An-Najah National University
Faculty of Graduate Studies

Effects of Noise Pollution on Arterial Blood Pressure, Heart Pulse Rate, Hearing Threshold and Blood Oxygen Saturation of Schools' Children in Ramalla County in Palestine

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الإقرار

أنا الموقعة أدناه مقدمه الرسالة التي تحمل عنوان:

Effects of Noise Pollution on Arterial Blood Pressure, Heart Pulse Rate, Hearing Threshold and Blood Oxygen Saturation of Schools' Children in Ramalla County in Palestine

تأثير الضوضاء على ضغط الدم، ونبض القلب، وعتبة السمع، ونسبة الأكسجين في الدم لطلبة مدارس رام الله في فلسطين

اقر بان ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص ، باستثناء مـــا تمـــت الإشارة إليه حيثما ورد، وان هذه الرسالة ككل من أو جزء منها لم يقدم من قبل لنيل أية درجـــة أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى .

Declaration

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

Student's name: **اسم الطالبة:**

Signature: **التوقيع:**

Date: **التاريخ:**

List of Abbreviations

ANSI	American National Standard Institute
ASHA	American Social Health Association
b	Before Exposure to The Noise
D	During Exposure to The Noise
dB	Decible (Unit of Sound Level Using Logarithmic Scale)
dB(A)	Decible (Unit of Sound Level Using Logarithmic Scale) by A Weighting Filter
DBP	Diastolic Blood Pressure
EPA	Environmental Protection Agency
HPR	Heart Pulse Rate
HTL	Hearing Threshold Levels
L_{eq}	Equivalent Continuous Sound Level
L_{NP}	Noise Pollution Level
NIHL	Noise Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
S_1	Al-Isbanya Girls School
S_2	Khawla Girls School
S_3	Ni'leen Girls School
S_4	Al-Beera Boys School
S_5	Deir-Ibzei' Boys School
S_6	Ni'leen Boys School
SBP	Systolic Blood Pressure
SD	Standard deviation
SPL	Sound Pressure Level
SpO_2%	Blood Oxygen Saturation
WHO	World Health Organization

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Abstract

This study finds the relation between the occupational noise level and the systolic and diastolic blood pressure (SBP and DBP), heart pulse rate (HPR), blood oxygen saturation (SpO_2%), and hearing threshold level (HTL) of selected students in the schools in Ramalla county in Palestine. The study sample consisted of 360 students aged 15 to 17 years old, distributed equally in six schools (3 males and 3 females). Studied schools were selected randomly in three different regions. The measured sound pressure levels (SPL) in all tested schools were found to be above the standard of international acceptable levels. In this study SBP, DBP, HPR, SpO_2% and HTL are correlated positively (P- value < 0.050) with the occupational noise levels in all studied schools. Whereas the Pearson coefficient correlation (R) value of SBP, DBP, HPR, SpO_2% and HTL in all selected schools are ranged from 0.529 to 0.785 for SBP, from -0.198 to 0.825 for DBP, from 0.712 to 0.879 for HPR, from -0.007 to 0.290 for SpO_2% and from 0.722 to 0.994 for HTL.

Chapter 1
Introduction

Chapter 1
Introduction

Noise, is defined as unwanted sound that causes various health effects (Paul M, 1993) on human, plants and animals (Bjorn M, 2010 and Slabbekoom H, 2003). It has become a very important “stress factor” in the environment of people. Health effects are differing from one person to another according to several determinants like sound level, frequency and the time of duration to noise pollution.

Exposure to noise pollution causes various health effects, including, hypertension, hearing loss, sleep disturbance, change in skin temperature and blood circulation (Loeb M, 1986). The average sound level (Day-Night Level) should not exceed 40 dB(A) according to the US Environmental Protection Agency standards (Rosenhall U, 1990). In other respect, the average sound level during day time should not exceed 65 dB(A) according to the Occupational Safety and Health Administration (OSHA). Whereas exposure to noise pollution at 85 dB(A) should not exceed 40 hours per week. For every additional 3 dB(A), the maximum exposure time is reduced by a factor 2, e.g, exposure to noise pollution at 88 dB(A) should not exceed 20 hours (Leighton P, 2009). Loss of hearing and audiotary fatigue occur when exposed to noise levels of 90 dB(A) (Kryter KD, 1985). Spain researchers found that in urban areas households are willing to pay approximately four Euros per decibel per year for noise reduction (Jesus B, 2005). Children exposed to high noise pollution had an increase of 2 beats/min higher than those did not exposed to noise (Goran B, 2008).

Reduction in blood oxygen saturation and impairing of hearing can be noticed on young, children, males and females who exposure to noise pollution. (Henderson D, 2006).

1.1. Literature Review

Many studies have been done worldwide to find out the negative effects of noise pollution on human. A study performed on automobile drivers showed that the systolic blood pressure is affected by noise (Chang TY, 2003). In both traffic and aircraft noise studies, noise levels have been found to be associated with raised systolic and diastolic blood pressure (Rosenlund M, 2001).

A study performed on 9 – 10 years- old- children in four high noise schools and four low noise schools. The results showed that, high noise schools children had affected badly in impaired reading comprehension after adjustment for age, main language spoken at home and social deprivation (Hainess M, 2002). Moreover, a study in London, stated that there was a strong relation between noise pollution and poorer auditory discrimination and speech perception (Hainess M, 2001). Another study by Bronzaft and McCarthy compared classroom which was exposed to high levels with a quiet classroom in the same school. It stated that children in high noise classrooms had impaired reading comprehension (Bronzaft AL, 1975). In addition, American researchers found that More than five million children in the United State had hearing impairment as a result of noise (Havas V, 2006). Physiological disorders were be noticed on workers who

exposure to high noise pollution as reduction of skin resistance, change in breathing rate, dilation of pupils and change in levels of hormones (Vallet M, 1983). Another study included 114 workers employed factories exposed to industrial noise levels exceeding 80 dB(A). That study emphasized workers suffered from increase in systolic blood pressure, diastolic blood pressure and heart pulse rate (Sangeeta S, 2009).

The effect of noise pollution on humans has been intensively carried out. In a study in New York, comparing children in high noise schools with children in quiet schools, showed that blood pressure of children in the first schools were increased about 4-8 mmHg (Harabidis A, 2008). The chance of occurring strike stroke was higher in people who exposed to noise pollution than who did not expose to it, that study was performed in Denmark on 57000 men and women for ten years (Kristie L, 2011).

In Los Angeles Airport study, children exposed to chronic aircraft noise were less likely to solve a difficult puzzle (Cohen S, 1981). A study in children schools which is near the Munich Airport, showed that children in those schools had impaired comprehension. On other respect, an improvement had been shown in comprehension when Munich Airport was closed down (Hygge S, 2002).

In Taiwan, the average sound levels in hospitals was ranged from 52.6 dB(A) to 64.6 dB(A) which is higher than the allowed noise level 50 dB(A) (Juang D, 2010). A study in Pune University in the west of India, stated that exposure to high noise level affected on blood circulation (Alieh

R, 2011). Another study showed that heart disease caused by noise exposure which can lead to elevated blood pressure and increased concentrations of stress hormones. This costs western Europeans about 61,000 healthy life years annually, and causes about 3,000 deaths (Rebecca C, 2011). In Nablus city in palestine, it was found that exposure to the occupational noise in schools showed some association with raised blood pressure (Abdel Raziq I. R, 2003). In Jenin city, it was found that exposure to the nois in schools raised blood pressure and heart pulse rate, (saeed R, 2010).

1.2. Objectives

The aims of this research are:

1. Measuring the sound level in some schools in Ramallah county.
2. finding out the relation between the occupational noise level and the several health parameters of selected students such as:
    a. systolic blood pressure (SBP)
    b. diastolic blood pressure (DBP)
    c. heart pulse rate (HPR)
    d. blood oxygen saturation (SpO_2)
    e. Hearing threshold level (HTL)of selected students in the schools in Ramalla county in Palestine.

Chapter 2
Theoretical Issues

Chapter 2
Theoretical Issues

This chapter includes four sections, the first section describes the theory of sound pressure, the second section shows the human ear theory, the third section investigates the blood oxygen saturaion. Finally the fourth section describes the blood pressure.

2.1. Theory of Sound Pressure

Sound events are air pressure oscillations with an alternation of 20 to 20,000 Hz, which can be perceived by the human ear. The perceptibility of sound events by the human ear extend from the audibility threshold, with an effective value of the air pressure oscillation of 0.00002 Pascal (0.0002 µbar), up to the pain threshold, with an effective value of 20 Pascal (200 µbar). To obtain a graduation scale conceivable to the human mind, the sound pressure is indicated in a logarithmic scale of sound pressure levels, by means of the unit "decibels" (dB) which is expressed by (Stumpf F. B, 1980) as

$$\mathbf{dB = 20 \log_{10} (P/P_0) \ldots\ldots (2.1)}$$

Where:

(P) is the measured sound pressure.

(P_0) is the reference pressure which is equivalent to $2x10^{-5}$ Pascal.

The factor 20 appears in the equation due to the fact that energy or intensity of sound waves is proportional to the square of their amplitude ($I \alpha A^2$) (Stumpf F. B, 1980).

A human ear can hear -10 dB(A) (which is referred to as threshold of hearing) up to 120 dB(A) (which is referred to as threshold of pain). In this scale of values, the above-mentioned perceptibility range of the human ear extends from -10 to 120 dB(A). The sound volume perception of the person is determined by the interaction of the physical sound pressure level (-10 to 120 dB) and the frequency (20 to 20,000 Hz).

The greatest sensitivity of human ear is in the medium range, between 1,000 and 4,000 Hz. For this reason, sound meters are usually fitted with a filter whose response to frequency is a bit like that of the human ear. Therefore "A weighting filter" is used. The sound pressure level is given in units of dB(A) or dBA. Sound pressure level on the dBA scale is easy to measure and is therefore widely used (Daniel J, 2004). The C scale is practically linear over several octaves and is thus suitable for subjective measurements only for very high sound levels. Measurements made on this scale are expressed as dB(C). There is also a (rarely used) B weighting scale, intermediate between A and C. Measurements made on this scale are expressed as dB(B). D-frequency-weighting was specifically designed for use when measuring high level aircraft noise. Measurements made on this scale are expressed as dB(D).

In the field of noise pollution (especially when sound pressures become noisy) several physical quantities and notations are being used:

L_{NP}: Noise Pollution Level in dB, also written as NPL

L_{eq} : Equivalent Continuous Sound Level in dB.

L_{10} : The noise level in dB exceeded 10% of the measured time.

L_{90} : The noise level in dB exceeded 90% of the measured time.

These quantities can be related to each other as below (Stumpf F. B, 1980):

$L_{NP} = L_{eq} + L_{10} - L_{90}$ …….(2.2)

The typical noise levels of some point sources are shown in Table 2.1. (Secunderabad, 1991).

Table (2.1): The typical noise levels of some point sources.

Source	Noise level dB(A)	Source	Noise level dB(A)
Ticking clock	30	Air compressors	95-104
Quiet garden	30	110 KVA diesel generator	95
Computer rooms	55-60	Lather Machine	87
Type institute	60	Milling machine	112
Printing press	80	Oxy-acetylene cutting	96
Sports car	80-95	Pulveriser	92
Trains	96	Riveting	95
Trucks	90-100	Power operated portable saw	108
Car horns	90-105	Steam turbine (12, 500 KW)	91
Jet takeoff	120	Pneumatic Chiseling	118

2.2. Human Ear Theory

The elevated sound levels cause trauma to cochlear structure in the inner ear, which gives rise to irreversible hearing loss (Rosen S, 1965). A very loud sound in a particular frequency range can damage the cochlea's hair cells that respond to that range thereby reducing the ear's ability to hear those frequencies in the future. However, loud noise in any frequency range has deleterious effects across the entire range of human hearing. The outer ear (visible portion of the human ear) combined with the middle ear amplifies sound levels by a factor of 20 when sound reaches the inner ear (EPA, 1987).

2.3. Blood Oxygen saturation

Healthy blood oxygen levels are essential for proper functioning of the body. Less amount of oxygen flowing through the blood or oxygen deprivation can lead to organ failure. Oxygen in blood is measured by performing a blood test. For this, blood sample is taken from an artery. The level can also be measured with the help of a 'pulse oximeter' attached to a finger. A '95-100% level' is considered as normal or healthy while 80-94% oxygen is considered as 'low blood oxygen' or 'hypoxemia'. In children, 97% oxygen level (at least 97% of the bloodstream should be oxygen saturated) is considered as normal. Very low levels of oxygen (less than 80%) can lead to serious symptoms like cell death and serious damage, especially to the central nervous system, eye and lungs (Davidson JA, 1993). Oxygen saturation is defined as the ratio of oxyhemoglobin to the

total concentration of hemoglobin present in the blood. A hemoglobin molecule carry a maximum of four oxygen molecules. 100 haemoglobin molecules can carry a maximum of 400 oxygen molecules; if they together were carrying 320 oxygen molecules, then the oxygen saturation level would be (320/400)*100 or 80%. Pulse oximeter: A pulse oximeter is a device intended for the non-invasive measurement of arterial blood oxygen saturation and pulse rate. Typically it uses two light-emitting diodes generating red and infrared lights through a translucent part of the body (Moyle J, 1994).

2.4. Blood Pressure

Blood pressure is defined as the force of the blood pushing against the walls of the arteries. Each time the heart beats, it pumps blood into the arteries. Blood pressure is measured by the systolic and diastolic pressures. The systolic pressure represents the pressure in the arteries as the heart contracts and pumps blood, while the diastolic pressure, represents the pressure in the arteries as the heart relaxes. Normal blood pressure is considered below 120/70 mmHg. The value, 120 mmHg being the systolic pressure while 70 mmHg being the diastolic pressure (Shaw G, 2009).

Blood pressure of 140/90 mmHg or above is considered as high blood pressure. In high blood pressure, the heart works harder, and the chances of a stroke or heart attack are greater. Studies show that stress and high blood pressure play a major role in causing strokes. Experts believe that people who report high levels of stress in their lives are twice as likely

to suffer from a fatal stroke, than compared to people who report low stress levels. Having a stressful job may also be raised blood pressure in human (Fisher DL, 2005).

Chapter 3
Methodology

Chapter 3
Methodology

This chapter includes four sections, the first section describes the study sample, the second section shows the hearing impairment definition, the third section includes the data colleting. Finally the fourth section provides the experimental equipments.

3.1. Study Sample

The Study Sample consisted of 360 students aged 15 to 17 years old, distributed equally in six schools (3 males and 3 females), of three different sound pressure levels located in the following three locations:

1. Ramallah city of about 92,000 inhabitants during day time (high level noise).
2. Deir Ibzei' village of about 2,000 inhabitants, located at 10 Km west of Ramallah (middle level noise).
3. Ni'leen village of about 8,000 inhabitants, located at 30 Km west of Ramallah (low level noise).

Sixty students were selected randomly at each school, after checking that they didn’t suffer from any healthy problem dependent on their schools health reports. These schools are:

1. Al-Isbanya girls school which lies in Al-Irsal street in Ramallah city.
2. Al-Beera boys school which lies in Al-Quds street in Ramallah city.

3. Khawla girls school which lies in Al-Beera region.

4.Deir Ibzei' boys school which lies in Deir Ibzei' village.

5. Ni'leen girls school which lies in Ni'leen village.

6. Ni'leen boys school which lies in Ni'leen village.

The sample was selected according the Cochran relation (Cochran, 1977).

$$M = Z^2 P q / \alpha^2 / \{1+[(Z^2 P q / \alpha^2)/N]\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

Where:

M is the minimum number of students that belongs to the study sample

N is population size, it is approximately 250 for each school

α = 0.05 (the probability of type 1 error, for population above 120, α = 0.05)

Z = 1.96 (the abscissa of the normal curve that cuts an area of α at the two tails, for population above 120, Z = 1.96)

P = 0.9 (the estimated proportion that one is trying to estimate in the population)

P q = estimate of variance (q = 1-P = 0.1)

By substituting α, Z, P, q and N values in Eq. (3.1), then M is nearly 57 which is less than the taken sample (60 students for each school). Except measurement of HTL (35 students for each school) were tested by digital audiometer, because it required time.

3.2. Hearing Impairment Definition

Mean values of hearing threshold level (HTL) of right (R) and left (L) ears before (b) and during (d) exposure to occupational noise in studied schools according to different frequencies limited the hearing impairment. The relation between (HTL) and frequency will be discussed according to four organizations that discuss the phenomenon of hearing impairment. These organizations are:

1. American National Standard Institute (ANSI (1969)). Its mission is to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.

