani Hospital were taken in three departments, the neonatal intensive care unit (NICU), intensive care units (ICU) and the hospital corridors (COR).

4.1.1 Sound Pressure Level Results in Al-Watani Hospital

Al-Watani Hospital is located within a commercial zone of Nablus city. During one shift, the number of workers in NICU is at least 5 workers and 4 workers in the ICU. The building of this hospital is quite old of about 120 year. The nurse station in the NICU is in the center of this department and it is isolated by glass walls. This public hospital is a very busy one, in which 4 beds exist in the ICU department with 4 patients in critical conditions. Sometimes, some patients are forced to leave because there is a new patient in more dangerous condition. Also, in NICU there are more than 12 incubators in addition to several monitors and alarms connected at least to 10 babies. The mean values of SPL as a function of time in Al-Watani Hospital departments (NICU, ICU and COR) during one day in Feb. 2009 and another day in Jul. 2009 are shown in Fig. (4.4), from which the following points can be concluded:

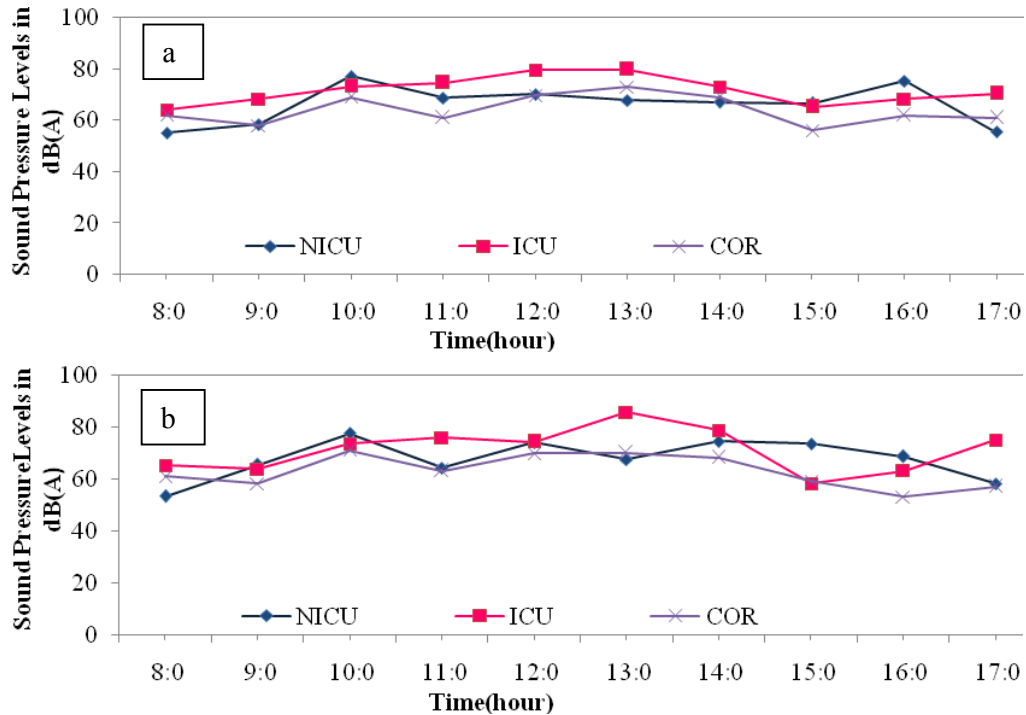


Figure (4. 4): Values of SPL as a function of time in Al-Watani Hospital during one day in (a) Feb. 2009. (b) Jul. 2009. (Note: OR department does not exist in this hospital).

- Values of SPL in a certain department in the two days of the same hospital (Fig.4.4 a&b) are nearly the same. However, there are some exceptions appearing in the ICU department, which is very logical due to unpredictable emergency cases.
- The values of SPL in Al-Watani Hospital ranged from 64.5 to 78.1dB(A) in NICU with mean of 71.7dB(A), from 61.7 to 82.7dB(A) in ICU with mean of 71.6dB(A), and from 57.5 to 71.5dB(A) in COR with mean of 63.7dB(A).
- The noise in Al-Watani Hospital COR is high because this hospital is located in the commercial center of Nablus city which is too close to the heavy traffic.

- Knowing that the acceptable SPL value in hospitals in daytime which is about 45.0 dB(A) and in nighttime is about 35.0dB(A) (American Academy of Pediatrics 1997), one can easily conclude that the values of SPL in Al-Watani hospital departments are high, therefore, those departments are noisy polluted.
- The SPL values in the NICU department show a peak at 10 o'clock (Fig.4.4) which can be explained by the fact that doctors at this time are visiting patients and discussing the situation of the babies with their relatives.
- There is no noticeable big difference between the results of SPL value in February (winter) and in July (summer) in Al-Watani Hospital as shown in Fig. (4.5).

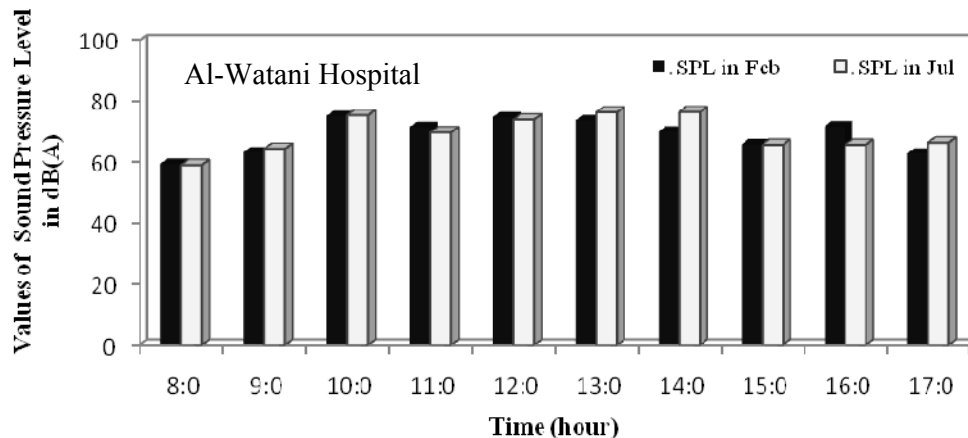


Figure (4.5): Values of sound pressure levels in all departments of Al-Watani Hospital as a function of time during the selected two days in Feb. and Jul. 2009.

4.1.2 Blood Pressure and Heart Pulse Rate Results in Al- Watani Hospital

The systolic and diastolic arterial blood pressure (SBP & DBP) and heart pulse rate (HPR) were measured for 17 workers in Al-Watani Hospital, eight of them (4 males and 4 females) work in NICU

department and nine (7 males and 2 females) in ICU department. The following data were measured and collected for the sample workers in Al-Watani Hospital and is summarized in table (4.4):

- Gender and ages of the workers.
- The department in which they work.
- Years of employment in the last job for all sample workers.
- The SBP, DBP and HPR measurements for each sample workers.
- History of hypertension disease in their fathers and mothers.
- Finally, the workers' health condition and whether they are sick and take antihypertensive drugs or normal.

Table 4.4: Gender, work location, age, parents history of hypertension disease, systolic and diastolic blood pressure, heart pulse rate and finally, workers health of hypertension and treatment for the sample workers in Al-Watani Hospital.

Gender	department	Years of work	Age	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)		Parents History of hypertension disease	Workers Health and treatment
				Before Work	After Work	Before Work	After Work	Before Work	After Work		
F	NICU	6	27	104	108	61	68	66	68	Father	Normal
F	NICU	13	37	94	113	71	78	66	80	None	Normal
M	NICU	12	39	111	127	72	86	78	106	Mother	Normal
F	NICU	25	50	122	133	91	96	66	68	None	Sick
M	NICU	18	48	130	143	82	92	91	99	None	Normal
M	NICU	25	55	109	107	85	89	70	74	None	Normal
M	NICU	2	27	124	135	90	95	105	106	None	Normal
F	NICU	4	27	118	120	71	77	80	91	Mother	Normal
F	ICU	10	32	116	137	81	86	82	86	None	Normal
M	ICU	1	21	115	123	62	68	66	67	None	Normal
F	ICU	1	20	87	98	70	74	75	88	None	Normal
M	ICU	13	35	127	133	73	77	74	69	None	Normal
M	ICU	14	40	109	116	69	74	93	97	None	Normal
M	ICU	6	26	134	135	78	82	86	87	None	Normal
M	ICU	20	55	108	119	81	88	84	89	None	Normal
M	ICU	12	37	110	112	64	77	81	86	None	Normal
M	ICU	39	70	134	145	82	98	80	88	None	Sick

The following can be noticed from table 4.4:

- The duration of employment in the current job for the sample workers in Al-Watani hospital ranged from 1 to 39 year.
- The ages of workers ranged from 20 to 70 year.
- 18% of the sample workers parents are taking antihypertensive drugs.
- 12% of the sample workers are taking antihypertensive drugs, although their parents didn't take antihypertensive drugs
- The SBP, DBP and HPR were measured for each selected doctor and nurse twice a day. The readings were taken just before work and 5 hours after the beginning of the work.
- The maximum, the minimum and the average values for SBP, DBP and HPR for males and females are presented in table (4.5).

Table 4.5: Average, maximum and minimum values of SBP, DBP and HPR before and after work for the sample males and females in Al-Watani Hospital.

Gender	variables	SBP(mmHg)		DBP(mmHg)		HPR(beat\min)	
		Before work	After work	Before work	After work	Before work	After work
Male	Average	119.2	126.8	76.2	84.2	82.5	88.0
	Max.	134.0	145.0	90.0	98.0	105.0	106.0
	Min.	108.0	107.0	62.0	68.0	66.0	67.0
Female	Average	106.8	118.2	74.2	79.8	72.5	80.2
	Max.	122.0	137.0	91.0	96.0	82.0	91.0
	Min.	87.0	98.0	61.0	68.0	66.0	68.0

Table (4.5) shows that there is an increase in average, maximum and minimum values for SBP, DBP and HPR after work for all studied male and female workers in Al-Watani Hospital.

4.2 Measurements in Rafidya Hospital

The sound pressure levels, the arterial blood pressure and the heart pulse rate for the sample workers were measured in Rafidya Hospital in four sections (NICU, ICU, OR and COR). The results are presented in the following subsection.

4.2.1 Sound Pressure Level Results in Rafidya Hospital

The mean values of SPL in NICU, ICU, OR and in COR in Rafidya Hospital during one day in Feb. 2009 and another day in Jul. 2009 are presented in Fig. (4.6 a&b), from which the following points can be concluded:-

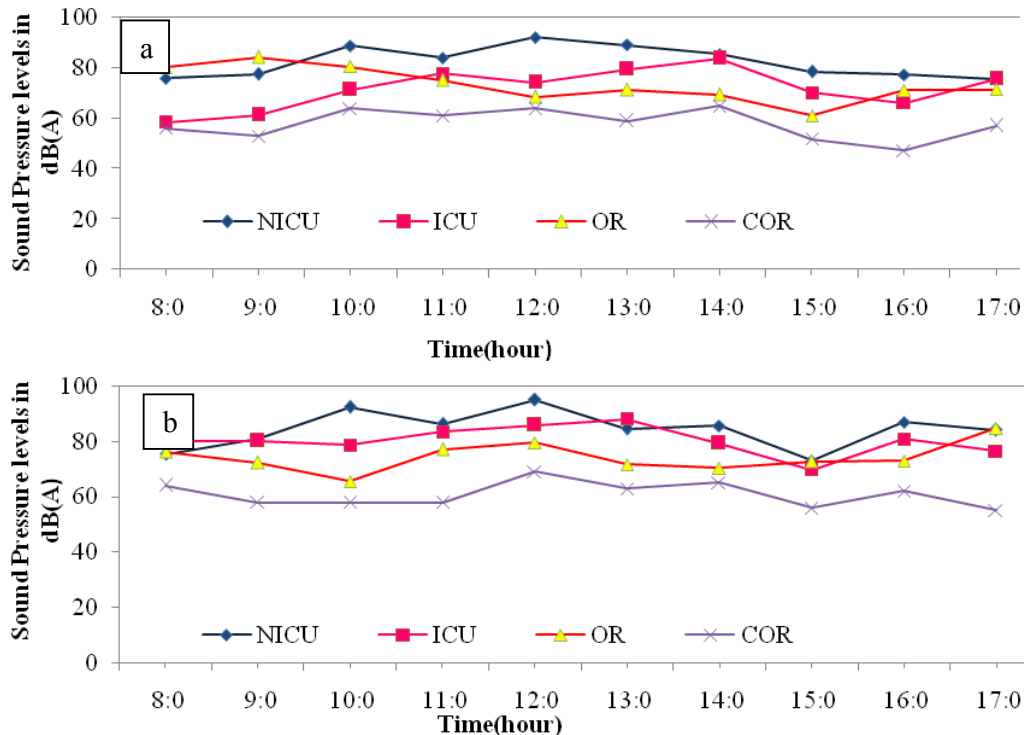


Figure (4. 6): Values of SPL in dB(A) as a function of time in Rafidya Hospital during one day in (a) Feb. 2009. (b) Jul. 2009.

- The values of SPL in Rafidya Hospital ranged from 75.4 to 93.5dB(A) in NICU with mean of 83.4dB(A), from 69.3 to 84.0dB(A) in ICU with mean of 76.0dB(A), from 66.6 to 78.3dB(A) in OR with mean of 73.7dB(A), and from 54.0 to 66.5dB(A) in COR with mean of 59.6dB(A). These numbers indicate that all studied department in Rafidya Hospital is noise polluted.
- The mean values of SPL in COR was the least, so the noise in the different department are due to the equipments and workers inside those departments themselves and not from outside.
- The values of SPL in NICU are in general the highest most of the time in the two dates (Fig. 4.6). This might be due to the fact that this department consists of one room with 15 incubators mostly full with babies. In addition, there are more than 4 nurses in this department which has no walls separating nurse station from babies.
- Although the operation rooms are very busy in this hospital, the measured values of SPL are the lowest compared to other departments in the same hospital. However, this can be due to the large area of this department which is constituted of four big rooms.
- The mean SPL is in general higher in Feb. compared to Jul. in NICU, ICU and OR departments of Rafidya Hospital as shown in Fig. (4.7).

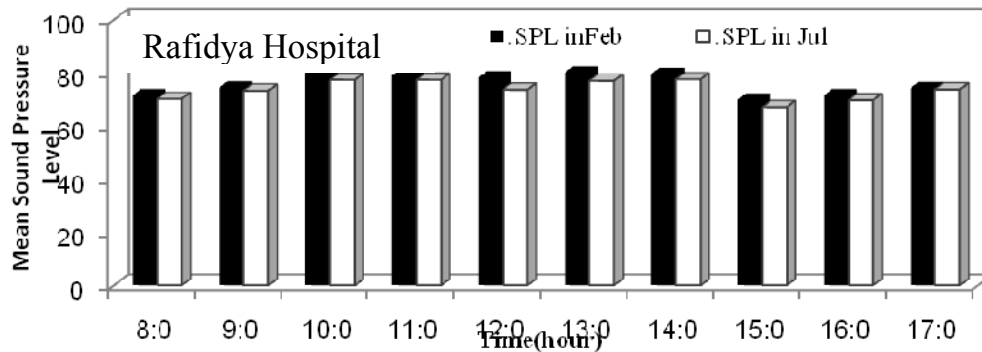


Figure (4.7): Values of sound pressure levels as a function of time in Rafidya Hospital during the selected two days in Feb. and Jul. 2009.

