An-Najah National University
Faculty of Graduate Studies

The Effects of Noise Pollution on Arterial Blood Pressure and Heart Pulse Rate of Doctors in their Dental Offices in Jenin City - Palestine

By

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Declaration

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

The Effects of Noise Pollution on Arterial Blood Pressure and Heart Pulse Rate of Doctors in their Dental Offices in Jenin City - Palestine

اقر 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 أي مؤسسة تعليمية او 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

ANOVA	Analysis of Variance.
dB	Decibel (s) (Unit of Sound Level Using a Logarithmic Scale).
DBP	Diastolic Blood Pressure.
D_i	ith dental offices.
$\overline{D_i}$	The average value of SPL of the ith dental office .
HI	Hearing Impairment.
HPR	Heart Pulse Rate
HR	Heart Rate.
L_{10}	Noise Level Exceeds 10% of Time.
L_{50}	Noise Level Exceeds 50% of Time.
L_{90}	Noise Level Exceeds 90% OF Time.
L_{eq}	Equivalent Noise Level.
L_N	Noise Levels Exceeds N% of Time.
L_{NP}	Noise Pollution Level.
Log	Logarithmic Scale.
M-SPL	Mean Sound Pressure Level
OSHA	The Occupational Safety and Health Act
P	Measured Sound Pressure.
P_{ref}	Reference Sound Pressure of Audible Sound.
P.R	Pulse Rate
SBP	Systolic Blood Pressure.
SPL	Sound Pressure Level.
WHO	World Health Organization.

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Abstract

This study reports the relationship between occupational noise levels with arterial blood pressure (systolic and diastolic), and heart pulse rate for dentists in their offices chosen randomly in Jenin City. The mean age of the sample doctors (dentists) is 40 year, and the mean duration of their service is 13.8 year. The noise levels measured during operational periods in the chosen dental offices were found to be between 90.5 and 91.7 dB. The arterial blood pressure (systolic and diastolic) and heart pulse rate of doctors were measured before and after exposure to noise for four hours. Strong positive correlation (Pearson Correlation Coefficient) with noise pollution was found for all measured variables. The mean blood pressure, for examples, has Pearson's Coefficient R = 0.629 for systolic and R = 0.475 for diastolic. In addition, heart pulse rate has a Pearson's Coefficient

R = 0.560. This study shows that after four hours of work, there is a significant increase in the mean measured values of blood pressure (systolic and diastolic) and heart pulse rate. The systolic blood pressure mean, for example, is increased by 4.4 mm-Hg, while the diastolic blood pressure mean is increased by 3.8 mm-Hg, and finally, the heart pulse rate mean is increased by 3.6 beats/minute. In addition, significant dependence is noticed between mean values of arterial blood pressure (systolic and diastolic) and heart pulse rate from one side, and doctors' ages and duration of their serving years from the other side.

Preface

Noise has always been an important environmental problem for human being. It has several impacts on human kind such as interfering with speech communication, raising blood pressure, producing temporary or permanent hearing loss and increasing heart pulse rate. In order to decrease the impact of noise on human life, rules and legislations have been issued since the early days in several countries. Going back in history, rules were issued in ancient Rome to reduce the effects of noise due to the ironed wheels of wagons which causing disruption of sleep and annoyance to the people. Similarly in Medieval Europe, horse riding was not allowed during night time in certain cities in order to ensure a peaceful sleep for the inhabitants (WHO 1999).

Recently, noise pollution is a challenging environmental issue appearing in the continuous disturbance of daily life of civilians in large areas. It has several impacts on mental and physical health and disturbance of daily activities. These effects might not be apparent immediately, but they can be noticed after continuous exposure to noise for long times.

The response of the human ear to sound depends on sound frequency and sound pressure. A normal ear in a healthy young person can detect sounds

with frequencies ranging between 20 Hz to 20 kHz, corresponding to the range from -10 to 140 decibels (dB) (Harris 1979).

Doctors in dental offices are exposed to equipments that emit different levels of noise ranging from 66 dB to 91 dB (Rebecca 2008) depending on a designated intensity, frequency, and duration (Bono 2006). Continuous exposure to high noise levels above 85 dB (Aysun 1994) from such equipments may result in some impacts on some of the following (Bono 2006): blood pressure, heart pulse rate, annoyance, emotional problems, nervousness, indigestion, headache, concentration ability …etc.

In this study, several measurements investigating the impacts of noise pollution in some selected dental offices in Jenin city were performed. Explicitly, the effects of noise pollution on arterial blood pressure (sec. (2. 3. 3)), heart pulse rate (sec. (2. 3. 3)), and hearing threshold levels of doctors in those offices are demonstrated (sec. (2. 3. 1).

Chapter One

Introduction

1.1 Literature Review

In order to minimize the effect of noise on human's attitude and health, many studies were conducted investigating the impact of noise in several places throughout the world. In dental offices, for example, several researches were done dealing with the equipments used and their effects on blood pressure, heart pulse rate, hearing threshold and tinnitus (Yonsei 1999, Daneby 2008, and Rebecca 2008). Another study dealt with the question of whether dentists are at greater risk than others (Bono 2006). The result of that study insure that 67% of dentists should use hearing protection because dental hand pieces were emitting noise levels that could cause hearing loss. Other studies have shown significant correlation between noise and its impact on artery disease including systolic and diastolic blood pressure, cholesterol concentration and plasma viscosity (Babisch 1998, Hanini 2002, and Sangeeta Singhal 2009). Additional study has found that noise can stimulate the bodies' stress response (Rick Weiss 2007). Some of the symptoms appearing on people in such cases might be

raising the blood pressure, increasing heart pulse rate and the blood becomes thick with Oxygen - toting red blood cells.

A set of studies have examined the level of hearing as a result of being exposed to noise. These studies highlighted the fact that there were many deafness cases which have occurred as a result of exposure to loud noise (Al-Wazzan 2005).

Impacts of noise pollution were also studied in some hospitals. The result of such studies have shown that high level noise have caused interference with communication, depression and induced hearing loss for patients and staff members (Rabinowitz PM 2000 and James 2008).

In 2007, the World Health Organization (WHO) published quantifying burden of disease resulted from some noise sources such as road traffic, trains and aircraft and their health effects on Europeans. They concluded that about 2% of Europeans suffer from severe sleep disturbance, and about 15% suffer from severe annoyance (Tart 2007).

In Palestine, some studies concerning noise and its effects on humans were done. For example, the sound pressure level was measured in some factories in Nablus city and Jenin city (Hanini 2002, Abdel-Ali 2001, and Salameh 2005). The effects of noise on the level of hearing, blood pressure and heart pulse rate were also studied (Hanini 2002). Moreover, efforts were made to investigate the impact of noise on children in some schools (Abdel-Raziq 2003 and Saeed 2010), and patients and workers in some hospitals (Sadeq 2011). It was shown that noise produces changes in systolic and diastolic blood pressures and heart pulse rate. This study have been initiated in order to gain more insight about noise levels and its effects on dentists' blood pressures and heart pulse rates as they work in their offices.

1.2 Objectives of This Study

Noise pollution data and its effects on human being are lacking in Palestine. Therefore regulations of noise pollution have not yet been formulated. In order to fill this gap, several measurements are still to be performed through over the country. The topic of this thesis constitutes part of such measurements which includes:

1- Investigations of noise pollution impacts in dental offices in Jenin city on the following:-

a. Systolic and diastolic blood pressure of dentists.

b. Heart pulse rate of dentists.

Chapter Two

Noise Pollution and its Health Effects

Measuring noise pollution is valuable because it gives researchers a method to determine its health effects and to learn how to control it. A common method of measuring noise is by sound pressure level (SPL) which can be defined as a measure of air vibrations that makes up sound. However, human ear can detect sounds in the range (20 μPa – 200 Pa) (Harris 1979). Since this is a wide range, logarithmic scale in decibel (dB) is used to compress the tremendous range of audible sound pressures.

Most environments contain a combination of sounds from more than one source. Adverse health effects are related to the total noise exposure from all sources.

2.1 Sound pressure level

As mentioned before, the lowest sound pressure possible to hear that corresponds to the threshold of hearing at 1000 Hz is approximately 20 μPa. And since this is a wide range, it is, therefore, more convenient to express the sound pressure as a logarithmic scale related to this lowest human audible sound as follows (Dara 1997):

$$SPL = 20 \log (P / P_{ref}) \text{ dB}. \qquad (2\text{-}1)$$

Where:

(P) is the measured sound pressure.

(P_{ref}) is the reference sound pressure of audible sound which is equivalent to 20 μPa.

If (P) is ranging between 20 μPa and 200 Pa then the (SPL) corresponding to this values is ranging between 0 dB and 140 dB, as obtained from equation (2-1). Several other physical quantities are being used to measure noise pollution including:

L_{eq}: The equivalent continuous sound level in dB.

L_{NP}: Noise pollution level which is given by the following equation (Stumpf 1980):-

$L_{NP} = L_{eq} + L_{10} - L_{90}$.

L_{10}, L_{50} and L_{90} represent noise levels exceeding 10%, 50% and 90% of time, respectively.

L_N: Noise levels exceeding N % of the time.

2.2 Sources of noise pollution

2.2.1 Industrial Noise

In industrial areas, noise sources exist both inside and outside the factory buildings from several machines and equipments. Using these machines includes various types of processing and production that are emitting high noise levels. In Britain, a study of noise emission levels in industry (Sharma 1998) has revealed that coal industry has higher noise levels than established limits for occupational noise exposure in WHO. The industrial

noise problem is very obvious. Many institutes pay attention to this issue. The Occupational Safety and Health Administration (OSHA) play an essential role. It puts the occupational noise standards which guarantee the humans health, such as the OSHA permissible noise exposure (Table 1.1) (OSHA 2004).

Table (2.1): OSHA permissible noise exposures.

Time permitted per day (hour)	Sound Level (dB)
16	85
12	87
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

2.2.2 Transportation Noise

Transportation noise includes road, rail and air traffic noises. All of them emit high level of sounds in different method like: engine, frictional contact between the vehicle and the ground, proportions of take off and landings. These methods change in engine speed and power, as a result of this, noise levels are increasing (Mato and Mufuruki 1999).

2.2.3 Buildings Services and Construction Noise

There are a lot of sounds emitted from buildings construction including: cranes, cement mixers, welding, hammering, boring and other work processes. Building operations and construction equipments are poorly silenced because they are carried out in free air where it is very difficult to surround noise. As a result noise emissions are increased by such equipments (WHO 1999).

2.3 Health Effects of Noise Pollution

Noise produces direct adverse health effects in residential, social, working, and learning environments. Several of these effects on humans have been studied in several places.

2.3.1 Hearing Impairment

Human hearing systems are not equally sensitive to all sound frequencies. Exposure to loud sounds from several sources for long periods reduces ear ability to transmit sound causing hearing impairment (HI). Table (2.2) (Rebecca 2008) shows the types of noise induces hearing impairment.

Table (2.2): Types of noise-induced hearing impairment

Types of noise	Level of hearing loss
Few exposures, intense sound level	Acoustic trauma
Temporary hearing change following exposure to noise	Temporary threshold shift
Result of accumulation of exposure to noise; irreversible	Permanent threshold shift

Other effects of noise on hearing like hemorrhage, rupture, and luxation have been studied (Harris 1979 and Nguyen 1998).

2.3.2 Tinnitus (طنين الأذن)

Tinnitus is a condition in which one hears what is often described as a ringing, whistling, or buzzing sound that is perceived only by the affected person (Rebecca Mervine, 2008). In addition to tinnitus, dentists have other

health noise impacts like anxiety, concentration difficulty, sleep disturbances, depression, or difficulty in spoken communication.

2.3.3 Systolic and Diastolic Blood Pressure and Heart Pulse Rate

Scientists in the world have observed a significant increase in systolic blood pressure, diastolic blood pressure and heart pulse rate when humans are exposed to any source of noise. For example, direct effect of noise on arterial wall tension was found to influence the blood pressure and heart pulse rate through sympathetic nervous system (Neurophysio 2001). In addition, exposure to noise causes an elevation of blood pressure by the increase in total peripheral resistance and myocardial contractility (Edwards 1995). Moreover, the repeated stimulation with noise accelerates the development of structural vascular changes in the peripheral resistance vessels. Accordingly, this mechanism creates permanent blood pressure elevation to hypertensive levels.

2.3.4 Social and Behavioral Effects of Noise Annoyance

People are exposed to noise in different levels. Depends on many factors of a social, psychological and economic nature. Therefore, social and psychological behavior has been noticed to be negatively influenced. Including: performance (Harris 1979 and Hanini 2003), mental illness (Cunniff 1997), sleep disturbance (Rebecca 2008).

Chapter Three

Methodology

3.1 Study Population

This study was carried out on a sample of fifteen doctors (4 females, 11 males) aged 24-54 years, with a minimum of 2 years serving duration. All doctors had no history of heart disease, blood pressure, or hearing loss. The 15 dental offices are rented in large buildings in different sites in the city. These buildings have no regulations to reduce noise pollution there. Therefore, this study is found to investigate the status of noise pollution there. The measured values will be compared with the standard scales of noise to classify the selected dental offices according to noise level and noise dose. The variations of noise level are consistent with all working hours.

3.2 Experimental Method

Data collection was carried out in the selected offices during morning hours (between 9:00 am and 13:00 pm), during the period from January to May 2009. At the dental offices, the microphone of sound level meter was placed at a 15cm distance from the dentist's ear in order to capture sounds at the intensity they influence the operator's ears. High-speed hand pieces, low-speed hand pieces, high-volume aspirators, ultrasonic scalars, amalgamators, and background noises were the equipment tested. The level of the noise was measured while the instrument was at different running speed without cutting operation every 40 second, and arterial blood pressure and heart pulse rate were taken every 30 minute.

3.3 Instrumentation for Noise Measurements

In order to compute the parameters and assess the results of noise, two instruments have been used in this study including:

3.3.1 Sound Pressure Level Meter

Sound Level Meter, is the instrument used to measure the noise level in dB. It is designed to approximate the loudness level sensitivity of the human ear. It gives objective, reproducible measurements for the sound pressure level. The microphone converts the sound to an equivalent electrical signal, which varies in with the acoustical signal. The output signal from the microphone is very small and needs to be converted in the preamplifier before further processing takes place (Instruction manual 1998 b). In this study sound pressure level meter measurements were carried out using a logging sound level meter (Quest Technologies, U.S.A, model 2900 type 2), in dB units with an accuracy of ± 0.5 dB at 25ºC. This device gives the readings with precision of 0.1 dB.