2. Occupational Safety and Health Administration (OSHA**).** It is part of the U.S. Department of Labor and is responsible for developing and enforcing workplace safety and health regulations.

3. National Institute for Occupational Safety and Health **(**NIOSH) and American Social Health Association **(**ASHA)**.** NIOSH is part of the Centers for Disease Control and Prevention in the United State.

Department of Health and Human Services. It conducts research and provides information, education, training, and recommendations regarding occupational safety and health. As such, it is in a position to recommend standards and best practices, but it is not in a position to regulate or enforce standards.

ASHA's goal is to impart long term changes by facilitating cultivation of good health habits that help the youth to become healthier humans and citizens. Thus as the name suggests, it is a fundamental and effective alternative approach towards community and national health.

4. Environmental Protection Agency (EPA). It is an agency of the federal government of the United States charged with protecting human health and the environment, by writing and enforcing regulations based on laws passed by Congress. Each one of these four organizations has special definition of hearing impairment.

ANSI (1969) put degrees of hearing impairment as following:

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

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

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

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

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

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

OSHA defines hearing impairment as the average of hearing threshold levels in either one or both ears exceeds 25 dB(A) at 1000, 2000 and 3000Hz. NIOSH and ASHA define hearing impairment as the average of hearing threshold levels in either one or both ears exceeds 25 dB(A) at 1000, 2000,3000 and 4000Hz.

EPA defines hearing impairment as the average of hearing threshold levels in either one or both ears exceeds 25 dB(A) at 500, 1000 and 2000Hz.

3.3. Collecting Data

Data were recorded during April and May 2011, by using a Digital Sound Level Meter. The levels of noise were measured in class rooms every 30 minutes during school day from 7.00 a.m to 1.30 p.m. The sound level meter was calibrated between 40 dB(A) and 110 dB(A) with resolution 0.1 dB(A). The SpO_2%, HPR, SBP, DBP and HTL were measured twice for each student : from 7.00- 8.00 a.m (since coming to school) and from 12.30- 1.30 p.m (before leaving the school). The minimum, maximum, mean and standard deviation of various parameters of blood oxygen saturation, heart pulse rate, systolic blood pressure and diastolic blood pressure were calculated for each school.

3.4. Experimental Equipments

1. Digital Sound Level Meter (Quest Technologies, U.S.A, model 2900 type2) with an accuracy ± 0.5dB at 25degree centigrade, was used to measure sound level in dB(A) in class rooms.

Fig. (3.1): Digital Sound Level Meter (Quest Technologies, U.S.A, Model 2900 Type2).

2. Audiometer (Welch Allyn Inc, U.S.A) with accuracy ± 3%, at operating temperature (15-40) degree centigrade was used to measure the threshold of hearing levels at different frequencies (250 Hz-8 KHz). The results of left and right ears were recorded in a digital audiogram.

Fig. (3.2): Audiometer (Welch Allyn Inc, U.S.A).

3. Wrist Blood Pressure Monitor (Nihon Seimitsu Sokki Co, Japan Model WS300) with accuracy ± 3mmHg cuff (pressure), and ± 5% of reading pulse rate with operating temperature range ± 10 degree centigrade to ± 40 degree centigrade, was used to measure the systolic and diastolic blood pressure.

Fig. (3.3): Wrist Blood Pressure Monitor (Nihon Seimitsu Sokki Co, Japan Model WS300).

4. Pulse Oximeter LM-800 (Finger Oximeter), was used to measure the blood oxygen saturation.

Fig. (3. 4): Pulse Oximeter LM- 800 (London Medical LM- 800 Pulse Oximeter).

3.5. Statistical Analysis

The measurements were analyzed statistically by using the SPSS program to find out the association between noise level and the systolic and diastolic blood pressure, heart pulse rate, blood oxygen saturation and hearing threshold level. The Pearson's correlation coefficient (R) and the (P-value) were calculated by using SPSS for all sample students in all studied schools. Where as the Pearson correlation coefficient (R) reflects the degree of linear relationship between two variables. It ranges from –1 to +1. A correlation +1 is a perfect positive (increasing linear relationship). –1 is a perfect negative (decreasing linear relation ship). If R is zero that means no correlation between studied variables. A decision about the significance of the result is based on the P- value. 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-value ≤ 0.050 strong significance

P-value = 0.050 the threshold of statistical significance

$0.050 < \text{P-value} \leq 1.000$ no significance

(William L. Carlson, 2007).

Chapter 4
Results

Chapter 4
Results

This chapter includes six sections, the first section describes the measurements of sound pressure levels, the second section describes the measurements of blood oxygen saturation, heart pulse rate, systolic blood pressure and diastolic blood pressure, the third section provides the hearing threshold results, the fourth section provides the blood oxygen saturation results, the fifth section provides the heart pulse rate results. Finally the sixth section provides the systolic and diastolic blood pressure.

4.1. Measurements of Sound Pressure Levels

The results of sound pressure levels of different schools are tabulated in Table 4.1. The highest noise levels were in Al-Beera boys school and Al-Isbanya girls school (very noisy)[81.0 dB(A)-83.5 dB(A)]. The middle's noise levels were in Deir Ibzei' boys school and Khawla girls school (noisy) [76.6 dB(A)-78.1 dB(A)] . Whereas both schools (boys and girls) in Ni'leen village had the lowest values of noise levels (quiet) [72.6 dB(A)-73.6 dB(A)].

Table (4.1): The mean SPL values in dB(A) for the six schools during day time Schools

	Very noisy		Noisy		Quiet	
Time	**S_4**	**S_1**	**S_5**	**S_2**	**S_6**	**S_3**
8.00	77.6	73.8	72.0	70.6	67.4	67.0
8.10	79.1	69.9	83.0	63.0	71.8	68.0
8.20	81.0	75.7	78.0	72.4	69.1	69.0
8.30	83.0	83.4	84.0	75.6	75.0	68.5
8.40	89.0	88.5	90.0	87.0	72.1	75.0
8.50	77.1	77.4	69.9	81.0	70.9	74.2
9.00	78.0	70.7	75.0	72.0	74.3	68.1
9.10	81.0	74.2	89.0	75.2	70.7	69.0
9.20	76.3	87.0	77.0	77.0	71.0	68.0
9.30	87.0	87.6	68.0	72.0	77.0	71.0
9.40	78.3	67.2	72.0	76.0	69.0	77.2
9.50	76.4	69.5	71.0	76.0	73.1	69.5
10.00	71.0	74.3	95.0	82.9	72.6	65.3
10.10	88.0	84.9	80.0	75.7	80.0	77.0
10.20	94.9	98.2	97.0	78.0	86.7	82.0
10.30	93.0	97.5	82.0	79.2	78.0	84.0
10.40	91.8	91.5	79.0	80.0	74.4	78.3
10.50	95.6	78.2	86.0	68.0	75.0	61.0
11.00	89.3	74.5	84.0	78.0	75.1	62.1
11.10	82.3	76.8	92.0	82.3	71.3	72.0
11.20	80.0	73.3	83.0	84.4	86.7	79.1
11.30	87.4	75.1	79.0	75.0	70.9	77.2
11.40	78.8	72.8	71.0	78.3	68.4	69.4
11.50	82.5	74.5	75.1	76.0	76.3	63.5
12.00	79.0	68.9	71.8	78.6	76.3	69.7
12.10	82.1	84.8	81.0	72.0	83.5	76.0
12.20	91.6	88.8	71.1	81.0	76.0	82.0
12.30	88.0	76.5	72.7	78.0	73.0	74.7
12.40	81.0	75.2	70.6	71.0	72.0	72.1
12.50	90.0	96.1	73.2	77.0	71.5	88.0
13.00	83.0	87.8	68.0	83.1	67.0	77.0
13.10	78.0	84.3	77.9	82.2	68.9	73.4
13.20	82.0	99.7	71.0	71.9	70.2	67.0
13.30	84.5	95.4	68.0	76.5	67.1	72.5
Average	**83.5**	**81.0**	**78.1**	**76.7**	**73.6**	**72.6**

4.2. Measurments of blood oxygen saturation, heart pulse rate, systolic blood pressure and diastolic blood pressure

Tables 4.2-4.7 show the minimum, maximum, mean and standard deviation of various parameters of blood oxygen saturation, heart pulse rate, systolic blood pressure and diastolic blood pressure for each school.

Table (4.2): Minimum, maximum, and standard deviation values of studied variables for Al-Beera boys school (S4) (Very noisy).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	95	99	98.30	0.88
SpO_2%(d)	95	99	97.50	0.94
HPR(b) beats / minute	52	99	73.71	11.72
HPR(d) beats / minute	51	102	78.10	8.56
SBP(b) mmHg	82	175	120.16	15.00
SBP(d) mmHg	99	182	130.95	13.77
DBP(b) mmHg	54	104	70.50	8.94
DBP(d) mmHg	48	95	74.85	8.56

Table (4.3): Minimum, maximum, and standard deviation values of studied variables for Al-Isbanya girls school (S1) (Very noisy).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	97	99	97.98	0.95
SpO_2%(d)	95	99	97.00	0.79
HPR(b) beats / minute	61	103	80.67	10.33
HPR(d) beats / minute	66	109	86.50	10.69
SBP(b) mmHg	90	145	115.10	11.00
SBP(d) mmHg	98	156	123.00	10.50
DBP(b) mmHg	53	100	68.09	8.50
DBP(d) mmHg	58	104	75.80	8.97

Table (4.4): Minimum, maximum, and standard deviation values of studied variables for Deir Ibzei' school (S5) (Noisy).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	97	99	98.40	0.74
SpO_2%(d)	92	99	97.33	1.44
HPR(b) beats / minute	50	107	79.20	13.54
HPR(d) beats / minute	51	113	84.97	14.39
SBP(b) mmHg	95	177	115.14	12.85
SBP(d) mmHg	99	147	123.18	11.01
DBP(b) mmHg	52	92	69.47	9.19
DBP(d) mmHg	54	96	76.65	9.79

Table (4.5): Minimum, maximum, and standard deviation values of studied variables for Khawla girls school (S2) (Noisy).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	96	99	97.70	0.85
SpO_2%(d)	96	99	97.10	0.62
HPR(b) beats / minute	58	113	78.80	11.27
HPR(d) beats / minute	65	124	86.90	12.80
SBP(b) mmHg	96	141	114.20	9.89
SBP(d) mmHg	100	148	122.70	11.64
DBP(b) mmHg	50	94	68.27	10.10
DBP(d) mmHg	60	100	76.60	10.76

Table (4.6): Minimum, maximum, and standard deviation values of studied variables for Ni'leen boys school (S6) (Quiet).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	96	99	98.00	0.95
SpO_2%(d)	96	99	97.46	0.91
HPR(b) beats / minute	53	95	76.86	10.65
HPR(d) beats / minute	58	111	81.28	11.38
SBP(b) mmHg	81	150	118.15	13.29
SBP(d) mmHg	97	150	126.73	12.66
DBP(b) mmHg	52	95	66.15	8.53
DBP(d) mmHg	57	102	73.13	9.48

Table (4.7): Minimum, maximum, and standard deviation values of studied variables for Ni'leen girls school (S3) (Quiet).

Variables	Min.	Max.	Mean	SD
SpO_2% (b)	96	99	98.20	0.89
SpO_2%(d)	95	99	97.40	1.02
HPR(b) beats / minute	57	102	82.30	11.62
HPR(d) beats / minute	57	121	89.37	12.80
SBP(b) mmHg	76	138	112.00	11.99
SBP(d) mmHg	98	151	124.35	13.40
DBP(b) mmHg	52	93	70.11	8.80
DBP(d) mmHg	62	99	77.22	9.00

4.3. Hearing Threshold Results

Percentage of degrees of hearing impairment in both ears before (b) and during (d) exposure to occupational noise in whole study population according to each one organization are presented in Tables 4.8 – 4.14.

Table (4.8): Percentage of degrees of hearing impairment at different sound frequencies in whole study population [according to ANSI (1969) criteria].

Degrees of H.I*	Right ear (b) %	Right ear (d) %	Left ear (b) %	Left ear (d) %
1	69	63.3	70	63.1
2	23	25	22	24
3	7.8	10.6	7.7	11.8
4	0.2	1.1	0.3	1.1
5	0	0	0	0
6	0	0	0	0
Total	**100**	**100**	**100**	**100**

***H.I : hearing impairment.**

Table 4.8 shows 69% (R) and 70% (L) of the selected students' ears (right (R) and left (L)) were classified in normal state, when they were examined before exposure to occupational noise. On the other hand, 63.3% (R) and 63.1% (L) of the selected students' ears (right (R) and left (L)) were

classified in normal state, when they were examined during exposure to occupational noise at different frequencies. This means that 5.7% (R) and 6.9% (L) of the selected students had loss their ear's capacitance of hearing between -10 -26 dB(A).

23% (R) and 22% (L) of the selected students' ears (right (R) and left (L)) were classified in mild state, when they were examined before exposure to occupational noise. In other respect, 25% (R) and 24% (L) of the selected students' ears (right (R) and left (L)) were classified in mild state, when they were examined during exposure to occupational noise at different frequencies.

The change in this state was reached 2% on both ears right (R) and left (L), this is an indication of effect of noise pollution on hearing impairment. 7.8% (R) and 7.7% (L) of the selected students' ears (right (R) and left (L)) were classified in moderate state, when they were examined before exposure to occupational noise. In other respect, 10.6% (R) and 11.8% (L) of the selected students' ears (right (R) and left (L)) were classified in moderate state, when they were examined during exposure to occupational noise at different frequencies.

Table (4.9): Percentage of degrees of hearing impairment at different sound frequencies in Al-Isbanya Girls School [according to ANSI (1969) criteria].

Degrees of H.I	Right ear(b) %	Right ear(d) %	Left ear(b) %	Left ear(d) %
2	62.2	51.8	59.6	51.3
3	22.2	27.2	22.2	25.3
4	14	18.5	12.3	15.9
5	1.2	3.4	5.9	7.5
6	0	0	0	0
Total	0	0	0	0
	100	**100**	**100**	**100**

Table (4.10): Percentage of degrees of hearing impairment at different sound frequencies in Ni'leen Girls School [according to ANSI (1969) criteria].

Degrees of H.I	Right ear(b) %	Right ear(d) %	Left ear(b) %	Left ear(d) %
2	84	76.9	79.2	73.3
3	16	19.8	16.5	19.8
4	0	3.3	4.3	6.9
5	0	0	0	0
6	0	0	0	0
Total	0	0	0	0
	100	**100**	**100**	**100**

Table (4.11): Percentage of degrees of hearing impairment at different sound frequencies in Ni'leen Boys School [according to ANSI (1969) criteria].

Degrees of H.I	Right ear(b) %	Right ear(d) %	Left ear (b) %	Left ear (d) %
2	72.5	70.5	70.5	64.5
3	27.5	29.5	29.2	35.5
4	0	0	0.3	0
5	0	0	0	0
6	0	0	0	0
Total	0	0	0	0
	100	**100**	**100**	**100**

The effect of noise pollution level on hearing impairment according to ANSI criteria can be shown by comparing girls schools together in Table

4.9 and Table 4.10. Comparing the difference percentage of degrees of hearing impairment before and during exposure to occupational noise, this difference is bigger in Al-Isbanya girls school than the difference in Ni'leen girls school. Comparing of the noise levels showed that the effect of noise pollution was significantly higher among the students in the highest noise level (Al-Isbanya girls school). The effect of noise pollution on gender can be shown by comparing males school with females school that belong to the same noise levels. Comparing Ni'leen girls school with Ni'leen boys school. Based on the difference percentage of degrees of hearing impairment before and during exposure to occupational noise in Table 4.10 and Table 4.11, the differences are bigger in Ni'leen girls school than the differences in Ni'leen boys school. This means that females are more affected by noise pollution than males.

Table (4.12): Percentage of degrees of hearing impairment in each studied school [according to OSHA's definition of hearing impairment].

	School	Right ear (b) %	Right ear (d) %	Left ear (b) %	Left ear (d) %
Very noisy	**S_4**	25(9/36)	36.1(13/36)	25(9/36)	36.1(13/36)
	S_1	37(13/35)	51(18/35)	37(13/35)	54(19/35)
Noisy	**S_5**	13.1(5/38)	15.7(6/38)	13.1(5/38)	18.4(7/38)
	S_2	50(18/36)	63.8(23/36)	47.2(17/36)	63.8(23/36)
Quiet	**S_6**	5.8(2/34)	5.8(2/34)	2.9(1/34)	8.8(3/34)
	S_3	3.3(1/30)	6.6(2/30)	6.6(2/30)	13.3(4/30)
	Total	**22.9(48/209)**	**30.6(64/209)**	**22.4(47/209)**	**33(69/209)**

Table 4.12 shows a total of 22.9% (R) and 22.4% (L) of the selected students ears (right (R) and left (L)) were classified to have hearing impairment according to OSHA, when they were examined before

exposure to occupational noise. In other respect, 30.6% (R) and 33% (L) of the selected students ears (right (R) and left (L)) were classified to have hearing impairment, when they were examined during exposure to occupational noise.

