An-Najah National University

Faculty of Graduate Studies

The Effects of Noise Pollution on Arterial Blood Pressure and Heart Pulse Rate of School Children at Jenin City

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Acknowledgments

This thesis is dedicated to my mother and father, as well as, to my husband, my brothers and sisters, and my family … with love and respect.

Special dedication is to be presented to the souls of all martyrs who sacrificed themselves for the sake of our beloved homeland, Palestine.

I would like to express my sincere appreciation and gratitude to my supervisor Dr. Zeid Naim Qamhieh and co-supervisor Prof. Dr. Issam Rashid, for their helpful efforts, fruitful guidance and continual encouragement throughout entire research.

Finally, I am very grateful to all those who helped and encouraged me to make this research possible.

Declaration

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Effect of Noise Pollution on Arterial Blood Pressure and Heart Pulse Rate of School Children at Jenin City

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 أية مؤسسة تعليمية أو بحثية أخرى.

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

Student's name: **اسم الطالب:**

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Date: **التاريخ:**

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List of Abbreviations

ANOVA	Analysis of Variance
dB	Decible (unit of sound level using logarithmic scale)
DBP	Dyastolic Blood Pressure
HPR	Heart Pulse Rate
L_{10}	The Noise Level Exceeded 10% of Measured Time
L_{90}	The Noise Level Exceeded 90% of Measured Time
L_{eq}	Equivalent Continues Sound Level
L_{NP}	Noise Pollution Level
NIHL	Noise Induced Hearing Loss
NPL	Noise Pollution Level
Pa	Pascal (unit of pressure)
RMS	Root Mean Square
SBP	Systolic Blood Pressure
SPL	Sound Pressure Level
WHO	World Health Organization

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Abstract

This study reports the association of noise pollution level with blood pressure (systolic and dyastolic) and heart pulse rate in schools' children. The test sample schools consist of six different schools chosen randomly in Jenin city. The measured sound pressure levels (SPL) in all tested schools were found to be above the standard international acceptable levels. Strong positive correlation (person correlation coefficient) was found between sound pressure levels in the sample schools from one side and blood pressures (R=0.96 for systolic and R= 0.98 dyastolic) and heart pulse rate (R=0.991) from the other side. The average change rate of systolic and dyastolic blood pressures were found to be about 4.60 mm-Hg and 2.74 mm- Hg for every 76.86 dB/hr change in SPL values, respectively. Also, the average rate of change of heart pulse rate was found to be about 5 beats/min which reflects the strong correlation between changes of systolic blood pressure and heart pulse rate.

Chapter 1

Introduction

Noise is an audible acoustic energy that disturbs the human environment physiological and psychological well being of the people. It has been escalating at such a high rate so that it is considered now as a major threat to the quality of human lives. In the past thirty years, noise have been increasing rapidly namely in urban areas, due to the modern technological developments, especially in industry and transportation. This fact urged researchers to focus on such field in order to organize and issue new rules and legislations controlling noise pollution and protecting people from its hazardous effects (Hanini A. R. 2002).

The normal audible frequency for young people ranges from 20 Hz to 20 kHz. The non audible frequencies come in two regions, the infrasonic region below 20 Hz and the ultrasonic region above 20 kHz (Abdel –Raziq H. R. et.al. 2000).

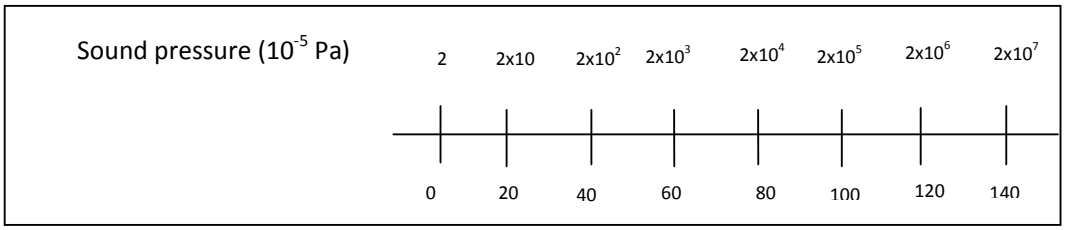


Figure (1.1): Sound pressure levels (SPL) in dB and Pa. Arranged data taken from (Hanini A. R. 2002).

In figure (1.1) the most acceptable sound pressures by human ears ranges between 65 and 70 dB. Outside this range, sound is getting harmful noise especially with high sound levels. However, such high sound level noises

might arise from factories, trains, air and road traffic, motorcycles, etc. It must be noted that continuous exposure to such high level noise higher than the acceptable values can lead to a progressive loss of hearing and/or an increase in the threshold of hearing (WHO 1999).

1.1. Literature Review

The effect of noise pollution on humans has been intensively carried out. In a study in New York, comparing the children exposed to noise to those not exposed to noise several problems were found (Harabidis A. S. 2008). In that study the blood pressure of children was found to be raised by 4-8 mmHg, and their ability to learn and to discriminate words was also affected. A recent study of 3000 inhabitants in Serbia has proved that men who were extremely annoyed by traffic noise had an increasing risk of reporting hypertension compared to those not annoyed (Charlotte C. et.al. 2007). A another study in Serbia, has shown that music major students have more awareness to world's noise compared to other students (Chesky K. et.al. 2009). Studying the effect of noise pollution on young children attending nursery schools in high traffic areas in Tel Aviv have shown that those children have higher mean systolic blood pressures and lower mean heart pulse rates compared to those in quiet areas (Recova V. et.al. 1995).