4.2.2 Blood Pressure and Heart Pulse Rate Results in Rafidya Hospital

The arterial blood pressure (Systolic and Diastolic) and heart pulse rate were measured for 21 workers in Rafidya Hospital, 7 workers (all females) in NICU and 7 workers (6 males and 1 females) in ICU and there are also 7 workers (4 males and 3 females) in OR. The age of the sample workers in Rafidya Hospital, the duration of their employment in the last job, the SBP, the DBP and the HPR values before and after work are shown in table (4.6).

Table 4.6: Gender, work location, parents history of hypertension, years of employment in the current job, workers health of hypertension and treatment, SBP, DBP and HPR for the sample workers in Rafidya Hospital.

Gender	Work Location	Years of Work	Age	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)		Parents History of hypertension disease	Workers Health and treatment
				Before Work	After Work	Before Work	After Work	Before Work	Before Work		
F	NICU	9	36	104	110	73	83	97	126	None	Normal
F	NICU	15	41	130	151	73	81	97	98	Mother	Normal
F	NICU	5	42	98	136	63	70	90	92	None	Normal
F	NICU	12	38	115	130	79	88	101	94	None	Normal
F	NICU	13	39	137	129	92	84	78	102	None	Normal
F	NICU	15	40	119	126	79	65	76	78	None	Normal
F	NICU	10	32	110	113	70	62	65	73	None	Sick
M	ICU	13	38	113	129	74	89	77	65	None	Sick
M	ICU	15	39	127	124	86	80	68	74	None	Normal
F	ICU	14	36	101	103	63	61	72	78	None	Normal
M	ICU	32	56	132	142	86	92	79	91	None	Normal
M	ICU	12	40	126	132	77	79	85	87	None	Normal
M	ICU	22	46	109	115	56	67	56	73	None	Normal
M	ICU	13	38	122	129	73	78	92	86	None	Normal
F	OR	5	30	115	118	78	80	95	100	None	Normal
M	OR	20	42	135	143	90	68	93	82	None	Sick
F	OR	10	29	109	111	73	69	88	89	None	Normal
F	OR	15	33	113	125	69	62	68	73	None	Normal
M	OR	20	45	148	152	98	103	65	72	None	Normal
M	OR	15	45	126	137	80	94	87	90	None	Normal
M	OR	30	50	111	120	64	75	65	78	None	Normal

From table (4.6) we understand the following points:

- The duration of employment in the current job ranged from 5 to 32 year.
- The ages of the sample workers in Rafidya Hospital ranged from 29 to 56 year.
- About 5% of the sample workers parents are taking antihypertensive drugs.
- About 14% of the sample workers are taking antihypertensive drugs, although their parents don't take antihypertensive drugs.

- The maximum, the minimum and the average values for SBP, DBP and HPR for the sample males and females in Rafidya Hospital are presented in table (4.7).

Table 4.7: Average, maximum and minimum values of SBP, DBP and HPR before and after work for the sample males and females in Rafidya Hospital.

Gender	Variables	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)	
		Before work	After work	Before work	After work	Before work	After work
Male	Average	124.9	132.3	78.4	82.5	76.7	79.8
	Max.	148.0	152.0	98.0	103.0	93.0	91.0
	Min.	109.0	115.0	56.0	67.0	56.0	65.0
Female	Average	113.7	122.9	73.8	73.2	84.3	91.2
	Max.	137.0	151.0	92.0	88.0	101.0	126.0
	Min.	98.0	103.0	63.0	61.0	65.0	73.0

The following two points can be concluded from table (4.7):

- There is an increase in average, maximum and minimum values for SBP and HPR after work for studied male and female workers in Rafidya Hospital.
- Although there is an increase in DBP values for males in Rafidya Hospital, a decreasing trend for females was noticed. However, further investigations of this trend is necessary.

4.3 Measurements in Nablus Speciality Hospital

The SPL results, the systolic and diastolic blood pressure and heart pulse rate measurements for the selected workers in Nablus Speciality Hospital are presented in the following subsections.

4.3.1 Sound Pressure Level Results in Nablus Speciality Hospital

The mean values of SPL in NICU, ICU, OR and in COR in Nablus Speciality Hospital during one day in Feb. 2009 and another day in Jul. 2009 are presented in Fig. (4.8 a&b). There are 4 incubators with one baby

in the same room during the two days in the NICU department with one nurse. Four beds with two patients exist in the ICU department with at least two nurses. The OR department in this hospital was very busy during the selected two days so the SPL values in this department were high as shown in Fig. (4.8 a&b).

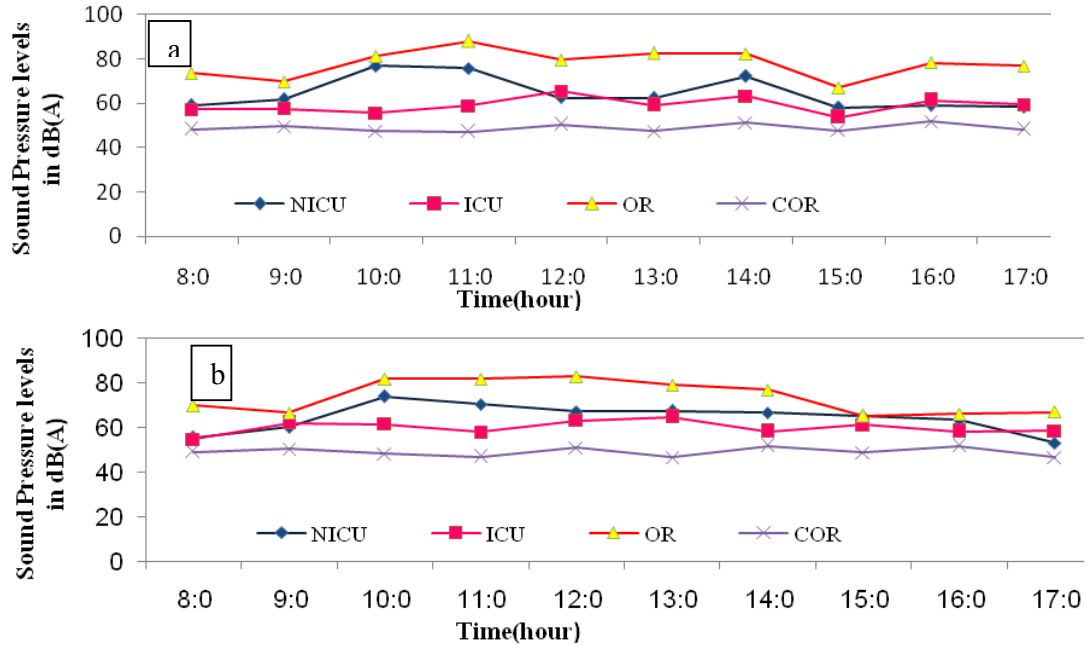


Figure (4. 8): Values of sound pressure levels SPL as a function of time in Nablus Speciality Hospital during one day in (a) Feb. 2009 (b) Jul. 2009.

The following points can be concluded from Fig. (4.8 a&b):

- The values of SPL in OR is the highest during the two days. Because this department was very busy with a lot of surgery operations such as heart operations.
- The values of SPL in Nablus Speciality Hospital ranged from 55.7 to 75.4dB(A) in NICU with mean of 64.5dB(A), from 56.0 to 64.4dB(A) in ICU with mean of 59.7dB(A), from 66.2 to 85.0dB(A) in OR with mean of 75.9dB(A), and from 47.1 to 51.8dB(A) in COR with mean of 49.1dB(A).

- The values of SPL in COR is very close to the recommended values which is 45.0 dB(A) (American Academy of Pediatrics, 1997). This indicates that the noise inside all studied departments comes from internal sources and not from external sources.
- The values of SPL in NICU are higher than in ICU during the two days. This might be due to the ICU area is too large with only one patient. While the NICU area is too small with one baby in it.
- The mean SPL is in general higher in Feb. compared to Jul. in NICU, ICU and OR departments in Nablus Speciality Hospital as shown in Fig. (4.9).

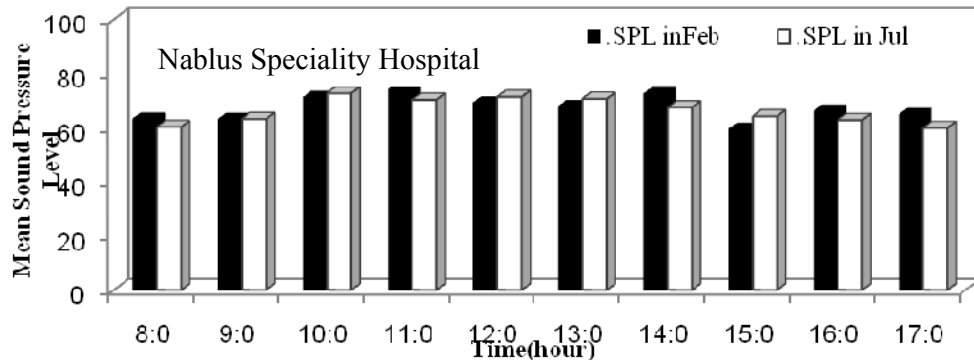


Figure (4.9): Values of sound pressure levels in dB(A) as a function of time in Nablus Speciality Hospital during the selected two days in Feb. and Jul. 2009.

4.3.2 Blood Pressure and Heart Pulse Rate Results in Nablus Speciality Hospital

The arterial blood pressure (Systolic and Diastolic) and heart pulse rate were measured for 22 workers in Nablus Speciality Hospital, four workers (1male and 3 females) from them exist in the NICU, six workers (4 males and 2 females) in the ICU, and 12 workers (8

males and 4 females) in OR. The ages of the sample workers in Nablus Speciality Hospital, the duration of their employment in the last job, and the SBP, the DBP and the HPR values before and after work are shown in table (4.8).

Table 4.8: Gender, work location, parents history of hypertension, years of employment in the current job, Workers health condition and treatment SBP, DBP and HPR for the sample workers in Nablus Speciality Hospital.

Gender	Work Location	Years of Work	Age	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)		Parents History of hypertension	Workers Health
				Before Work	After Work	Before Work	After Work	Before Work	After Work		
M	NICU	3	26	117	120	62	71	71	77	Mother	Normal
F	NICU	4	23	107	111	69	77	65	72	Mother	Normal
F	NICU	8	28	116	110	62	79	78	84	Mother	Normal
F	NICU	10	32	83	92	62	70	81	89	None	Normal
M	ICU	2	22	120	127	68	72	68	82	Father	Normal
M	ICU	4	25	120	126	71	90	77	90	None	Normal
M	ICU	10	31	111	117	69	85	78	82	None	Normal
M	ICU	1	22	114	116	71	75	68	72	None	Normal
F	ICU	10	32	111	118	68	85	91	97	None	Normal
F	ICU	12	36	114	123	70	80	82	87	None	Normal
M	OR	20	50	142	158	81	89	84	88	None	Normal
F	OR	25	47	110	130	65	77	77	96	None	Normal
M	OR	47	73	142	153	77	88	70	72	Mother	Sick
F	OR	10	30	100	112	65	78	76	82	Father	Normal
F	OR	17	39	132	140	77	92	63	79	None	Normal
F	OR	15	40	120	131	77	93	59	71	None	Normal
M	OR	15	46	141	156	86	91	92	113	Father	Normal
M	OR	14	43	144	151	78	92	94	112	Father	Normal
M	OR	18	39	125	136	89	103	76	84	Mother	Normal
M	OR	29	51	133	147	82	86	68	71	Father	Normal
M	OR	16	36	139	140	79	87	66	73	Father	Normal
M	OR	4	23	127	133	71	80	70	74	Father	Normal

The following remarks can be concluded from table (4.8):

- The duration of employment in the current job ranged from 1 to 47 year.
- The ages of the sample workers in Nablus Speciality Hospital ranged from 22 to 73 year.
- About 41% of the sample workers parents are taking antihypertensive drugs.

- About 5% of the sample workers are taking antihypertensive drugs.
- The maximum, the minimum and the average values for SBP, DBP and HPR for the sample males and females in Nablus Speciality Hospital are presented in table (4.9).

Table 4.9: Average, maximum and minimum values of SBP, DBP and HPR before and after work for the sample males and females in Nablus Speciality Hospital.

Gender	variables	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)	
		Before work	After work	Before work	After work	Before work	After work
Male	Average	128.8	136.9	75.7	85.3	75.5	83.8
	Max.	144.0	158.0	89.0	103.0	94.0	113.0
	Min.	111.0	116.0	62.0	68.0	66.0	68.0
Female	Average	110.3	118.6	68.3	81.2	74.7	84.1
	Max.	132.0	140.0	79.0	93.0	91.0	97.0
	Min.	83.0	92.0	62.0	70.0	59.0	71.0

Table (4.9) shows that there is an increase in average, maximum and minimum values for SBP, DBP and HPR after work for all studied male and female workers in Nablus Speciality Hospital.

4.4 Measurements in Al-Ittihad Hospital

The SPL results, the systolic and diastolic blood pressure and heart pulse rate measurements for the selected workers in Al-Ittihad Hospital are presented in the following subsections.

4.4.1 Sound Pressure Level Results in Al-Ittihad Hospital

The mean values of SPL as a function of time in NICU, ICU, OR and in COR in Al-Ittihad Hospital during one day in Feb. 2009 and another day in Jul. 2009 are presented in Fig. (4.10 a&b). There are four incubators with two babies in NICU department during one day in Feb. 2009 and one baby in Jul. 2009 with one nurse. One medical surgery is done each day in the OR. The ICU department in this hospital contains four beds with two patients in the first day and one patient in the second day.

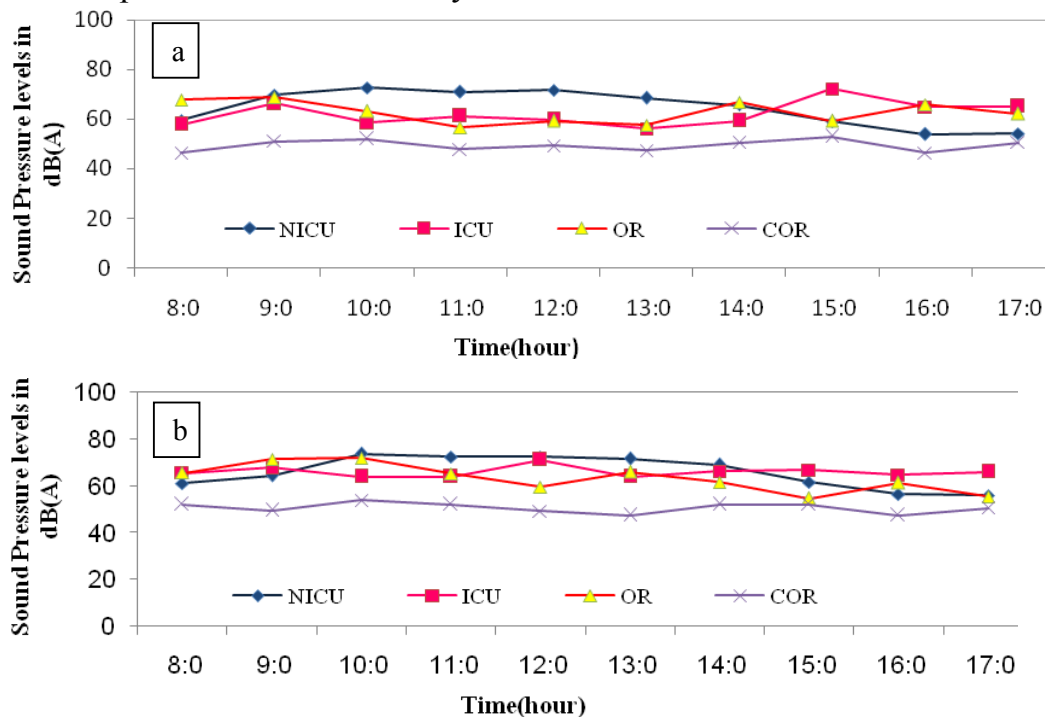


Figure (4.10): Values of SPL in dB(A) as a function of time in Al-Ittihad Hospital during one day in (a) Feb. 2009.(b) Jul. 2009.