Figure (3.1): Sound pressure level meter model 2900 type 2(Instructions manual 1998 b).

3.3.2 Wrist Blood Pressure Monitor

The blood pressure (systolic and diastolic) and heart pulse rate were measured for each doctors by Automatic Digital Electronic Wrist Blood Pressure Monitor, (model WS-300) with accuracy ± 3 mm-Hg, and ± 5% for reading heart pulse rate with operating temperature range of +10 ºC to +40 ºC (Instruction manual 1998a).

Figure (3.2): Arterial Blood Pressure and Heart Pulse Rate Meter, model WS-300 (Instruction manual 1998a).

3.4 Statistical Analysis

The measurements will be analyzed statistically as the following:

1- SPSS program was used to obtain global picture about the noise pollution practices at the dental offices. Many statistic measures were known there like mean values.

2- Analysis of variance test (ANOVA) was used in this study, to detect associations between noise level as independent variables and heart pulse rate, systolic blood pressure, and diastolic blood pressure as dependent variables.

3- Pearson correlation factor (R) was used to measure the strength correlation between noise pollution levels and the dependant variable. Statistical tests with $P < 0.05$ were considered statistically significant.

Chapter Four

Results

4.1.1 Sound Pressure Levels (SPL)

The sample study of this research is composed of fifteen doctors (11 males and 4 females) with the mean age of about 40 year. The mean duration of their serving time is 13.8 year. The studied 15 dental offices are located in different zones of the city. All of them are located in big buildings as rented offices and they are chosen according to the most effective ones. They are symbolized by D_i, where (i) is an integer from 1 to 15. The average value of SPL of each dental office is denoted by $\overline{D}_i$. All D_i values and their means during four hours of work are shown in table (4.1).

Table (4.1):

The measured values of sound pressure Levels in all selected dental offices divided into three groups of doctors as follows: (a) 24 - 34 year old (D_1 - D_5), (b) 34 - 44 year old (D6 - D10), (c) 44 - 60 year old (D11- D15), and average value $\overline{D}_i$ for each dental office during four hours of work (9:00 am – 13:00 pm).

Time (minute)	(a) Sound Pressure Levels (dB)					(b) Sound Pressure Levels (dB)					(c) Sound Pressure Levels (dB)					The average value for all dental offices
	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	
10	85.6	85.6	85.6	85.8	85.1	87.6	87.2	87.6	86.9	86.9	88.0	87.7	87.7	87.1	86.9	**86.8**
20	89.8	89.6	90.2	89.6	88.9	93.2	93.6	93.3	93.4	93.1	91.5	91.6	91.5	91.6	91.7	**91.5**
30	94.0	93.4	93.6	94.0	93.8	94.9	94.8	94.7	94.2	94.7	93.3	92.5	91.9	92.9	92.9	**93.7**
40	93.0	93.0	93.9	93.0	93.8	90.1	90.4	90.0	89.7	90.1	95.6	95.0	94.5	94.5	94.9	**92.8**
50	87.8	88.3	89.1	87.6	87.9	90.8	90.0	91.2	89.1	89.6	91.2	90.9	91.6	91.1	90.8	**89.8**
60	86.9	87.0	86.7	86.5	87.0	91.9	92.6	92.6	92.0	92.4	89.2	89.5	89.4	89.0	89.5	**89.5**
70	91.1	91.0	91.4	90. 5	90.1	94.9	94.8	94.7	94.2	94.7	94.9	94.8	94.7	94.2	94.6	**93.4**
80	95.2	95.3	94.9	94.7	94.8	93.0	93.7	93.1	92.0	92.6	90.3	90.0	90.0	89.6	90.0	**92.6**
90	94.3	94.3	93.7	93.2	94.3	90.7	92.0	89.7	91.6	88.1	86.5	86.8	87.6	86.7	87.3	**90.4**
100	88. 5	88.3	89.3	88.0	88.3	92.5	93.6	90.8	92.1	90.9	89.1	88.5	89.2	89.0	89.6	**89.8**
110	90.1	90.4	90.9	89.5	89.5	93.3	94.7	91.9	93.0	93.0	92.2	92.8	92.7	92.3	91.7	**91.9**
120	93.8	93.6	94.0	93.3	92.8	95.8	94.7	92.9	93.9	94.6	94.9	95.1	94.6	95.3	94.8	**94.3**
130	89.7	89.9	89.3	89.6	89.8	87.0	85.9	84.8	90.8	85.7	93.0	93.4	92.9	93.3	93.9	**89.9**
140	88.1	88.6	88.7	88.4	89.0	88.9	87.4	86.8	92.0	89.2	91.5	90.0	90.4	90.9	91.6	**89.4**
150	92.9	92.4	93.0	92.8	92.3	89.9	88.1	89.0	89.5	90.7	87.6	87.2	87.6	86.9	86.9	**89.8**
160	87.0	86.9	87.4	86.7	86.8	91.5	89.6	89.7	90.9	91.7	93.2	93.6	93.3	93.5	93.1	**90.3**
170	94.9	94.8	94.7	94.2	94.3	91.6	90.6	89.9	90.2	90.6	94.9	94.8	94.7	94.2	94.6	**93.3**
180	94.3	94.3	93.7	93.2	94.3	91.9	92.6	92.6	92.0	92.4	90.1	90.4	90.0	89.7	90.1	**92.0**
190	89.9	90.9	90.4	90.4	90.0	94.9	94.8	94.7	94.2	94.7	91.9	91.7	93.0	91.2	91.6	**92.3**
200	85.7	85.5	86.0	85.7	85.8	88.3	88.4	87.1	91.0	86.6	93.1	93.5	93.0	92.6	92.5	**89.0**
210	88.0	88.0	88.8	88.3	89.0	88.0	87.0	85.8	91.2	87.3	88.9	87.4	87.4	88.0	89.2	**88.1**
220	90.8	90.8	91.1	90.6	90.3	90.9	88.9	89.5	93.0	91.9	91.0	90.1	90.8	90.6	91	**90.7**
230	93.7	93.8	93.6	93.9	93.6	93.4	94.7	91.9	92.9	92.9	95.2	95.2	94.9	94.7	94.7	**93.4**
240	95.6	96.0	95.7	95.8	95.6	94.9	94.8	94.7	94.2	94.6	93.2	93.6	93.3	93.5	93.1	**94.6**
$\overline{D}_i$	**90.8**	**90.6**	**91.1**	**90.9**	**90.9**	**91.1**	**90.9**	**90.5**	**91.6**	**91.0**	**91.7**	**91.6**	**91.3**	**91.5**	**91.5**	

From table (4.1) the mean values of the sound pressure levels to all selected dental offices lies between 90.5 - 91.7 dB. These measured values are considered to be high (according to OSHA permissible noise exposures above 90 dB with eight hours working is considered risky, recall table (2.1). So all selected dental offices can be classified as noisy sources because the same instrumentation are used during working hours. Table (4.1) is used to display graphically the measurements of sound pressure levels during four working hours in figure (4.1). The values are plotted in three graphs a, b and c (groups). Every group includes five dental offices which depends on the ages of the doctors as follows: Group (a) doctors whom ages are 24-34 year, group (b) doctors whom ages are 34-44 year, group (c) doctors whom ages are 44 - 60 year, respectively.

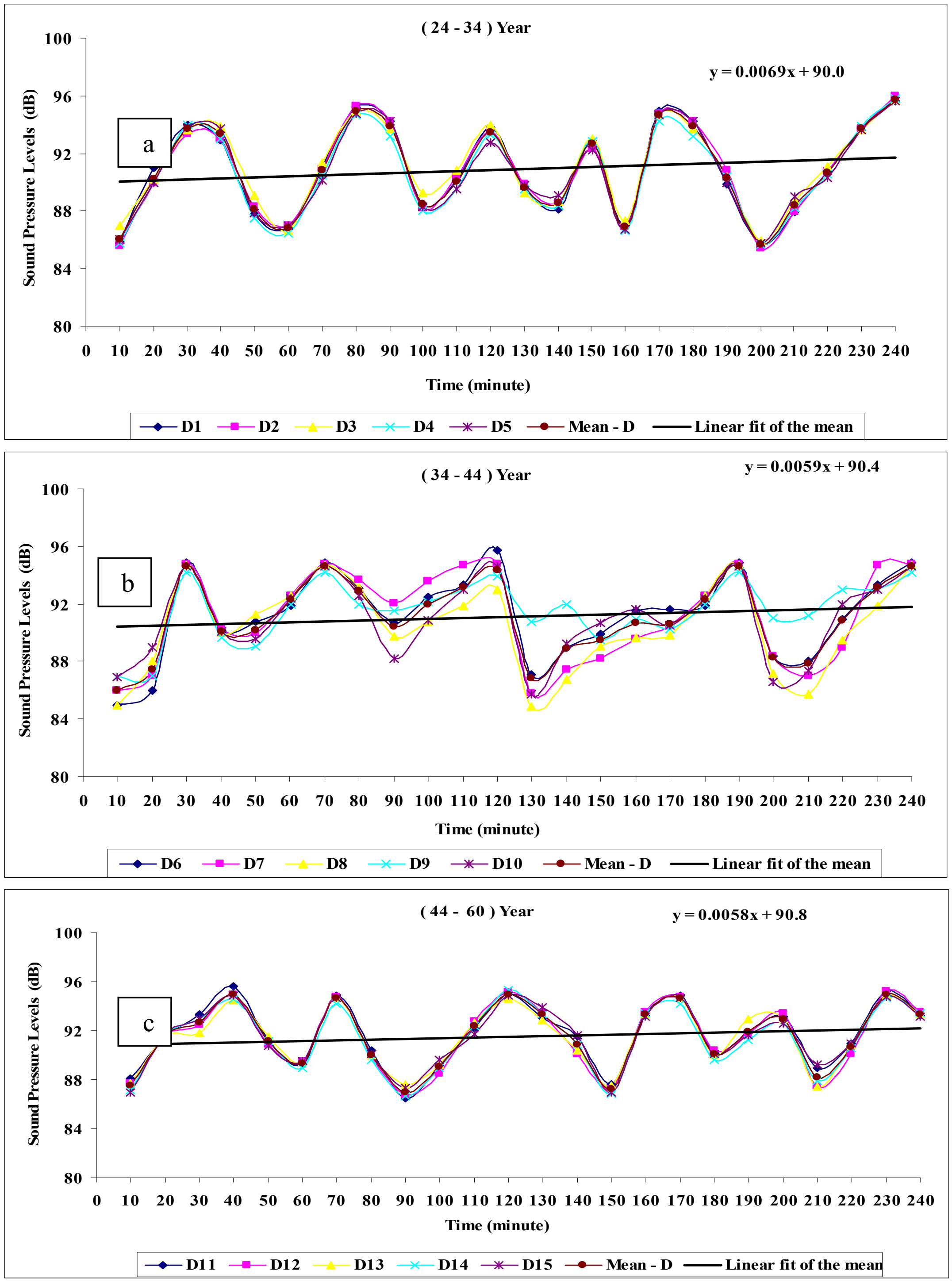


Figure (4.1): The values of sound pressure levels and best linear fit of the means as a function of exposure time in all selected dental offices divided into three groups of doctors as follows: group (a) 24 - 34 year old, group (b) 34 - 44 year old, and group (c) 44 - 60 year old.

The mean values of sound pressure levels for all dental offices fluctuate around 91 dB with no significant change as a function of time. The mean values of those noise levels were calculated every five minutes during four continuous hours between (9:00 am and 13:00 pm) and are shown in fig. (4.2).

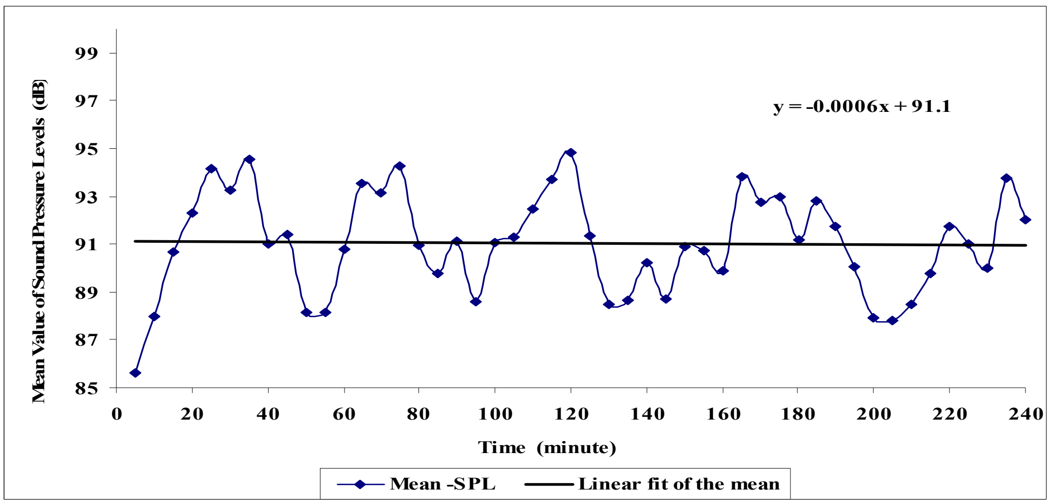


Figure (4.2): The mean sound pressure levels and best linear fit of the mean as a function of time in all selected dental offices.

Several remarks are obvious from figures (4.1) and (4.2):

1- Figure (4.1) shows that the intercepts of SPL in the four working hours was 90.0 – 90.8 dB, and the slopes of SPL approximately lies between 0.0058 – 0.0069. Accordingly, all doctors in the selected sample were exposed to similar SPL.

2- It is noticed that the peak value of SPL was around eleven o'clock which is the rush hour (after 120 minute from starting measurements).

4.1.2 Arterial Blood Pressure (Systolic and Diastolic)

Systolic and diastolic blood pressure (SBP and DBP) during working hours for doctors (9:00 am – 13:00 pm), in all selected dental offices, were measured and recorded (table (4.2)). The doctor's genders, ages, and serving years were also recorded.

Table (4.2):
Doctor's genders, ages, and their serving year and the measured values of systolic and diastolic blood pressure during working hours (9:00 am – 13:00 pm) for doctors, in all selected dental offices.