The impact of noise pollution was also studied on workers in some factories in Turkey (Tunay M. et.al. 2008). The results of such studies showed strong correlations between time of work and hearing loss from

one side, and between workers age and hearing loss from another side. A study in the construction industry (Richard N. et.al. 1999) showed that 16 - 50% of workers in that field are suffering from Noise-Induced Hearing Loss (NIHL), so that it is considered as one of the most common diseases in construction industry.

Locally, in Palestine, studying the impact of noise pollution has been carried out. For example, the effect of noise on workers in some factories resulted in precious advice. The conclusions were given to both the workers and the owners of the factories in order to relieve the noise pollution problem (Hanini A. R. 2002). Moreover, some studies were performed in Nablus schools in Palestine (Abdel-Raziq I. R. et.al. 2000). The results of such studies have shown that most of those schools are noisily polluted far beyond the recommended standards, so that a lot of precautions should be considered.

1.2. Objectives of This Study

As a continuation of such research in order to obtain more information about noises and their impacts on the health and the environment of people in Palestine, this study has been performed.

Several measurements were carried out throughout this work:

a- Measuring the noise levels in some schools due to people, equipments and environment.

b-Investigating the impact of noise on several health parameters of humans in some schools such as:

1. Systolic blood pressure.

2. Dyastolic blood pressure.

3. Heart pulse rate.

Chapter 2

Sound Pressure and its Health Effects

Sound pressure level (SPL) is a measure of air vibrations that makes up sound. Because the audible sound range by human ear is wide ($2x10^{-5}$- 200 Pa) as shown in fig. (1-1), logarithmic scale with units of decibels (dB) is being used to indicate the loudness of sound.

When humans are exposed to noise, a lot of health effects occur. Some of such effects are shown in this chapter.

2.1. Sound Pressure Level

Sound pressure levels are expressed in units of pressure (force per unit area) and are defined mathematically as:

$$SPL = 20 \log_{10} (P/P_0)$$

Where:

(P) is the measured sound pressure.

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

The factor 20 appears in the equation due to the fact that energy or intensity of the sound wave is proportional to the square of the amplitude of sound waves ($I \alpha A^2$) (Abdel-Raziq I. R. et.al. 2000) .

As mentioned before (fig.1.1) the audible sound pressure ranges from 0 to 140 dB. Some important facts about noise and its effects are shown in table 2 (WHO 1999).

Table (2.1): Some actual sound pressure levels with their corresponding subjective noise values in dB.

Description	Noise Level (dB)
The Threshold of Pain	120
5 Pneumatic drill (at 7m distance)	95
Heavy diesel lorry (40km/h at 7m distance)	83
Modern twin-engine jet (at take-off at 152m distance)	81
Passenger car (60km/h at 7m distance)	70
Office environment	60
Ordinary conversation	50
Library	40
Quiet bedroom	35
Threshold of hearing	0

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 (Hanini A. R. 2002):

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

2.2. Health Effects of Noise Pollution

Many bad effect of noise pollution on people have been noticed. Some of these effects such as hearing loss, attitude and arterial blood pressure and heart pulse rate.

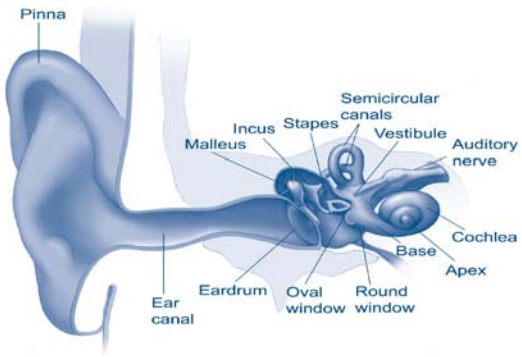


Figure (2.1): Human inner and outer ear (Chesky K. et.al. 2009).

2.2.1. Hearing Loss

In our environment, normal sounds from televisions, radios, household appliances, and traffic are sounds which are considered to be safe on human ears fig. (2.1). However, when our ears are exposed to harmful noisy sound that are too loud and/or last for long periods, sensitive structures in our inner ear can be damaged, causing Noise-Induced Hearing

Loss (NIHL). Such effects have been extensively studied by several research groups (Harabidis A. S. 2008).

2.2.2. Human Attitude

Annoying is a feeling of discomfort which occurs when noise interferes with someone's thoughts, feelings or daily activities. This annoying can be due to sounds with high SPL or exposing to noise for long time even with low SPL. The degree of annoyance depends on the intensity and/or the frequency of the noise and its variation with time. The age of people supposed to such high level noise can play a major roll in the results. In general, children are expected to be more sensitive to such effect. Their ability of learning languages, concentration, memory reduction and ability to carry out their tasks can be easily affected (Marie Louise 2002). For that reason, **c**hildren have been chosen as the focal point of some research groups (Abdel-Raziq I. R. et.al. 2000 and Bisturp M. L. et.al. 2002).

However the effect of noise might be temporary after which the person returns to its normal condition. There are obvious evidences that variation of blood pressure levels at early ages can be considered as good indicators for blood pressure levels at later ages (Wolfgang B. 2008).

2.2.3. Arterial Blood Pressure and Heart Pulse Rate

The strongest evidence for the effect of noise on cardiovascular system comes from the studies of blood pressure and heart pulse rate. Noise studies have shown that noise cause severe increase in systolic and dyastolic blood pressures (Stansfed S. A. 1992). In addition, noisily sounds can affect hormonal systems of human body leading to variations in blood pressure and heart pulse rate which can develop permanent effects (Hanini A. R. 2002).

Chapter 3

Methodology

In this chapter, the study sample, the collecting data and the experimental equipments and tools are clarified. Moreover, software used during collecting data and analyzing the results are briefly discussed.

3.1. Study Sample

The study sample consisted of 462 school children aged 12 to 13 years old, distributed equally from gender point of view. The sample was chosen in a manner that seventy seven children were selected randomly from each of six different schools located in the following three regions:

1-Jenin city of about 65,000 inhabitants, and crowded with traffic and factories.