The effect of noise pollution on gender by comparing males schools with females schools that belong to the same noise levels. Comparing Ni'leen girls school (quiet school) with Ni'leen boys school (quiet school). The difference percentages of hearing impairment in Ni'leen girls school ($\mathbf{S_3}$) are 3.3% (R) and 6.7% (L) in their ears (right (R) and left (L)) of girls, the difference percentages of hearing impairment in Ni'leen boys school ($\mathbf{S_6}$) are 0% (R) and 5.9% (L) in their ears (right (R) and left (L)) of boys. Comparing Noisy schools together, the change percentages of hearing impairment in Khawla girls school ($\mathbf{S_2}$) are 13.8% (R) and 16.6% (L) in their ears (right (R) and left (L)) of boys. In other respect, the change percentages of hearing impairment in Deir-Ibzei' boys school ($\mathbf{S_5}$) are 2.6% (R) and 5.3% (L) in their ears (right (R) and left (L)) of boys. Comparing Al-Isbanya girls school (very noisy school) with Al-Beera boys school (very noisy school). Al-Isbanya girls school ($\mathbf{S_1}$) has more differences in hearing impairment 14% (R) and 17% (L) in their ears (right (R) and left (L)). while Al-Beera boys school has a difference 11.1% (R) and (L) in both ears (right (R) and left (L)). Comparing males schools with females schools showed that the differences of hearing impairment are significantly higher in girls schools than boys schools. This means that girls had affected by noise pollution more than boys.

The effect of noise pollution level on hearing impairment can be shown by comparing the three females schools together, also comparing the three males schools together. The difference percentages of hearing impairment are (14% and 17%), (13.8% and 16.6%) and (3.3% and 6.7%) in right (R) and left (L) ears in Al-Isbanya girls school (**S_1**), Khawla girls school (**S_2**) and Ni'leen girls school (**S_3**). The difference percentages of hearing impairment are (11.1% and 11.1%), (2.6% and 5.3%) and (0% and 5.9%) in right (R) and left (L) ears in Al-Beera boys school (**S_4**), Deir-Ibzei' boys school (**S_5**) and Ni'leen boys school (**S_6**). Comparing of the noise levels showed that the effect of noise pollution was significantly higher among the students in the highest noise level.

Table (4.13): Percentage of degrees of hearing impairment in each studied school [according to NIOSH and ASHA's definition of hearing impairment].

	School	Right ear (b) %	Right ear (d) %	Left ear (b) %	Left ear (d) %
Very noisy	**S_4**	17(6/36)	27.7(10/36)	19.4(7/36)	30.5(11/36
	S_1	2.8 (1/35)	40(14/35)	29(10/35)	43(15/35)
Noisy	**S_5**	10.5(4/38)	18.4(7/38)	10.5(4/38)	13.1(5/38)
	S_2	38.8(14/36)	50(18/36)	36.1(13/36)	50(18/36)
Quiet	**S_6**	2.9(1/34)	5.8(2/34)	2.9(1/34)	5.8(2/34)
	S_3	3.3(1/30)	6.6(2/30)	3.3(1/30)	10(3/30)
	Total	**12.9(27/209)**	**25.3(53/209)**	**17.2(36/209)**	**25.8(54/209)**

Table 4.13 shows a total of 12.9% (R) and 17.2% (L) of the selected students ears (right (R) and left (L)) were classified to have hearing impairment according to NIOSH and ASHA, when they were examined before exposure to occupational noise. Otherwise, 25.3% (R) and 25.8% (L) of the selected students ears (right (R) and left (L)) were classified to

have hearing impairment, when they were examined during exposure to occupational noise.

The effect of noise pollution on gender can be shown by comparing males schools with females schools that belong to the same noise levels. Comparing Ni'leen girls school (quiet school) with Ni'leen boys school (quiet school). The difference percentages of hearing impairment in Ni'leen girls school ($\mathbf{S_3}$) are 3.3% (R) and 6.7% (L) in their ears (right (R) and left (L)) of girls, the difference percentages of hearing impairment in Ni'leen boys school ($\mathbf{S_6}$) are 2.9% (R) and (L) in both ears (right (R) and left (L)) of boys. Comparing Noisy schools together, the change percentages of hearing impairment in Khawla girls school ($\mathbf{S_2}$) are 11.2% (R) and 13.9% (L) in their ears (right (R) and left (L)) of boys. In other respect, the change percentages of hearing impairment in Deir-Ibzei' boys school ($\mathbf{S_5}$) are 7.9% (R) and 2.6% (L) in their ears (right (R) and left (L)) of boys respectively. Comparing Al-Isbanya girls school (very noisy school) with Al-Beera boys school (very noisy school). Al-Isbanya girls school ($\mathbf{S_1}$) has more differences in hearing impairment 12% (R) and 14% (L) in their ears (right (R) and left (L)). while Al-Beera boys school has 10.7% (R) and 11.1% (L) in their ears (right (R) and left (L)). Comparing males schools with females schools showed that the differences of hearing impairment are significantly higher in girls schools than boys schools. This means that girls had affected by noise pollution more than boys. The effect of noise pollution level on hearing impairment can be shown by comparing the three females schools together, also comparing the three males schools together. The difference

percentages of hearing impairment are (12% and 14%), (11.2% and 13.9%) and (3.3% and 6.7%) in right (R) and left (L) ears in Al-Isbanya girls school ($\mathbf{S_1}$), Khawla girls school ($\mathbf{S_2}$) and Ni'leen girls school ($\mathbf{S_3}$). The difference percentages of hearing impairment are (10.7% and 11.1%), (7.9% and 2.6%) and (2.9% and 2.9%) in right (R) and left (L) ears in Al-Beera boys school ($\mathbf{S_4}$), Deir-Ibzei' boys school ($\mathbf{S_5}$) and Ni'leen boys school ($\mathbf{S_6}$). Comparing of the noise levels showed that the effect of noise pollution was significantly higher among the students in the highest noise level.

Table (4.14): Percentage of degrees of hearing impairment in each studied school [according to EPA's definition of hearing impairment].

	School	Right ear (b) %	Right ear (d) %	Left ear (b) %	Left ear (d) %
Very noisy	**S_4**	41.6(15/36)	55.5(20/36)	41.6(15/36)	55.5(20/36)
	S_1	63(22/35)	77(27/35)	65(23/35)	80(28/35)
Noisy	**S_5**	31.5(12/38)	39.4(15/38)	31.5(12/36)	42.1(16/38)
	S_2	75(27/36)	83.3(30/36)	72.2(26/36)	80.5(29/36)
Quiet	**S_6**	21(7/34)	24(8/34)	21(7/34)	26(9/34)
	S_3	20 (6/30)	33.3(10/30)	23.3(7/30)	40(12/30)
	Total	**42.5(89/209)**	**52.6(110/209)**	**43(90/209)**	**54.4(114/209)**

Table 4.14 shows a total of 42.5% (R) and 43% (L) of the selected students ears (right (R) and left (L)) were classified to have hearing impairment according to EPA, when they were examined before exposure to occupational noise. On the other hand, 52.6% (R) and 54.4% (L) of the examined students ears (right (R) and left (L)) were classified to have hearing impairment, when they were examined during exposure to occupational noise. The effect of noise pollution on gender can be shown

by comparing males schools with females schools that belong to the same noise levels. Comparing Ni'leen girls school (quiet school) with Ni'leen boys school (quiet school). The difference percentages of hearing impairment in Ni'leen girls school (**S_3**) are 13.3% (R) and 16.7% (L) in their (right (R) and left (L)) ears of girls, the difference percentages of hearing impairment in Ni'leen boys school (**S_6**) are 3% (R) and 5% (L) in their ears (right (R) and left (L)) of boys. Comparing Noisy schools together, the change percentages of hearing impairment in Khawla girls school (**S_2**) are 8.3% (R) and (L) in both ears (right (R) and left (L)) of girls. In other respect, the change percentages of hearing impairment in Deir-Ibzei' boys school (**S_5**) are 7.9% (R) and 10.6% (L) in their ears (right (R) and left (L)) of boys. Comparing Al-Isbanya girls school (very noisy school) with Al-Beera boys school (very noisy school). Al-Isbanya girls school (**S_1**) has more differences in hearing impairment 14% (R) and 15% (L) in their ears (right (R) and left (L)). while Al-Beera boys school has a difference 13.9% (R) and 13.9% (L) in their ears (right (R) and left (L)). Comparing males schools with females schools showed that the differences of hearing impairment are significantly higher in girls schools than boys schools. This means that girls had affected by noise pollution more than boys. The effect of noise pollution level on hearing impairment can be shown by comparing the three females schools together, also comparing the three males schools together. The difference percentages of hearing impairment are (14% and 15%), (8.3% and 8.3%) and (13.3% and 16.7%)

in right (R) and left (L) ears in Al-Isbanya girls school (S_1), Khawla girls school (S_2) and Ni'leen girls school (S_3) .

The difference percentages of hearing impairment are (13.9% and 13.9%), (7.9% and 10.6%) and (3% and 5%) in right (R) and left (L) ears in Al-Beera boys school (S_4), Deir-Ibzei' boys school (S_5) and Ni'leen boys school (S_6). Comparison of the noise levels showed that the effect of noise pollution was significantly higher among the students in the highest noise level. Tables 4.8- 4.14 show that there are a significant shifts in percentage of hearing impairment in both ears in different schools before exposure and during exposure of relatively occupational noise. Percentage of degrees of hearing impairment in right ear (R)/ left ear (L) of students before (b) and during (d) exposure to occupational noise in studied boys'/ girls' schools [according to EPA's definition of hearing impairment] is displayed in Figs. 4.1/ 4.2.

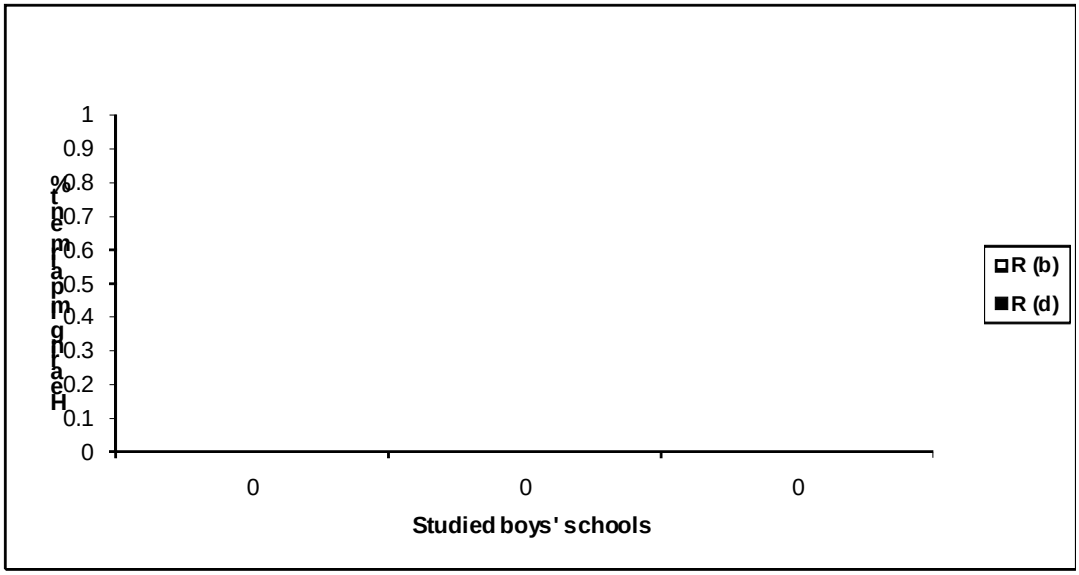

Fig. (4.1): Percentage of degrees of hearing impairment in right ear(R) of before (b) and during (d) exposure to occupational noise in studied boys' schools [according to EPA's definition of hearing impairment].

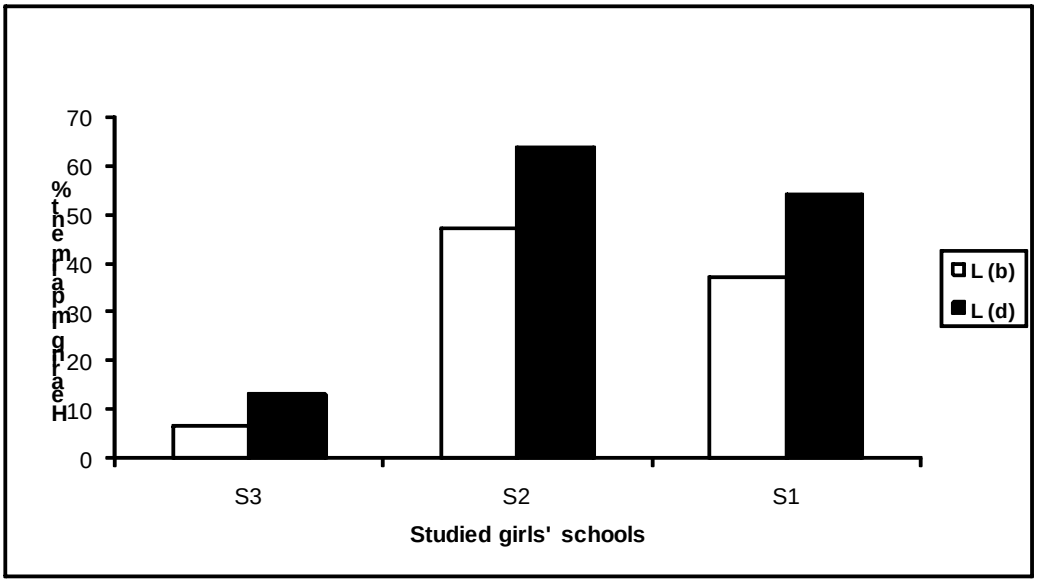

Fig. (4.2): Percentage of degrees of hearing impairment in Left ear (L) of girls before (b) and during (d) exposure to occupational noise in studied girls' schools [according to OSHA's definition of hearing impairment].

Both ears right (R) and left (L) suffer from a significant increase of percentage of degrees of hearing impairment during (d) exposure to occupational noise in our studied schools according to OSHA, NIOSH and ASHA and EPA's definitions (Appendix A). The digital audiometer shows the relation between the hearing threshold levels (HTL) and frequencies (250 Hz – 8 KHz) before (b) and during (d) exposure to occupational noise. Fig. 4.3 shows the relation between means of hearing threshold levels (HTL) of right ear (R) of girls with different frequencies (250 Hz -8 KHz) before (b) and during (d) exposure to occupational noise in Ni'leen girls school.

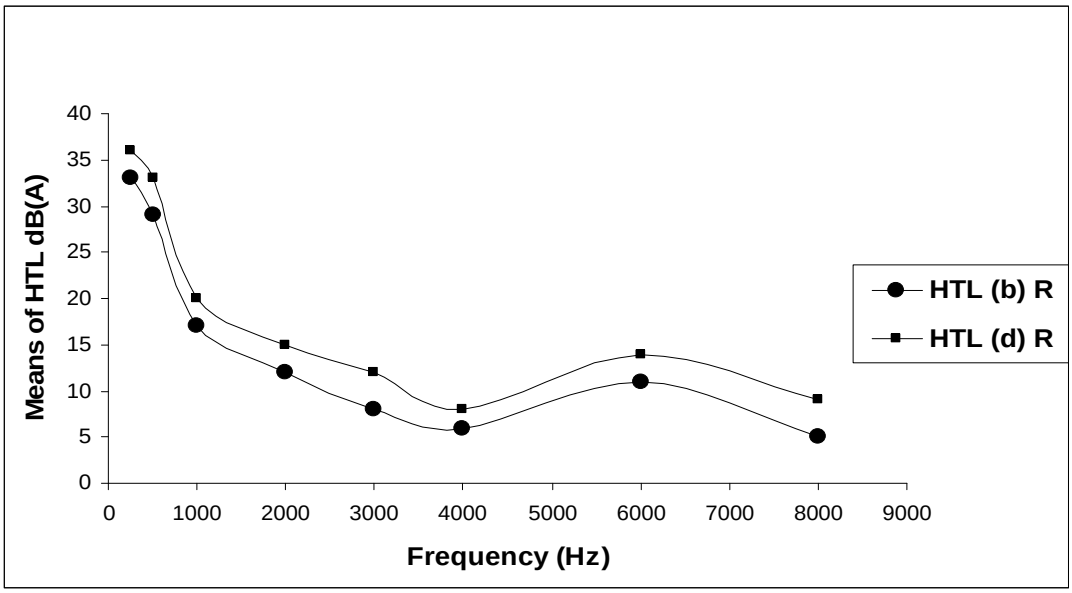

Fig. (4.3): Mean values of hearing threshold level (HTL) of right (R) ear before (b) and during (d) exposure to occupational noise in Ni'leen girls school according to different frequencies.