Gender	Age (year)	Number of serving years (year)	Systolic Blood Pressure Before Work (mm-Hg)	Systolic Blood Pressure During Work (mm-Hg)								Diastolic Blood Pressure Before Work (mm-Hg)	Diastolic Blood Pressure During Work (mm-Hg)							
			9:00 am	9:30 am	10:00 am	10:30 am	11:00 am	11:30 am	12:00 noon	12:30 pm	13:00 pm	9:00 am	9:30 am	10:00 am	10:30 am	11:00 am	11:30 am	12:00 noon	12:30 pm	13:00 pm
			Sys	Sys	Sys	Sys	Sys	Sys	Sys	Sys	Sys	Dia	Dia	Dia	Dia	Dia	Dia	Dia	Dia	Dia
M	24	2	125	126	128	132	134	136	138	139	140	81	85	87	88	88	89	89	90	90
M	26	3	126	128	129	130	131	134	136	137	139	83	85	86	87	87	87	88	89	89
F	29	4	126	128	130	136	140	140	141	142	143	82	81	82	86	89	90	90	91	91
M	30	5	125	127	134	137	140	141	143	143	145	75	78	81	82	86	87	88	90	90
M	32	6	124	128	133	137	140	140	141	143	144	78	79	86	87	88	88	90	90	91
F	36	10	128	133	133	140	141	145	148	150	150	78	84	84	85	88	91	93	93	94
M	38	11	130	134	136	140	145	146	150	151	151	85	87	88	88	91	94	95	97	98
M	41	13	125	131	138	142	144	147	149	150	151	83	87	90	94	95	96	97	98	98
F	42	15	130	137	139	143	146	147	149	150	151	75	82	85	88	89	91	93	94	95
M	43	17	138	138	139	141	144	152	154	156	156	85	88	88	90	92	101	103	103	104
M	45	20	125	130	132	138	140	142	146	150	153	78	81	86	87	90	94	98	99	100
F	47	21	135	140	144	146	149	150	152	153	154	88	89	90	93	90	93	97	97	99
M	53	27	138	138	139	141	144	152	154	156	156	85	88	88	90	92	101	103	103	104
M	55	28	124	135	138	139	143	145	147	147	151	78	88	85	91	92	93	98	99	100
M	60	30	125	135	137	139	144	149	153	155	157	88	89	90	90	94	99	100	100	101

Table (4.2) shows the effect of noise pollution on the dependent variables (systolic and diastolic blood pressure). The data of systolic and diastolic blood pressure due to noise are plotted in figures (4.3) and (4.4), respectively. Both figures are divided into three groups a, b, and c, every group includes five dental offices according to doctors' ages.

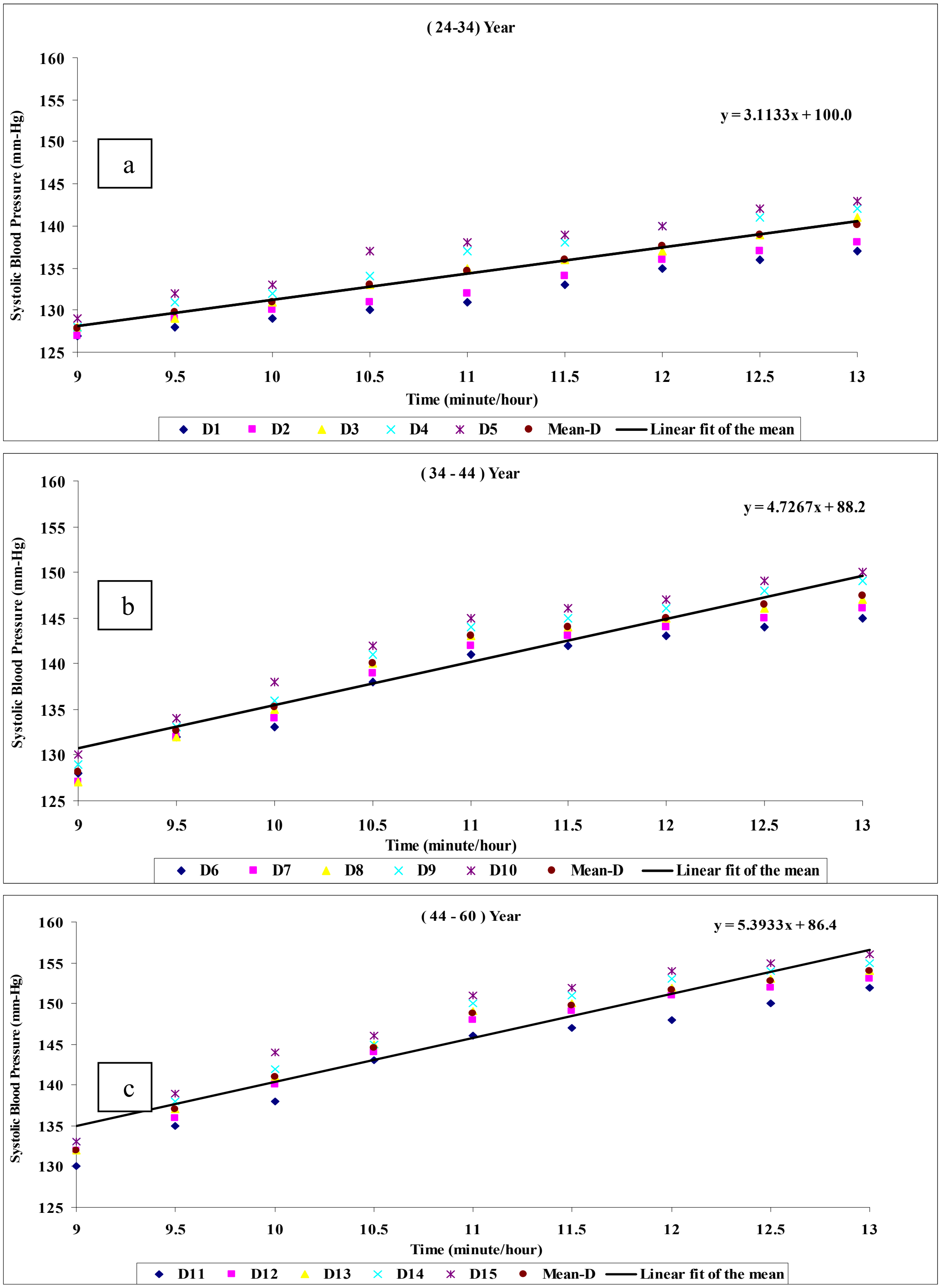


Figure (4.3): The values of SBP and best linear fit of the mean as a function of exposure time in all selected dental offices divided into three groups of doctors as follows: group (a) 24-34 year old, group (b) 34-44 year old, and group (c) 44-60 year old.

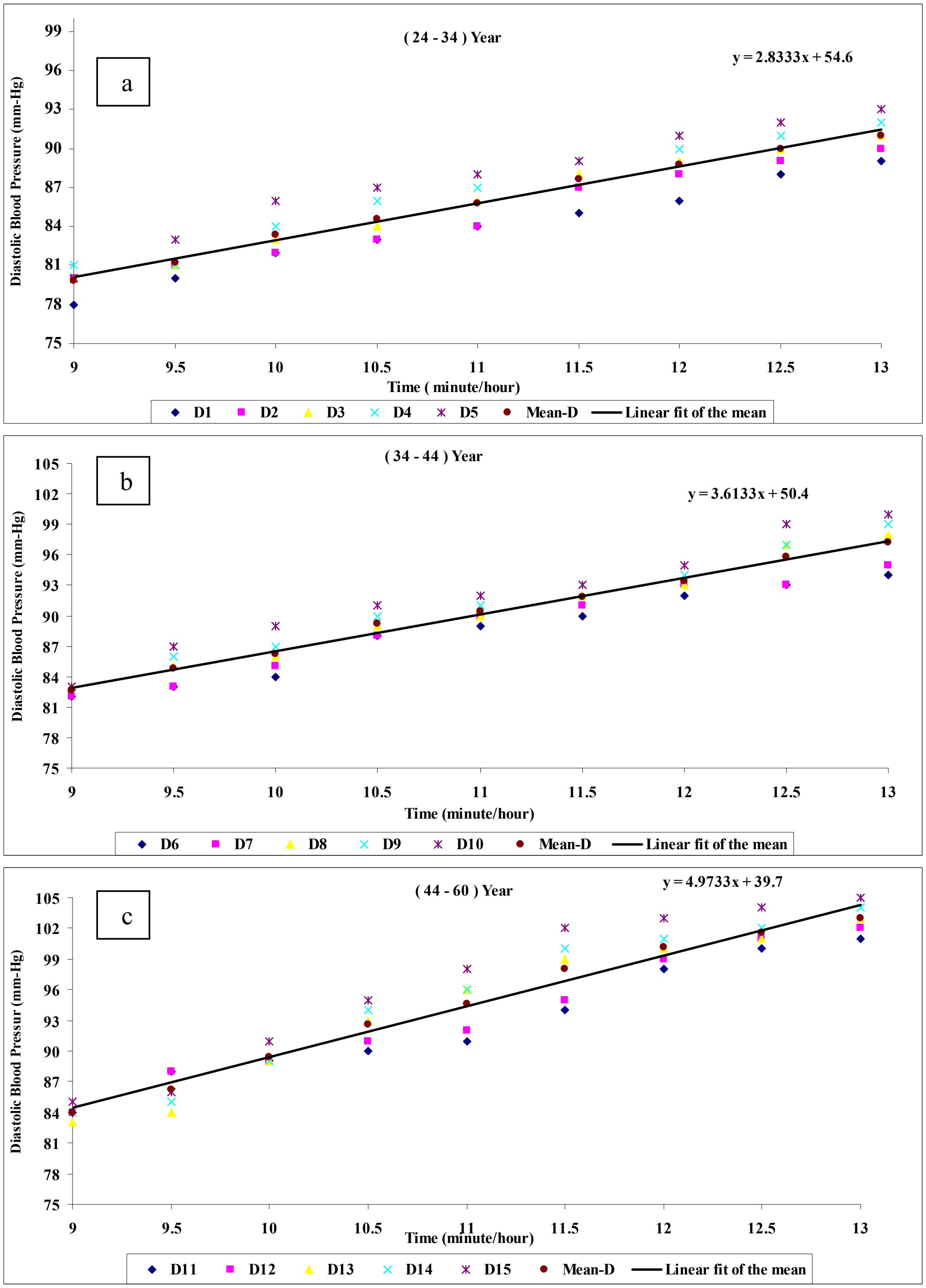


Figure (4.4): The values of DBP and best linear fit of the mean as a function of exposure time in all selected dental offices divided into three groups of doctors as follows: group (a) 24-34 year old, group (b) 34-44 year old, and group (c) 44-60 year old.

Figures (4.3) and (4.4) show an increase in the measured values of systolic blood pressure and diastolic blood pressure to all selected doctors before and while exposed to noise during all working hours. This increase might be due to the long time that doctors exposed to noise from instrumentation used in their dental offices. The degree of increment is different from one group to another, and this difference might be due to some factors like doctor ages and serving duration as discussed below:

1. Doctor ages

The slopes of the measured values of systolic blood pressure to all doctors according to their ages are as follows: 3.1, 4.7, 5.4 mm-Hg, respectively, and for diastolic blood pressure are: 2.8, 3.6, 5.0 mm-Hg, respectively. Comparing the slopes, the study concludes that the measured values of these variables increasing with the increasing of doctor ages when they are exposing to noise. Doctors whom ages 44 - 60 year (D_{11}–D_{15}) are more affected by noise than doctors whom ages are 34 - 44 year (D_6 –D_{10}). Whereas the doctors of the group of ages 24 – 34 year (D_1 –D_5) are the least affected ones. The data of each group can be fitted to a linear function as shown in figures (4.5) and (4.6). The results of the fits show that the increasing rate for each group ages is different from another, also the arithmetic mean of the increasing rate of the different group of all selected doctor's is also different.

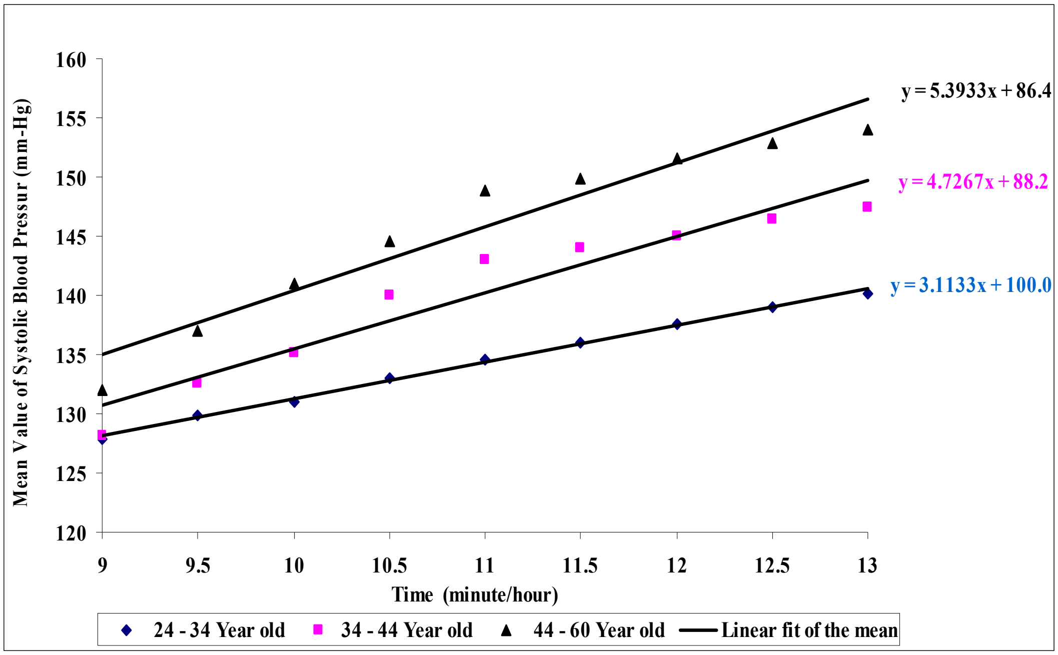


Figure (4.5): The mean values and best linear fit of the mean of SBP as a function of exposure time which measured every 30 minutes for different group ages.