2- Jenin refugee camp of about 25,000 inhabitants, located one kilometer to the south of Jenin city at Jenin- Haifa road.

3- Al –Yamon village of about 18,000 inhabitants, located 8 km east- west Jenin city, and is considered as a quiet rural area.

According to the medical records available in the six schools the children participated in this study were considered healthy.

3.2. Collecting Data

Data collection took place in the period extending from January to May 2009. It was carried out in the classrooms, the corridors, and the fields at the selected schools during morning hours between 7:00 and 13:00 o'clock. The DBP and SBP measured one time every hour from 7:00 to 13:00 o'clock for each student during amount in each school then the mean value was calculated, while the SPL measurement was taken every minute during a school day from 7:00 to 13:00 o'clock for a month in each school then the mean value was calculated.

The measurements were done by using the following meters:

1- Sound pressure level meter.

2- Arterial blood pressure and heart pulse rate meter.

3.3. Experimental Equipments and Tools

3.3.1. Sound Pressure Level Meter

Sound pressure level (SPL) measurement was carried out inside class rooms using a logging sound level meter, with an accuracy of ± 0.5 dB at 25 C^{o} (Instructions manual 1998 a).

There is a similarity between the sound level meter and human ear in the way of responding to sounds. In the sound level meter the small signal

sound is converted to identical electrical signal by a high quality microphone. That signal is then amplified to be high enough to drive an ammeter. In addition, root mean square (RMS) value of the signal has been determined in the RMS detector. Since the sound level meter is a precision instrument it has to be calibrated. Therefore, provision is made to calibrate it for accurate results by placing a portable acoustic calibrator directly over the microphone.

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

3.3.2. Arterial Blood Pressure and Heart Pulse Rate Meter

The systolic and dyastolic blood pressure and heart pulse rate were measured for each child by Automatic Digital Electronic Wrist Blood Pressure Monitor, with accuracy ± 3 mmHg, and ± 5% of the reading heart pulse rate with operating temperature range of +10 to +40 C^{o} (Instruction manual 1998 b).

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

3.3.3. Statistical Analysis

The data were analyzed using the SPSS program. Analysis of variance (ANOVA) test was used to detect the effects of sound pressure levels on both heart pulse rates and arterial blood pressures. However, the test sample was found to have an obvious influence on blood pressure as well as on heart pulse rates. For that purpose multiple comparisons was carried out.

Chapter 4

Results Discussion and Recommendations

In this chapter, the results, the conclusions and the recommendations of some effects of noise pollution are demonstrated. At the beginning, the measurements of sound pressure levels (SPL) for the six schools are being discussed. Then the arterial blood pressure and heart pulse rate measurements. Finally, a brief summary with further discussion and some recommendations are presented.

4.1. Sound Pressure Level (SPL)

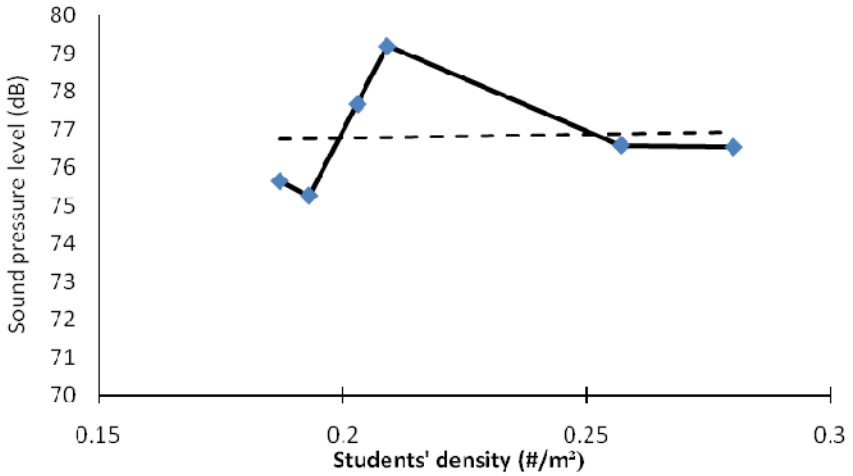
Sound pressure levels (SPL) for the six selected schools were measured. The results of those measurements in addition to a full description of the schools' environments are shown in table (4.1).

Table (4.1): Schools environments and sound pressure levels measured in each school. School area (area of floors + area of corridors + area of fields), the geometric shape is the outer shape of the building.

School name		Gender	School area (m^2)	Student number	Student density (#/ m^2)	Teachers number	class rooms number	SPL (dB)	School geometric shape
1	Al-Yamon primary school	Male	2500	700	0.28	27	20	76.53	Empty cube
2	Jenin primary school	Male	2900	590	0.203	24	17	77.67	T-shape
3	Jenin camp primary school	Male	4300	830	0.193	30	18	75.25	U-shape
4	Nusayba Primary school	Female	1800	462	0.257	21	21	76.58	T-shape
5	Al-Zahraa primary school	Female	4200	785	0.187	32	22	75.63	T-shape
6	Jenin camp primary school	Female	4025	842	0.209	31	21	79.19	Empty cube

In order to give more insight to the schools' environments, some remarks have to be noted. For example, Al-Yamon primary school lies next to a stone quarry that its noise is heavily polluting the environment inside the school. The second school, Jenin primary school, is surrounded by other schools, UNRWA schools located at the middle of Jenin camp which is crowded with traffics and peoples. Moreover, Nusayba primary school lies next to the main road and the municipality building. Finally Al-Zahraa school lies at the main road and is surrounded by police station and several governmental buildings.