Fig. 4.3 shows that there is a different shift in hearing threshold level (HTL) at each frequency when the students exposure to occupational noise. Fig. 4.4 shows the relation between means of hearing threshold levels (HTL) of both ears right (R) and left (L) of students with different frequencies (250 Hz - 8 KHz) before (b) and during (d) exposure to occupational noise for one girl in Ni'leen girls school. There are a significant shifts in means of hearing threshold levels (HTL) of both ears right (R) and left (L) of student with different frequencies (250 Hz-8000 Hz) in different schools before (b) exposure and during (d) exposure to occupational noise in selected schools (Appendix B).

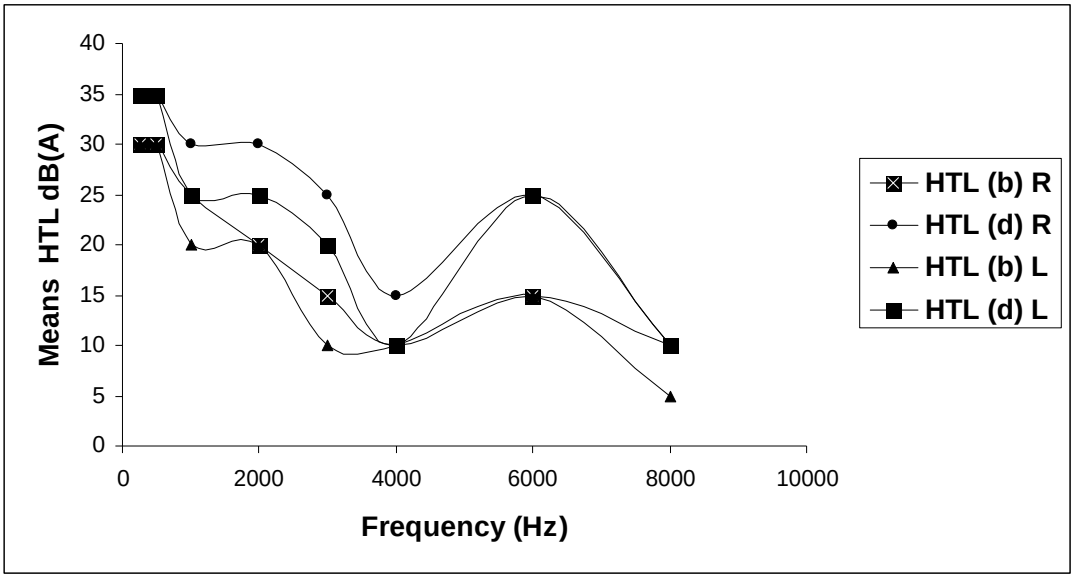

Fig. (4.4): Mean values of hearing threshold level (HTL) of right (R) and left (L) ears before (b) and during (d) exposure to occupational noise for one girl in Ni'leen girls school according to different frequencies.

4.4. Blood Oxygen Saturation Results

Values of blood oxygen saturation (SpO_2%) of selected students, were taken by pulse oximeter (finger oximeter) twice for each student : from 7.00- 8.00 a.m (since coming to school) and from 12.30- 1.30 p.m (before leaving the school). Mean values of blood oxygen saturation (SpO_2%) of selected students were decreased when they were examined during exposure to occupational noise. (tables 4.2 - 4.7). The mean values of blood oxygen saturation (SpO_2%) before (b) and during (d) exposure to occupational noise for studied boys and girls schools are represented in Figs. 4.5- 4.6.

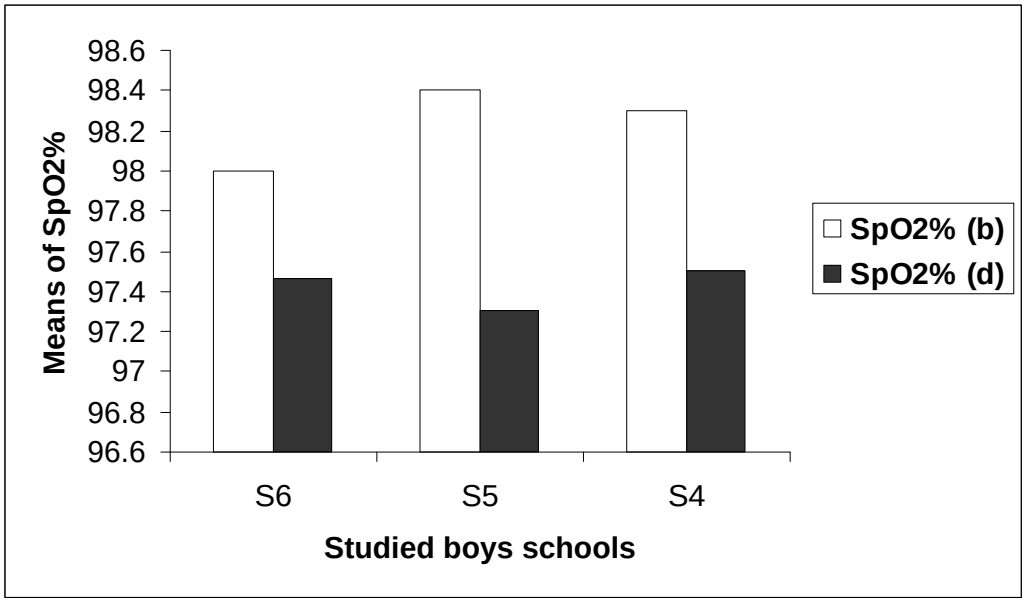

Fig. (4.5): Means of blood oxygen saturation before (b) and during (d) exposure to occupational noise in studied boys schools.

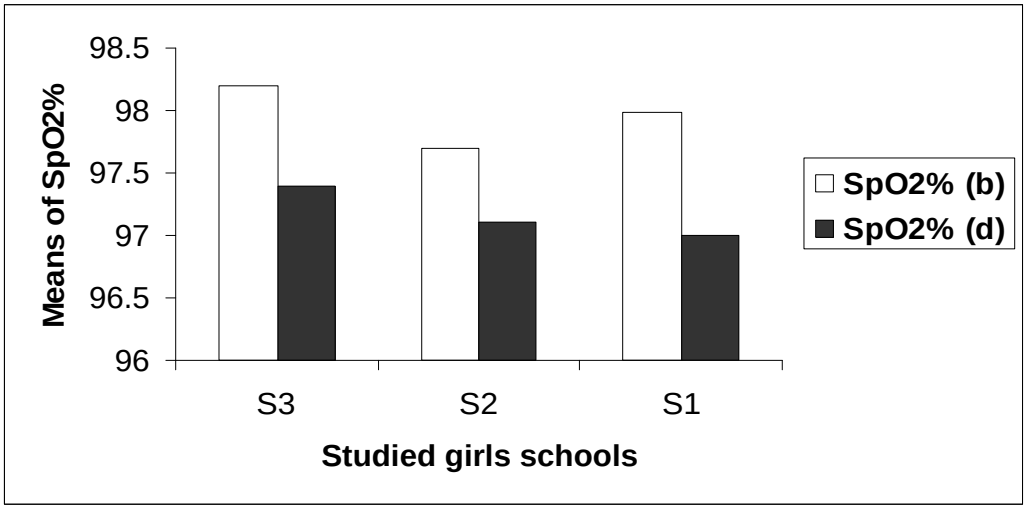

Fig. (4.6): Means of blood oxygen saturation before (b) and during (d) exposure to occupational noise in studied girls schools.

4.5. Heart Pulse Rate Results

Values of heart pulse rate (HPR) were recorded by using wrist blood pressure monitor twice for each student from 7.00- 8.00 a.m (since coming to school) and from 12.30- 1.30 p.m (before leaving the school). It was noticed that mean values of heart pulse rate were increased as students

exposure to occupational noise (tables 4.2 – 4.7). The effect of noise pollution on heart pulse rate (HPR) for studied girls and boys schools are represented in Figs. 4.7- 4.8.

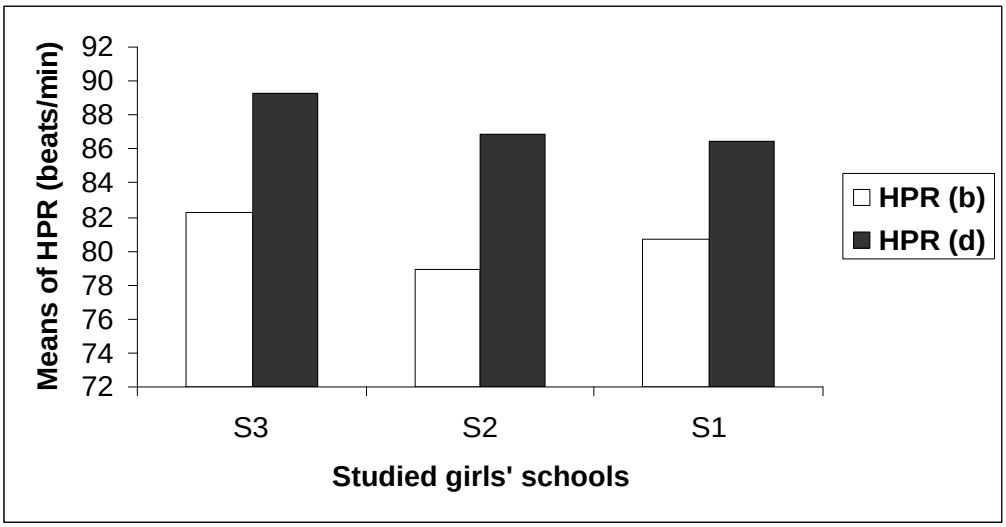

Fig. (4.7): Mean values of heart pulse rate before (b) and during (d) exposure to occupational noise in studied girls schools.

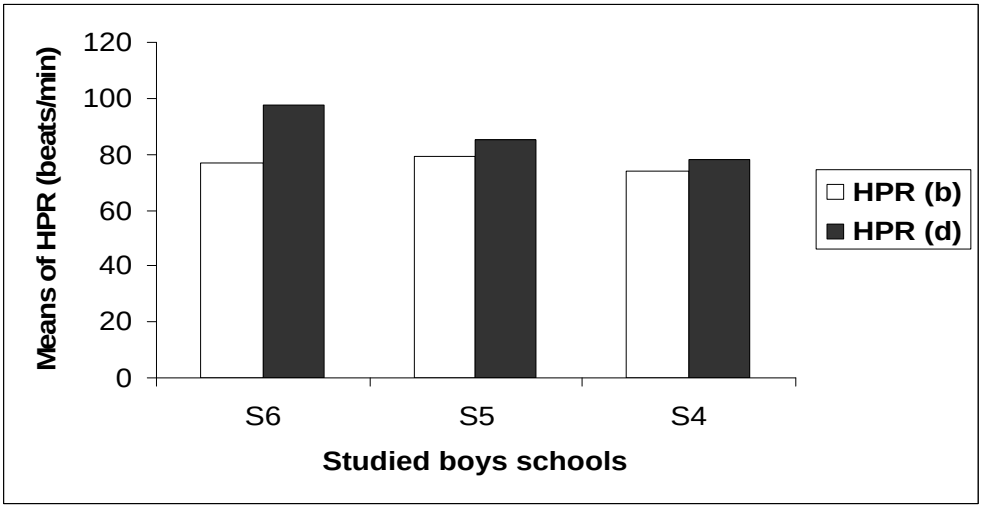

Fig. (4.8): Mean values of heart pulse rate before (b) and during (d) exposure to occupational noise in studied boys schools.

Figs. 4.7- 4.8 show a clear increase in heart pulse rate (HPR) that occurs when they were examined during exposure to occupational noise in the schools.

4.6. Systolic and Diastolic Blood Pressure (SBP and DBP) Results

The measured values of systolic and diastolic blood pressure (SBP and DBP) were recorded by using wrist blood pressure monitor. Means of systolic and diastolic blood pressure (SBP and DBP) of selected students, when they were examined during exposure to occupational noise were obviously increased as shown from tables 4.2 – 4.7. The effect of noise pollution on systolic and diastolic blood pressure (SBP and DBP) in studied schools are represented in Figs. 4.9- 4.12.

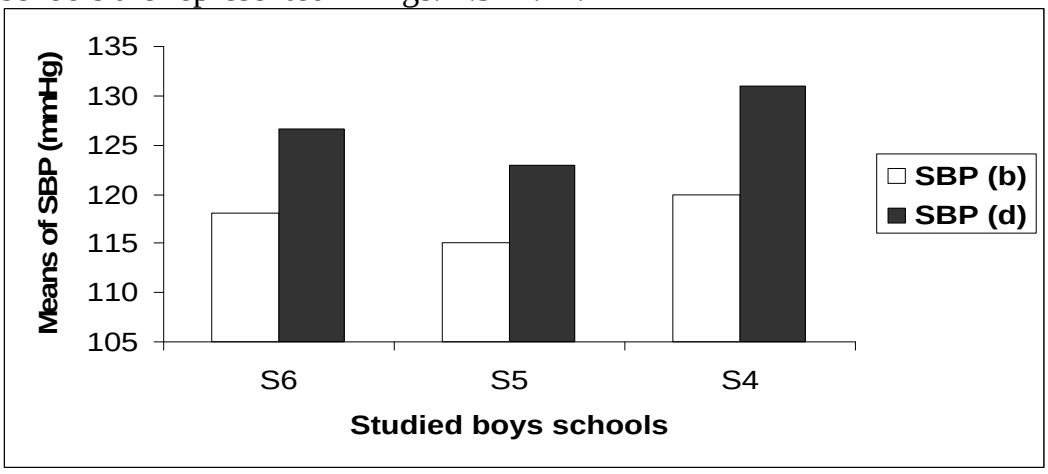

Fig. (4.9): Mean values of systolic blood pressure before (b) and during (d) exposure to occupational noise in studied boys schools.

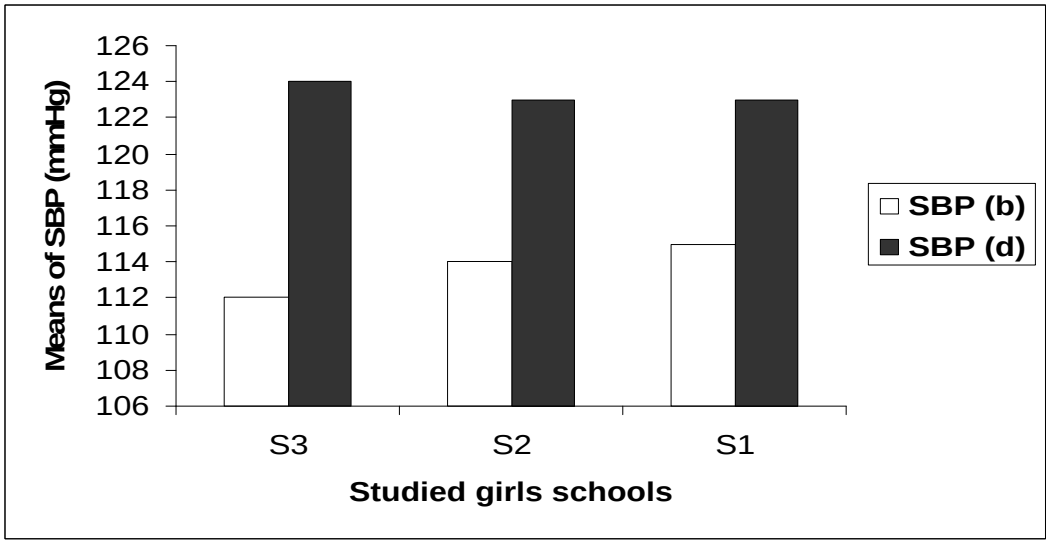

Fig. (4.10): Mean values of systolic blood pressure before (b) and (d) during exposure to occupational noise in studied girls schools.