The following remarks can be concluded from Fig. (4.10 a&b):

- The values of SPL in Al-Ittihad Hospital ranged from 55.0 to 73.1dB(A) in NICU with mean of 65.2dB(A), from 59.9 to 69.4dB(A) in ICU with mean of 64.0dB(A), from

56.9 to 70.0dB(A) in OR with mean of 63.0dB(A), and from 46.9 to 52.9dB(A) in COR with mean of 50.1dB(A).

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he values of SPL in NICU department are almost the same during the two selected working days, while there are some fluctuations in OR and ICU departments.

- The values of SPL in COR are less than the value of SPL inside all departments.
- There is no noticeable big difference between the results of SPL value in February (winter) and in July (summer) in NICU, ICU and OR departments in Al-Ittihad Hospital as shown in Fig. (4.11).

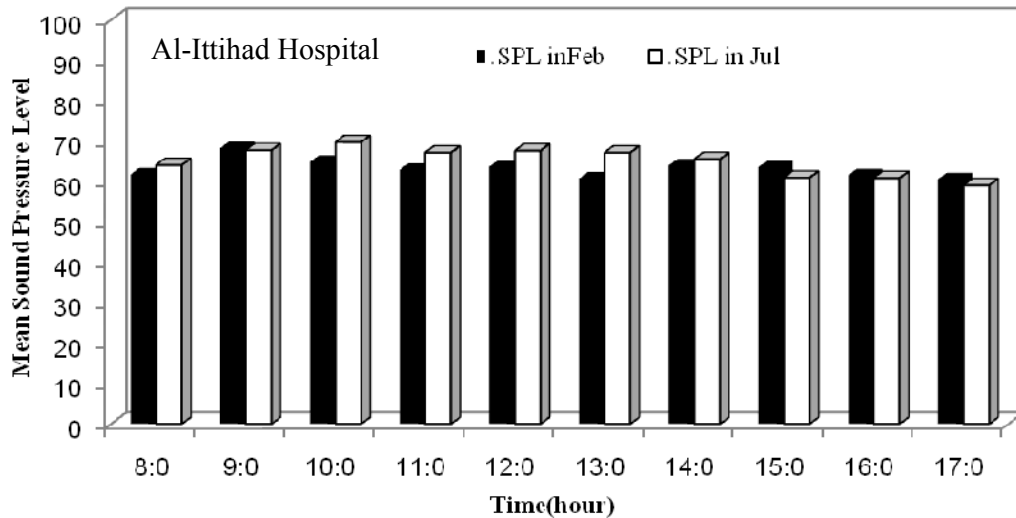


Figure (4.11): Values of sound pressure levels in dB(A) as a function of time in Al-Ittihad Hospital during the selected two days in Feb. and Jul.2009.

4.4.2 Blood Pressure and Heart Pulse Rate Results in Al-Ittihad Hospital

The systolic and diastolic blood pressure and heart pulse rate were measured for 15 workers in Al-Ittihad Hospital, four workers (1 male and 3 females) work in NICU, four workers (3 males and 1 female) in ICU and 7 (4 males and 3 females) in OR. The ages of the sample workers in Al-Ittihad Hospital, the duration of their employment in the last job, and the SBP, the DBP and the HPR values before and after work are shown in table (4.10).

Table (4.10):Gender, work location in Al-Ittihad Hospital, parents history of hypertension disease in the family, years of employment in the current job, SBP, DBP and HPR for the sample workers in Al-Ittihad Hospital.

Gender	Work Location	Work Years	Age	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)		Parents History of hypertension	Workers Health
				Before Work	After Work	Before Work	After Work	Before Work	After Work		
M	NICU	2	32	128	136	84	93	87	91	None	Normal
F	NICU	20	43	94	100	60	68	65	67	Father	Normal
F	NICU	3	26	120	128	91	96	60	65	None	Normal
F	NICU	1	20	110	117	90	83	69	72	None	Normal
M	ICU	22	42	117	123	84	93	67	83	None	Sick
M	ICU	3	26	110	153	70	79	70	74	None	Normal
F	ICU	15	40	130	146	80	107	68	73	None	Normal
M	ICU	7	34	126	141	80	90	67	72	None	Normal
M	OR	28	52	177	182	95	107	64	68	Mother	Normal
F	OR	9	40	120	125	81	87	90	96	None	Normal
M	OR	3	25	118	126	74	79	62	74	None	Normal
F	OR	30	57	108	128	69	87	69	72	None	Normal
F	OR	15	52	96	120	70	79	59	69	None	Normal
M	OR	32	62	146	158	83	91	92	98	None	Normal
M	OR	20	47	150	164	94	102	97	101	None	Normal

The following points can be summarized from table (4.10)

- The duration of employment in the current job ranged from 1 to 32 year.
- The ages of the sample workers in hospital ranged from 20 to 62 year.
- About 13% of the sample workers parents are taking antihypertensive drugs.

- About 7% of the sample workers are taking antihypertensive drugs.
- The maximum, the minimum and the average values for SBP, DBP and HPR for the sample males and females in Al-Ittihad Hospital are presented in table (4.11).

Table 4.11: Average, maximum and minimum values of SBP, DBP and HPR before and after work for the sample males and females in Al-Ittihad Hospital.

Gender	variables	SBP(mmHg)		DBP(mmHg)		HPR(beat\min)	
		Before work	After work	Before work	After work	Before work	After work
Male	Average	134.6	147.3	85.5	89.3	76.8	81.6
	Max.	182.0	177.0	95.0	107.0	97.0	101.0
	Min.	110.0	123.0	70.0	79.0	62.0	64.0
Female	Average	112.1	122.4	77.3	86.7	72.1	69.9
	Max.	130.0	146.0	91.0	107.0	90.0	96.0
	Min.	94.0	100.0	60.0	68.0	65.0	59.0

Table (4.11) shows that there is an increase in average values for SBP, DBP and HPR after work for all studied male and female workers in Al-Ittihad Hospital.

5.5 Measurements in Al-Injeeli Hospital

The SPL results, the systolic and diastolic blood pressure and heart pulse rate measurements for the selected workers in Al-Injeeli Hospital are presented in the following subsections.

4.5.1 Sound Pressure Level Results in Al-Injeeli Hospital

The mean values of SPL as a function of time in NICU, ICU, OR and in COR in Al-Injeeli Hospital during one day in Feb. 2009 and another day in Jul. 2009 are presented in Fig. (4.12 a&b). The NICU department contains four incubators with two babies in the first day and one baby in the second day with only one nurse. The ICU department contains four beds with one

patient in the two days and only one nurse working in the shift. There are 12 surgery operations in the first day and five surgery operations in the second day.

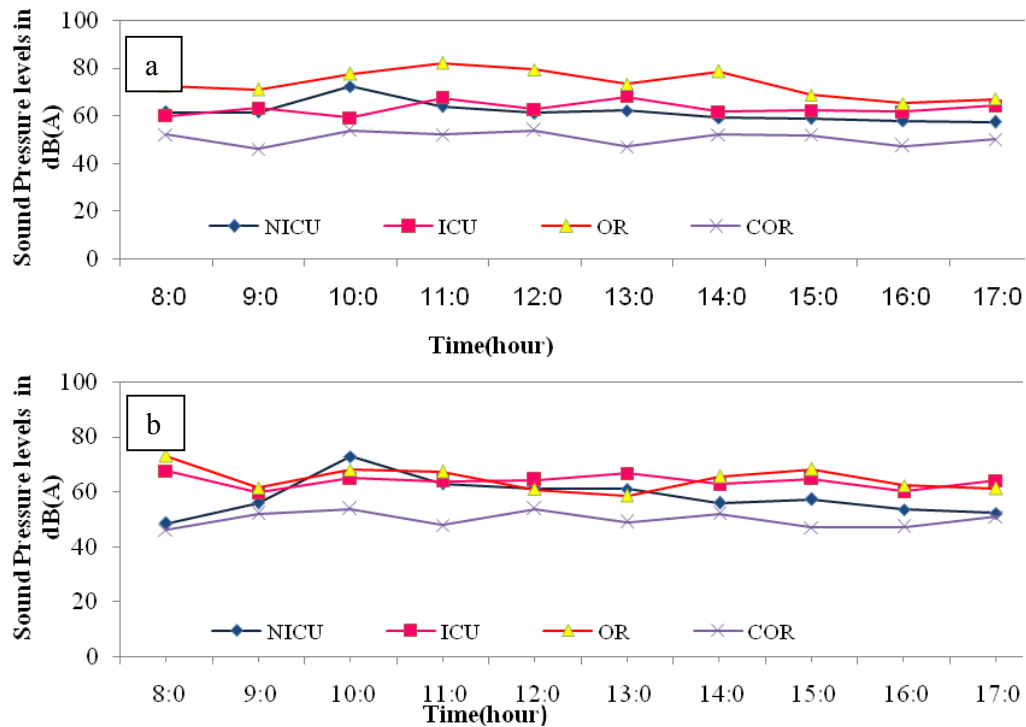


Figure (4. 12): Values of sound pressure levels SPL in dB(A) in Al-Injeeli Hospital during one day in (a) Feb. 2009 (b) Jul. 2009.

The following points can be concluded from Fig. (4.12 a&b):

- The values of SPL in Al-Injeeli Hospital ranged from 54.8 to 72.5dB(A) in NICU with mean of 59.8dB(A), from 61.0 to 67.3dB(A) in ICU with mean of 63.5dB(A), from 63.9 to 74.8dB(A) in OR with mean of 69.2dB(A), and from 47.3 to 53.8dB(A) with mean of 50.3dB(A).
- The values of SPL in OR during the first day are the highest because there are more than 12 surgery operations in this day.
- In general the values of SPL in COR are acceptable compared with the SPL in other departments of the hospital.

- There is a peak in the SPL value at 10:00 o'clock in NICU in the two measuring days. This might be due to babies feeding time and doctors tour.
- The mean SPL is in general higher in Feb. compared to Jul. in Al-Injeeli Hospital (NICU, ICU and OR) as shown in Fig. (4.13).

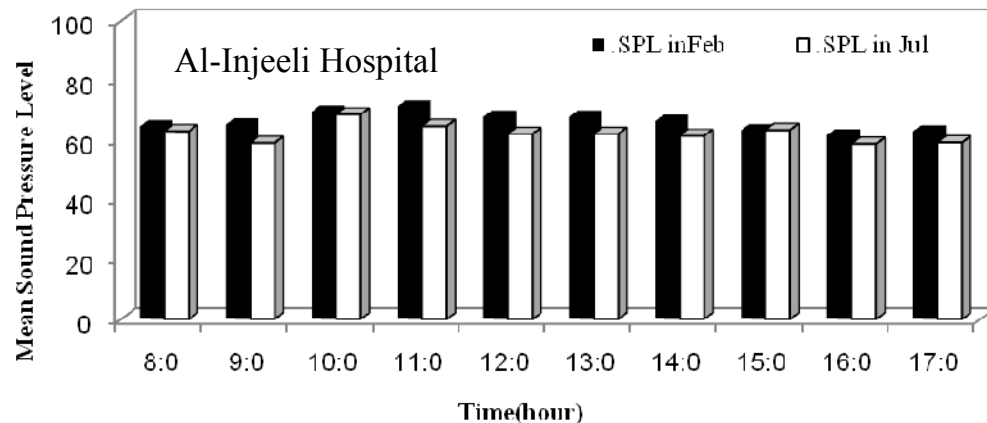


Figure (4.13): Values of sound pressure levels in dB(A) as a function of time in Al-Injeeli Hospital during the selected two days in Feb. and in Jul. 2009.

4.5.2 Blood Pressure and Heart Pulse Rate Results in Al-Injeeli Hospital

The systolic and diastolic blood pressure and heart pulse rate were measured for 20 workers in Al-Injeeli Hospital, four workers (1 male and 3 females) work in NICU, 4 workers (2 males and 2 females) in ICU, and there are 12 workers (10 males and 2 females) in OR. The ages of the sample workers in Al-Injeeli Hospital, the duration of their employment in the last job, and the SBP, the DBP and the HPR values before and after work are given in table (4.12).

Table (4.12): Gender, work location, parents history of hypertension disease, years of employment in the current job, workers health condition and treatment, SBP, DBP and HPR for the sample workers in Al-Injeeli Hospital.

Gender	Work Location	Work Years	Age	SBP(mmHg)		DBP(mmHg)		HPR(beat/min)		Parents History of hypertension on disease	Workers Health Condition and Treatment
				Before Work	After Work	Before Work	After Work	Before Work	After Work		
M	NICU	6	38	90	110	53	65	87	90	None	Normal
F	NICU	17	40	117	113	75	85	86	95	None	Normal
F	NICU	10	32	110	113	88	82	99	85	None	Normal
F	NICU	12	38	115	130	79	88	101	94	None	Normal
F	ICU	23	46	126	117	86	80	85	90	None	Normal
M	ICU	10	39	109	116	69	78	89	94	None	Normal
F	ICU	5	28	125	113	69	61	68	73	None	Normal
M	ICU	32	56	132	142	86	92	79	91	None	Normal
F	OR	2	21	109	94	79	70	67	75	None	Normal
M	OR	30	50	110	124	81	87	90	96	None	Normal
M	OR	8	30	116	134	76	92	85	97	Father	Normal
M	OR	20	45	146	152	91	110	91	88	None	Normal
M	OR	20	45	148	152	98	103	65	72	None	Normal
M	OR	30	55	117	131	79	91	81	83	None	Normal
M	OR	28	48	111	125	58	64	80	86	None	Normal
F	OR	8	28	127	110	66	56	75	81	None	Normal
M	OR	20	46	134	154	92	98	89	92	None	Normal
M	OR	33	60	122	124	62	80	83	96	None	Sick
M	OR	27	56	140	150	80	87	84	86	None	Normal
M	OR	18	40	136	138	93	102	71	72	None	Normal

The following points can be summarized from table (4.12)

- There is a decrease in SBP, DBP and HPR for many nurses (female), because they have other health problems.
- The duration of employment in the current job ranged from 2 to 33 year.
- The ages of the sample workers in hospital ranged from 21 to 60 year.
- About 5% of the sample workers parents are taking antihypertensive drugs.
- About 5% of the sample workers are taking antihypertensive drugs

- The maximum, the minimum and the average values for SBP, DBP and HPR before and after work for the sample males and females in Al-Injeeli Hospital are presented in table (4.13).

Table 4.13: Average, maximum and minimum values of SBP, DBP and HPR before and after work for the sample males and females in Al-Injeeli Hospital

Gender	variables	SBP(mmHg)		DBP(mmHg)		HPR(beats\min)	
		Before work	After work	Before work	After work	Before work	After work
Male	Average	123.9	134.8	78.3	88.4	82.6	87.9
	Max.	148.0	154.0	98.0	110.0	91.0	97.0
	Min.	90.0	110.0	53.0	64.0	65.0	72.0
Female	Average	118.4	112.9	77.4	74.6	83.0	84.7
	Max.	127.0	130.0	88.0	88.0	101.0	95.0
	Min.	109.0	94.0	66.0	56.0	67.0	73.0

The following two points can be concluded from table (4.13):

- There is an increase in average values for SBP, DBP and HPR after work for studied male workers in Al-Injeeli Hospital.
- There is a decrease in average values for SBP and DBP after work for studied female workers. However, this has to be further investigated.