One might think that higher students' density is a major parameter in raising noise pollution in the sample schools. Therefore, the effect of students' density on the SPL measurements was studied. The plot of SPL values versus students' density in the sample schools, extracted from table (4.1), is shown in fig. (4.1). This figure shows that there is almost no direct systematic correlation between SPL values and the density of students as can be understood from the linear fit (dashed line) of the data. In the contrary, some schools with less students' density show higher noise levels compared to the schools with higher students densit, that's due to the environment around the schools and schools shape.



Figure(4.1): The dependence of SPL average values during 6 continues hours in the six sample schools of table (4.1) students' density.

The shape of the school was found to have an influence on the SPL measurements. Comparing the U- shaped school (school # 3 Jenin camp primary boys school) with the empty cube -shaped school (school # 6 Jenin

camp primary girls school), it is clear that the empty cube-shaped has SPL value of 79.19 dB which is higher than the U-shaped schools of SPL value 75.25 dB, although both schools exist in the same environment (Jenin camp). It is not safe to compare the rest of the schools according to their shapes since the environments are not the same.

Fig. (4.2) presents the hourly average value of the SPL during 6 continues hours (7:00 – 13:00). The average SPL value for all schools is about 76.86 dB as can be extracted from table (4.1).

Several remarks are obvious in fig. (4.2):

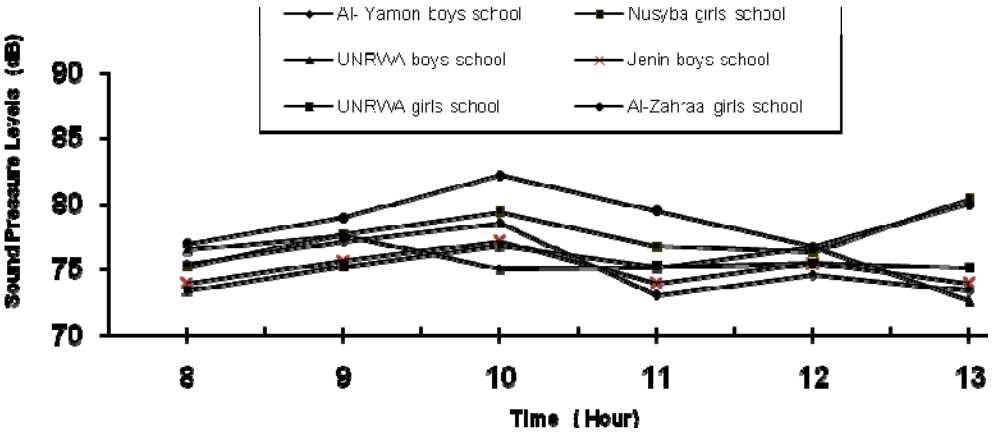


Figure (4.2): Sound pressure levels measured during 6 continuous hours for the schools shown in the inlet.

1. The average SPL value of the sample schools of this study is about 76.86 dB. And since the values of SPL acceptable by human ear range between 65 and 70 dB (WHO 1999), the schools under study can easily be considered as noisy environments.

2. In general, the SPL reaches its maximum value around 10 o'clock in the morning. This can be explained by the fact that students have a break at that time.

3. There is an increase in SPL values in UNRWA and Al-Zahraa girls' schools around 1 o'clock. This can be explained by the fact that the camp and the city are very crowded with peoples and traffics at that time (time of leaving work).

4.2. Arterial Blood Pressure

There are several parameters affecting systolic and dyastolic blood pressures. One of these parameters is expected to be the noise in the environment in which the sample schools exist. The changes due to noise on systolic blood pressure (SBP) and dyastolic blood pressure (DBP) in the six sample schools are summarized in figures (4.3) and (4.4), respectively.

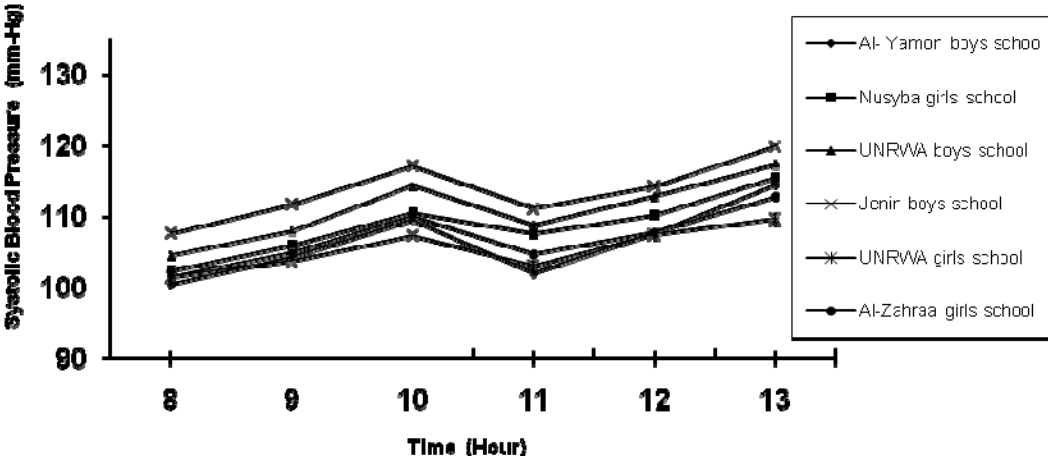


Figure (4.3): Systolic blood pressure measured during 6continuous hours for schools shown in the inlet.