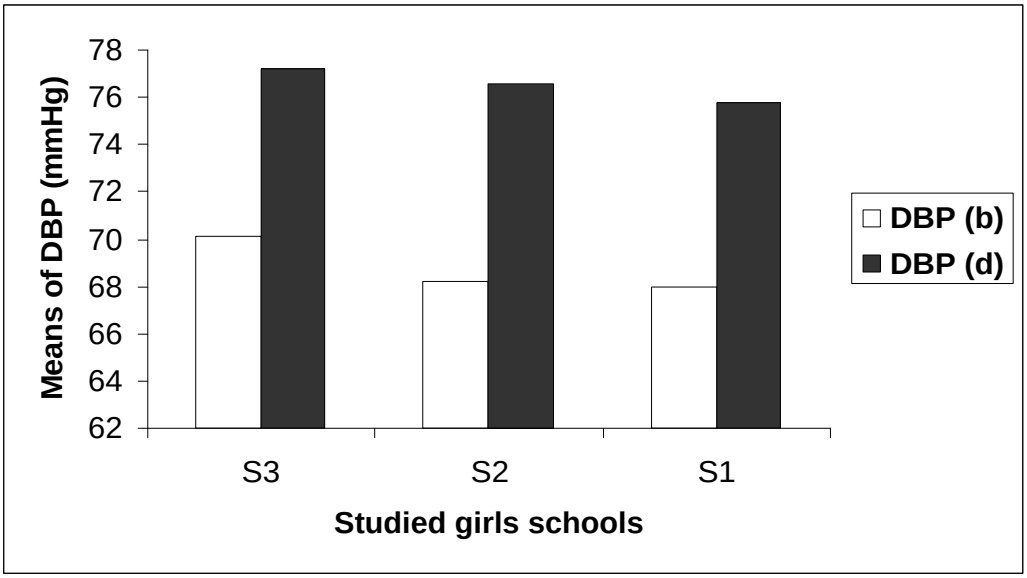

Fig. (4.11): Mean values of diastolic blood pressure before (b) and during (d) exposure to occupational noise in studied girls schools.

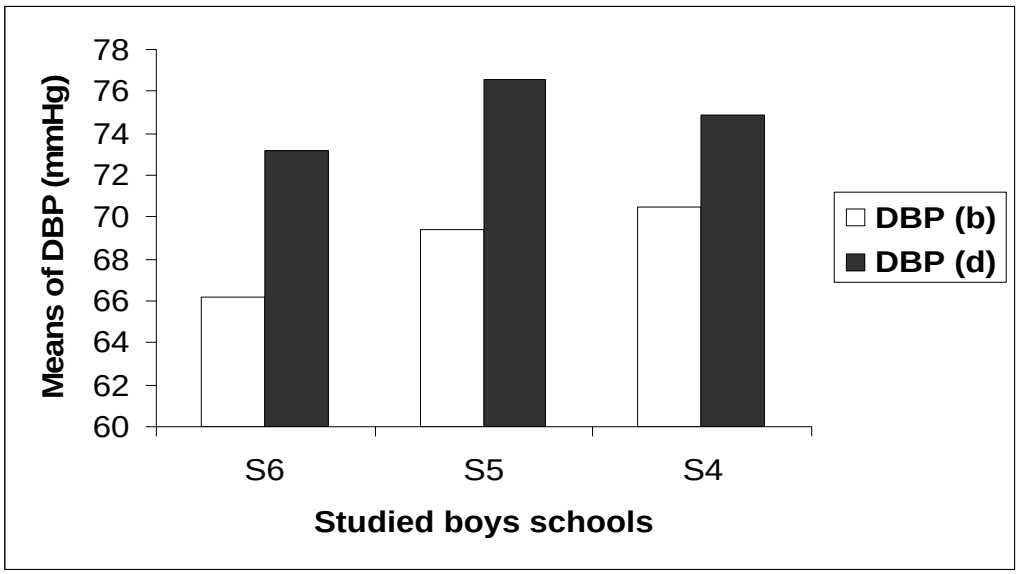

Fig. (4.12): Mean values of diastolic blood pressure before (b) and during (d) exposure to occupational noise in studied boys schools.

Figures 4.9- 4.12 show that mean values of systolic and diastolic blood pressure (SBP and DBP) of selected students, when they were examined during exposure to occupational noise were obviously increased in whole studied schools.

Chapter 5

Discussion, Recommendations and Conclusions

Chapter 5
Discussion, Recommendations and Conclusions

This chapter includes three sections, the first section describes the statistical analysis by using SPSS programm, the second section suggests some solutions inorder to reduce noise pollution in schools. Finally the third section provides the summary of this study.

The findings of this study support the hypothesis that exposure to high industrial noise levels may risk factor for cardiovascular disease via increased systolic and diastolic blood blood pressure, and pulse rate (Melamed & Ribak, 1997, Recova & Kellerova, 1995, WHO, 1999). The finding of this study has a good agreement with the results of other reports of increasing in systolic blood pressure, diastolic blood pressure, mean arterial blood pressure and heart pulse rate of the workers who exposed to noise levels exceeding 80 dB(A) (Sangeeta S, 2009).

5.1. Statistical Analysis

Tables 4.15- 4.18 show the dependent variables and the correlation coefficient and the P-values in all schools.

Table (5.1): Paired samples correlation of all studied variables (b) and during (d) exposure to occupational noise in all studied schools.

Paired variables	Pearson correlation Coefficient (R)	P-value
SP O_2% (b) and SP O_2% (d)	0.220	0.000
HPR (b) and HPR (d)	0.794	0.000
SBP (b) and SBP (d)	0.529	0.000
DPB (b) and DBP (d)	0.672	0.000
HTL (b) and HTL (d) / (R) at 250 Hz	0.973	0.001
HTL (b) and HTL (d) / (L) at 250 Hz	0.972	0.001
HTL (b) and HTL (d) / (R) at 500 Hz	0.990	0.000
HTL (b) and HTL (d) / (L) at 500 Hz	0.987	0.000
HTL (b) and HTL (d) / (R) at 1000 Hz	0.994	0.000
HTL (b) and HTL (d) / (L) at 1000 Hz	0.984	0.003
HTL (b) and HTL (d) / (R) at 2000 Hz	0.983	0.005
HTL (b) and HTL (d) / (L) at 2000 Hz	0.989	0.003
HTL (b) and HTL (d) / (R) at 3000 Hz	0.973	0.001
HTL (b) and HTL (d) / (L) at 3000 Hz	0.954	0.003
HTL (b) and HTL (d) / (R) at 4000 Hz	0.870	0.024
HTL (b) and HTL (d) / (L) at 4000 Hz	0.848	0.033
HTL (b) and HTL (d) / (R) at 6000 Hz	0.908	0.012
HTL (b) and HTL (d) / (L) at 6000 Hz	0.922	0.009
HTL (b) and HTL (d) / (R) at 8000 Hz	0.722	0.105
HTL (b) and HTL (d) / (L) at 8000 Hz	0.739	0.093

A strong positive correlation ($R > 0.5$) was found between the variables in all studied schools of HPR, SBP, DBP and HTL at most frequencies while ($0.5 > R > 0$) of SpO_2%. In other respect ($p < 0.05$) of SpO_2%, HPR, SBP, DBP and HTL at most frequencies except at 8000 Hz of right ear.

Table (5.2): SPL values, Pearson correlation coefficients R and the P-values of the studied variables in girls school.

School	Mean of SPL (dB(A))	Dependent Variables	R	P – value
S_1	81.0	SPO_2 %	0.248	0.068
		HPR	0.807	0.000
		SBP	0.700	0.000
		DBP	0.601	0.000
S_2	76.7	SPO_2%	0.290	0.026
		HPR	0.718	0.000
		SBP	0.785	0.000
		DBP	0.722	0.000
S_3	72.6	SPO_2%	0.221	0.111
		HPR	0.773	0.000
		SBP	0.586	0.000
		DBP	0.579	0.000

A strong positive correlation ($R > 0.5$) was found between the variables in all girls schools of HPR, SBP and DBP. ($0.5 > R > 0$) of SPO_2%. On the other hand ($p < 0.05$) of all variables except SPO_2% ($P > 0.05$) for S_1 (Al-Isbanya girls schools) and for S_3 (Ni'leen girls schools).

Table (5.3): SPL values, Pearson correlation coefficients R. and the P-values of the studied variables in boys school.

School	Mean of SPL (dB(A))	Dependent Variables	R	P – value
S_4	83.5	SPO_2%	0.262	0.043
		HPR	0.879	0.000
		SBP	0.644	0.000
		DBP	-0.198	0.129
S_5	78.1	SPO_2%	-0.007	0.965
		HPR	0.789	0.000
		SBP	0.670	0.000
		DBP	0.749	0.000
S_6	73.6	SPO_2%	0.337	0.024
		HPR	0.712	0.000
		SBP	0.661	0.000
		DBP	0.825	0.000

R correlation values of HPR, SBP and DBP is (R > 0.5) except R correlation value of DBP for S_4 (Al-Beera boys school) (0 > R> -1) and R correlation value of R correlation values of SPO_2% (0< R< 0.5) for S_4 (Al-Beera boys school) and for S_6 (Ni'leen boys school) and (0 > R> -1) for S_5 (Deir-Ibzei' boys school). Table 5.3 shows ($p < 0.05$) of all variables except SPO_2% for S_5 (Deir-Ibzei' boys school) and DBP for S_4 (Al-Beera boys school) ($P > 0.05$) there.

Table (5.4): SPL values, Pearson correlation coefficients R. and the P-values of the studied variables in studied schools.

School	Mean of SPL (dB(A))	Dependent Variables	R	P – value
Males schools	78.4	SPO_2%	0.017	0.835
		HPR	0.811	0.000
		SBP	0.664	0.000
		DBP	0.530	0.000
Females shools	76.7	SPO_2%	0.261	0.001
		HPR	0.761	0.000
		SBP	0.668	0.000
		DBP	0.620	0.000

R correlation values of HPR, SBP and DBP for males and females ($R > 0.5$) and ($P < 0.05$) of these variables. R correlation values of SPO_2% for males and females ($0 < R < 0.5$). ($P > 0.05$) of SPO_2%.

5.2. Conclusions

The results of this study indicate the following points:

- The average values of SPL in all studied schools were:

  83.5 dB(A) in Al-Beera boys school, 81.0 dB(A) in Al-Isbanya girls school, 78.1 dB(A) in Deir Ibzei' boys school, 76.7 dB(A) in Khawla

girls school, 73.6 in Ni'leen boys school, and 72.6 in Ni'leen girls school.

- The measured sound pressure levels (SPL) in all tested schools were found to be above the standard international acceptable levels. Because the SPL values acceptable by human ear range from 65 to 70 dB(A) according to the international standards defined by the world health organization (WHO, 1999).

- Comparing males schools with females schools showed that the differences of hearing impairment are significantly higher in girls schools than boys schools. This means that girls had affected by noise pollution more than boys.

- comparing the three females schools together, also comparing the three males schools together showed that the effect of noise pollution was significantly higher among the students in the highest noise level.

In this study SBP, DBP, HPR, SpO_2% and HTL are correlated positively (P- value < 0.050) with the occupational noise levels in all studied schools. Whereas the Pearson coefficient correlation (R) value of SBP, DBP, HPR, SpO_2% and HTL in all selected schools are ranged from 0.529 to 0.785 of SBP, from -0.198 to 0.825 of DBP, from 0.712 to 0.879 of HPR, from -0.007 to 0.290 and from 0.722 to 0.994 of HTL.

5.3. Recommendations

Negative effects of noise pollution were noticed obviously on students health. Decreasing in blood oxygen saturation, increasing in heart pulse rate, increasing in systolic and diastolic blood pressure and increasing in hearing impairment.

These are some suggestions that can reduce the noise pollution in school environment:

1. Making a proposal to the ministry of education in order to arrange for more than one break for students during the same working school day.
2. Constructing schools in silence zones.
3. Using sound proofing materials absorb noise over a wide range of frequencies:
    a. using insulating layers on the walls.
    b. increasing wall insulation.
    c. double glass windows.
4. Al-Isbanya girls school management has to plant trees around school in order to absorb noise, since there are no trees there.
5. Talking with students about noise pollution and its effects.
6. Number of students is exceeding 40 students for each class in Al-Isbanya girls school, Khawla girls school and Al-Beera boys school. Reducing the students number can reduce the source of noise pollution.

7. Designers and decision makers must consider the noise consequence when designing the shape of schools.

8. Designer has to establish the play land with increase spaces from classes.in Ni'leen boys school and Deir-Ibzei' boys school.

9. Setting rules and laws to punish the person who makes noise around schools.

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Appendices

Appendix A

The following figures (1 to 10) show percentage of degrees of hearing impairment in both ears right (R) and left (L) of students before (b) and during (d) exposure to occupational noise in studied schools according to OSHA, NIOSH and ASHA and EPA's definitions of hearing impairment.

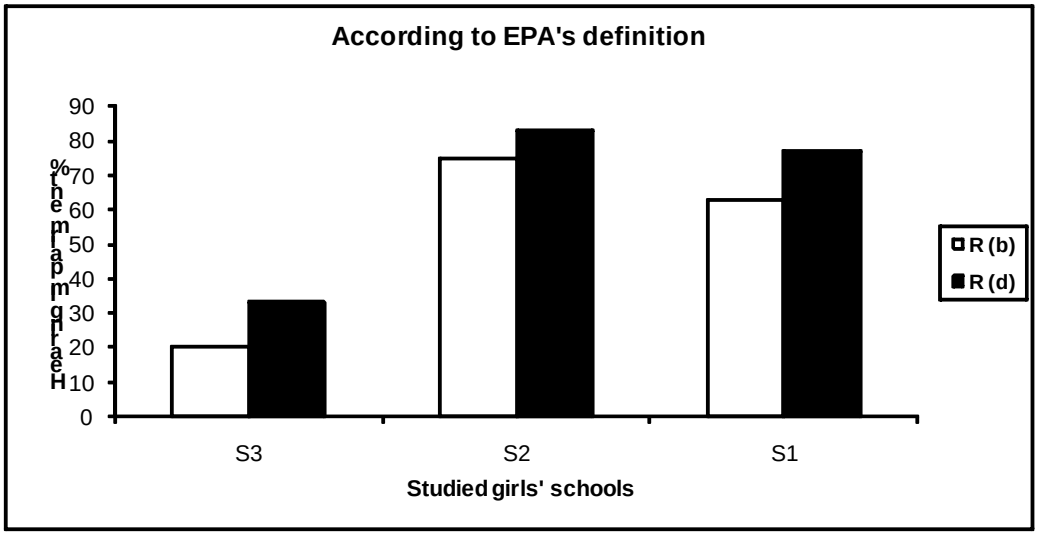

Fig. 1

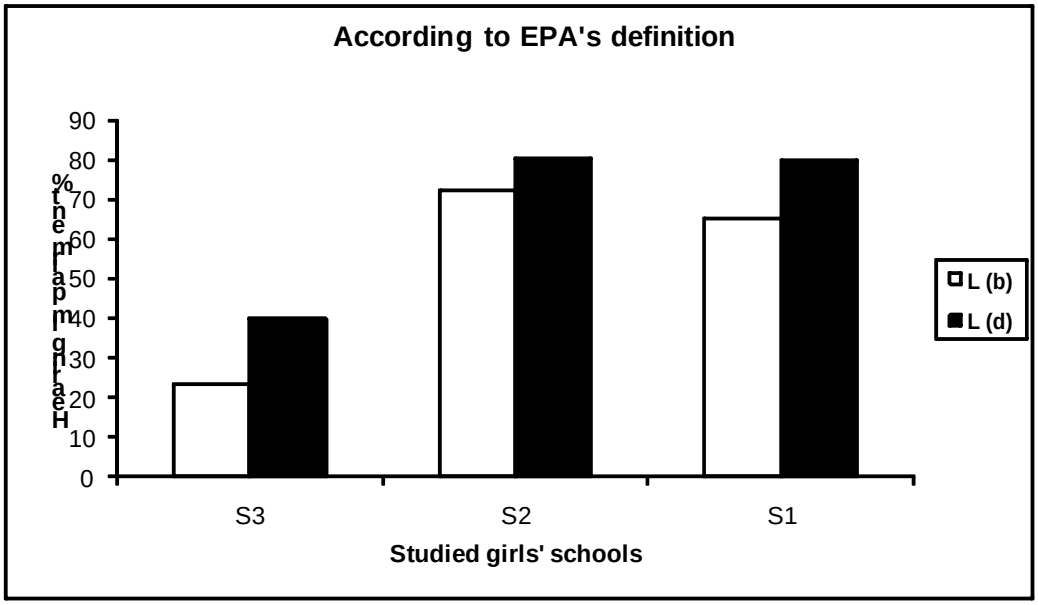

Fig. 2

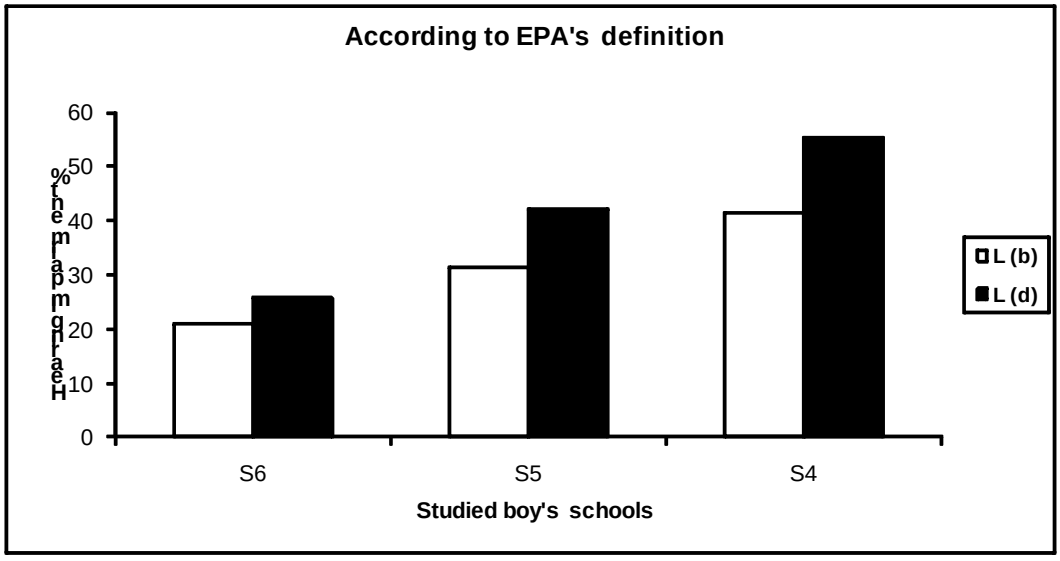
According to EPA's definition
% thermal gradient
60
50
40
30
20
10
0
S6
S5
S4
Studied boy's schools
L (b)
L (d)