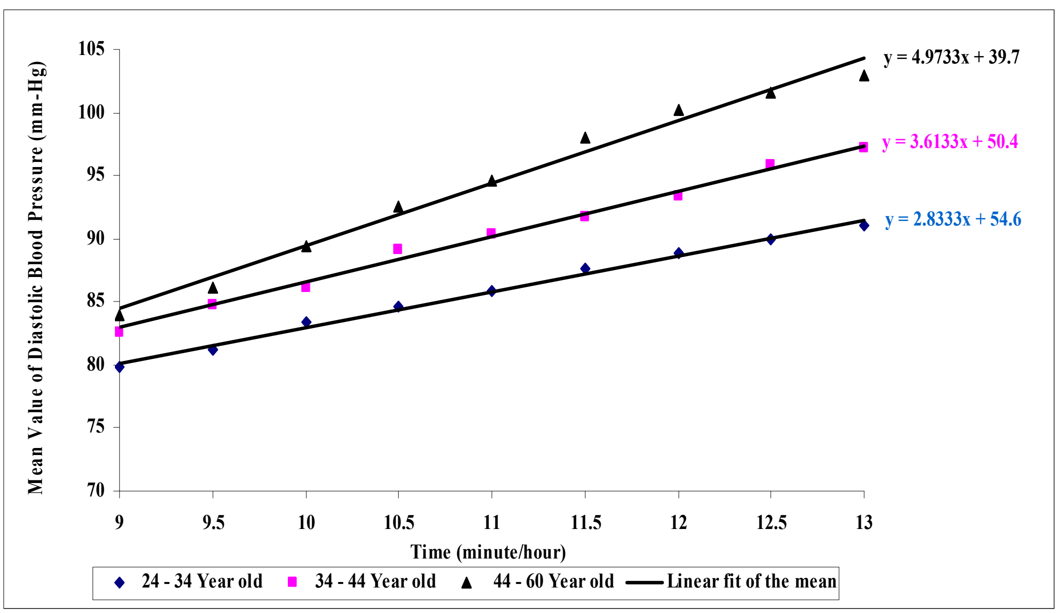


Figure (4.6): The mean values and best linear fit of the mean of DBP as a function of exposure time which measured every 30 minutes for different group ages.

Figures (4.5) and (4.6) show the mean values (every 30 minute) of systolic blood pressure and diastolic blood pressure for the five doctors in each group. The slopes of systolic blood pressure of different groups' ages are as follows: Group ages (24-34) year is 3.1 mm-Hg, group ages (34-44) year is 4.7 mm-Hg, and group ages (44-60) year is 5.4 mm-Hg, respectively. The slopes of diastolic blood pressure of different groups ages are: Group ages (24-34) year is 2.8 mm-Hg, group ages (34-44) year is 3.6 mm-Hg, and group ages (44-60) year is 5.0 mm-Hg, respectively.

Mean systolic and diastolic blood pressure were measured for doctors in all group ages before and after exposure to noise in table (4.3), and are plotted in figure (4.7).

Table (4.3): Mean values of systolic and diastolic blood pressure of all doctors (before and after exposure to noise) as a function of doctor ages and serving duration.

Age (year)	Serving Duration (year)	SBp before Exposure to Noise (mm-Hg)	Mean SBp after Exposure to Noise (mm-Hg)	DBP before Exposure to Noise (mm -Hg)	Mean DBp after Exposure to Noise (mm-Hg)
24	2	125	134.1	81	88.3
26	3	126	133.0	83	87.3
29	4	126	137.5	82	87.5
30	5	125	138.8	75	85.3
32	6	124	138.3	78	87.4
36	10	128	142.5	78	89.0
38	11	130	144.1	75	92.2
41	13	125	144.0	85	94.4
42	15	130	145.3	83	89.6
43	17	138	147.5	85	96.1
45	20	125	141.4	78	91.9
47	21	135	148.5	88	93.5
53	27	138	147.5	85	96.1
55	28	124	143.1	78	93.2
60	30	125	146.1	88	95.4

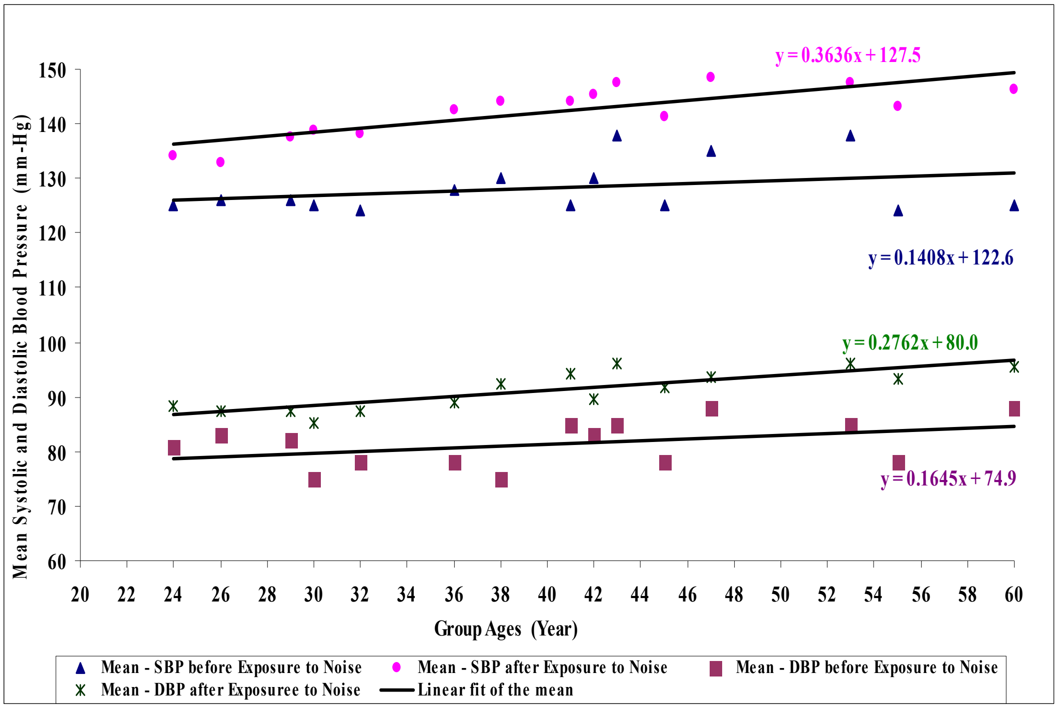


Figure (4.7): Mean values and best linear fit of systolic and diastolic blood pressure (SBP and DBP) of all doctors (before and after exposure to noise) as a function of doctors' ages.

figure (4.7) show an increase rate of systolic blood pressure before exposure of about 0.14 mm-Hg, and after exposure of about 0.36 mm-Hg, so there is a change of about 0.22 mm-Hg. While the increase rate of diastolic blood pressure before exposure of about 0.16 mm-Hg, and after exposure is of about 0.27 mm-Hg, so there is a change is of about 0.11 mm-Hg. Consequently, two notices are obvious here. Firstly, the changes in SBP and DBP depend on doctors' ages. Secondly, SBP is more affected than DBP by noise exposure.

2. Serving duration.

Duration of serving years for doctors were recorded in this study. The mean systolic and diastolic blood pressures were measured for doctors in all groups' ages before and after exposure to noise (table 4.3) and were plotted in figure (4.8).

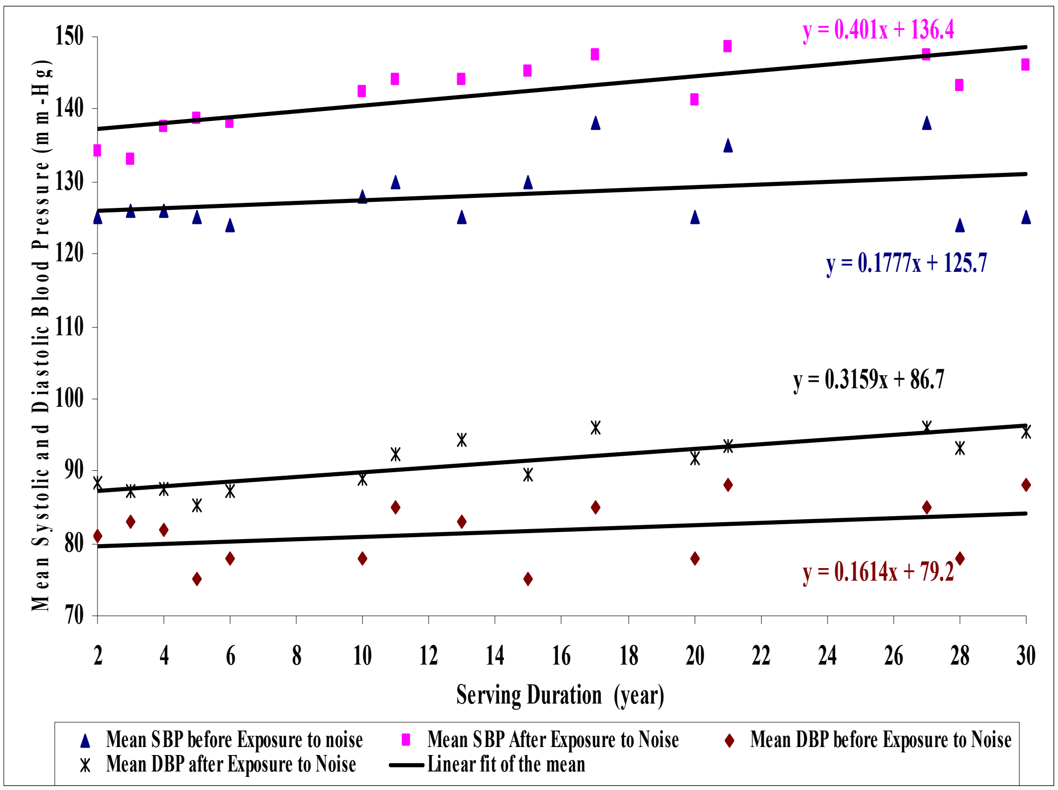


Figure (4.8): Mean values and best linear fit of systolic and diastolic blood pressure (SBP & DBP) of all doctors (before and after exposure to noise) as a function of doctors serving duration.

The fitted lines of figure (4.8) show an increase rate of systolic blood pressure before exposure is of about 0.18 mm-Hg, and after exposure is of about 0.40 mm-Hg, so there is a change of about 0.22 mm-Hg. While the increase rate of diastolic blood pressure before exposure is of about 0.16 mm-Hg, and after exposure is of about 0.32 mm-Hg, so there is a change is of about 0.16 mm-Hg. Consequently, two notices are obvious here. Firstly, serving duration considered to be a reason for increasing SBP and DBP. Secondly, SBP is more affected than DBP by noise exposure.

4.1.3 Sound Pressure Levels, Systolic and Diastolic Data Analysis

The data of sound pressure levels, systolic and diastolic blood pressure have been analyzed using the program (SPSS) software. Strong positive correlations (Pearson Correlation Coefficient) (R) were found between independent variables, mean sound pressure levels table (4.4), doctor ages

table (4.5) and dependent variables (systolic and diastolic blood pressure). Also, in the same tables, significant effect for all independent variables was detected by P- value to be $P < 0.05$.

Table (4.4) shows that there are strong positive correlations (R) between the independent variables (sound pressure levels in all selected dental offices) and the dependant variables SBP, and DBP. It also shows strong significance (P-value) of dependent variables SBP and DBP.

Table (4.4): Pearson correlation coefficients between sound pressure level and arterial blood pressure (SBP and DBP) in all selected dental offices.

Place	Number of Doctors	M-SPL	Dependant variables	R	Sig P-value
Selected dental offices	15	91.2	SBP	0.629	0.002
			DBP	0.475	0.040

The Pearson Correlation Coefficient (R) for all variables is > 0.475, and P-value for all variables is < 0.050, which means strong positive correlation appeared between all studied variables in all selected dental offices.

Table (4.5) shows that there are strong positive correlation (R) between the independent variables (doctors ages in all selected dental offices) and the dependant variables SBP and DBP. It also shows strong significance (P-value) of dependent variables SBP and DBP.

Table (4.5): Mean values of SBP, DBP of all doctors and Pearson correlation coefficients and P-values in all dental offices are shown (The independent variable is doctor ages).

Age	Number of doctors	Dependant variable	Mean			R	Sig, P value
			before	after	(after – before)		
24 - 34	5	SBP	126.0	136.3	10.3	0.630	0.019
		DBP	79.8	87.1	7.3	0.760	0.000
34 - 44	5	SBP	130.2	144.7	14.5	0.847	0.000
		DBP	81.2	92.2	11.0	0.520	0.027
44 - 60	5	SBP	129.4	145.3	15.9	0.789	0.000
		DBP	83.4	94.0	10.6	0.659	0.002

The Pearson Correlation Coefficient (R) for all variables is > 0.520, and P-value for all variables is < 0.050, which give strong relation between the dependant variables and independent variables.

4.1.4 Heart Pulse Rate

Noise causes stress (hazardous to the health), and stress is a principal cause of bad health especially in a cardiovascular system. Its role as a risk factor for high blood pressure (hypertension) and this lead to heart disease by raising heart pulse rate. To determine the effect of noise on cardiovascular system, measurements of heart pulse rate to all selected doctors have been performed while under exposure to noise in their dental offices. The results of the data are given in table (4.6).

Table (4.6): The values (D_1-D_{15}) and mean values ($\overline{D}_i$) of heart pulse rate in (beats/minute) of all selected doctors as a function of exposure time during the work (9:00 am – 13:00 pm).