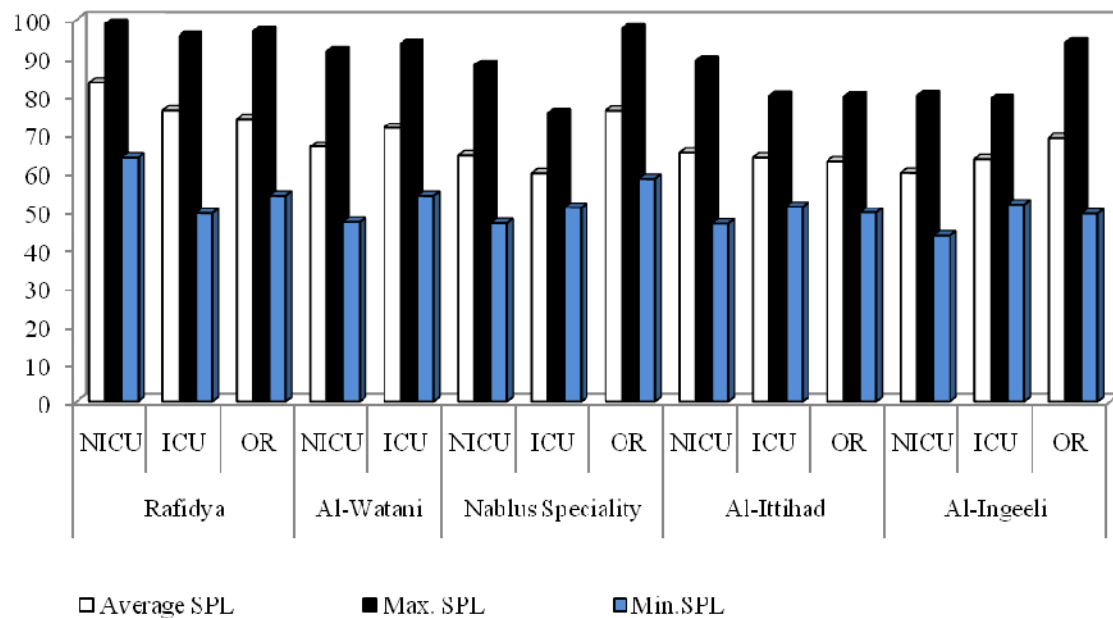
Chapter Five

Discussion and Conclusions

5.1 Data Analysis and Discussion for SPL

The overall results in this study indicate that all the sample workers are exposed to high continuous noise in all hospitals. In general, one can conclude the following points about the values of SPL in all studied departments in all sample hospitals:

- The average, maximum and minimum values of SPL in all studied hospitals departments are shown in Fig (5.1). These values show that all departments are noisy polluted compared to the recommended values of SPL which is 45.0 dB(A) in daytime and 35.0 dB(A) in nighttime (American Academy of Pediatrics 1997).



□ Average SPL ■ Max. SPL ■ Min. SPL

Figure (5.1): The average, maximum and minimum values of SPL in all studied hospitals' departments

- The SPL value in hospital corridors was always less than SPL inside NICU, ICU and OR departments in all studied hospitals except in Al-Watani Hospital. From this fact two points can be highlighted:-

1. The noise in the different departments are due to the equipments and the people inside those departments themselves and not from outside.
2. Al-Watani Hospital corridors have higher SPL contrary to other hospitals because this hospital is located in the commercial center of Nablus city too close to the heavy traffic (sec 4.1.1).

- In general, there was no noticeable big difference between the results of SPL value in February (winter) and in July (summer) in studied hospitals.

In the following three subsections, the SPL measurements in the similar departments of the different hospitals are compared to each other. The following is the discussion of SBP, DBP and HPR results. Finally, a summary and conclusions are presented in section (5.3).

5.1.1 Sound Pressure Levels (SPL) in Intensive Care Units (ICU)

The mean values of SPL as a function of time in the ICU department in all studied hospitals are shown in Fig.(5.2). From this Fig. one can conclude the following points:

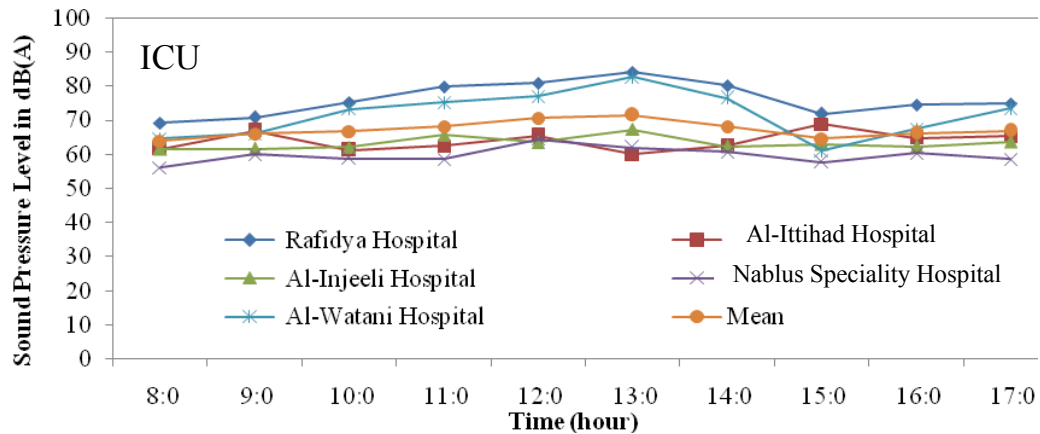


Figure (5.2) : Values of sound pressure levels SPL in dB(A) in ICU department in all studied hospitals.

It is not surprising that SPL value is high (noisy) in all hours in ICUs in all hospitals, because the ICU department is for emergency cases that need to be monitored all the time. Gabor Jonathan Y. et al. (2003) shows that the average noise levels in three ICUs rooms at night range from 43.2 ± 0.5 to 53.9 ± 2.5 dB, with maximum levels often reaching 49.1 ± 1.0 to 61.1 ± 2 dB. Whereas the mean value of noise levels in the same rooms at day range from 44.3 ± 0.7 to 56.2 ± 2.2 dB, with maximum levels often reaching 55.4 ± 1.0 to 67.1 ± 1.6 dB.

The highest value of SPL from all studied ICUs is in Rafidya Hospital followed by Al-Watani Hospital. The lowest value of SPL is in Nablus Speciality Hospital. The ICU department is always full with emergency patients in the governmental or public hospitals (Al-Watani and Rafidya Hospitals) for example,

there are four patients in Al-Watani ICU and also, four patients in Rafidya Hospital while there is only one patient in Al-Injeeli ICU, one patient in Nablus Speciality ICU and two patients in Al-Ittihad ICU.

- It was noticed that the ICU departments with highest SPL have larger number of nurses in each work shift. The number of nurses in Al-Injeeli ICU is one while there are at least four nurses in Rafidya and in AL-Watani ICUs. This factor might have an influence on increasing the SPL in ICUs departments.
- The peak of SPL in most studied ICUs comes at about one o'clock (noon), because another shift of working staff must take all the information about patients health before the end of the first shift.

5.1.2 Sound Pressure Levels in Neonatal Intensive Care Units (NICU)

The mean values of SPL as a function of time in the NICU department in all studied hospitals are shown in Fig. (5.3), from which the following can be concluded:

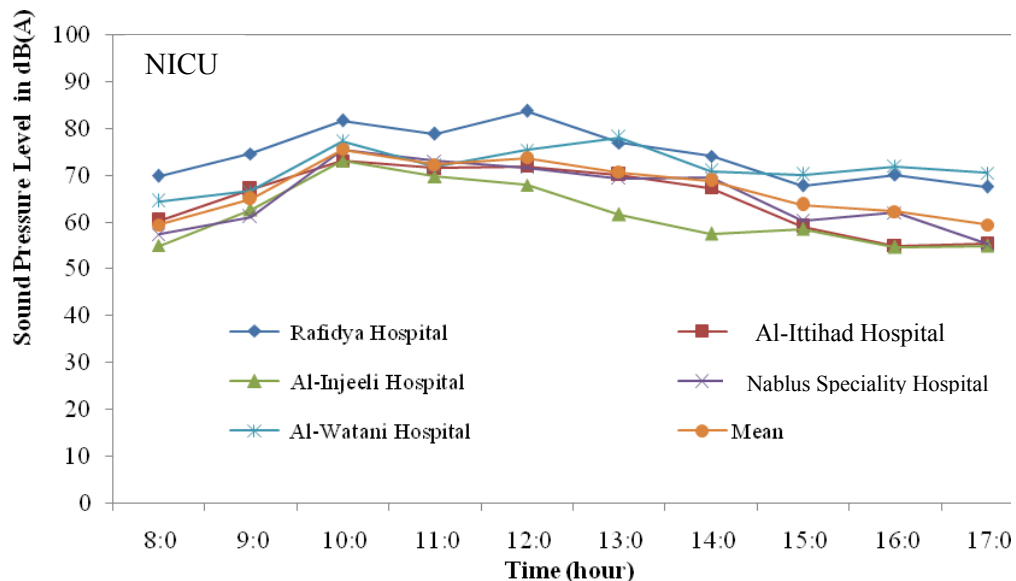


Figure (5.3): Values of sound pressure levels SPL in dB(A) in NICU in all studied hospitals.

- T
 he SPL values of Rafidya NICU were the highest while the lowest value of SPL was measured in Al-Injeeli NICU. The values of SPL in all NICU ranged from 54.2 to 83.8dB(A) which are too high compared to the international standard of about 45.0dB(A) according to the American Academy of Pediatrics. In Texas hospitals Morris B.H. et al. (2000) show that average noise levels in NICUs range from 50-75 dB(A), with peak levels often reaching 105 dB(A).
- T
 his highest value of SPL in NICU of Rafidya Hospital might be related to the fact that more than 15 incubators exist in the same room and every incubator has a lot of instruments and alarms. In addition, there is more than three nurses' working in this department. Moreover, the neonate nurse station is not separated by glass walls like the NICU in Al-Watani Hospital.
- T
 he results of SPL in NICU department in Al-Watani Hospital are high. In that hospital there are more than 10 incubators with 8 babies in the same room. The values of SPL in the NICU of Al-Injeeli, Al-Ittihad and Nablus Speciality Hospital are under the mean value of SPL in all NICUs, there are only two babies in each hospital NICU.

- The values of SPL for different NICUs in different hospitals are high between 10.00 to 11.00 o'clock, because this time is the doctors' tour.
- The fluctuations in the SPL values come due to the sources of Noise in NICUs, such as babies crying, telephone ringing, opening and closing incubator doors, monitoring alarms and unnecessary staff conversation.

5.1.3 Sound Pressure Levels in Operation Rooms (OR)

The mean values of SPL as a function of time in the OR department in all studied hospitals are shown in Fig. (5.4), from which the following can be concluded:

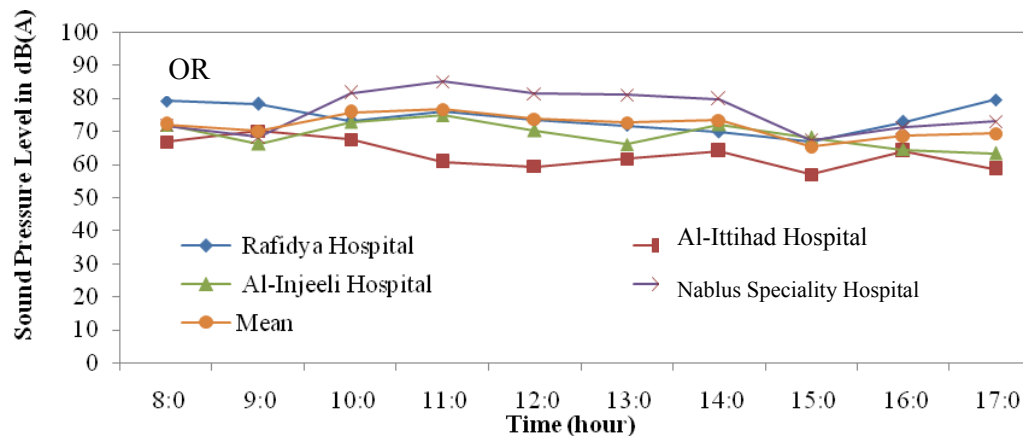


Figure (5.4): Values of sound pressure levels (SPL) in dB(A) in OR in all studied hospitals (Note :OR does not exist in Al-Watani Hospital).

- The values of SPL in ORs in all hospitals were ranging between 57.6 to 88.0 dB(A) with a mean of 71.9 dB(A). Eugene H.C. Liu and Su-Meng Tan (2000) measured the L_{eq} during the induction, maintenance, and recovery phases in New York OR's were 70.3 6

16.8 dB(A), 66.2 \pm 4.1 dB(A) and 71.8 \pm 6.1 dB(A), respectively. These sound levels are much higher than international recommendations.

- The highest value of SPL was in Nablus Speciality Hospital between 10.00 to 15.00 o'clock. Occasionally, a lot of emergency surgeries during this time were there, in addition, the radio with high music was on.
- The values of SPL in any ORs were affected by the number of surgeries taking place at the same time and by the types of these surgeries.
- The high values of SPL in OR were not surprising, because there are various sources of sounds in this department. These sources can be categorized in the following:-
 1. Sound caused by essential staff work like staff conversation, movement of equipment and surgical equipment preparation.
 2. Unavoidable sounds caused by instruments and machines in OR like monitor alarms, suction machines and respiratory machines.
 3. Sounds caused by telephones, air conditions, intercoms, automatic doors and music. However, this kind of noise can be avoided.

5.2 Data Analysis and Discussion of Blood Pressure and Heart Pulse Rate

The mean values of SBP, DBP and HPR before and after work and the difference between them were calculated and plotted in Fig. (5.4

to 5.7). The Pearson's correlation coefficient (R) and the probability value (P-value) were calculated by using Paired Sample T-test and One- Way ANOVA test for all sample workers in all studied hospitals. However, the most familiar measure of dependence between two quantities is the Pearson correlation coefficient (R). It is obtained by dividing the covariance of the two variables by the product of their standard deviations. The Pearson correlation is defined only if both of the standard deviations are finite and both of them are nonzero and the correlation coefficient is symmetric.

The Pearson correlation coefficient R. is +1 in the case of a perfect positive (increasing) linear relationship (correlation). It is -1 in the case of a perfect decreasing (negative) linear relationship (anticorrelation). Some values between -1 and 1 in all other cases, indicating the degree of linear dependence between the variables. As it approaches zero there is less of a relationship (closer to uncorrelated). The closer the coefficient is to either -1 or 1, the stronger the correlation between the variables. In this research the Pearson's coefficient correlation is measured by using the SPSS program, the value of (R) can be summarized as:-

$R > 0$ there is a correlation between studied variables (increase)

$R < 0$ there is a correlation between studied variables (decrease)

$R = 0$ there is no correlation between studied variables

Results are commonly summarized by a statistical test, and a decision about the significance of the result is based on the probability value (P-value). To define the P-value, one must first know the two hypotheses:

1. Null hypothesis (H_0): If $u_1 = u_2$ which means that the averages of the two groups are equal.
2. Alternative hypothesis (H_a): If $u_1 <$ or $> u_2$ which means that the averages of the two groups are not equal.

Where u_1 is the average value of the first group and u_2 is the average value of the second group.