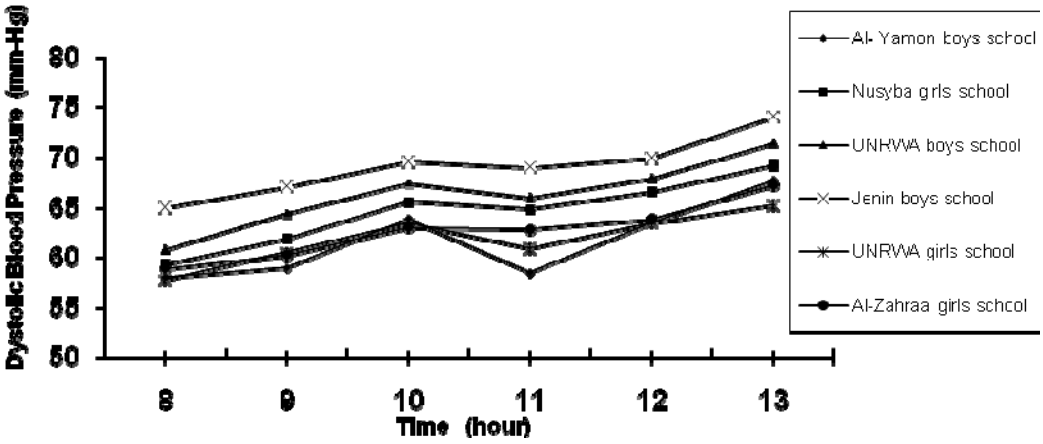


Figure (4.4): Dyastolic blood pressure measured during 6 continuous hours for schools shown in the inlet.

From these figures, it is clear that blood pressure suffers from a significant increase of systolic and diastolic blood pressures around 10 o'clock in the morning and around 13 o'clock in the afternoon. This increase can simply be explained by the facts that students have break at 10 o'clock, while 13 o'clock is the time at which students leave their schools. One important result obvious in the figures (4.3) and (4.4) is that there is an increasing trend of SBP and DBP values that can be due to the long time that students stay at schools after which they got exhausted.

The measurements for each school of fig. (4.4) can be divided into two subgroups, from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock.

Each group of each measurement can be easily fitted to a linear function as shown in figures (4.5) and (4.6). An interesting result out of the fits tells that the increasing rate for the two subgroups of each school is almost the

same. The more important result is that the arithmetic mean of the increasing rate of the two subgroups of all schools is also the same.

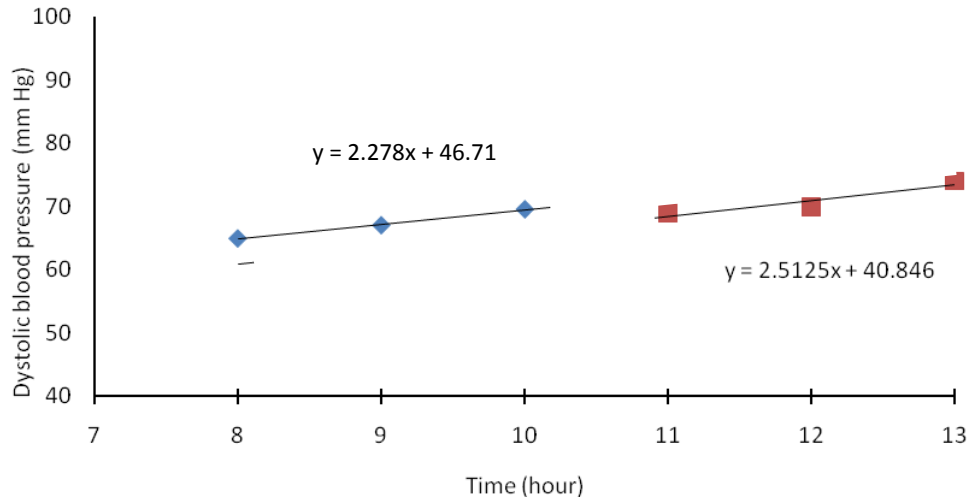


Figure (4.5): The rate of increase of dyastolic blood pressure for two from 7:00 to10:00 o'clock and from 10:00 to 13:00 o'clock; the measurements were done in Jenin boys' school.

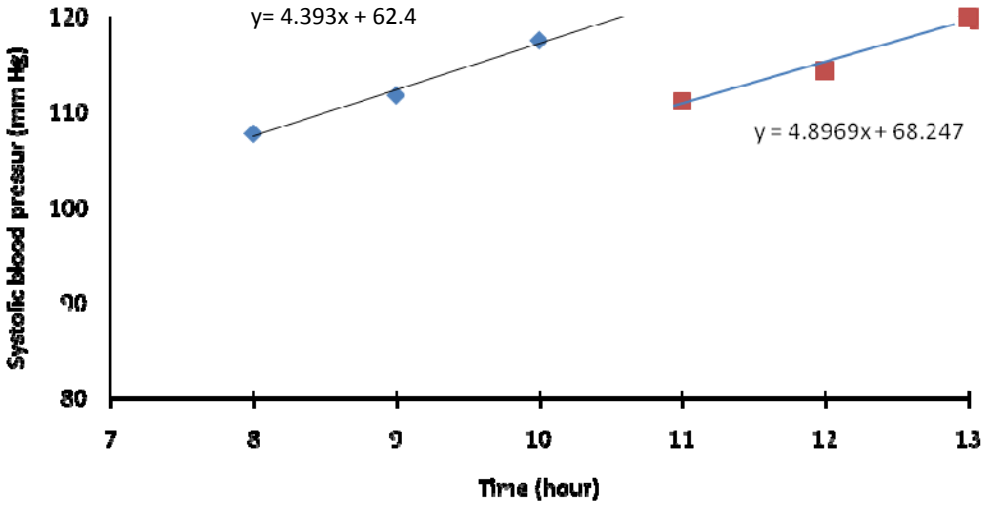


Figure (4.6): The rate of increase of systolic blood pressure for two subgroups from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock; measurements were done in Jenin boys' school.