	Heart Pulse Rate (beats / minute)															The average values for all doctors
Time	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**D_6**	**D_7**	**D_8**	**D_9**	**D_{10}**	**D_{11}**	**D_{12}**	**D_{13}**	**D_{14}**	**D_{15}**	
9:00	68.0	70.0	67.0	69.0	71.0	74.0	71.0	74.0	71.0	72.0	75.0	77.0	73.0	72.0	77.0	**72.2**
9:30	70.0	72.0	73.5	72.7	73.3	74.6	73.6	75.0	75.0	74.0	77.0	81.3	78.0	73.6	78.3	**75.6**
10:00	73.6	75.4	74.6	74.0	75.8	77.2	78.0	77.9	78.1	76.2	80.0	83.3	80.0	80.6	87.3	**78.5**
10:30	74.3	78.0	77.3	76.6	78.0	78.0	81.6	79.3	79.0	80.3	81.0	84.0	85.3	93.6	89.5	**80.6**
11:00	77.2	78.6	80.0	79.6	79.9	80.0	82.0	81.0	81.3	82.6	82.2	89.0	87.9	94.3	91.8	**82.6**
11:30	78.0	79.0	81.1	81.7	82.0	82.6	82.6	82.0	83.6	83.0	85.0	89.1	90.5	94.9	95.0	**84.2**
12:00	79.5	80.9	82.0	82.0	82.3	83.3	83.0	83.6	84.9	87.0	86.6	89.6	94.3	95.1	95.8	**85.3**
12:30	80.4	81.6	82.6	82.9	83.0	83.6	84.1	84.7	86.0	87.3	87.0	90.0	94.2	95.9	96.4	**86.2**
13:00	81.8	81.9	83.0	84.4	84.9	84.1	84.9	85.3	88.0	88.6	87.6	90.8	95.0	96.3	96.9	**87.1**
$\overline{D}_i$	**75.9**	**77.5**	**77.9**	**78.1**	**78.9**	**79.7**	**80.0**	**80.3**	**80.8**	**81.2**	**82.4**	**86.0**	**86.5**	**88.5**	**89.8**	

Table (4.6) displays the measured values of heart pulse rate to all doctors (D_1 – D_{15}), and their means ($\overline{D}_i$). The measured values of heart pulse rate ranged between 67.0 - 96.9 beats/minute, and their means ranged between 75.9 - 89.8 beats/minute. Comparing the values and their means, significant increase in heart pulse rate observed as a result of exposing to noise pollution. The data of table (4.6) and their means are plotted in figures (4.9) and (4.10).

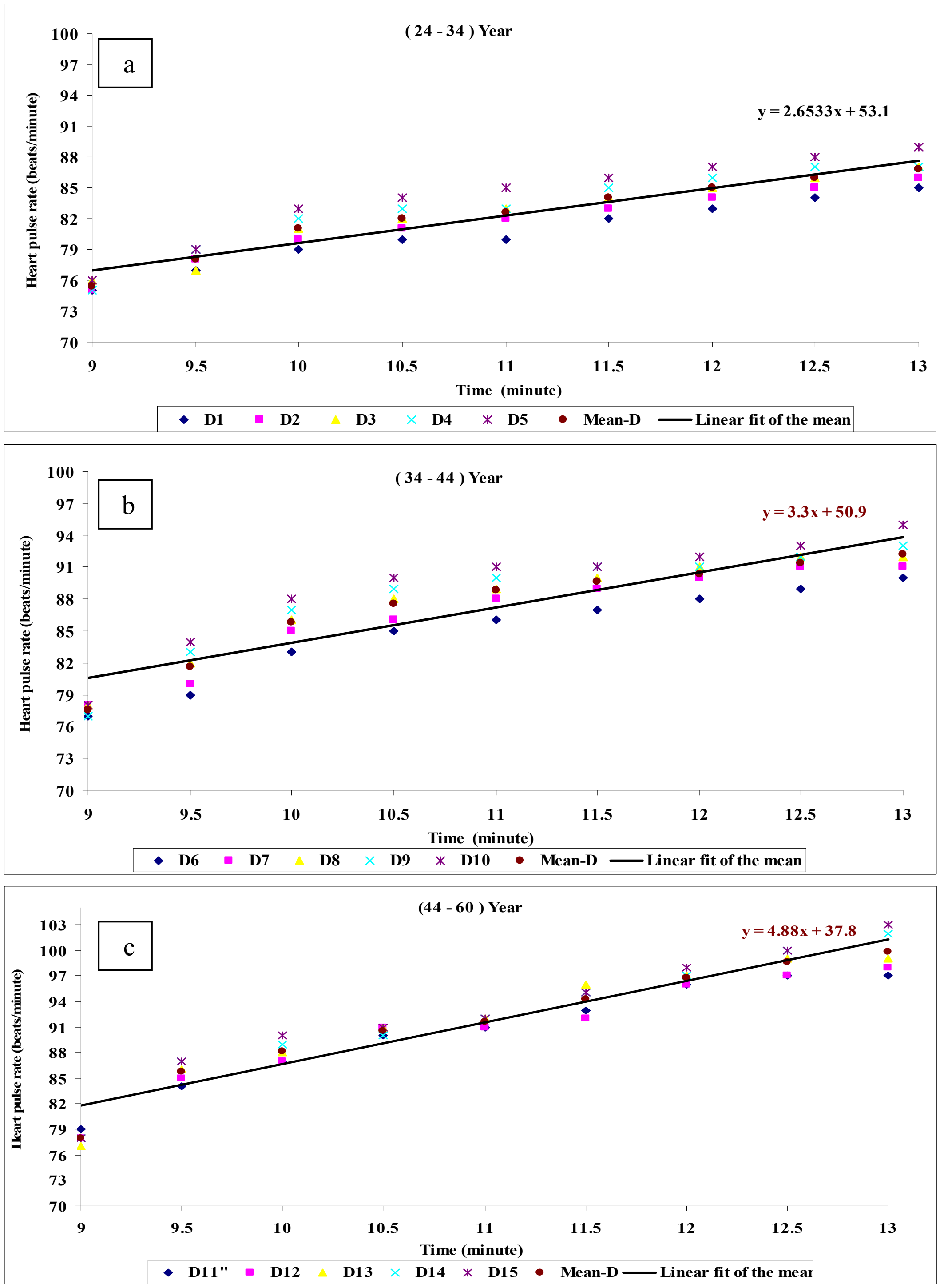


Figure (4.9): The values of HPR and best linear fit to their means as a function of exposure time in all selected dental offices divided to three groups of doctors as follows: group (a) 24-34 year old (D_1-D_5), group (b) 34-44 year old (D_6-D_{10}), and group (c) 44- 60 year old (D_{11}-D_{15}).

Figure (4.9) shows a positive increase of heart pulse rate of all doctors as a function of working time (9:00am – 13:00pm). This is might be because of the long time that doctors exposed to noise from the instrumentation used in their dental offices. The mean of the data of heart pulse rate is plotted as a function of time in figure (4.10).

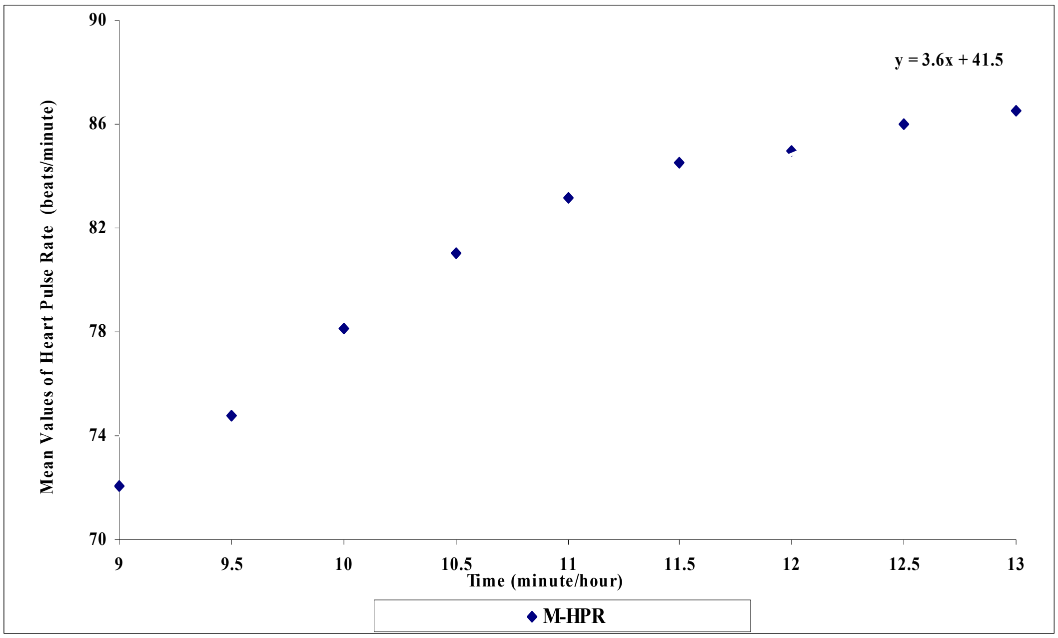


Figure (4.10): The mean values of heart pulse rate (HPR) of all selected doctors as a function of exposure time.

Figure (4.10) shows a positive increase of mean heart pulse rate of all doctors (D_1 – D_{15}) as a function of time, from the graph the rate of increasing in heart pulse rate of about 3.6 beats/minute. The degree of increment is different from one doctor to another which depends on some factors including:

1. Doctors ages

The slopes of the measured values of heart pulse rate to all doctors according to their groups' ages are as follows: 2.7, 3.3, and 4.9 beats/minute, respectively fig. (4.9). By comparing the slopes, the study concludes a positive linear relationship between doctors' ages and the rate of increasing in heart pulse rate. Doctors whom ages 44 – 60 year (D_{11} – D_{15}) are more affected by noise than doctors whom ages are 34 – 44 year (D_6 – D_{10}). Whereas the doctors of the group of ages 24 – 34 year (D_1 – D_5) are the least affected ones. Table (4.7) show the mean values of heart pulse rate of all doctors in different ages before and after exposure time to noise The data of table (4.7) are plotted in figure (4.11).

Table (4.7): Mean values of heart pulse rate of all doctor groups (before and after exposure to noise) as a function of doctor ages, and duration of serving years.

Age (year)	Duration of Serving in (year)	Mean HPR before Exposure to Noise (beats/minute)	Mean HPR after Exposure to Noise (beats/minute)
24	2	68	75.9
26	3	70	77.5
29	4	67	77.9
30	5	69	78.1
32	6	71	78.9
36	10	74	79.7
38	11	71	80.0
41	13	74	80.3
42	15	71	80.8
43	17	72	81.2
45	20	75	82.4
47	21	77	86.0
53	27	73	86.5
55	28	72	88.5
60	30	77	89.8

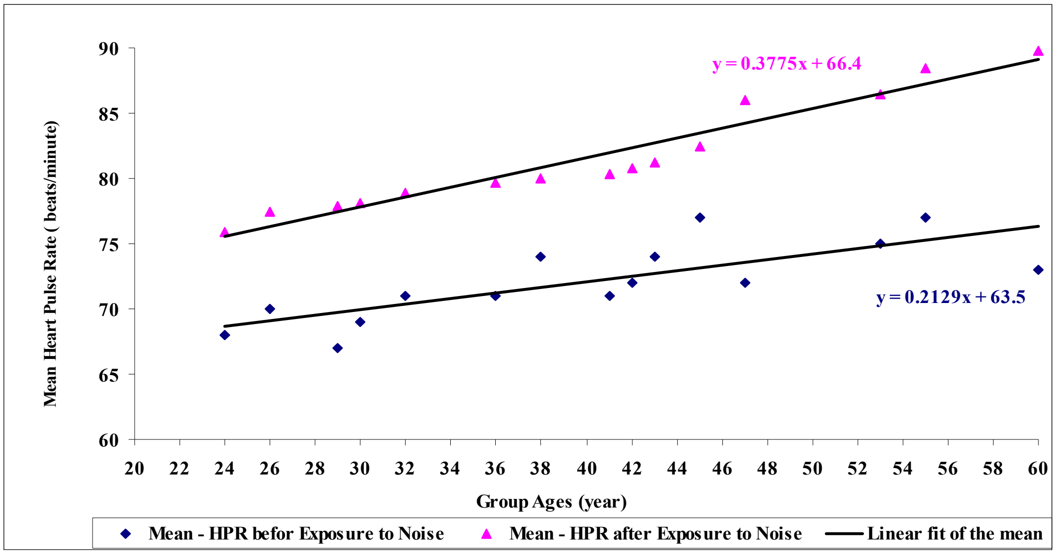


Figure (4.11): Mean values and best linear fit of heart pulse rate (HPR) of all doctors (before and after exposure to noise) as a function of doctors' ages.

Figure (4.11) shows that the rate of increasing in heart pulse rate before exposure to noise of about 0.2 beats/minute, and after exposure of about 0.4 beats/minute. Comparing the two slopes, there is a change of about 0.2 beats/minute. Consequently, it is obvious that HPR is affected by noise exposure and it depends on doctors' ages.

2. Serving duration.

Another factor can be considered as a reason for increasing heart pulse rate which is the serving duration. In table (4.7) duration of serving years to all doctors were recorded. The relation between mean-heart pulse rate and the duration of serving are plotted in figure (4.12) before and after exposure to noise.

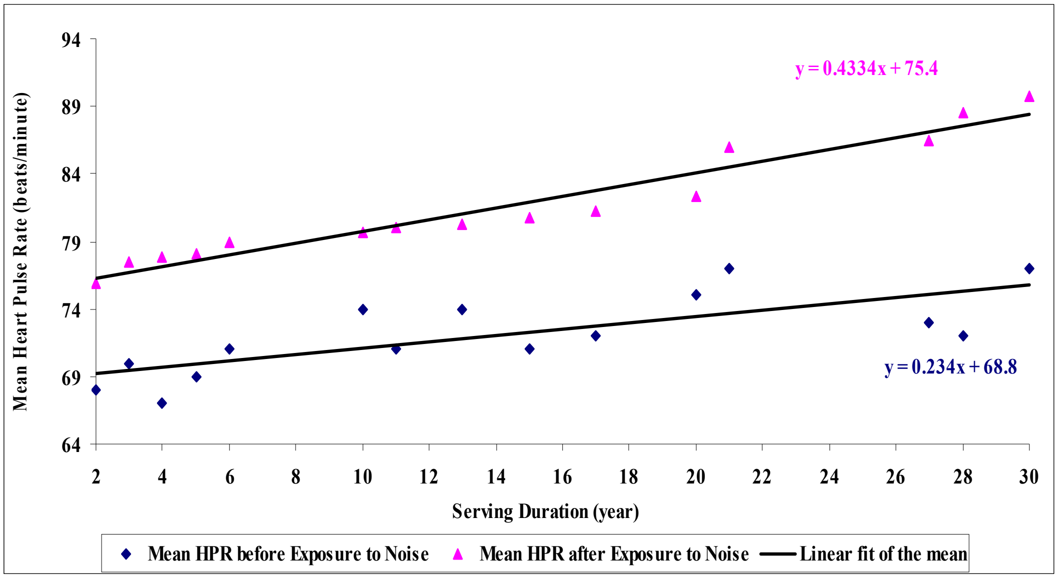


Figure (4.12): Mean values and best linear fit of the mean of heart pulse rate (HPR) of all doctor groups (before and after exposure to noise) as a function of doctors serving years.