In statistical significance testing, the P-value is the probability that the results observed in a study could have occurred by chance if the null hypothesis was true. The P-values do not simply provide researchers with a yes or no answer, it provides a sense of the strength of the evidence against the null hypothesis. The P-value ranged from zero to one, the lower the P-value, the stronger the evidence. The P-value is ranged as follows:

$0.000 \leq P\text{-value} \leq 0.050$ strong significance (Alternative hypothesis)

$P\text{-value} = 0.050$ the threshold of statistical significance

$0.050 < P\text{-value} \leq 1.000$ no significance (null hypothesis)

(William L. Carlson, 2007).

Tables (5.1), (5.2), (5.3), (5.4) and (5.5) show the dependent variables and the correlation coefficient and the P-values in all hospitals.

Table (5.1): Number of sample workers, SPL values, Pearson correlation coefficients R. and the probability P-values of the studied variables in all sample hospitals.

Hospital	Number of	SPL in	Dependant	R	P-value
Al-Watani	17	72.2	SBP(mmHg)	0.546	0.040
			DBP(mmHg)	0.695	0.001
			HPR(beat\min)	0.658	0.002
Rafidya	21	77.8	SBP(mmHg)	0.599	0.002
			DBP(mmHg)	0.643	0.044
			HPR(beat\min)	0.714	0.000
Special Nablus	22	67.4	SBP(mmHg)	0.906	0.000
			DBP(mmHg)	0.617	0.002
			HPR(beat\min)	0.693	0.000
Al-Ittihad	15	64.0	SBP(mmHg)	0.846	0.000
			DBP(mmHg)	0.695	0.030
			HPR(beat\min)	0.869	0.000
Al-Injeeli	20	64.1	SBP(mmHg)	0.744	0.000
			DBP(mmHg)	0.799	0.000
			HPR(beat\min)	0.762	0.000

Since R. values > 0.546 in table (5.1) the degree of linear dependence between the variables is strong positive correlation in all hospitals for SBP, DBP and HPR. It also shows strong significance of sound level on SBP, DBP and HPR. The P-value for all variables in all hospitals is < 0.050 and R. value of all studied variables in all hospitals is > 0.5 .

The Mean values of SBP, DBP and HPR for the sample workers and Pearson correlation coefficients and P-values in NICU, ICU and OR departments are shown in table (5.2).

Table (5.2): Mean values of SBP, DBP and HPR for the sample workers and Pearson correlation coefficients R. and P-values of the studied variables in NICU, ICU and OR departments from all studied hospitals.

Department	N	Dependent variables	Mean value of dependent variables		The difference between means	R.	P-value (Sig.)
			Before work	After work			
NICU	27	SBP(mmHg)	113.26	119.19	5.93	0.654	0.000
		DBP(mmHg)	76.37	80.15	3.77	0.502	0.008
		HPR(beat\min)	81.22	84.96	3.74	0.654	0.000
ICU	30	SBP(mmHg)	120.93	124.50	3.56	0.378	0.039
		DBP(mmHg)	73.77	80.27	6.50	0.631	0.000
		HPR(beat\min)	77.34	81.67	4.23	0.703	0.000
OR	38	SBP(mmHg)	128.11	135.13	7.02	0.823	0.000
		DBP(mmHg)	80.18	85.05	4.86	0.649	0.000
		HPR(beat\min)	77.55	83.79	6.23	0.743	0.000

The following points can be concluded from table (5.2):

- Strong positive correlation between SPL and SBP, DBP and HPR for workers working in all departments.
- The maximum P-value is 0.039 which is lower than 0.050 and this shows significance evidence and also, rejects the null hypothesis.
- The highest value of SBP difference and HPR difference are in the OR department, while the highest value of DBP difference are in the ICU department.

Mean values of SBP, DBP and HPR for the sample workers, Pearson correlation coefficients and P-values were calculated for all males and females as shown in table (5.3).

Table (5.3): Mean values of SBP, DBP and HPR for all workers and Pearson correlation coefficients R. and P-values 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	R	P value Sig.
				Before work	After work			
95	Female	40	SBP(mmHg)	112.78	118.15	5.37	0.580	0.000
			DBP(mmHg)	75.18	77.85	2.67	0.440	0.005
			HPR(beat\min)	78.00	82.88	4.87	0.783	0.000
	Male	55	SBP(mmHg)	128.05	133.85	5.80	0.650	0.000
			DBP(mmHg)	78.45	85.27	6.81	0.746	0.000
			HPR(beat\min)	78.96	83.87	4.90	0.664	0.000

The following points can be concluded from table (5.3):

- R correlation values for SBP, DBP and HPR for males and females show strong positive correlation.
- The maximum P-value is 0.005 this value is lower than 0.050 and this shows significance evidence and also, rejects the null hypothesis.
- The difference between means for males is more than means for females for all studied variables.

5.2.1 The relation Between Blood Pressure, Heart pulse Rate and the Duration of Employment

In order to compare the association between the increase in the studied variables (SBP, DBP and HPR) for workers (males and females) and the duration of employment in the current job, Figs (5.5 & 5.6) were plotted. These Fig.'s display the relationships between the mean values of systolic and diastolic blood pressure,

heart pulse rate and the duration of employment in the current job of the studied workers (males and females) in all studied hospitals

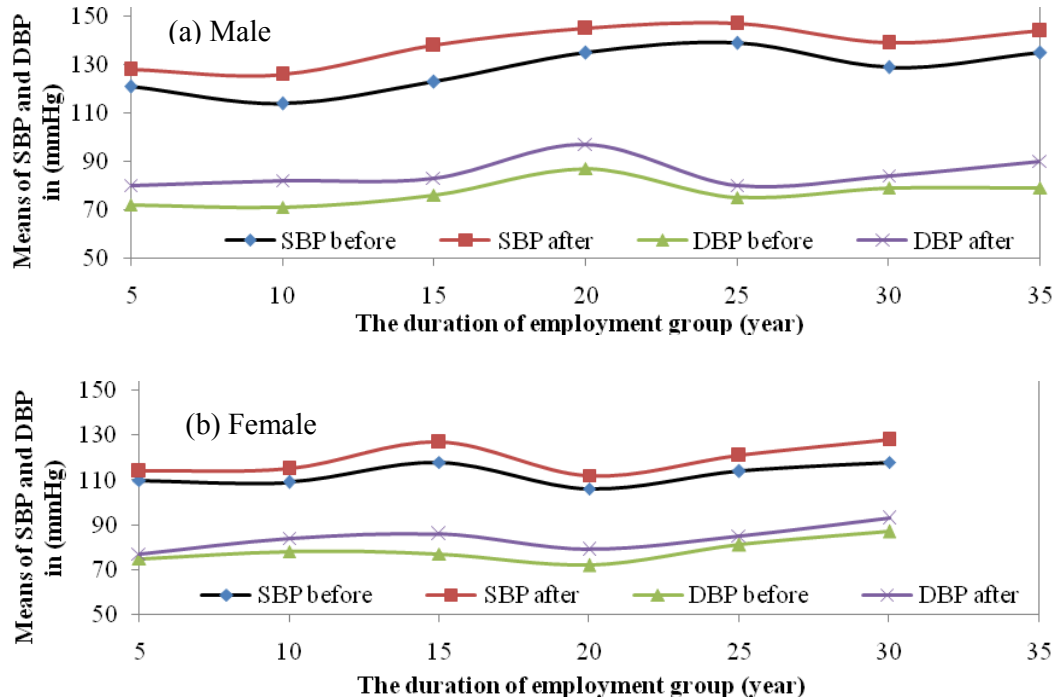


Figure (5.5): Mean values of systolic and diastolic blood pressure (SBP & DBP) (before and after) versus the duration of employment groups for (a) all selected males workers (b) all selected females workers. The duration of employment groups (5: 1-5; 10: 6-10; 15: 11-15; 20: 16-20; 25: 21-25; 30: 26-30; 35: > 31).

Fig. (5.5) show that there are significant interactions between the mean values of SBP and DBP and the duration of employment for sample workers. Comparison of the different duration of employment groups show that the value of increase in SBP, DBP for males be higher than in females. The relationships between the mean values of HPR and the duration of employment for the selected males and females workers are displayed in Fig. (5.6)

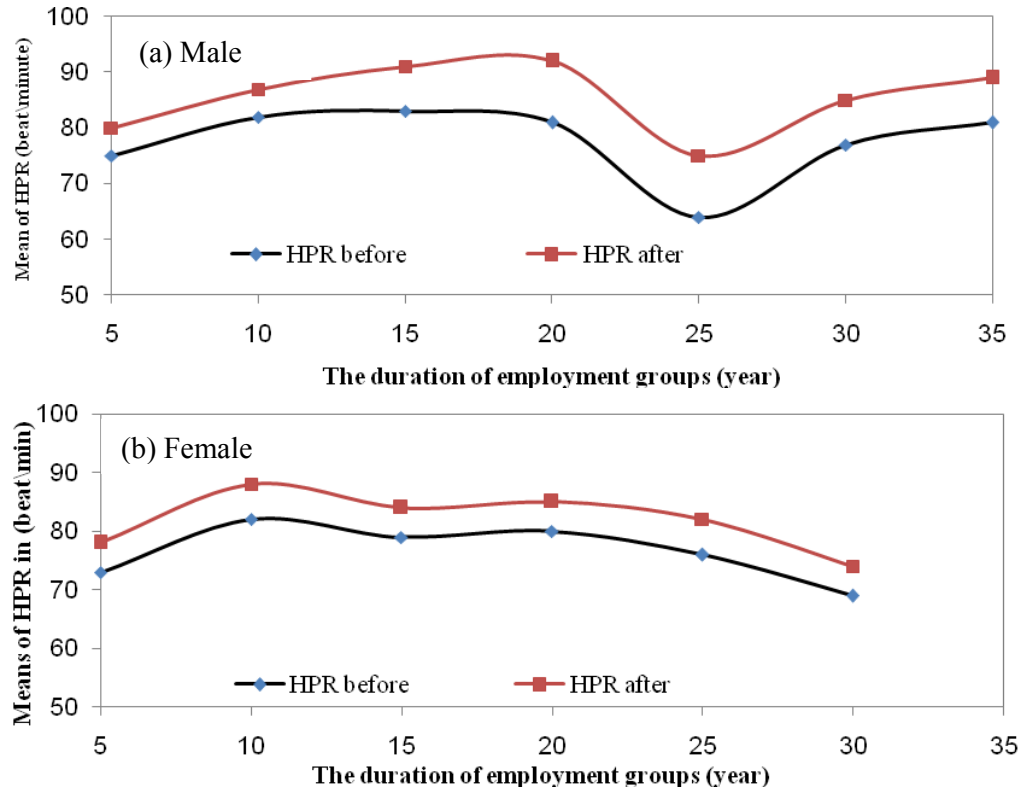


Figure (5.6): Mean values of heart pulse rate (before and after) versus the duration of employment groups for (a) all selected males workers (b) all selected females workers. The duration of employment groups (5: 1-5; 10: 6-10; 15: 11-15; 20: 16-20; 25: 21-25; 30: 26-30; 35: > 31).

Comparison of the different duration of employment groups in Fig. (5.6) show that the value of HPR for males and females increase, the sharp result of HPR in the duration of employment group 25 is due to other medical health problems.

Table (5.4) shows Pearson correlation and the P-value for SBP, DBP and HPR for the sample workers in all hospitals, the dependent variable is the duration of employment.

Table (5.4): Mean values of SBP, DBP and HPR before and after for all workers. Pearson correlation coefficients and P-values in all hospital. (the dependent variable is years of employment in the current job for the sample workers).

Years of employment	N	Dependant variable	Mean value of dependent variables		The difference between means	R	P-value Sig.
			Before work	After work			
1-5	18	SBP	116.11	121.61	5.50	0.531	0.023
		DBP	73.44	77.17	3.73	0.651	0.001
		HPR	73.89	79.06	5.17	0.736	0.000
6-10	18	SBP	110.89	116.78	5.89	0.709	0.001
		DBP	71.78	76.33	4.55	0.533	0.023
		HPR	82.22	87.78	5.56	0.788	0.000
11-15	22	SBP	120.50	129.23	8.73	0.729	0.000
		DBP	76.36	84.59	8.23	0.871	0.040
		HPR	80.95	85.68	4.73	0.536	0.010
16-20	15	SBP	139.93	139.97	0.04	0.362	0.018
		DBP	88.07	91.07	3.00	0.654	0.008
		HPR	80.07	81.20	1.13	0.762	0.001
21-25	7	SBP	116.00	120.00	4.00	0.454	0.030
		DBP	75.71	79.57	3.86	0.854	0.014
		HPR	68.57	76.57	8.00	0.708	0.075
26-30	8	SBP	126.50	137.75	11.25	0.983	0.000
		DBP	79.75	81.75	2.00	0.675	0.066
		HPR	76.00	79.13	3.13	0.863	0.006
>31	7	SBP	136.00	145.00	9.00	0.970	0.000
		DBP	79.29	89.57	10.28	0.818	0.025
		HPR	78.71	86.71	8.00	0.932	0.002

Since the value of R. range from 0.362 to 0.983 in table (5.4) there is strong correlation for SPB, DBP and HPR for all groups.

5.2.2 The Relation between Blood Pressure, Heart pulse Rate and Age

In order to compare the association between the increase in the studied variables (SBP, DBP and HPR) for workers (males and females) and the Age, Fig.'s (5.7 & 5.8) were plotted. These Fig.'s display the relationships between the mean values of systolic and diastolic blood pressure, heart pulse rate and the age of the studied workers (males and females) in all studied hospitals. The relationships between mean values of SBP, DBP and the age of all studied workers in all studied hospitals are displayed in Fig. (5.7).