The first graph (fig. 4.5) shows that the increasing rates for the two subgroups for dyastolic blood pressure of Jenin boys' school are approximately the same, 2.28 and 2.51 mm-Hg. However, considering the six sample schools, the overall average of the increasing rates is about 2.74 mm-Hg (see Appendix A). Similarly, the second graph (fig. 4.6) shows that the increasing rates for the two subgroups for systolic blood pressure are approximately the same, 4.39 and 4.90 mm-Hg. However, considering the six sample schools, the overall average of the increasing rates SBP is about 4.60 mm-Hg (see Appendix B). Moreover, by using SPSS software, a strong positive correlation was found between sound pressure levels in the sample schools and blood pressures (R=0.98 for systolic and R= 0.96 for dyastolic). Where as the person correlation (R) reflects the degree of linear relationship between two variables. It ranges from +1 to -1. A correlation of +1 means that there is a perfect positive linear relationship between variables, while -1 means that there is a perfect negative linear relationship between variables. In comparison with some previous studies, similar result was observed by (Abdel-Raziq et.al. 2000). study in which the SBP was found to be affected more than DBP as shown in fig.(4.7).

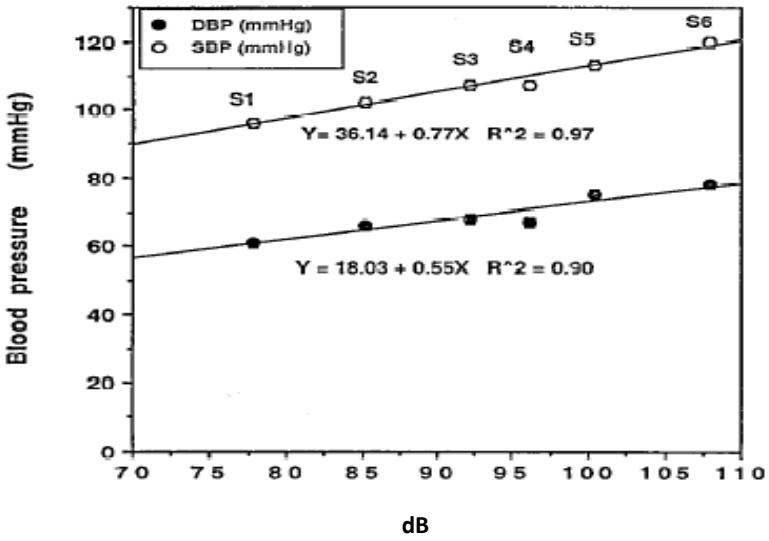


Figure (4.7): Relationship between blood pressure as a function of sound pressure, S1: Seida boys, S2: Seida girls, S3:Triq boys, 0000S4: Ali girls, S5: UNDP boys, S6:UNDP girls(Abdel –Raziq H. R.

4.3. Heart Pulse Rate (HPR)

It is very well known that high sound pressure levels increase the stress reaction which in its turn raises the blood pressure. Accordingly, the heart pulse rate (HPR) is expected to increase. The effect of noise pollution on HPR in the six sample schools is presented in fig. (4.8).

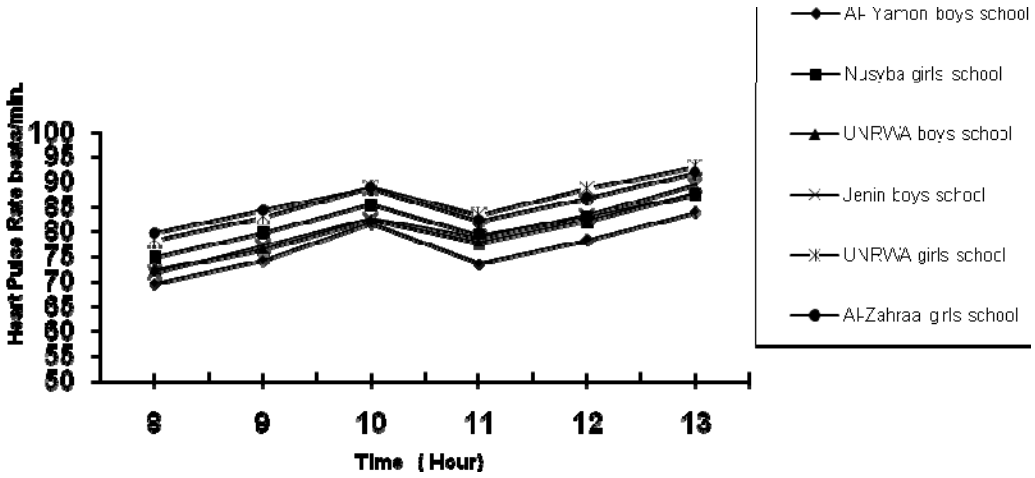


Figure (4.8): Heart pulse rate measured during 6 continuous hours for schools shown in the inlet.

From this figure, a clear increase in HPR occurs at 10 and 13 o'clock, the time of the break and the time of leaving schools.

Similar to the discussion in the previous section, each group of the measurements for each school can be divided into two subgroups, from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock. Each subgroup has a clear rate of increase whose overall average is about 5 beats/min (see Appendix C) for all schools shown in fig.(4.8). Strong positive correlation (person correlation coefficient) was found between sound pressure levels in the sample schools and heart pulse rate (R=0.288). For more clarification, the results of the linear fits of all subgroups of all schools are shown in Appendices A, B, and C. And for comparison purposes, all measured physical quantities (HPR, SPL, DBP and SBP), are shown in fig. (4. 9).