The slopes of this figure showed that the rate of increasing in heart pulse rate before exposure of about 0.23 beats/minute, and after exposure of about 0.43 beats/minute. Comparing the slopes of the two lines, there is a change of about 0.20 beats/minute. Comparing the changes values in heart pulse rate, the study concludes that, HPR is affected by doctors serving duration.

4.1.5 Heart Pulse Rate Data Analysis.

The data of heart pulse rate has been analyzed using the program (SPSS) software. Strong positive correlations (Pearson Correlation Coefficient) were found between independent variables, mean sound pressure levels table (4.8), doctors ages table (4.9), and dependent variables (heart pulse rate). In the same tables (4.8) and (4.9), significant effect of the (heart pulse rate) was detected by P- value. Since $P < 0.05$.

Table (4.8) shows that there is a strong positive correlation (R) between the sound pressure levels in all selected dental offices and the dependant variable heart pulse rate. It also shows strong significance (P-value) of dependent variables heart pulse rate.

Table (4.8): Pearson correlation coefficients between sound pressure level in dB and heart pulse rate in beats/minute in all selected dental offices.

Place	Number of Doctors	M-SPL (dB)	Dependant variable	R	Sig. P-value.
Selected dental offices	15	91.2	HPR	0.560	0.002

Table (4.9) shows that there is strong positive correlation (R) between the independent variables (doctors ages in all selected dental offices) and the dependant variable heart pulse rate. It also shows strong significance (P-value) of dependent variables heart pulse rate.

Table (4.9): Mean values of HPR of all doctors and Pearson correlation coefficients and P-values in all dental offices are shown (The independent variable is doctor ages).

Age (year)	Number of doctors	Dependant variable	Mean (beats/minute)		R	Sig. P-value
			Before	After		
24 - 34	5	HPR	69.0	77.7	0.513	0.029
34 - 44	5	HPR	72.4	80.4	0.436	0.017
44 - 60	5	HPR	74.8	86.6	0.766	0.000

The Pearson Correlation Coefficient (R) for all variables is > 0.436, and P-value for all variables is < 0.050, which gives strong relation between the dependant variables (heart pulse rate) and independent variables (doctor ages).

4.2 Comparison Study

An experiment was done on six doctors in their dental offices to record the accumulation of noises on blood pressure and heart pulse rate. Doctors were chosen as follows: 24, 29, 34, 39, 44, and 49 year old, respectively. Measurements were done in two days. The first day, with background noise source (about 70 dB) for four hours (9:00 am – 13:00 pm). The second day, measurements were repeated in an artificial noise (laud music) with sound pressure level (about 100 dB). The results are given in table (4.10), (4.11), and (4.12), respectively.

Table (4.10): The measured values of systolic blood pressure with background noise source (about 70 dB) and with additional noise source (about 100 dB) for six doctors with different ages as a function of exposure time.

	Systolic Blood Pressure (mm-Hg) with background Noise Source (about 70 dB)						Systolic Blood Pressure (mm-Hg) with additional Noise Source (about 100 dB)					
Doctors Ages (year) / Time (minute)	**24**	**29**	**34**	**39**	**44**	**49**	**24**	**29**	**34**	**39**	**44**	**49**
9.00 am	122	122	123	124	125	126	125	125	125	126	126	128
9.30 am	124	124	124	126	127	128	126	127	128	128	129	130
10.00 am	125	125	125	127	129	130	130	131	131	131	132	134
10.30 am	126	127	127	129	130	134	131	132	132	135	136	135
11.00 am	127	128	129	131	132	135	133	134	135	136	137	137
11.30 am	128	129	130	132	133	137	134	135	137	138	140	141
12.00 noon	129	130	131	133	134	138	136	136	138	140	141	145
12.30 pm	131	131	132	135	137	139	137	138	139	141	143	146
13.00 pm	132	132	133	136	138	140	138	139	140	143	145	149

Table (4.11): The measured values of diastolic blood pressure with background noise source (about 70 dB) and with additional noise source (about 100 dB) for six doctors with different ages as a function of exposure time.

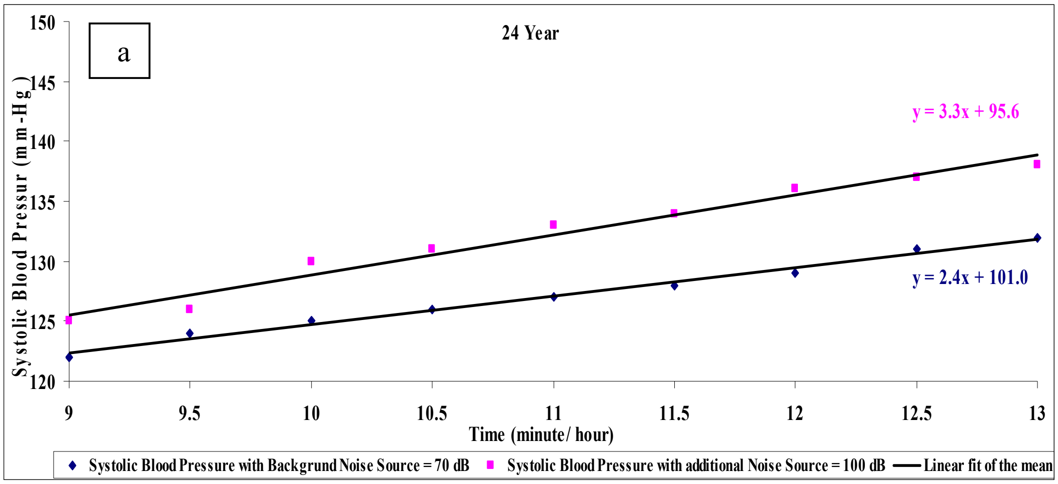
	Heart Pulse Rate (beats/minute) with background Noise Source (about 70 dB)						Heart Pulse Rate (beats/minute) with additional Noise Source (about 100 dB)					
Doctors Ages (year) / Time (minute)	24	29	34	39	44	49	24	29	34	39	44	49
9.00 am	69	72	70	71	69	70	72	72	72	71	72	70
9.30 am	70	73	71	71	70	74	73	73	74	74	74	76
10.00 am	71	74	72	72	71	75	73	76	76	77	76	78
10.30 am	72	74	73	73	72	77	74	79	77	78	77	80
11.00 am	73	75	74	74	74	79	75	80	81	82	81	83
11.30 am	74	76	75	77	77	80	77	80	82	83	83	84
12.00 noon	77	77	77	79	78	81	79	81	84	84	84	85
12.30 pm	78	80	80	80	79	82	80	83	85	85	85	86
13.00 pm	80	85	81	82	80	84	85	84	86	87	88	89

Table (4.12): The measured values of heart pulse rate with background noise source (about 70 dB) and with additional noise source (about 100 dB) for six doctors with different ages as a function of exposure time.

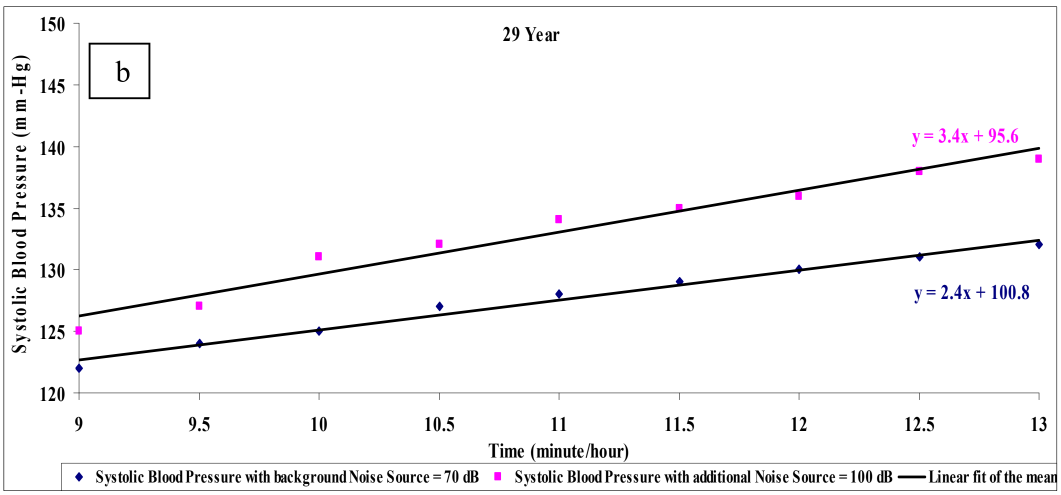
	Diastolic Blood Pressure(mm-Hg) with background Noise Source (about 70 dB)						Diastolic Blood Pressure (mm-Hg) with additional Noise Source (about 100 dB)					
Doctors Ages (year) / Time (minute)	24	29	34	39	44	49	24	29	34	39	44	49
9.00 am	78	79	80	81	80	81	80	80	81	82	83	82
9.30 am	80	80	81	82	83	84	82	83	83	84	86	84
10.00 am	81	82	83	83	85	86	84	85	85	86	88	88
10.30 am	83	83	84	85	86	87	85	86	87	87	89	93
11.00 am	84	84	85	87	88	89	86	87	88	90	92	96
11.30 am	85	86	86	88	89	90	88	88	89	91	93	97
12.00 noon	86	88	88	90	90	91	90	91	90	93	96	99
12.30 pm	87	90	89	91	91	93	91	92	93	95	98	100
13.00 pm	89	92	91	92	92	95	92	93	95	96	99	103

From tables (4.10), (4.11), and (4.12) the dependent variables (systolic, diastolic blood pressure, and heart pulse rate) for six doctors in different ages were measured in background noise source then were repeated in artificial noise source. The data of these variables are plotted in figures (4.13), (4.14), and figure (4.15), respectively.

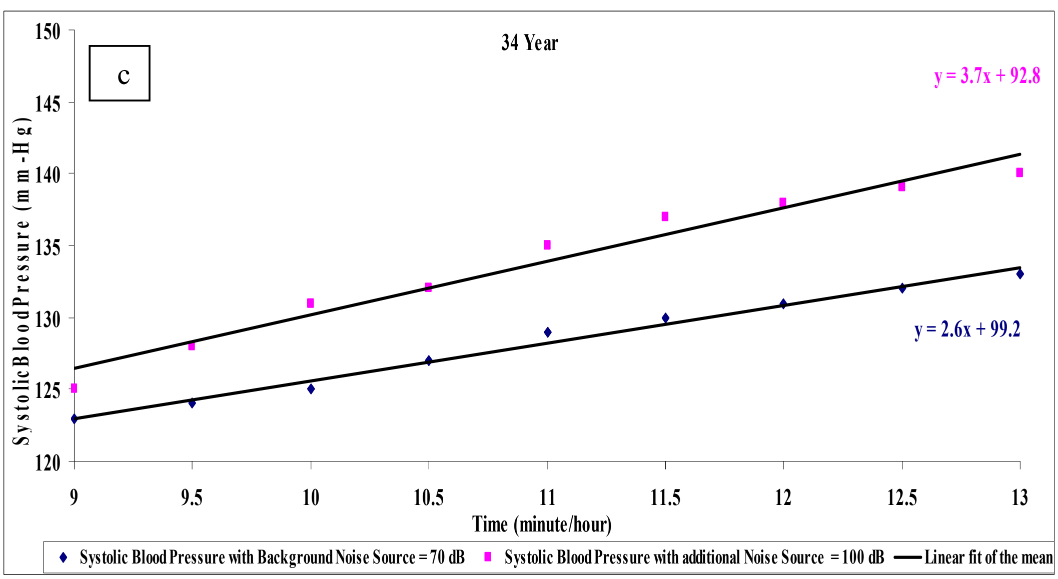
The following six figures (a to f) correspond to systolic blood pressure (mm-Hg).



a
24 Year
Systolic Blood Pressur (m m-H g)
y = 3.3x + 95.6
y = 2.4x + 101.0
Time (minute/ hour)
Systolic Blood Pressure with Backgrund Noise Source = 70 dB
Systolic Blood Pressure with additional Noise Source = 100 dB
Linear fit of the mean



b
29 Year
Systolic Blood Pressure (m m-H g)
y = 3.4x + 95.6
y = 2.4x + 100.8
Time (minute/hour)
Systolic Blood Pressure with background Noise Source = 70 dB
Systolic Blood Pressure with additional Noise Source = 100 dB
Linear fit of the mean



c
34 Year
Systolic Blood Pressure (m m -H g)
y = 3.7x + 92.8
y = 2.6x + 99.2
Time (minute/hour)
Systolic Blood Pressure with Background Noise Source = 70 dB
Systolic Blood Pressure with additional Noise Source = 100 dB
Linear fit of the mean