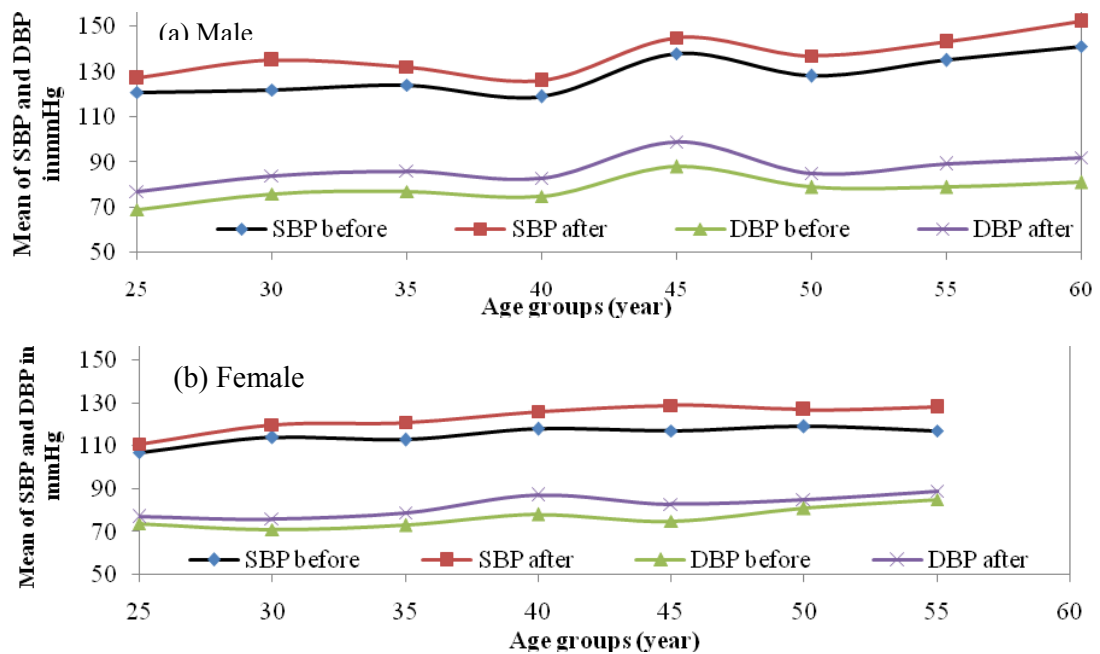


Figure (5.7): Mean values of systolic and diastolic blood pressure (SBP & DBP) (before and after) versus age groups for (a) all selected males workers (b) all selected females workers. Age groups (25: 20-25; 30: 26-30; 35: 31-35; 40: 36-40; 45: 41-45; 50: 46-50; 55: 51-55; 60: > 56)

Fig. (5.7) shows that there are significant interactions between mean values of SBP and DBP and age for males and females. The relation between HPR and age are presented in Fig. (5.8)

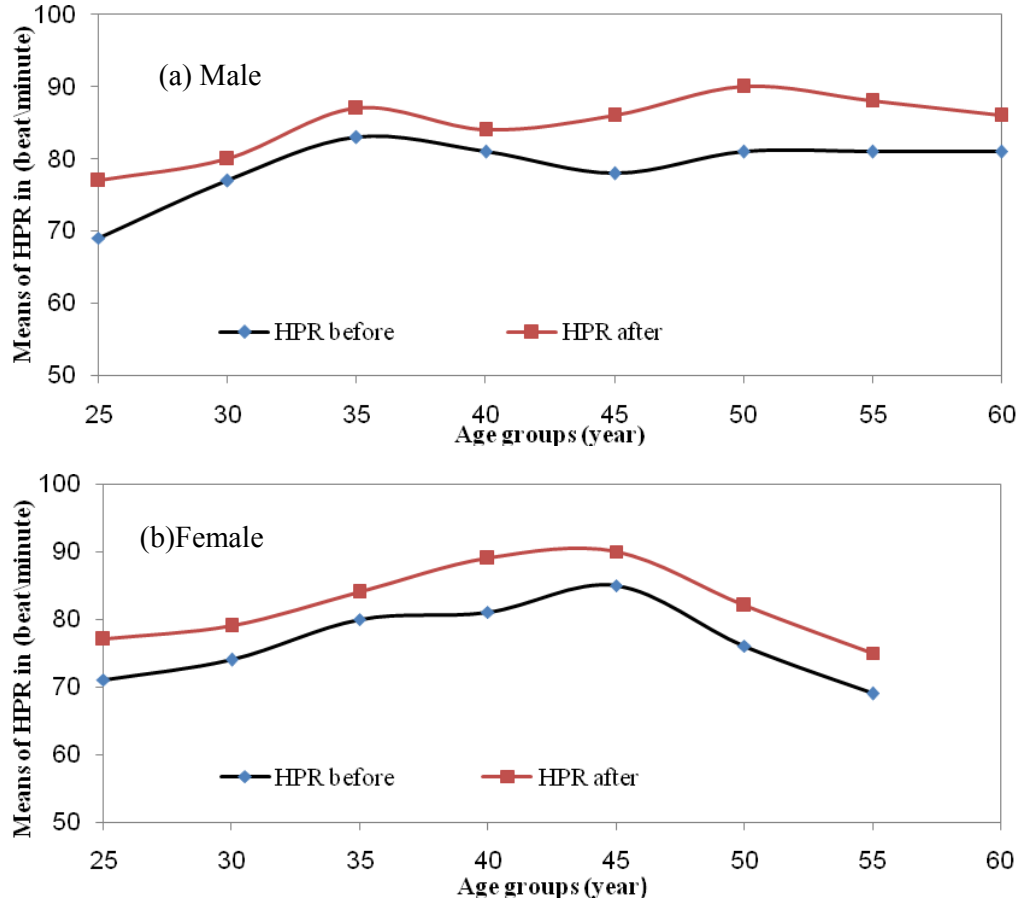


Figure (5.8): Mean values of heart pulse rate (HPR) (before and after) versus age groups for all selected workers. Age groups (25: 20-25; 30: 26-30; 35: 31-35; 40: 36-40; 45: 41-45; 50: 46-50; 55: 51-55; 60: > 56).

Fig. (5.8) show significant interactions between HPR and the age of all studied workers. Pearson correlation and the P-value for SBP, DBP and HPR for the sample workers in all hospitals are shown in table (5.5), the dependent variable is the age.

Table (5.5): Mean SBP, DBP and HPR before and after for all workers and Pearson's correlation coefficients and P-values in all hospitals are shown, the dependent variable is the age of all sample workers

Age	N	Dependent variable	Mean of dependent variables		The difference between means	R	P-value Sig
			Before work	After work			
20-25	10	SBP(mmHg)	114.70	115.10	0.40	0.749	0.013
		DBP(mmHg)	72.20	75.10	2.90	0.356	0.030
		HPR(beat/min)	69.00	76.30	7.30	0.677	0.032
26-30	13	SBP(mmHg)	118.15	124.38	6.23	0.752	0.035
		DBP(mmHg)	76.00	79.54	3.53	0.637	0.019
		HPR(beat/min)	81.38	85.69	4.30	0.912	0.000
31-35	10	SBP(mmHg)	114.70	120.30	5.60	0.806	0.005
		DBP(mmHg)	74.40	79.00	4.60	0.592	0.072
		HPR(beat/min)	79.20	81.70	2.50	0.790	0.007
36-40	24	SBP(mmHg)	118.08	125.42	7.33	0.787	0.000
		DBP(mmHg)	76.29	84.96	8.66	0.597	0.002
		HPR(beat/min)	81.04	86.67	5.62	0.653	0.001
41-45	11	SBP(mmHg)	128.27	136.18	7.90	0.715	0.013
		DBP(mmHg)	82.45	91.45	9.00	0.441	0.017
		HPR(beat/min)	80.27	85.18	4.90	0.775	0.005
46-50	12	SBP(mmHg)	126.00	134.67	8.66	0.783	0.003
		DBP(mmHg)	79.50	83.08	3.58	0.880	0.000
		HPR(beat/min)	80.00	87.67	7.66	0.419	0.017
51-55	6	SBP(mmHg)	133.50	137.50	4.00	0.514	0.029
		DBP(mmHg)	83.33	85.50	2.16	0.617	0.019
		HPR(beat/min)	70.50	73.33	2.83	0.928	0.007
>56	9	SBP(mmHg)	133.22	143.77	10.56	0.924	0.000
		DBP(mmHg)	81.11	87.56	6.44	0.211	0.058
		HPR(beat/min)	80.00	87.33	7.33	0.896	0.001

Since the value of R. is very close to +1 in table (5.5) there is strong positive correlation for SBP, DBP and HPR for all age groups.

5.3 Summary and Conclusions

The overall results in this study indicate the following points:

- The mean SPL values in all studied hospitals departments during the selected days ranged from 60.0 to 83.0 dB(A) in NICU, from 60.0 to 76.0 dB(A) in ICU and from 63.0 to 76.0 dB(A) in OR. 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 highest value of SPL from all studied ICUs was in Rafidya Hospital followed by Al-Watani Hospital. The lowest value of SPL was in Nablus Speciality Hospital.
- The SPL values of Rafidya NICU were the highest, while the lowest value of SPL was measured in Al-Injeeli NICU.
- The mean SPL values in all studied hospitals ranged from 64.0 to 77.8 dB(A). Therefore, all the sample workers are exposed to high continuous noise in all hospitals.
- The SPL value in hospital corridors (COR) in all studied hospitals was in general less than the SPL inside NICU, ICU and OR departments. One exception was noticed in Al-Watani Hospital due to its location. Accordingly, one can conclude that the noise in the different departments in most sample hospitals are due to the equipments and the workers inside these departments and not from outside.

- The mean SPL is in general higher in February (winter) than in July (summer) in all studied hospital except in Al-Watani and Al-Ittihad Hospitals.
- It was noticed that the ICU departments with highest SPL have larger number of nurses in each work shift. The number of nurses in Al-Injeeli ICU is one while there are at least four nurses in Rafidya and in AL-Watani ICUs. This factor might have an influence on increasing the SPL in ICUs departments.
- The values of SPL for different NICUs in different hospitals show a peak between 10.00 to 11.00 o'clock. This can be explained by the fact that doctors are making their tours during this period.
- The systolic and diastolic blood pressure might be affected by the person's physical, mental and health conditions (Iyawe, 2000).
- This study shows a strong positive correlation between noise and blood pressure from one side ($P < 0.05$, $0.5 < R < 1$) and between noise and heart pulse rate from the other side ($P < 0.05$, $R > 0.5$) in all hospital departments. All the tests show increasing trends of SBP, DBP and HPR for workers in all studied hospitals.
- Significant interactions ($P < 0.05$) were found between the mean values of all studied variables (SBP, DBP and HPR) and the duration of employment and age for males and females.

From the previous studies (Hui X. et al 2009, Tomoyuki K. 2004) and from our understandings during this work, several methods can be applied to reduce noise pollution in hospitals:

1. Hospital designer has to come up with designs that increase the area of the departments to increase spaces between patients from one side, and between patients and medical equipments from the other side.
2. Hospital managers should employ more workers as the department work need.
3. The nurse station inside each department must be separated by glass walls.
4. Noise from telephones can be lowered by reducing the volume of their rings.
5. Noise from the doors can be decreased by using rubber or door bumpers.
6. Noise from people can be reduced by issuing some rules limiting the interaction between visitors and working staff from one side, and between visitors and patients from the other side.
7. Noise caused by machines can be reduced through applying several mechanical adjustments, conducting maintenance, or buying new less noisy equipments.
8. Noise from reflecting surfaces can be reduced by covering all surfaces with antireflection materials of high noise absorbance.
9. Noise from floors can be reduced by changing the wheels of the used carts, or by using thick carpets.
10. When designing a new hospital, the designer has to come up with designs that increase spaces between patients from one

side, and between patients and medical equipments from the other side.

11. The external noise can be reduced by using well isolating walls and double glass windows.
12. Designers and decision makers must consider the noise consequence when designing hospitals.
13. Strategies must be planned to minimize noise in hospitals in our country.

Finally, as this study showed that the governmental hospitals have higher SPL than private hospitals. Therefore, special measure has to be considered by the government in an attempt to try to solve noise problems in governmental hospitals. This study also, provides useful data for decision makers to improve the status of hospital environments. However, still a lot of additional tests are needed to support this study. For example, and since blood pressure was found to be affected by noise, the concentration of oxygen in blood (hypoxemia) can be studied because it is directly affected by the breathing process which in turn is highly affected by blood pressure (Long John G. et al., 1980).

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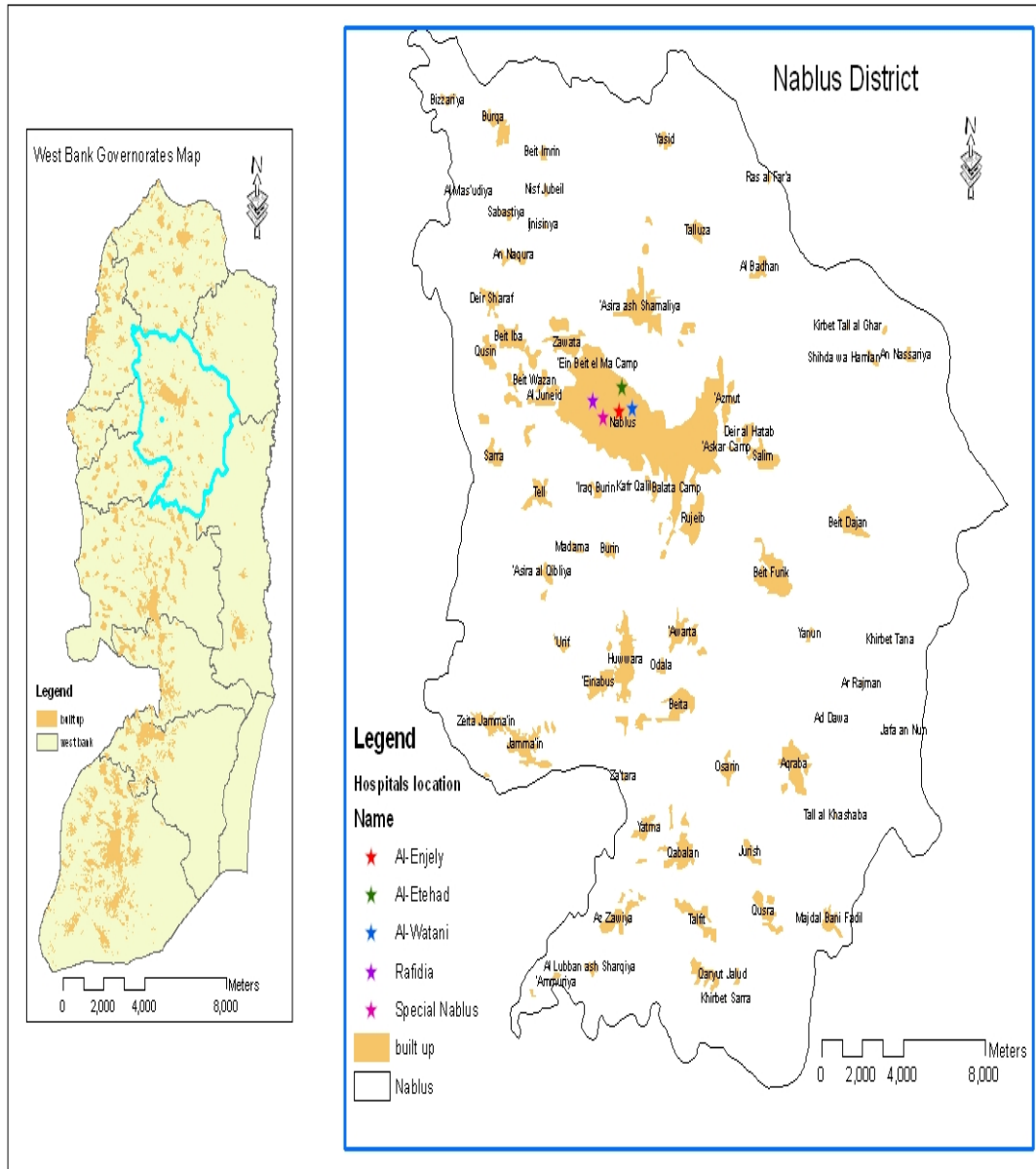
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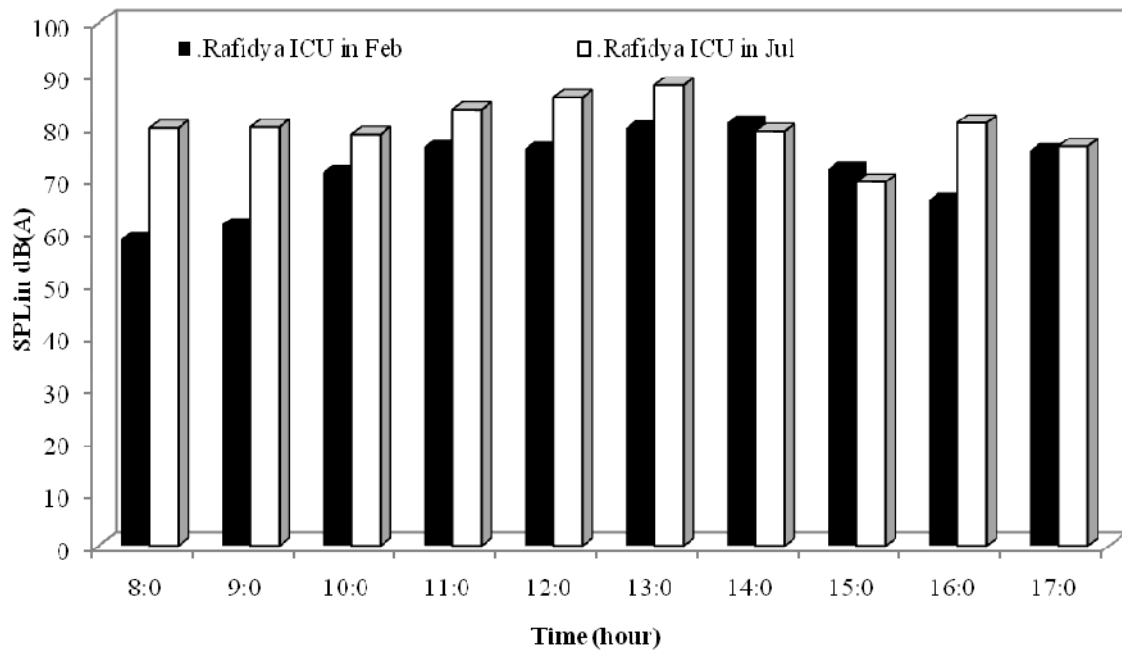
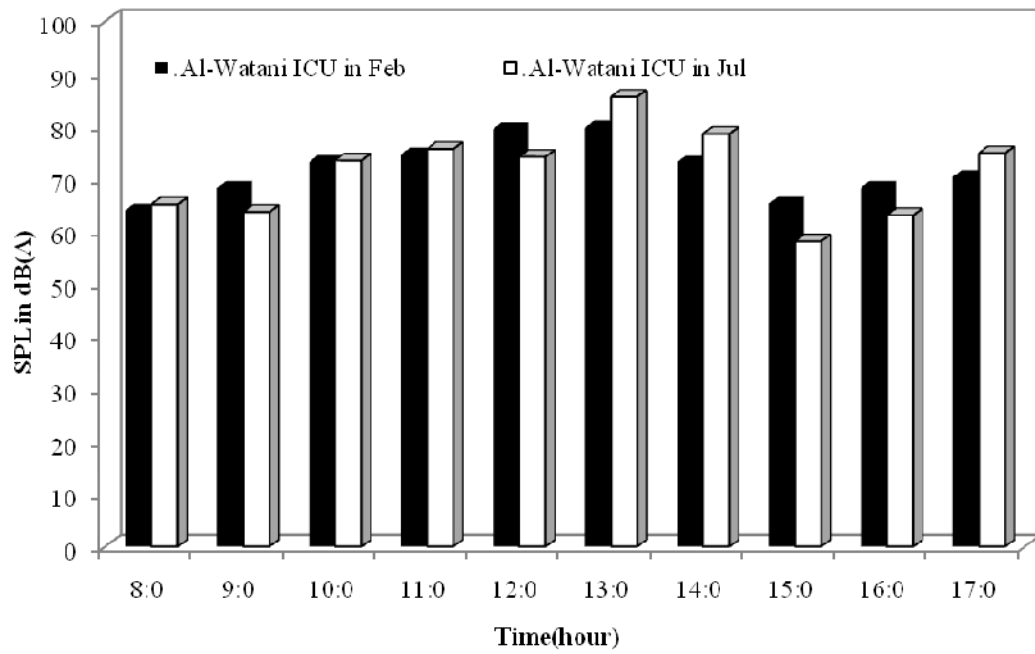
Appendix(A)