Fig. 3

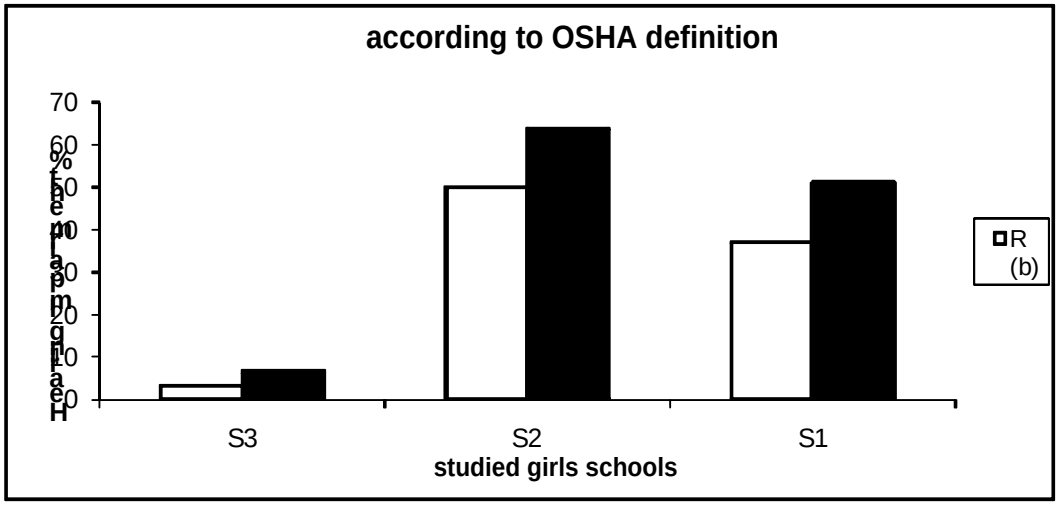
according to OSHA definition
% thermal gradient
70
60
50
40
30
20
10
0
S3
S2
S1
studied girls schools
R (b)

Fig. 4

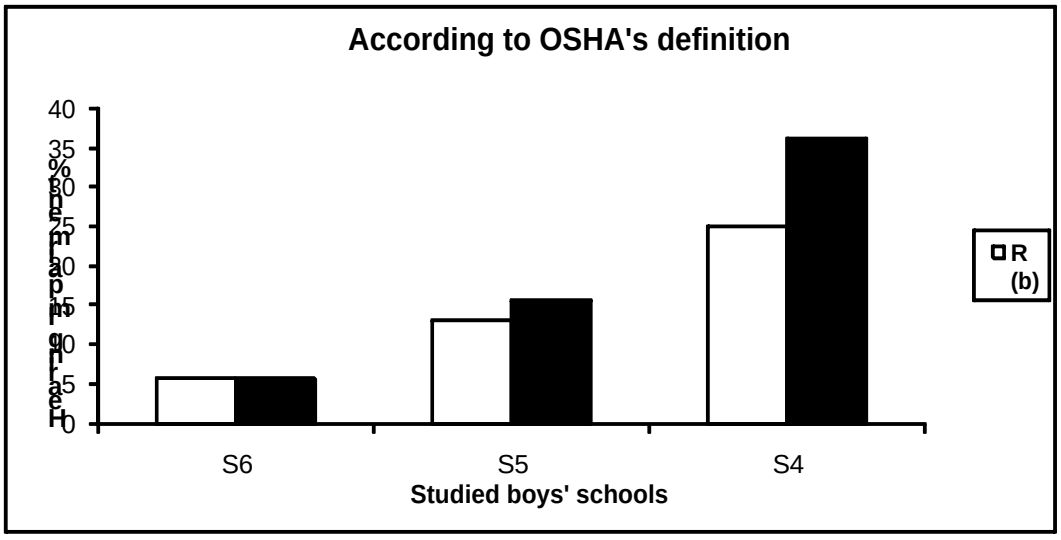
According to OSHA's definition
40
35
30
25
20
15
10
5
0
S6
S5
S4
Studied boys' schools
R (b)

Fig. 5

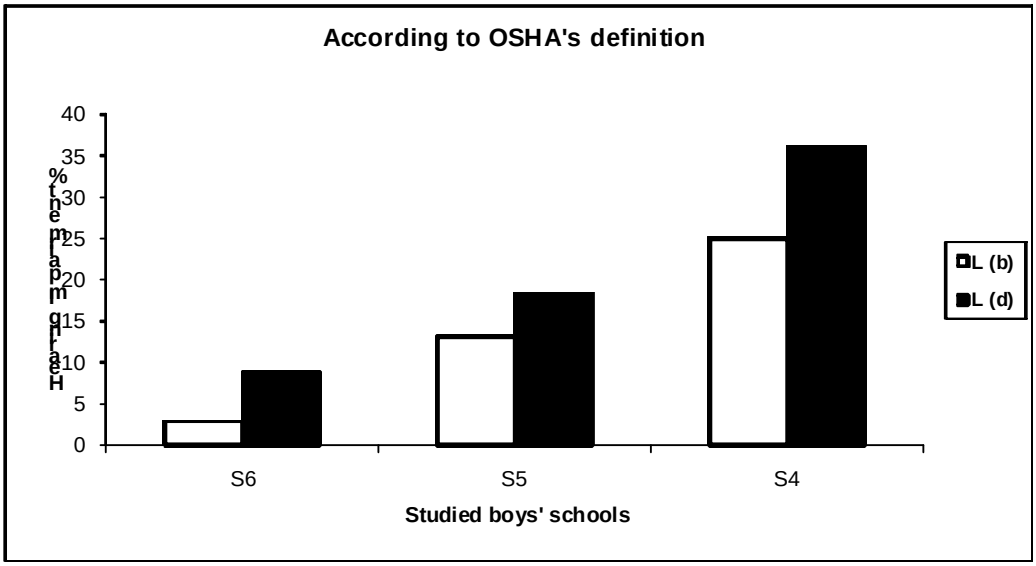
According to OSHA's definition
40
35
30
25
20
15
10
5
0
S6
S5
S4
Studied boys' schools
L (b)
L (d)

Fig. 6

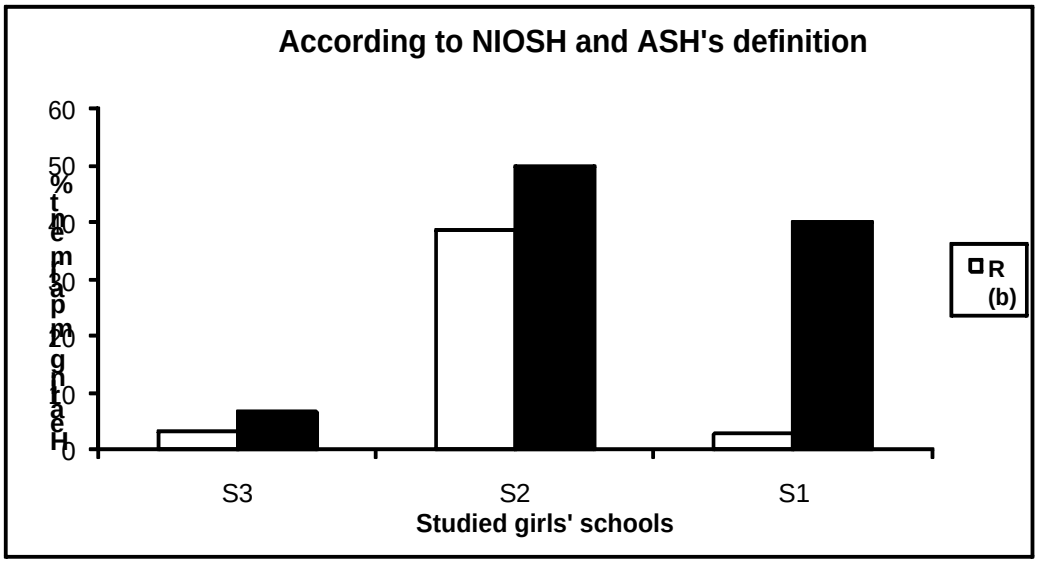
According to NIOSH and ASH's definition
60
50
40
30
20
10
0
S3
S2
S1
Studied girls' schools
R
(b)

Fig. 7

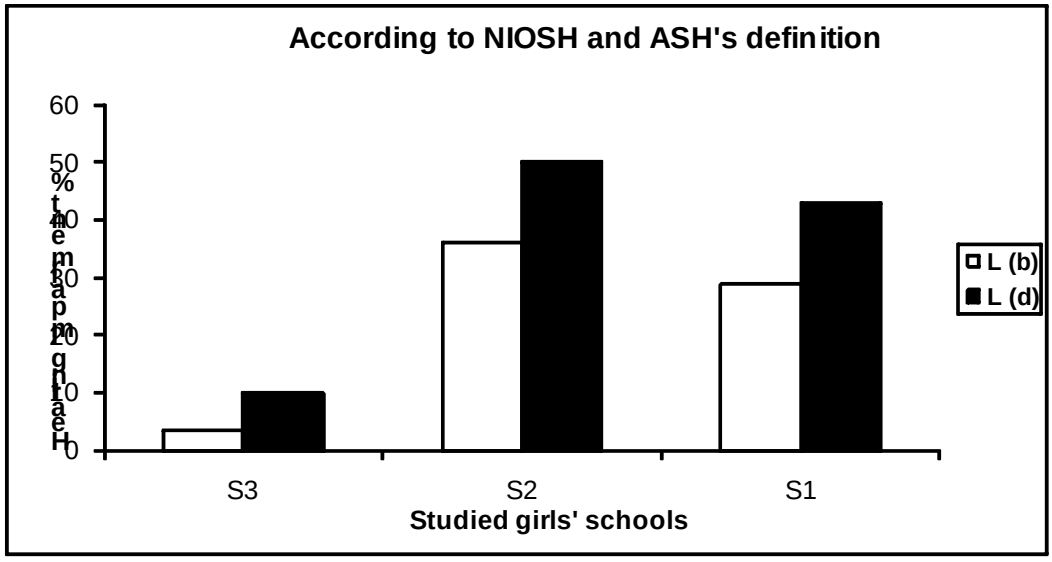
According to NIOSH and ASH's definition
60
50
40
30
20
10
0
S3
S2
S1
Studied girls' schools
L (b)
L (d)

Fig. 8

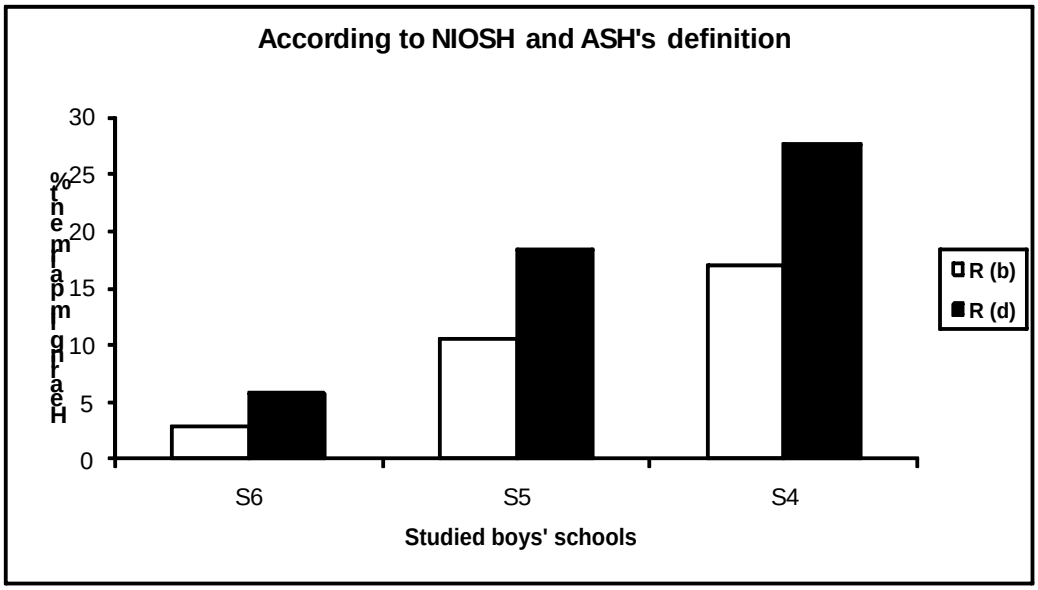
According to NIOSH and ASH's definition
% prevalence of HRT
30
25
20
15
10
5
0
S6
S5
S4
Studied boys' schools
R (b)
R (d)

Fig. 9

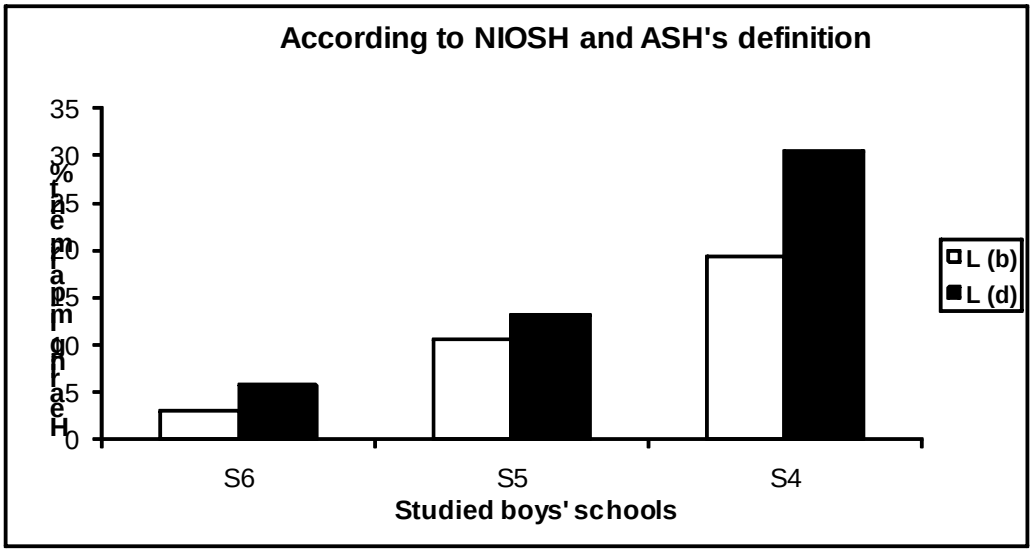
According to NIOSH and ASH's definition
% prevalence of HRT
35
30
25
20
15
10
5
0
S6
S5
S4
Studied boys' schools
L (b)
L (d)

Fig. 10

Appendix B

The following figures (11-26) show the hearing threshold levels (HTL) as a function of frequency of left and right ears for selected students before and during exposure to occupational noise.