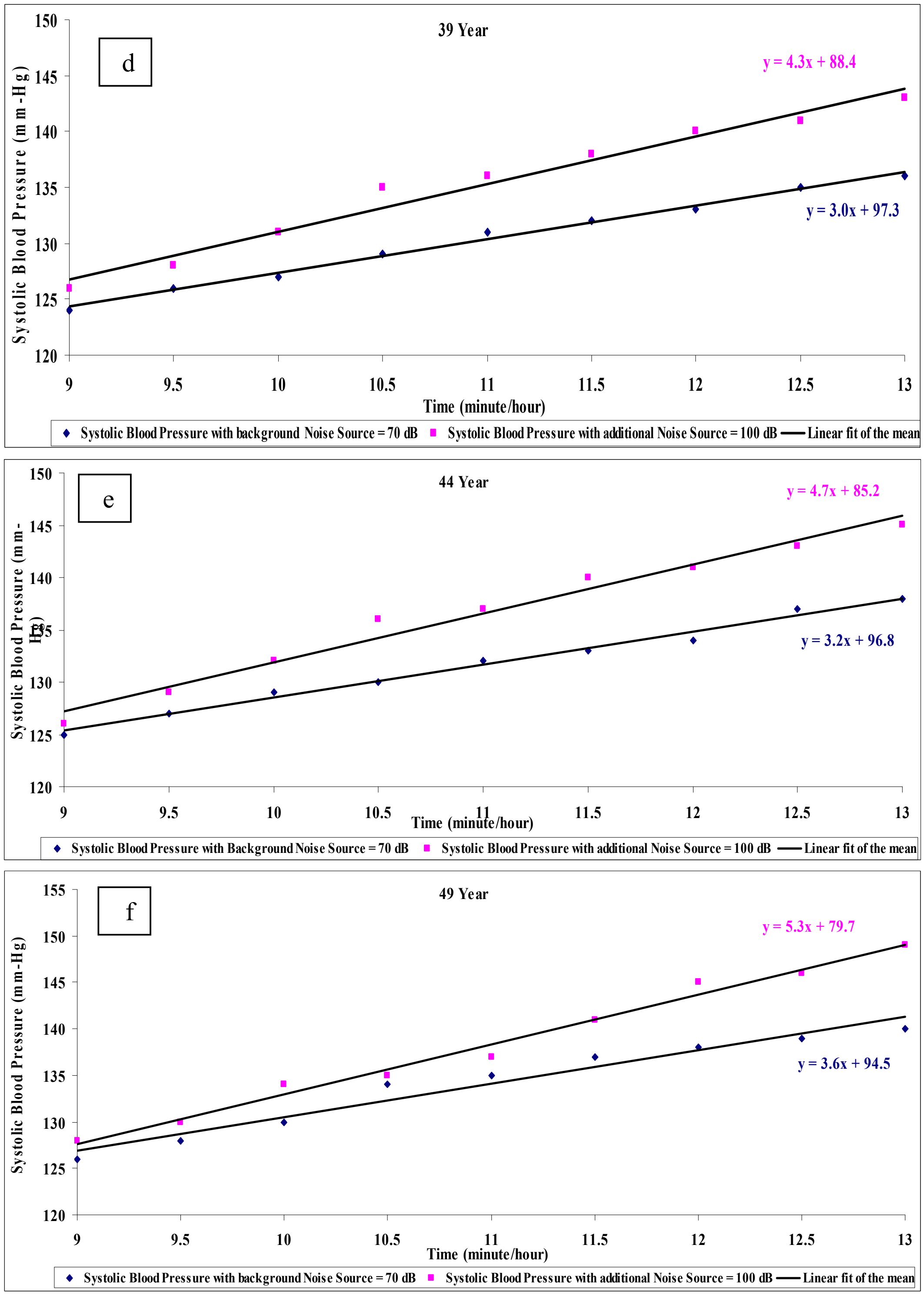
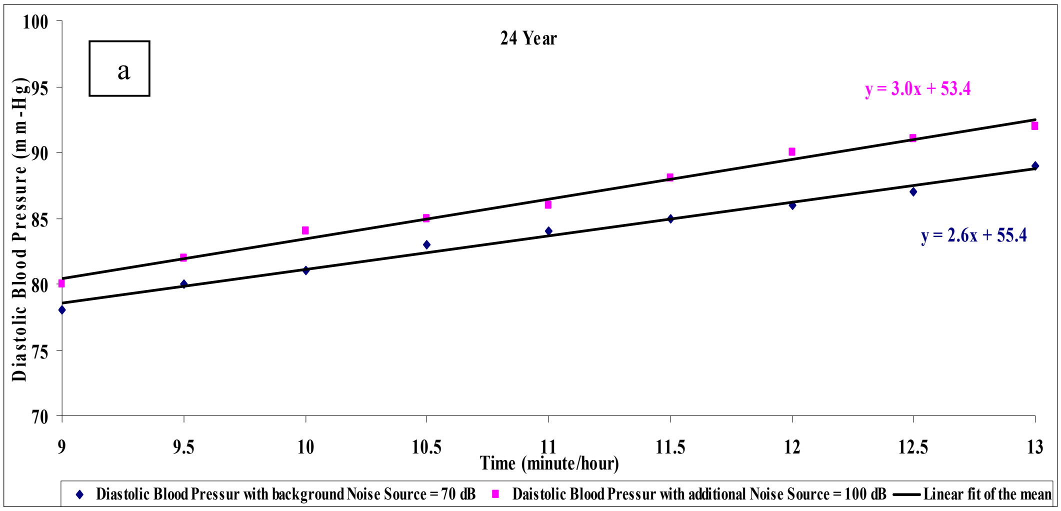
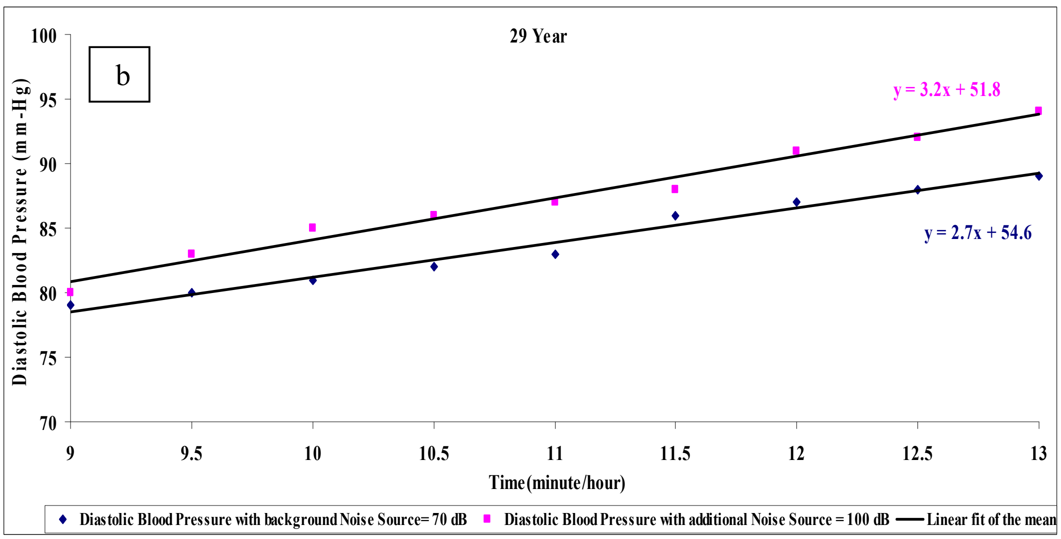
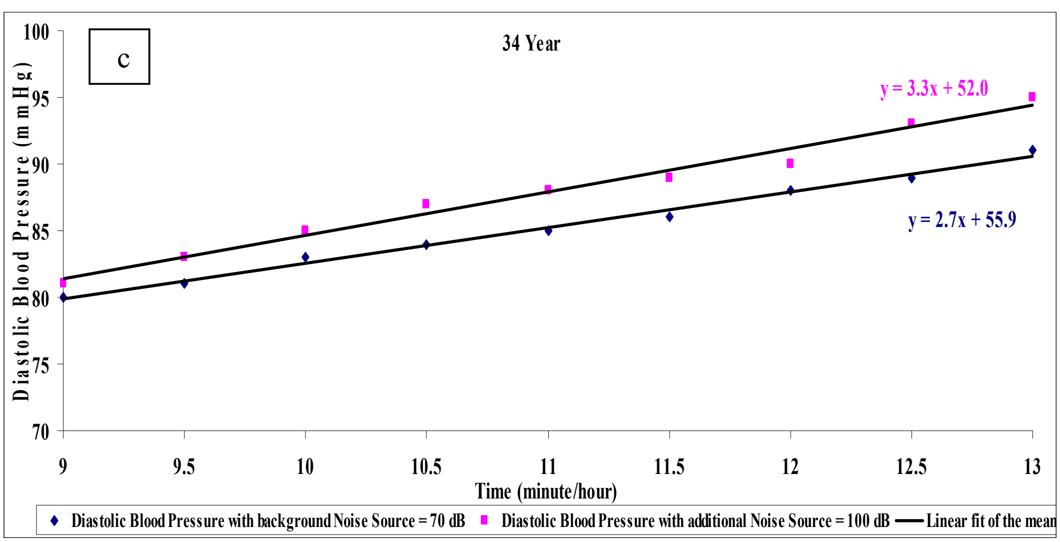


Figure (4.13): The rate of increase of systolic blood pressure as a function of exposure time for six doctors of different ages as indicated on each figure which are measured with the background noise (about 70 dB) and with additional noise (about 100 dB) .

The following six figures (a to f) correspond to diastolic blood pressure (mm-Hg).







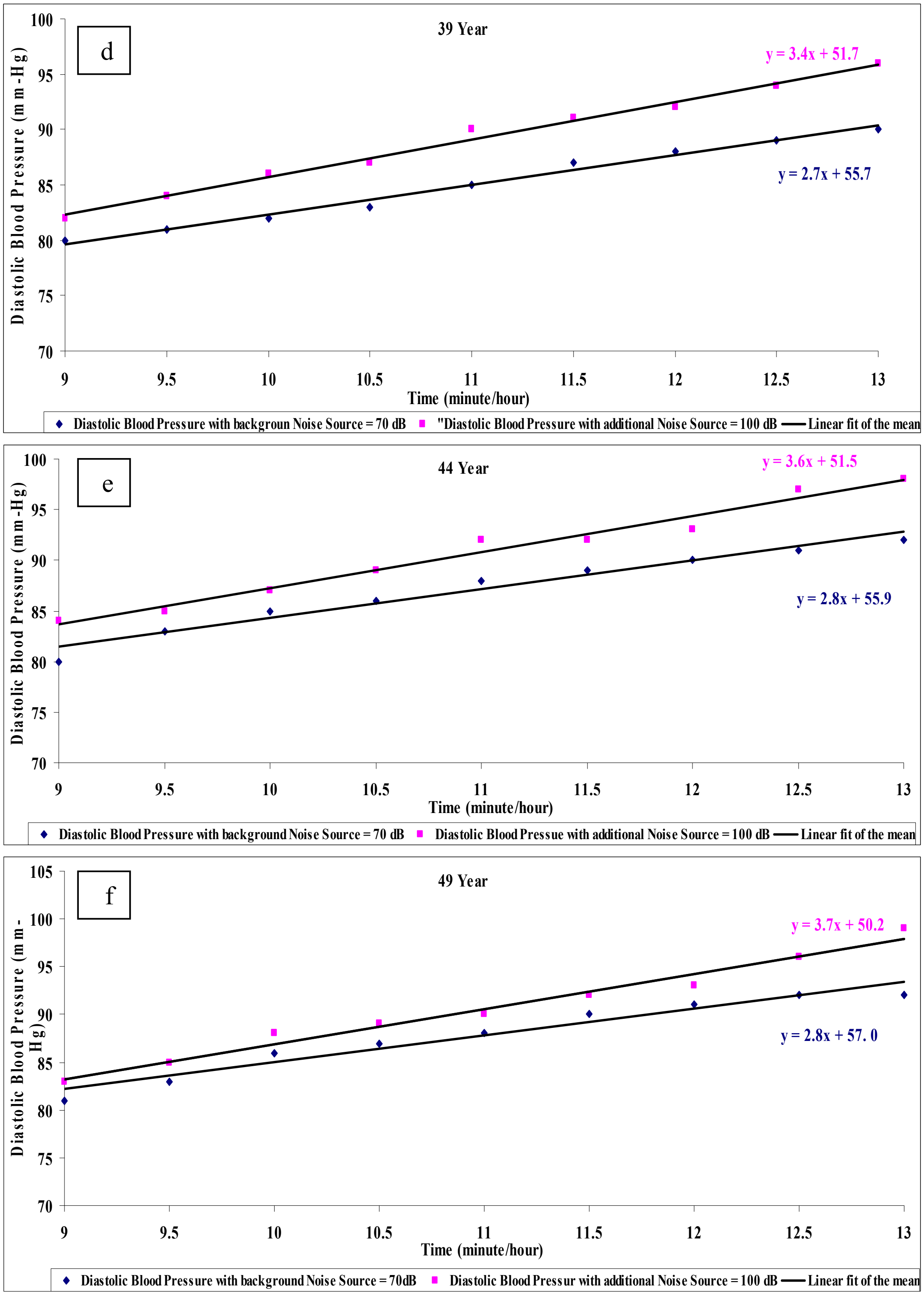
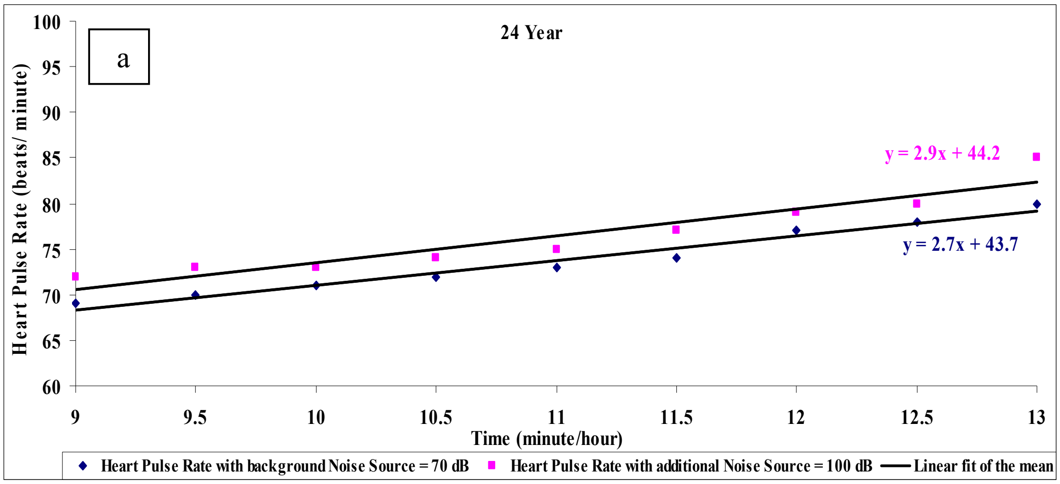
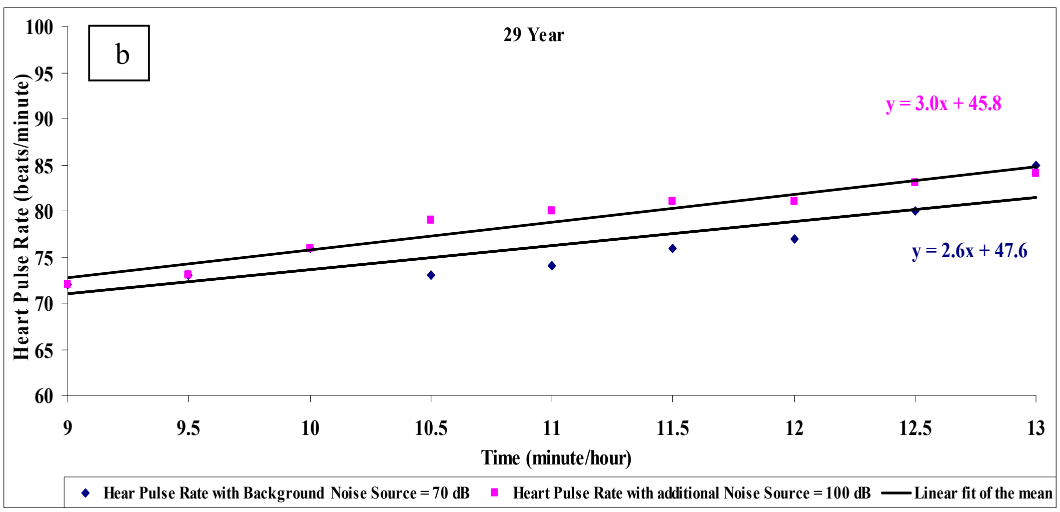
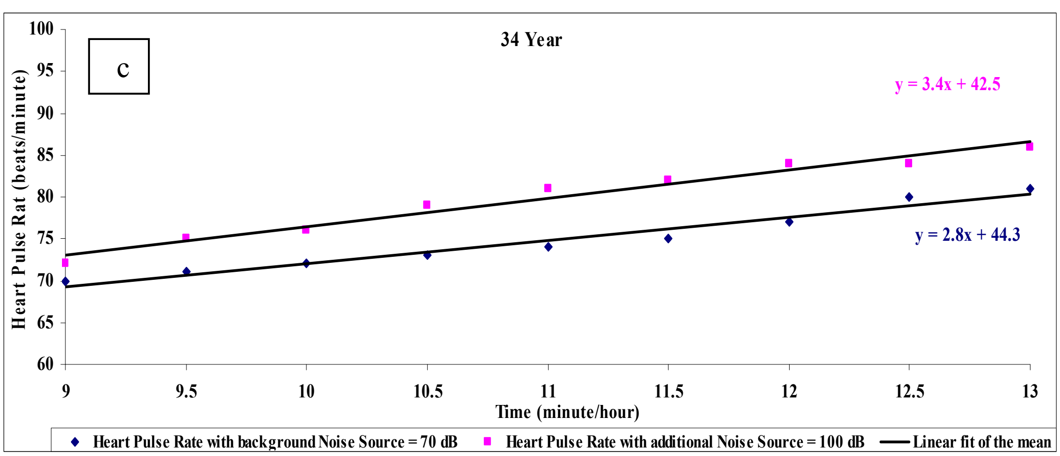