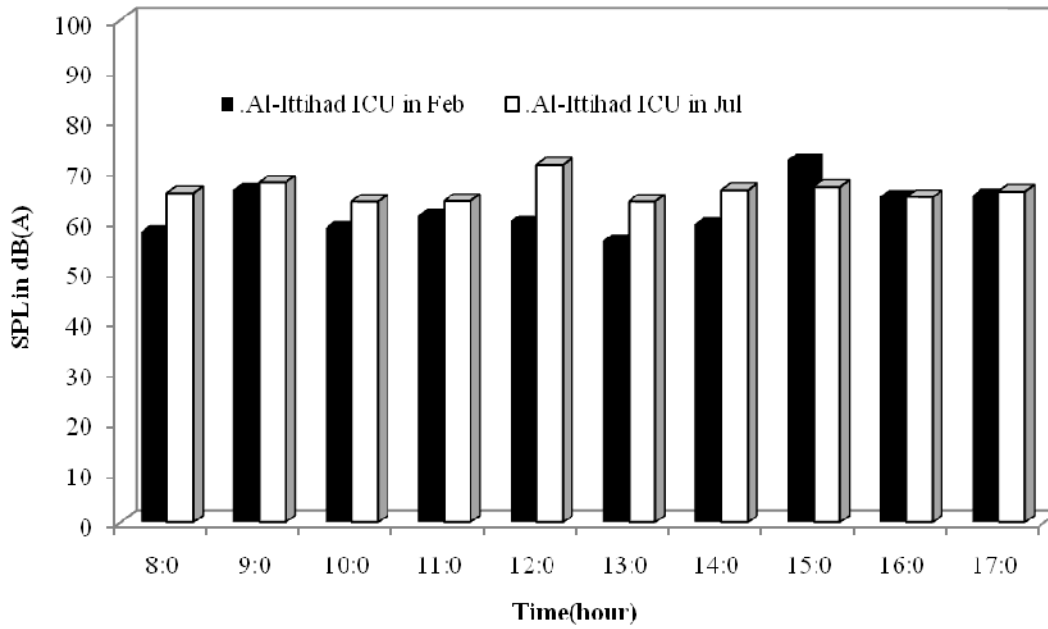
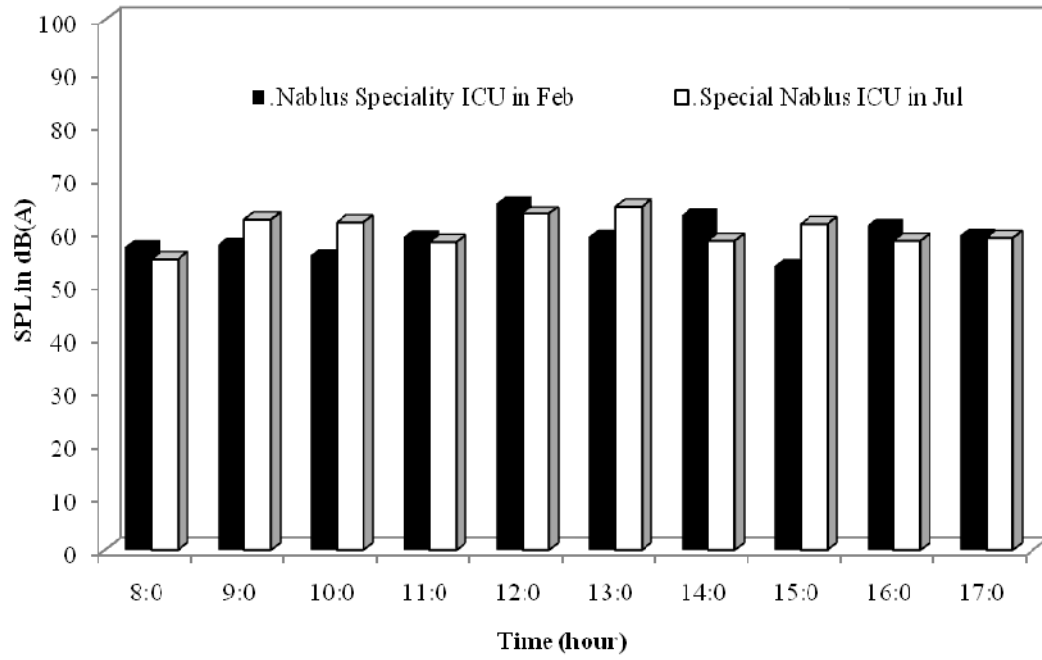


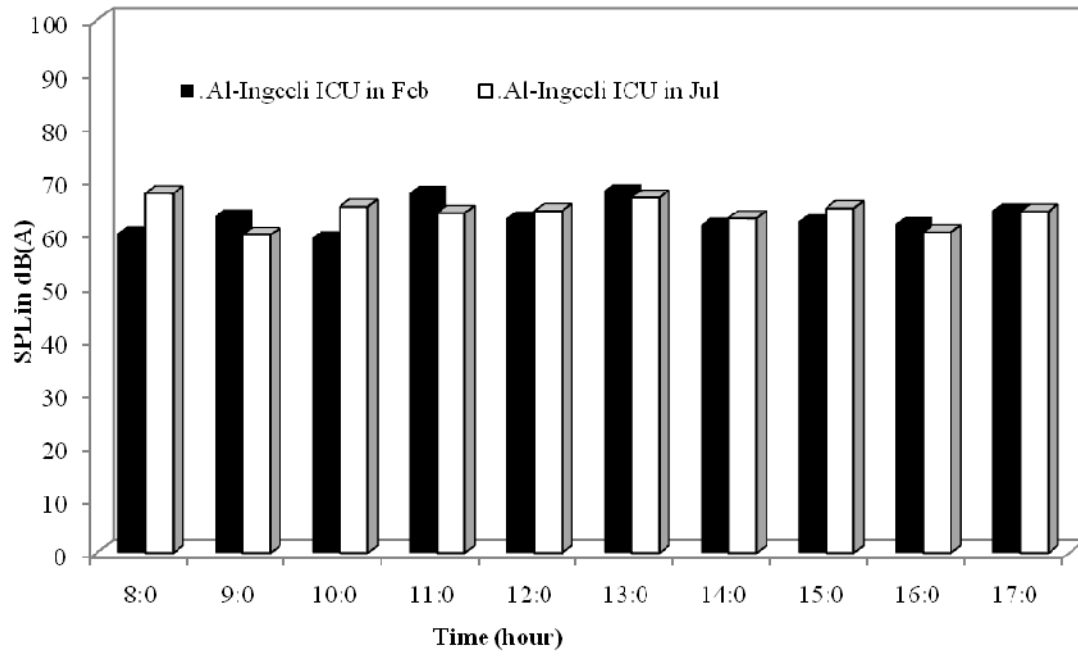
The sample hospital locations in Nablus city

Appendix (B)

Sound Pressure Level in all Studied ICU Departments

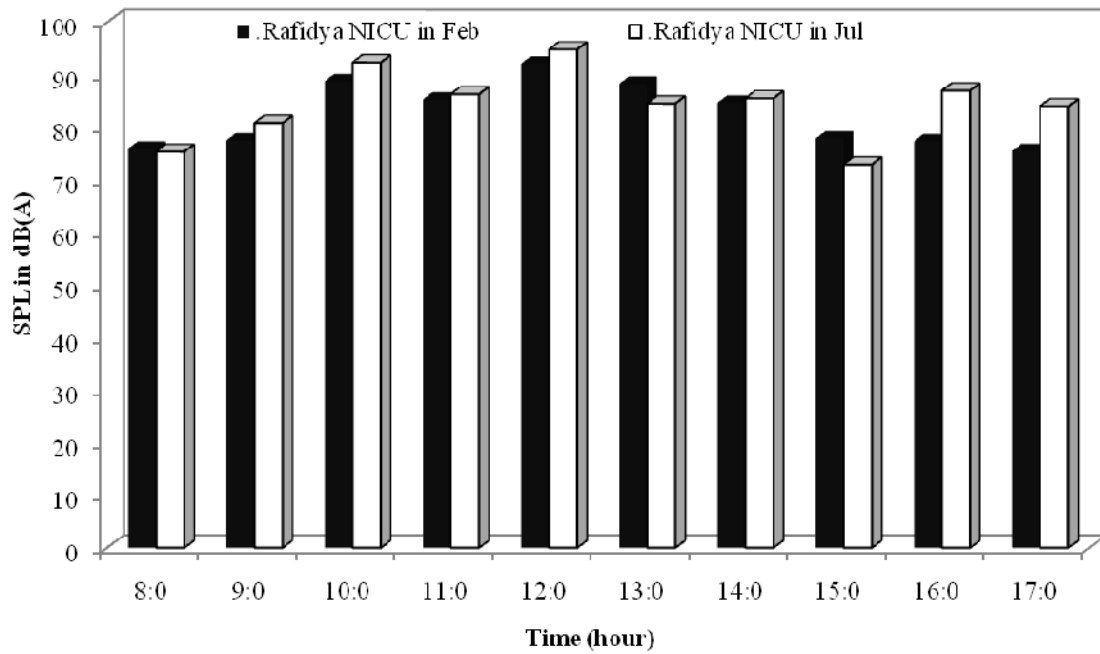
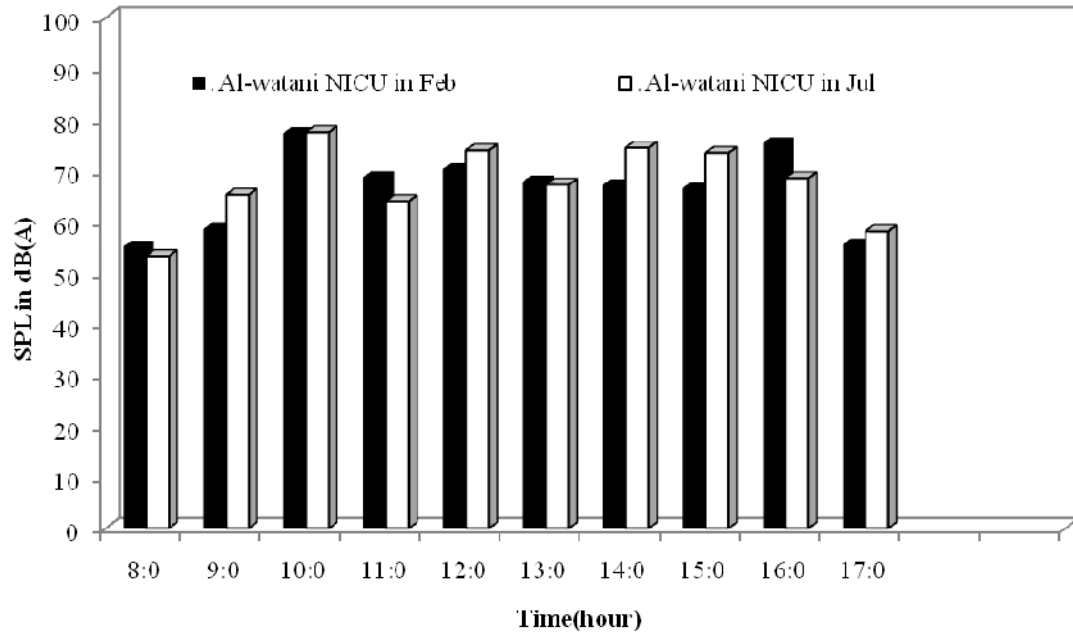