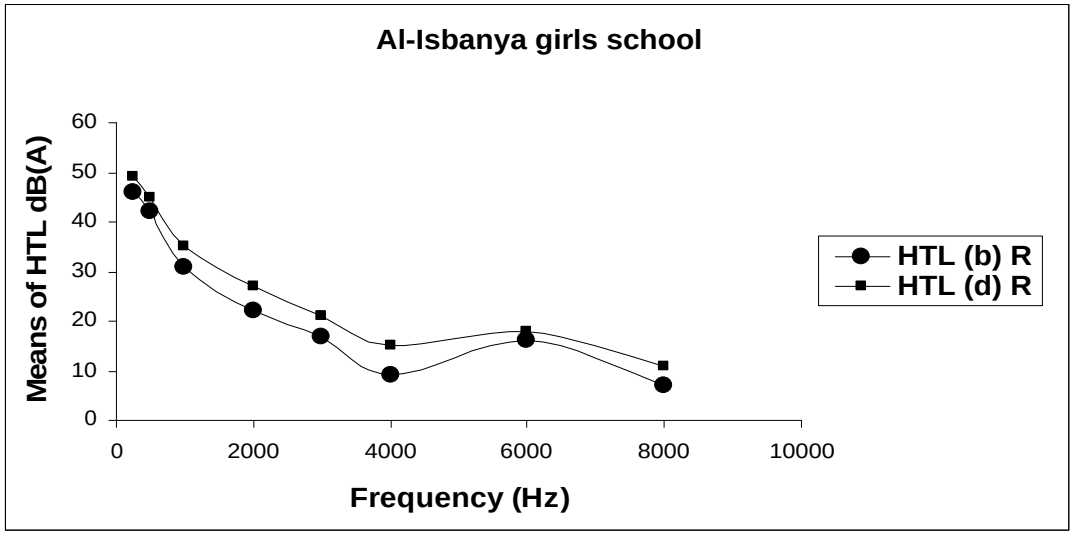

Fig. 11

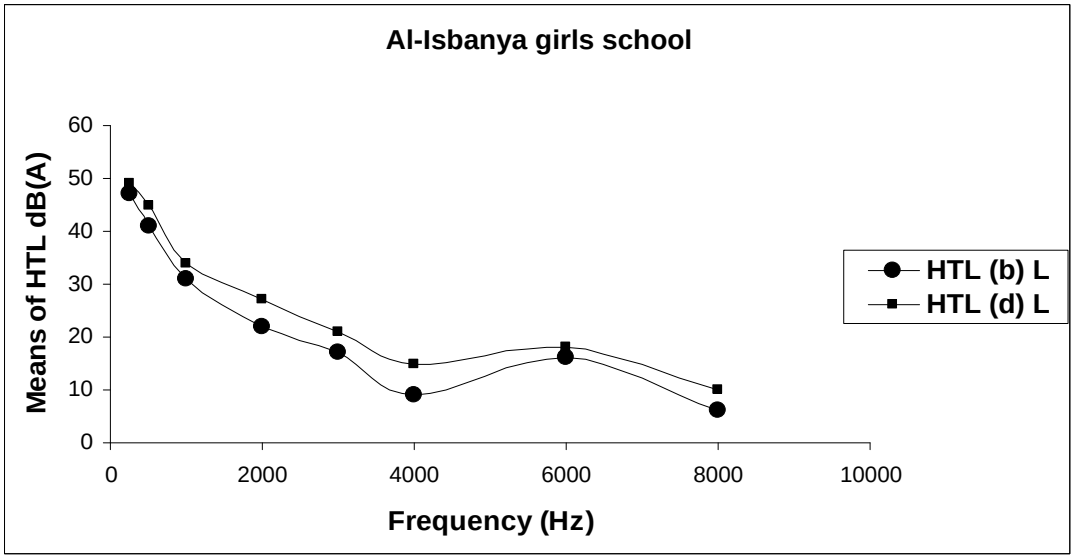

Fig. 12

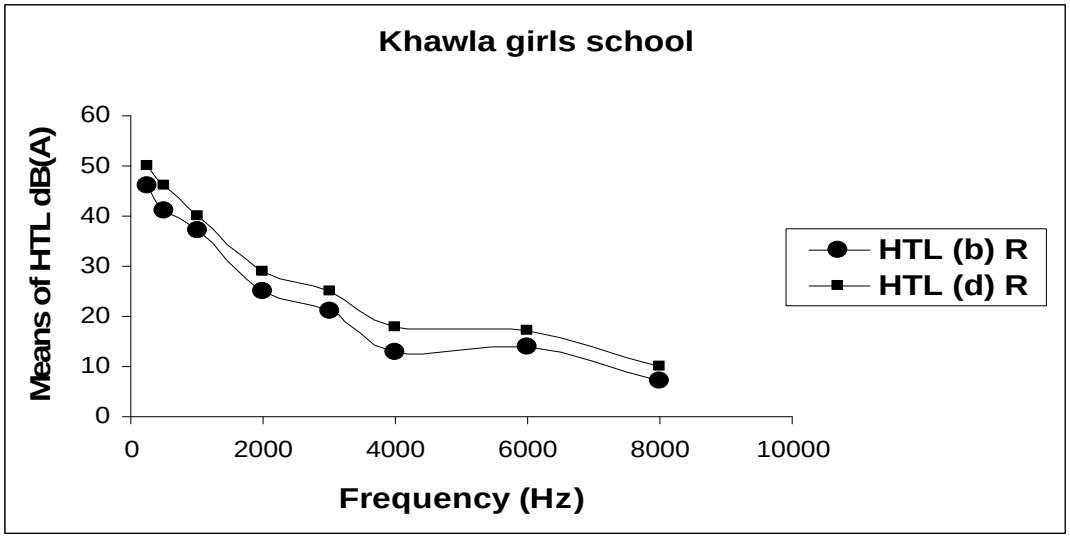
Khawla girls school
Means of HTL dB(A)
60
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R

Fig. 13

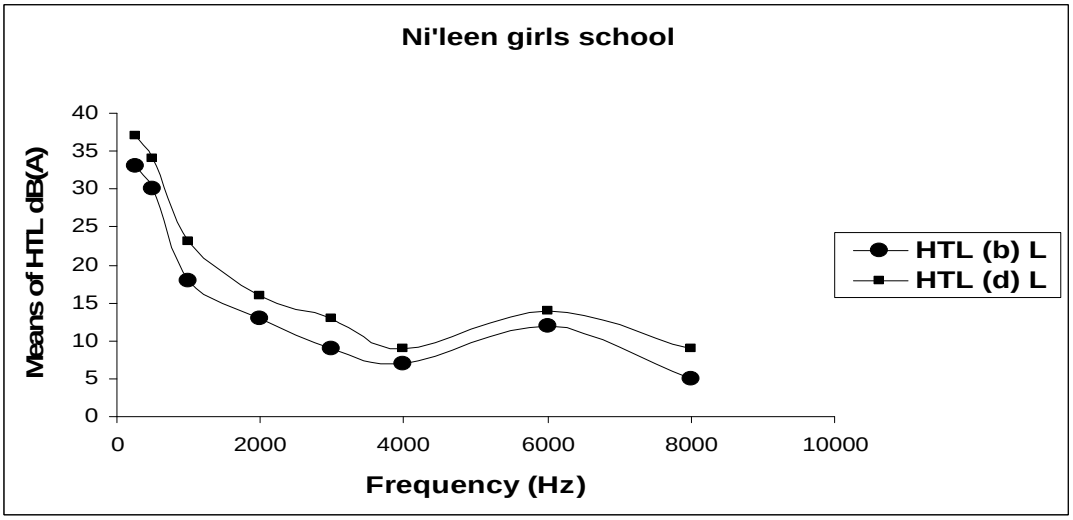
Ni'leen girls school
Means of HTL dB(A)
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) L
HTL (d) L

Fig. 14

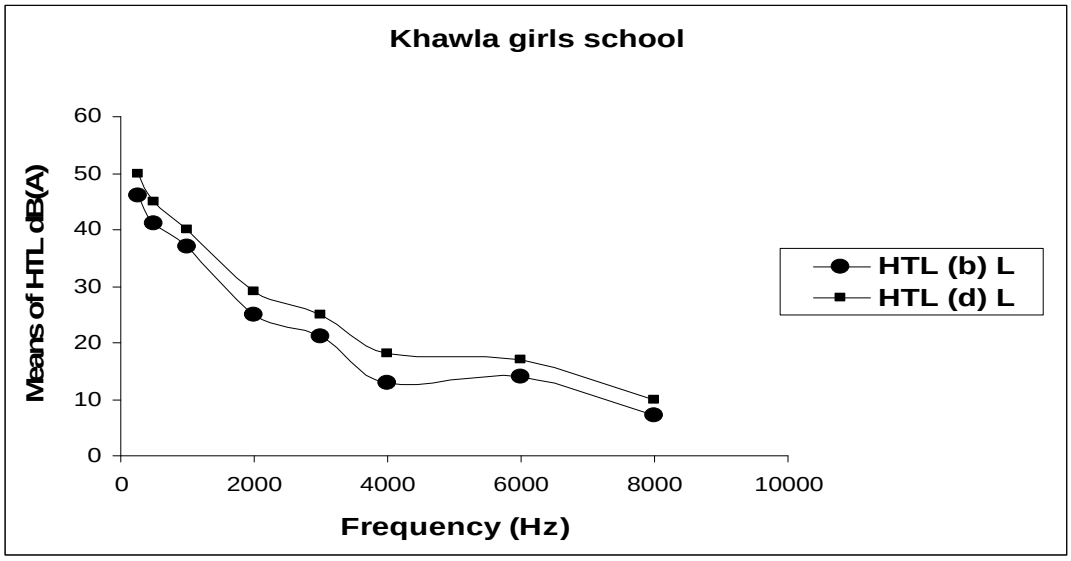
Khawla girls school
Means of HTL dB(A)
60
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) L
HTL (d) L

Fig. 15

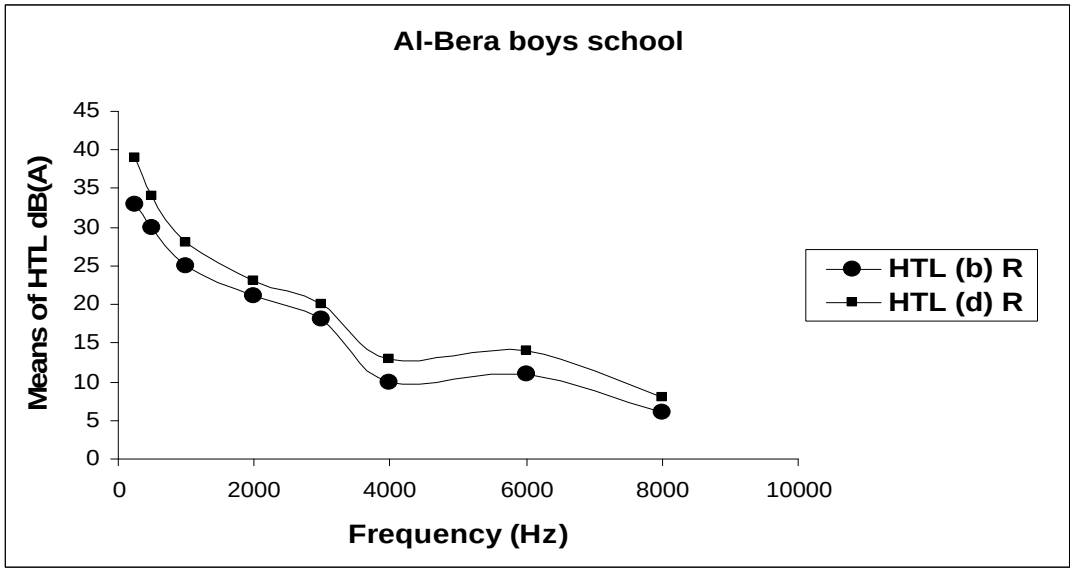
Al-Bera boys school
Means of HTL dB(A)
45
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R

Fig. 16

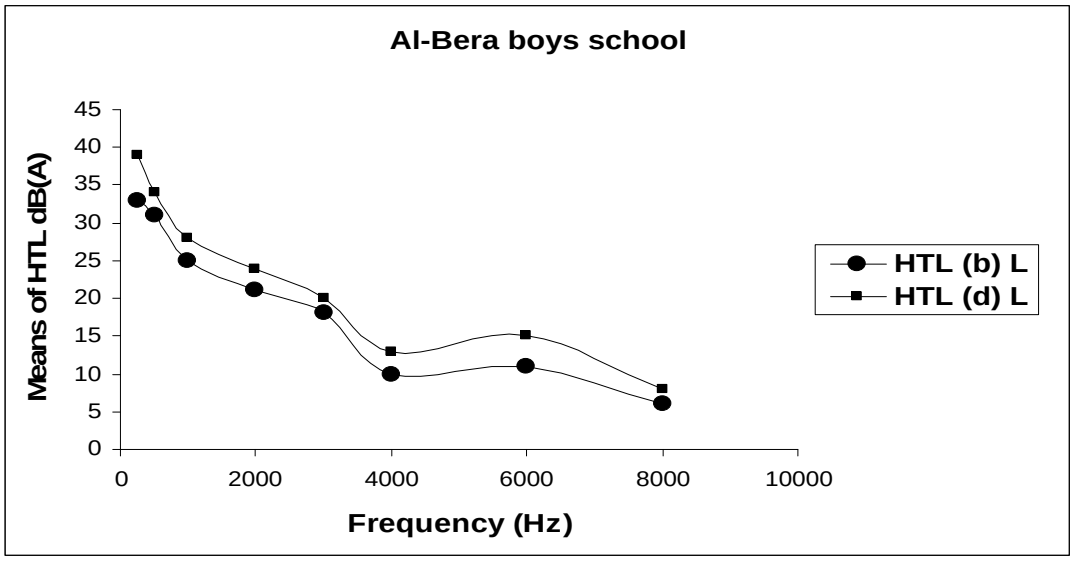
Al-Bera boys school
Means of HTL dB(A)
45
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) L
HTL (d) L

Fig. 17

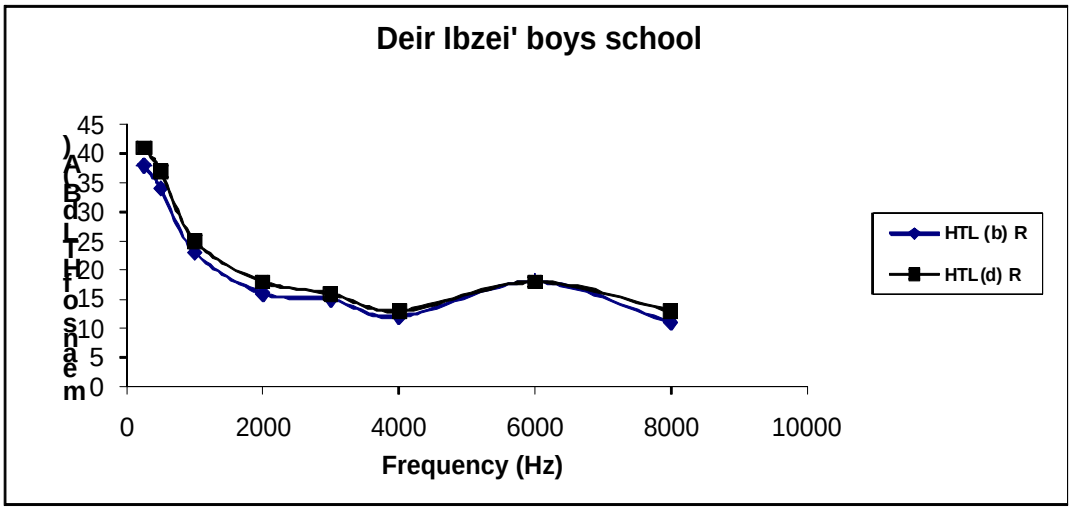
Deir Ibzei' boys school
45
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R