Figure (4.14) The rate of increase of diastolic blood pressure as a function of exposure time for six doctors of different ages as indicated on each figure which are measured with the background noise (about 70 dB) and with additional noise (about 100 dB).

The following six figures (a to f) correspond to heart pulse rate (beats/minute).







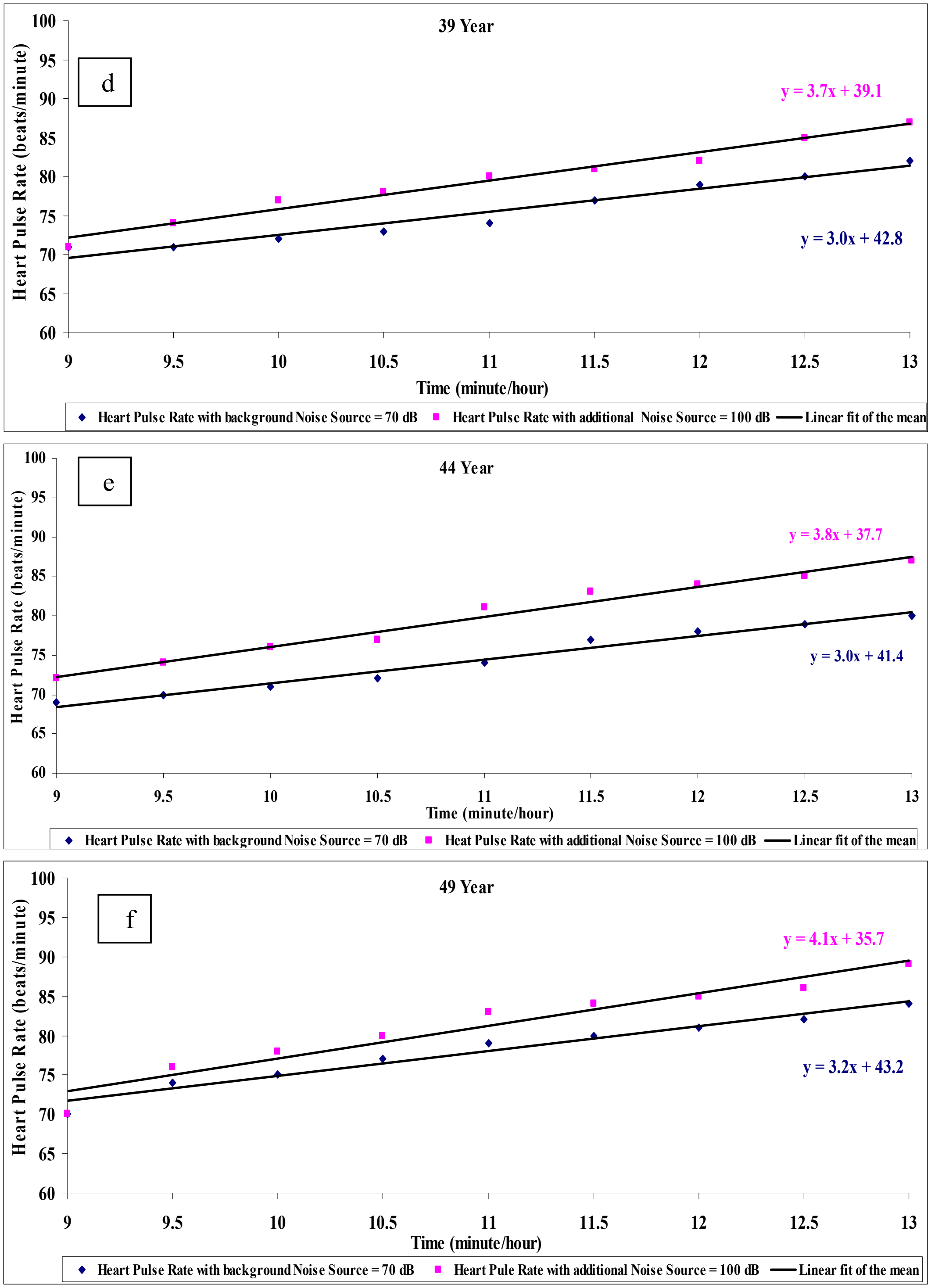


Figure (4.15): The rate of increase of heart pulse rate as a function of exposure time for six doctors of different ages as indicated on each figure which are measured with the background noise (about 70 dB) and with additional noise (about 100 dB).

The fitted lines of figures (4.13), (4.14), and (4.15) show an increase rate of systolic blood pressure, diastolic blood pressure, and heart pulse rate to all selected doctors with background noise source (about 70 dB), and with additional noise source (about = 100 dB) during four hours (9:00 am – 13:00 pm). The amounts of changes on these variables are summarized in table (4.12).

Table (4.13): The rate of the amount of changes in systolic blood pressure, diastolic blood pressure, and heart pulse rate as a function of doctors' ages during the exposure time to (100 dB) for four hours of experiment (9:00 am to 13:00 pm).

Doctors ages (year)	**The rate of the amount of change in systolic blood pressure (mm-Hg)**	**The rate of the amount of change in diastolic blood pressure (mm-Hg)**	**The rate of the amount of change in heart pulse rate (beats/minute)**
24	0.90	0.40	0.20
29	1.00	0.5 0	0.40
34	1.10	0.6 0	0.60
39	1.30	0.7 3	0.70
44	1.50	0.80	0.80
49	1.70	0.90	0.90

Chapter Five

Discussion

Noise pollution is increasingly being recognized as a physical factor in the environment that is injurious to many aspects of health. The aim of the present study was to assess the effects of noise on the cardiovascular system of fifteen doctors (11 male and 4 female) on their dental offices in Jenin city in Palestine during working hours. The selected dental offices were divided into three groups; every group includes five dental offices which depends on the ages of the doctors as follows: Group (a) doctors whom ages are 24 - 34 year, group (b) doctors whom ages are 34 - 44 year, group (c) doctors whom ages are 44 - 60 year respectively.

The measured values of sound pressure level for the selected dental offices during work were approximately the same. It is ranged from 90.5 to 91.7 dB, with mean value of 91.0 dB, which can be considered as a noisy level, figures (4.1) and (4.2). The maximum value is noticed for sound pressure levels were at eleven o'clock, which is the rush hour.

A hypothesis was set from the beginning of this study that there is an effect of noise pollution on arterial blood pressure (systolic and diastolic) and heart pulse rate, which was observed by (Abdel-Raziq 2000, Hanini 2003, Salameh 2005, Saeed 2010, and Sadeq 2011). The obtained results from measurements and statistical analysis (chapter four) provide a strong conviction for the assumed hypotheses for doctors in their dental offices. The arterial blood pressure (systolic and diastolic) and heart pulse rate of doctors before exposure to noise is close, while after exposure to noise is increased tables (4.2) and (4.6). This increment is might be due to the long time that doctors exposed to noise from instrumentation used in their dental offices. Systolic blood pressure increased by 4.8 mm-Hg, diastolic blood pressure increased by 3.8 mm-Hg, and the heart pulse rate increased by the value of 3.6 beats /minute. The strength of the results is good and is related to each other in a good agreement the rates of increase in diastolic blood pressure and heart pulse rate were almost the same (3.8 mm-Hg for diastolic blood pressure and3.6 beats/min for heart pulse rate). This result agrees with the well known medical information (Salameh 2005 and Sangeeta Singhal 2009). Tables (4.4) and (4.8) present the correlation coefficients for systolic and diastolic blood pressure and heart pulse rate. The degree of increment in arterial blood pressure (systolic and diastolic) and heart pulse rate for selected doctors as dependant variables is different from one group to another. This difference is due to several reasons including doctors' ages and serving duration which are independent variables (tables (4.3) and (4.7)). For example, Doctors whom ages 44-60 year (D_{11} –D_{15}) are more affected by noise than doctors whom ages are 34-44 year (D_6 –D_{10}). The group of ages 24-34 year (D_1 –D_5) showed that the doctors were affected by less than the other groups. The dependant variables correlated positively with the independent variables tables (4.5) and (4.9).

In this study the measured values of systolic, diastolic blood pressure, and heart pulse rate for doctors according to their genders were approximately the same. This is might be due to the number of female doctors (4 female) are not enough to enriched this study.

The results of this study support other studies. (Hanini 2003, Salameh 2005, and Sadeq 2011). (Talbott EO, et al., 1999) showed that for noise difference of 83 dB to 89 dB there is an increase of 2.5 mm-Hg for systolic blood pressure, and a 2.5 mm-Hg an increase of diastolic blood pressure. Also (Van Kempen Elise E. M. M., 1 Kruize Hanneke, 1 Ameling Caroline B., 1 Staatsen Brigit A. M., 1 & de Hollander Augustinus E.M. 1. (2002)), estimated that the relative increase per 5 dB noise will result an increase of 1.14 mm-Hg. This study also showed that there are significant changes in mean values of systolic blood pressure, diastolic blood pressure, and heart pulse rate before exposure to noise and during working hours.

Figures (4.7), (4.8), (4.11), and (4.12) display the amount of changing in mean values of these variables as a function of doctor ages and serving duration before and during exposure to noise.

Concerning the accumulation behavior of noises with background noise environment and then in an artificially noisy environment were suggested by (Saeed 2010). This suggestion was done in this study by using background noise source (about 70 dB), and then using additional noise source (about 100 dB) on six doctors on their dental offices. Systolic, diastolic blood pressure and heart pulse rate were measured for the selected doctors' in table (4.10), (4.11), and (4.12).The measurements of these variables were displayed graphically during four working hours' (9:00 am and 13:00 pm) in figures (4.16), (4.17), and (4.18), respectively. A positive linear relationship between doctors' ages and the rate of the amount of changes in systolic blood pressure, diastolic blood pressure, and heart pulse during the exposure time to (100 dB) for four hours of experiment (9:00 am to 13:00 pm) are shown in table (4.13).

As a conclusion there are a lot of methods, which can be used to reduce noise pollution to acceptable levels. Some of them are technical while others are administrative. There are many recommendations and actions (mainly from OSHA, WHO), which can be carried on to reduce or prevent the occupational noise problem in order to minimize the noise effect of the noise on doctors in their dental offices including:

1- Using a hearing protection device when exposed to noisy dental equipment.

2- Dental drills should be kept at least 35cm away from the ears of doctors.

3- The hand piece should be well maintained, since low maintenance of the equipments increases noise intensity.

4- Dental offices walls should be covered with sound absorbing materials.

5- Designing equipment which absorption to any unacceptable sound.

6- Reducing the exposure time of the doctors

7- Monitoring or changing the environment to decrease the effects of noise

8- Efforts should be made to control the noise at the source, to control the transmission of noise and to protect the exposed doctors.

9- The daily work schedule should be planned in certain intervals in the use of dental tools, thus limiting the acoustic trauma to shortest possible time period.

10- Awareness of the noise problem will be helpful in reducing and limitation its effects.

11- Further work with taking into consideration using doctors hearing protection is suggested.

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د. زيد نعيم قمحية

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

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الملخص

أظهرت هذه الدراسة العلاقة بين مستوى الضوضاء و كل من ضغط الدم (الانقباضي والانبساطي), و نبض القلب لعينة من أطباء الأسنان (ذكور وإناث) في عياداتهم التي أختيرت بناءً على الأكثر عملاً في مدينة جنين. معدل أعمار الأطباء كانت 40 سنة, معدل مكوثهم في العمل الحالي 13.8 سنه. تم اجراء قياسات دقيقه لمستوى الضوضاء, حيث تراوح مستوى الضوضاء بين (91.7 – 90.5) ديسيبل. تم اجراء قياسات لضغط الدم (الانقباضي و الانبساطي) ودقات القلب, قبل التعرض للضجيج و بعد التعرض للضجيج لمدة أربع ساعات. وجد معامل ارتباط قوي (معامل ارتباط بيرسون) بين مستوى الضوضاء وكل من ضغط الدم الانقباضي والانبساطي, و دقات القلب (R = 0.629 لضغط الدم الانقباضي, R = 0.475 لضغط الدم الانبساطي), و لدقات القلب (R = 0.560) على التوالي. كذلك نتيجة للتعرض للضوضاء كان هناك زياده في ضغط الدم الانبساطي والانقباضي حوالي 4.40 و 3.80 ملم زئبق على التوالي. أيضا ازداد معدل دقات القلب حوالي 3.60 نبضه لكل دقيقة.