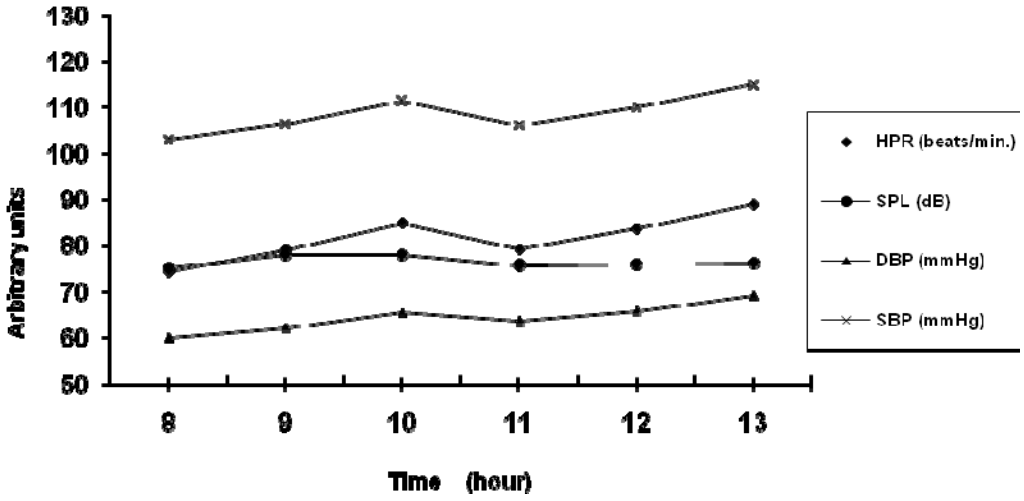
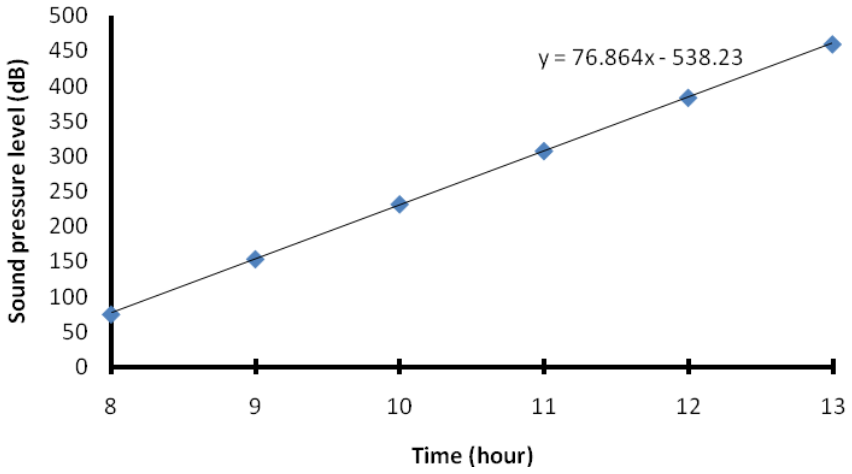


Figure (4.9): The average values of the four measured physical quantities shown the inlet for the six schools during 6 continues hour

Measurements of HPR, DBP and SBP show that the increasing rates in these quantities in some hours such as 10 and 13 o'clock, are due to noise pollution. Since the SPL values are almost the same as seen in fig. (4.8), someone may guesstimate that there is no effect of noise on those quantities. Actually, the accumulative doses of noise in the rate of 76.86 dB/hr as shown in figure (4.10) cause the effects presented in figure (4.9). However, the drop in the values of HPR, DBP and SBP at 10 o'clock can be easily related to the fact that children are relaxing at that time, although the noise did not decrease.



Figure(4.10): The accumulative sound pressure level (SPL) in the six sample schools.

4.4. Summary and Further Discussion

In this study, noise pollution measurements were performed in the six different sample schools in Jenin district (table (1.1)). The measurements were done during six continues hours from 7 to 13 o'clock (school day). The sound pressure levels (SPL) ranged between 75.25 and 79.19 dB (sec.4.1) with an average value for all sample schools of about 76.86 dB. And because the SPL values acceptable by human ear range between 65 and 70 dB according to the international standards defined by the world health organization (WHO 1999), the schools under study can easily be considered as noisy environments.

The students' density (No. of students/Area) in the sample schools (table (4.1)) was found not to be a major parameter in raising noise pollution in the sample schools. However, some schools with less students' density showed higher noise levels compared to the schools with higher students

density, that’s due to the environment around the schools and schools shape.

The shape of the school was found to have an influence on the measured SPL values. For example, the empty cube-shaped schools(sec. 4.1) were found to be nosier than the U-shaped schools, although both schools were located in the same environment.

In most sample schools, there were a general trend of SPL increase (fig. (4.2)). Two optimum values were noticed at two well defined times, at 10 o'clock which is the time of students' break and at 13 o'clock which is the time of leaving schools.

Some physiological effects of noise were also studied during this work such as dyastolic blood pressure (DBP), systolic blood pressure (SBP) and heart pulse rate (HPR). It is clear that DBP, SBP and HPR suffer from significant increase around 10 o'clock in the morning and 13 o'clock in the afternoon (sec. 4.2, 4.3). This increase can simply be explained by the fact that students have break at 10 o'clock, while they have to leave schools at 13 o'clock which seems to be very exciting and relaxing moment for them despite the a noisy atmosphere. One important result of these studies is that there is an increasing trend of the values of the three measured physical quantities (DBP, SBP and HPR) which might be due to the long time exposure to noise after which students got exhausted (sec. 4.2). Since the SPL values measured every hour are almost the same (fig. (4.9)), one may

gusstimate that there is no effect of noise on those quantities. Actually, students are expected to have an accumulative doses of noise in a rate of 76.86 dB/hr (fig. (4.10)). Therefore, for that rate of change of SPL the average rate of change of systolic and dyastolic blood pressure were found to be about 5 and 2.7 mm-Hg, respectively. Also the average rate of change in heart pulse rate was about 5 beats/min for every 76.86 dB/hr (sec.4.2). However, the rates of increase of systolic blood pressure and heart pulse rate were almost the same (4.7 mm-Hg for systolic blood pressure and 5 beats/min for heart pulse rate), which means that the systolic blood pressure and heart pulse rate are related to each other in a good agreement with the well known medical information (Hanini A. R. 2002). However, For future work concerning the accumulation behavior of noises is suggested. That work should include measuring the HPR, DBP and SBP first in quite environments for several hours, and then repeat the measurements on the same persons for several hour in an artificially noisy environment with a well defined SPL.