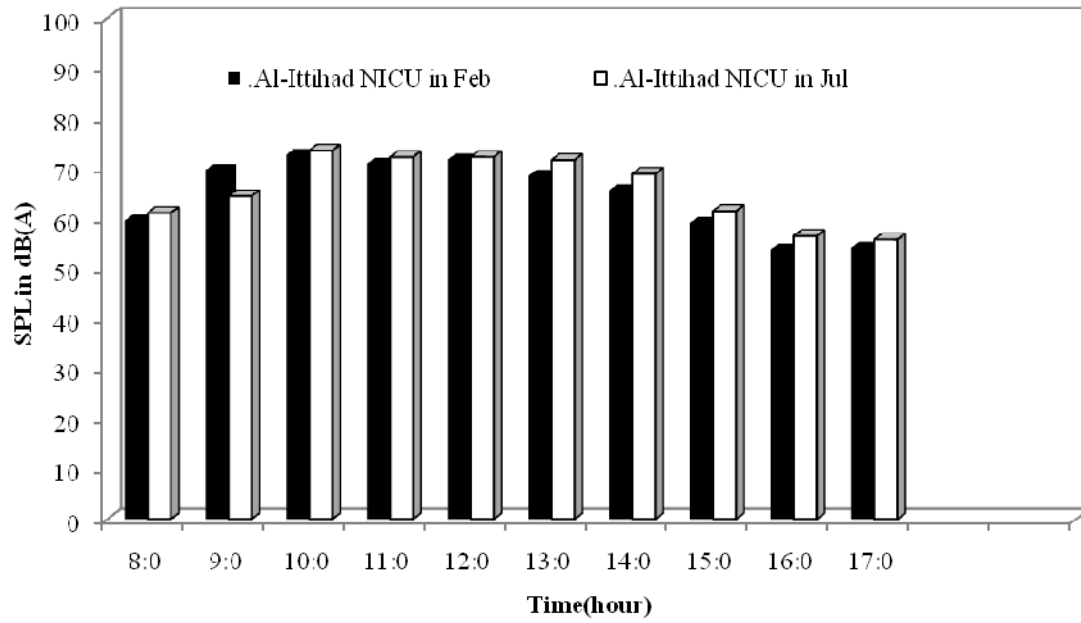
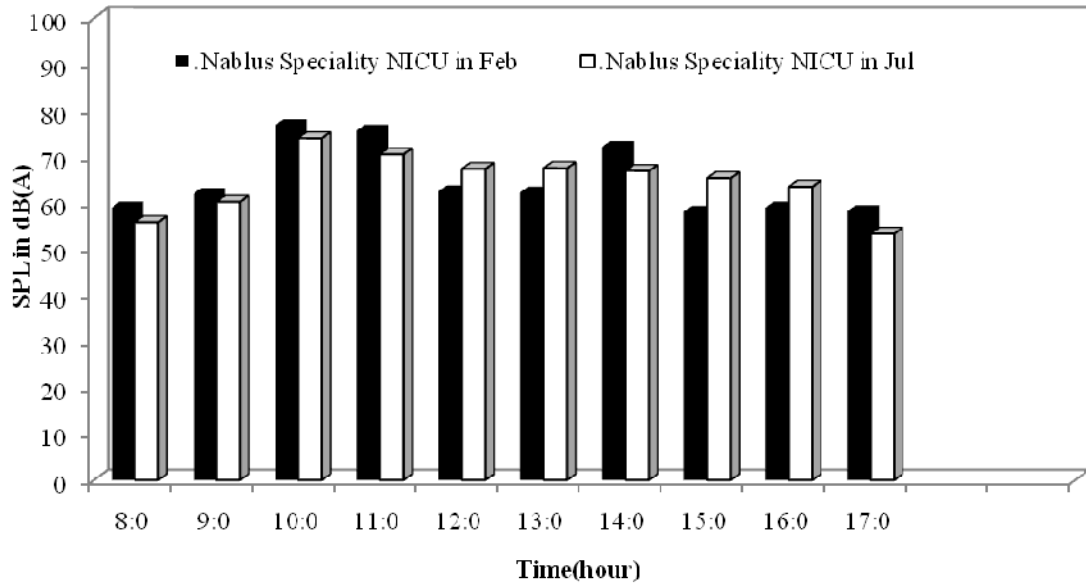


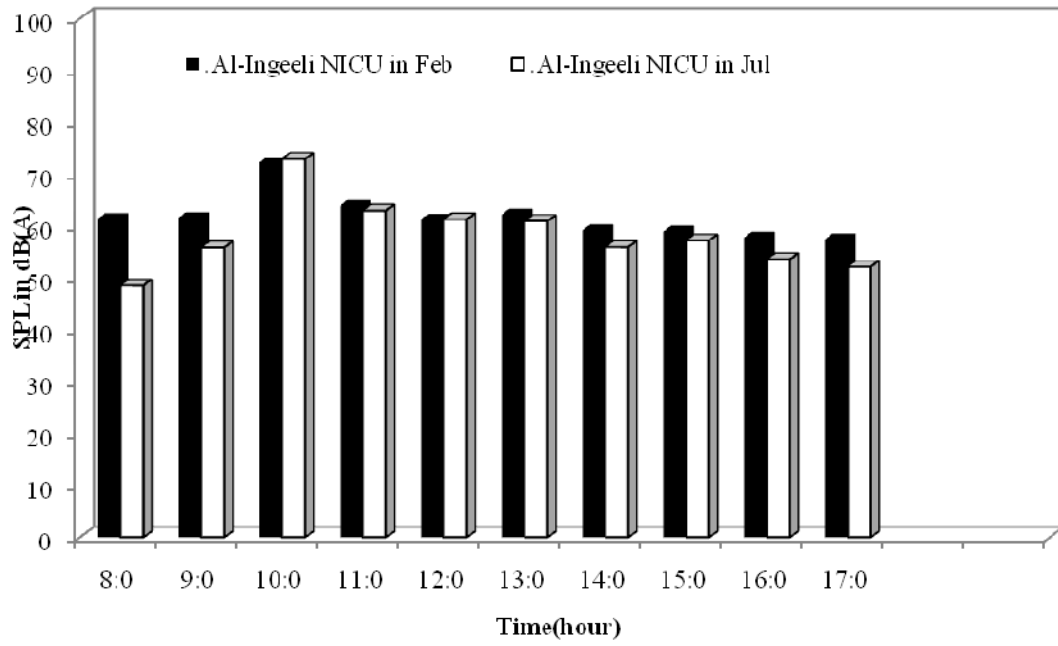


Appendix (C)

Sound Pressure Level in all Studied NICU Departments

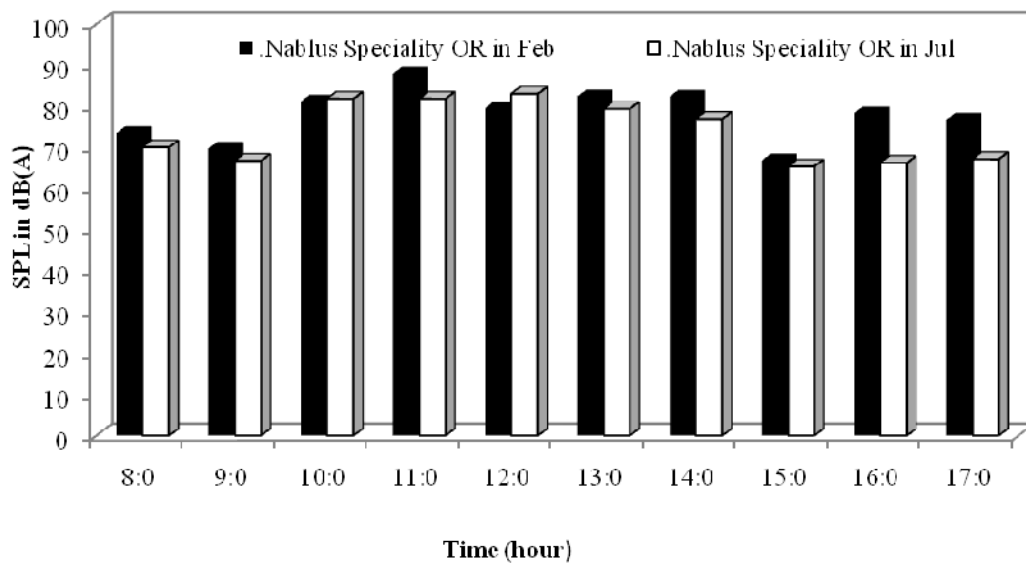
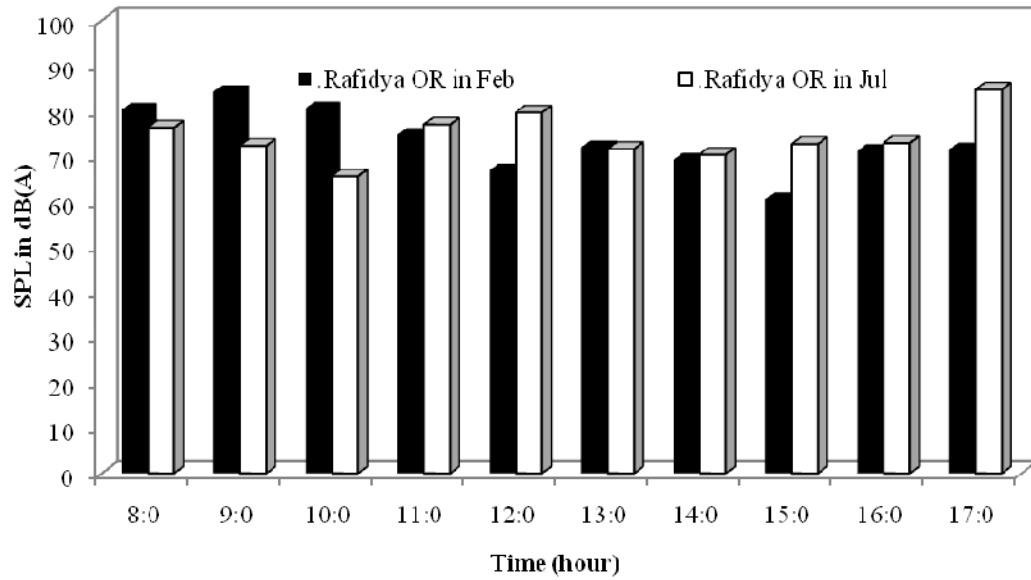


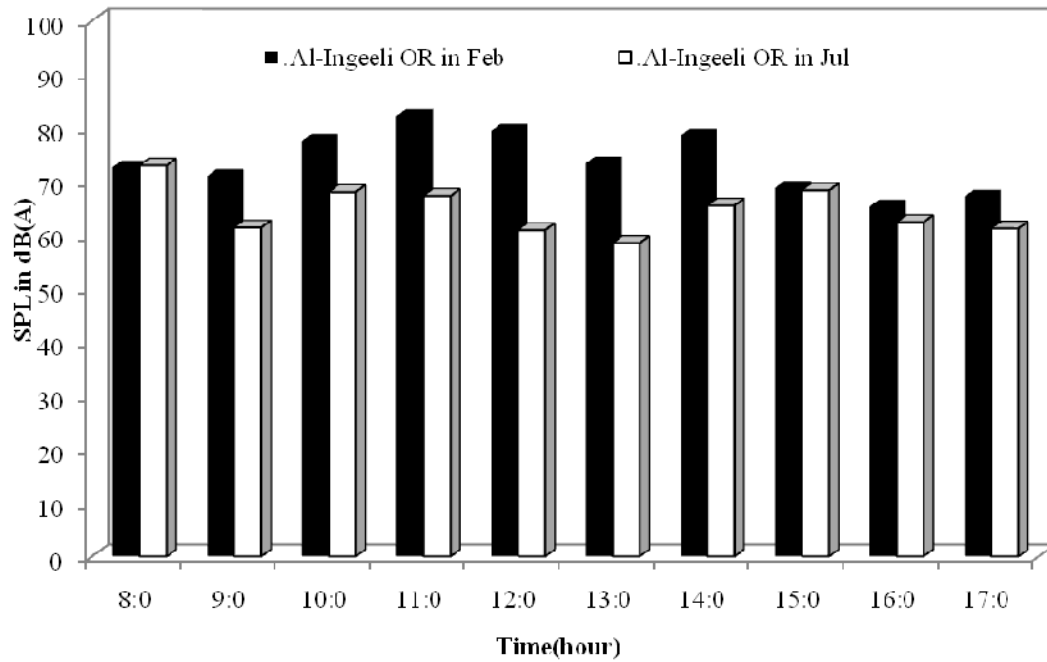
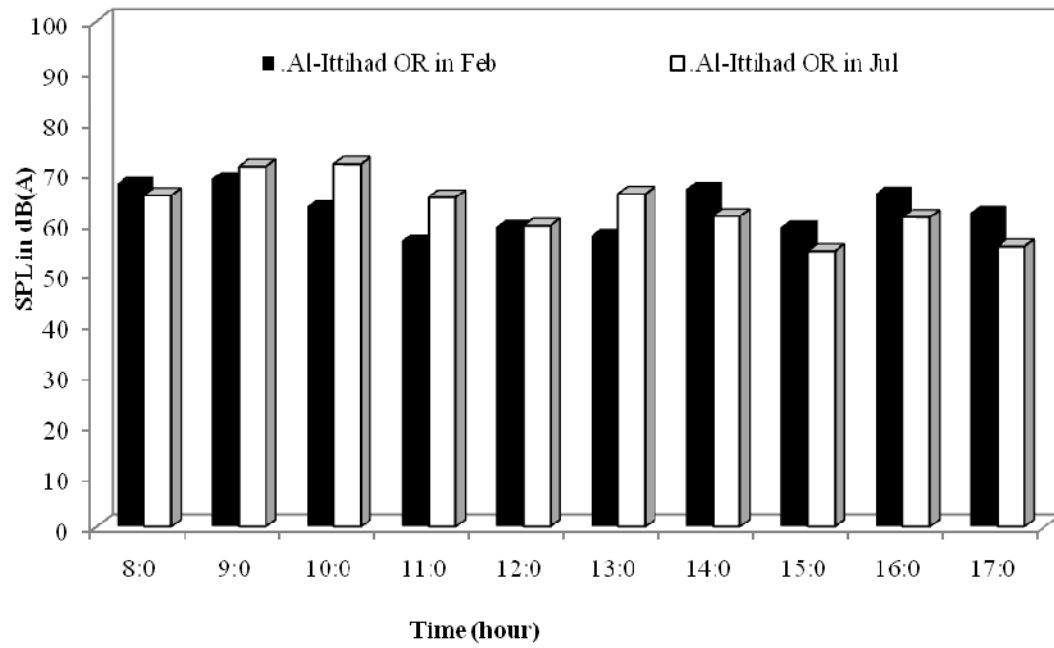




Appendix (D)

Sound Pressure Level in all Studied OR Departments





تأثير الضوضاء على ضغط الدم ونبض القلب عند الموظفين

في المستشفيات في مدينة نابلس - فلسطين

إعداد

رويدة محمود عيسى صادق

إشراف

أ. د. عصام راشد عبد الرازق

د. زيد نعيم قمحية

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

2011

ب

تأثير الضوضاء على ضغط الدم ونبض القلب عند الموظفين

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الملخص

ان التلوث الضوضائي قضية مهمة، خاصة في المستشفيات حيث يعد مشكلة بيئية تسبب الازعاج، لقد ركزت الدراسة على قياس مستويات الصوت في خمسة مستشفيات في مدينة نابلس، ثم مقارنتها بالمقاييس العالمية للضجيج، والمستشفيات هي مستشفى الوطني الحكومي ومستشفى رفيديا الحكومي و مستشفى نابلس التخصصي ومستشفى الاتحاد و مستشفى الانجيلي، ولقد تم اخذ القياسات في ثلاثة أقسام هي العناية المكثفة والحضانة وغرف العمليات.

أوجدت الدراسة ان معدل الضجيج يتراوح بين 64.0 الى 77.8 ديسبل في المستشفيات الخمس، وان التعرض المستمر لمستويات الضجيج هذه تسبب ارتفاع في ضغط الدم وتزايد في نبضات القلب حيث كان معامل ارتباط بيرسون قوي بين مستوى الصوت وضغط الدم (الانقباضي والانبساطي) ونبض القلب. اقترحت هذه الدراسة بعض التوصيات للعاملين في المستشفيات، والمسؤولين واصحاب القرار وذلك لتقليل مشكلة التلوث الضوضائي في مستشفيات مدينة نابلس.