Fig. 18

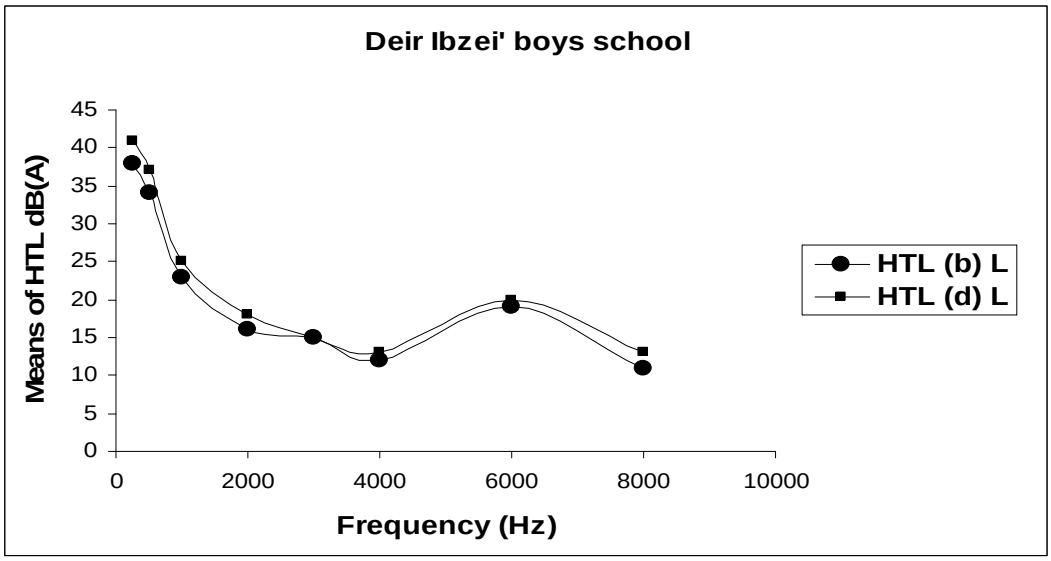
Deir Ibzei' boys school
Means of HTL dB(A)
45
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) L
HTL (d) L

Fig. 19

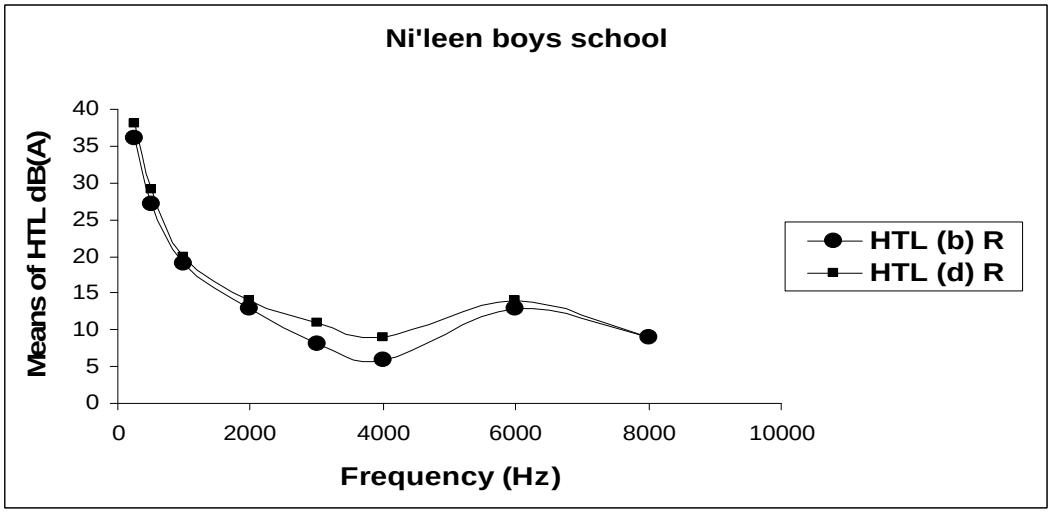
Ni'leen boys school
Means of HTL dB(A)
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R

Fig. 20

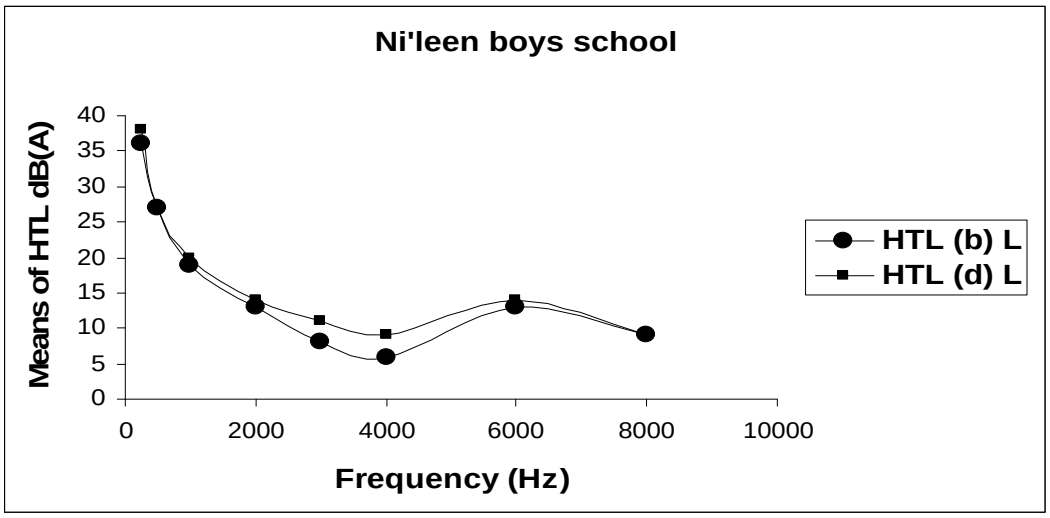
Ni'leen boys school
Means of HTL dB(A)
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) L
HTL (d) L

Fig. 21

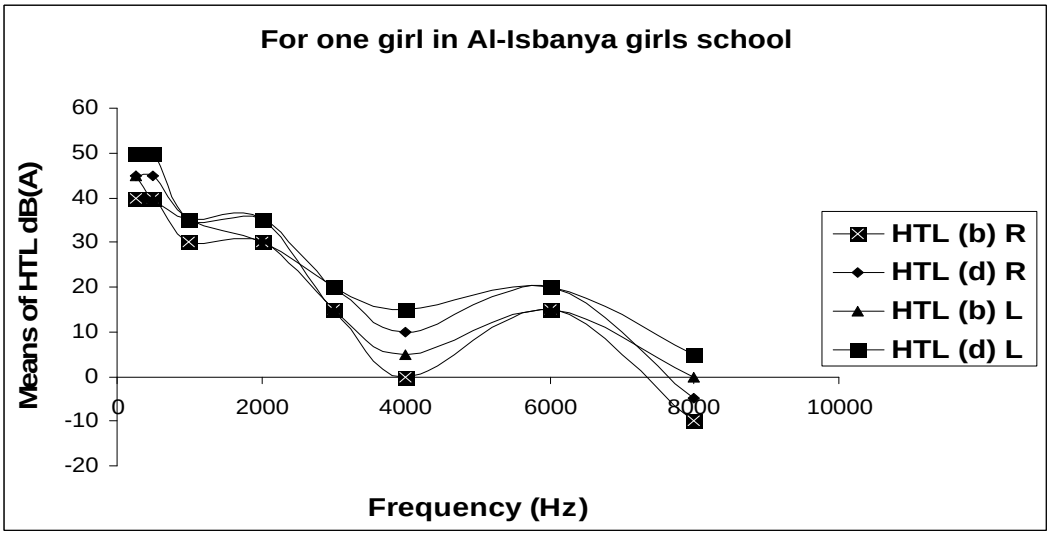
For one girl in Al-Isbanya girls school
Means of HTL dB(A)
60
50
40
30
20
10
0
-10
-20
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R
HTL (b) L
HTL (d) L

Fig. 22

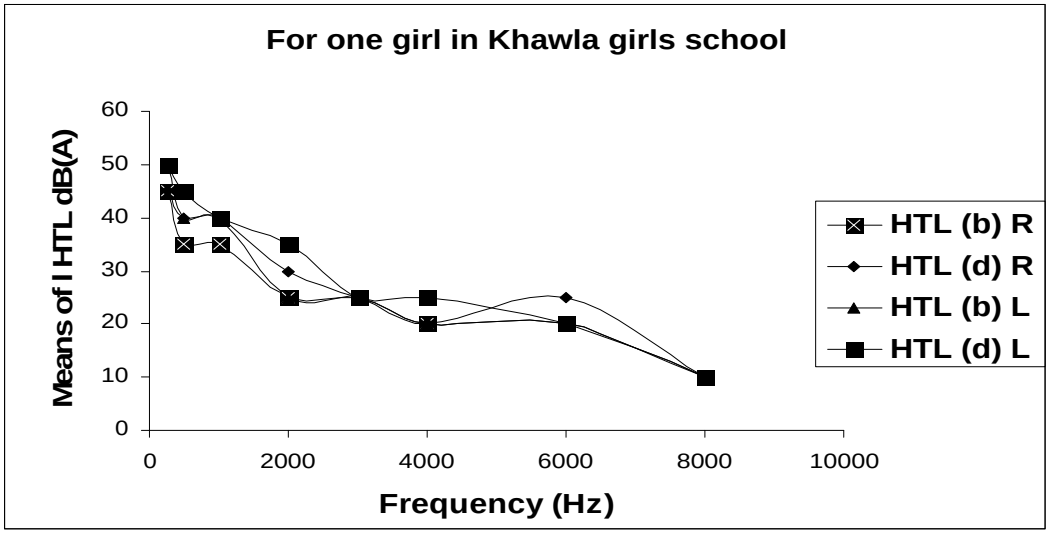
For one girl in Khawla girls school
Means of l HTL dB(A)
60
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R
HTL (b) L
HTL (d) L

Fig. 23

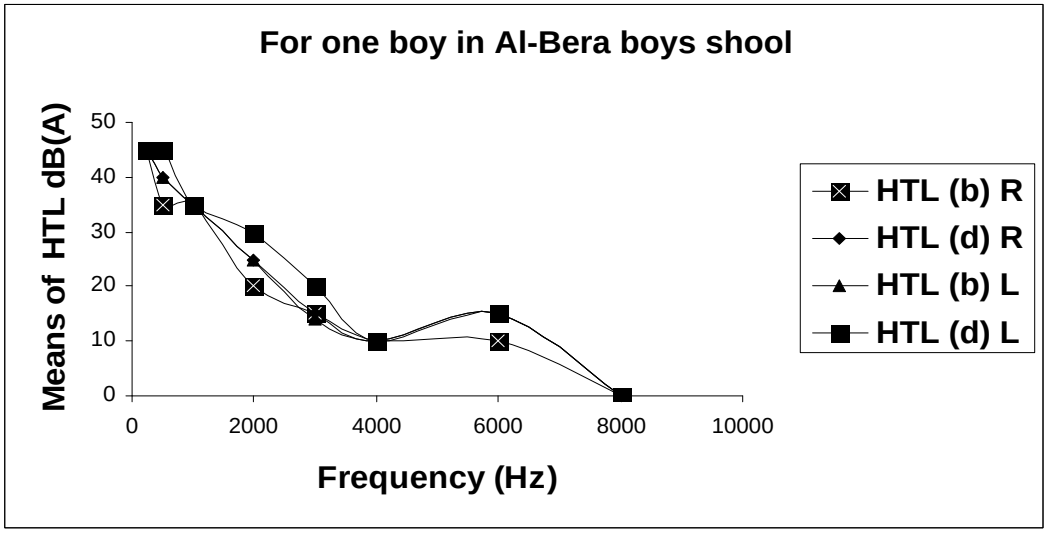
For one boy in Al-Bera boys shool
Means of HTL dB(A)
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R
HTL (b) L
HTL (d) L

Fig. 24

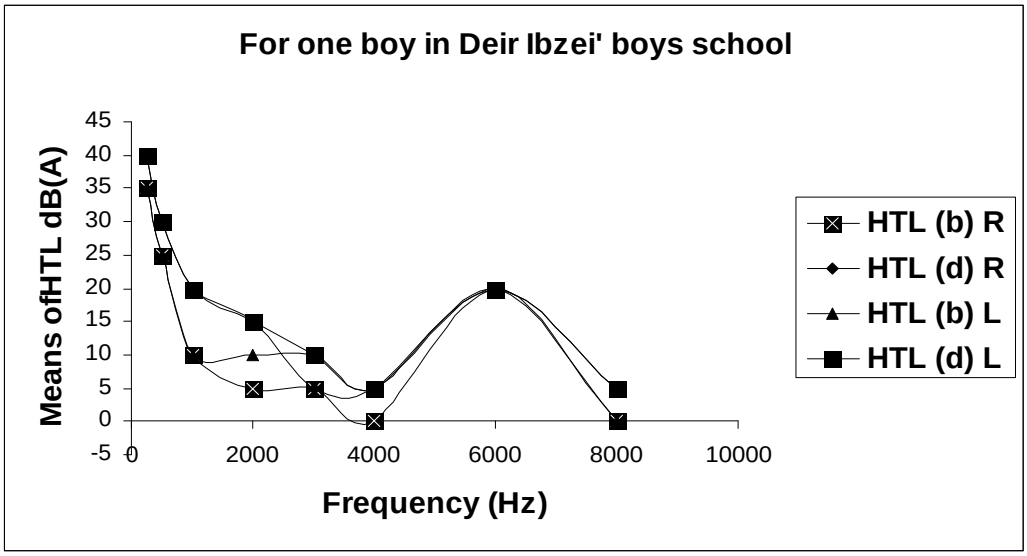
For one boy in Deir Ibzei' boys school
Means ofHTL dB(A)
45
40
35
30
25
20
15
10
5
0
-5
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R
HTL (b) L
HTL (d) L

Fig. 25

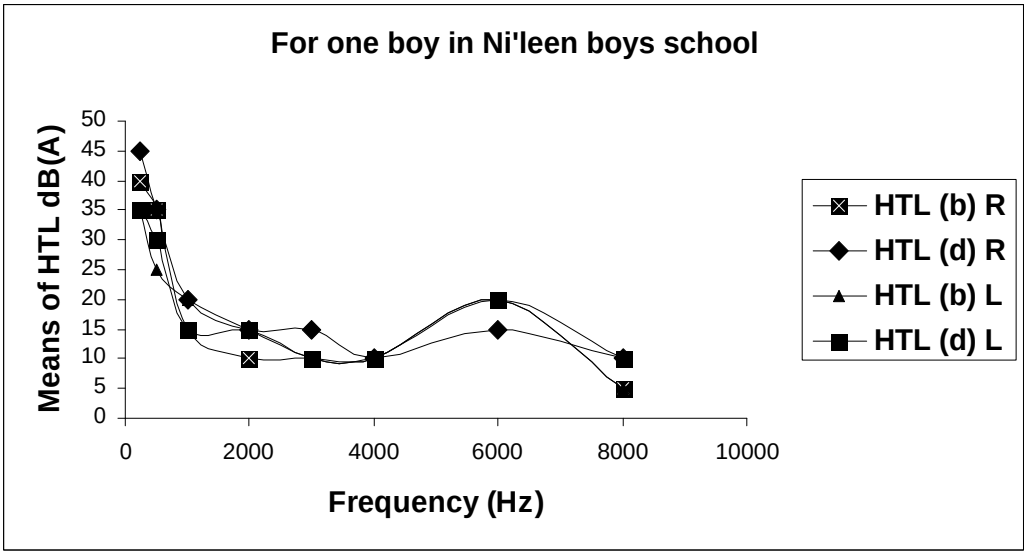
For one boy in Ni'leen boys school
Means of HTL dB(A)
50
45
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
Frequency (Hz)
HTL (b) R
HTL (d) R
HTL (b) L
HTL (d) L

Fig. 26

جامعة النجاح الوطنية
كلية الدراسات العليا

تأثير الضوضاء على ضغط الدم، ونبض القلب، وعتبة السمع، ونسبة الأكسجين في الدم لطلبة مدارس رام الله في فلسطين

إعداد
خديجة صالح محمد دوابشة

إشراف
أ. د. عصام راشد عبد الرازق
د. محمد الصح

قدمت هذه الأطروحة استكمالا لمتطلبات الحصول على درجة الماجستير في الفيزياء بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس - فلسطين.
2012م

تأثير الضوضاء على ضغط الدم، ونبض القلب، وعتبة السمع، ونسبة الأكسجين في الدم لطلبة مدارس رام الله في فلسطين

إعداد

خديجة صالح محمد دوابشة

إشراف

أ. د. عصام راشد عبد الرازق

د. محمد الصح

الملخص

تبين هذه الدراسة علاقة تأثير التلوث الضوضائي علـــى ضـــغط الـــدم (الانقباضـــي والانبساطي)، ونبض القلب، وعتبة السمع، ونسبة الأكسجين في الدم لطلبة مدارس رام الله.

اشتملت العينة على 360 طالبا تتراوح أعمارهم بين 15 - 17 سنة موزعين بالتساوي على ست مدارس (3مدارس ذكور، 3 مدارس إناث). تم اختيار المدارس بشكل عشوائي بحيث تقع في ثلاثة مستويات للضجيج.

تبين أن هذه المدارس تتعرض لمستوى ضجيج أعلى من الحد المسموح به.

و من خلال نتائج التحليل الإحصائي تبين أن معامل ارتباط بيرسون قوي بين مســـتوى الصوت وضغط الدم (الانقباضي والانبساطي)، ونبض القلب ، ونسبة الأكسجين في الدم وعتبة السمع.