4.5. Recommendations

Long and short run noise effects on student's health were observed in several schools of Jenin city. Therefore, some precautions have to be considered to reduce those effects. As a result of this study, the following recommendations are suggested in order to improve schools environments:

1- Building schools in quiet areas away from main noise sources such as roads and factories.

2- Avoiding the close-shaped buildings like cube-shaped, in order to reduce the sound echo and, therefore, health noise effects.

3- Using sound proof materials and absorbants while constructing all parts of school buildings. For example, using fiber glass has shown good insulation in the contrary of using gypsum (Abdel –Raziq H. R. et.al.2000).

4- Making a proposal for the ministry of education in order to arrange for more than one break for students during the same working school day.

5- Further work concerning the accumulation behavior of noises is suggested.

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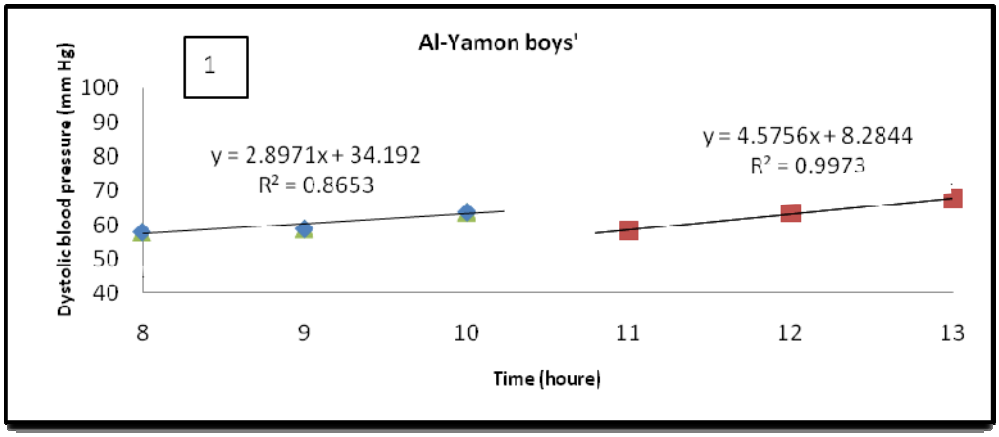
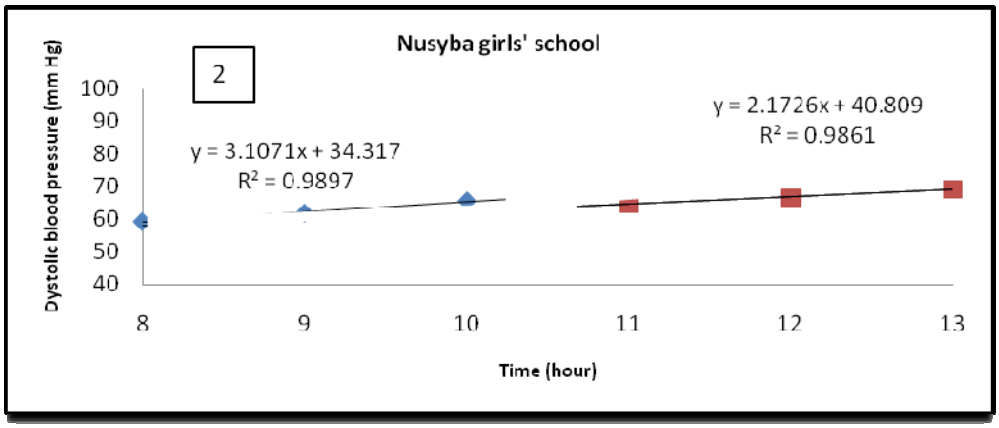
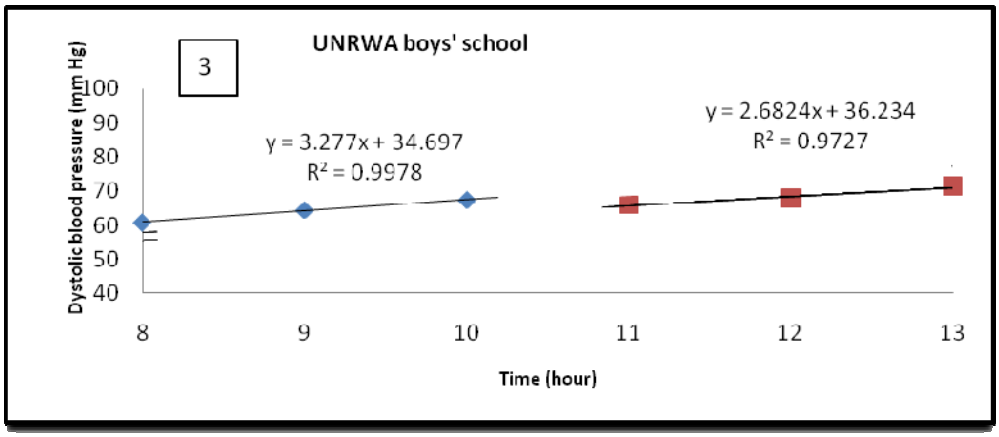
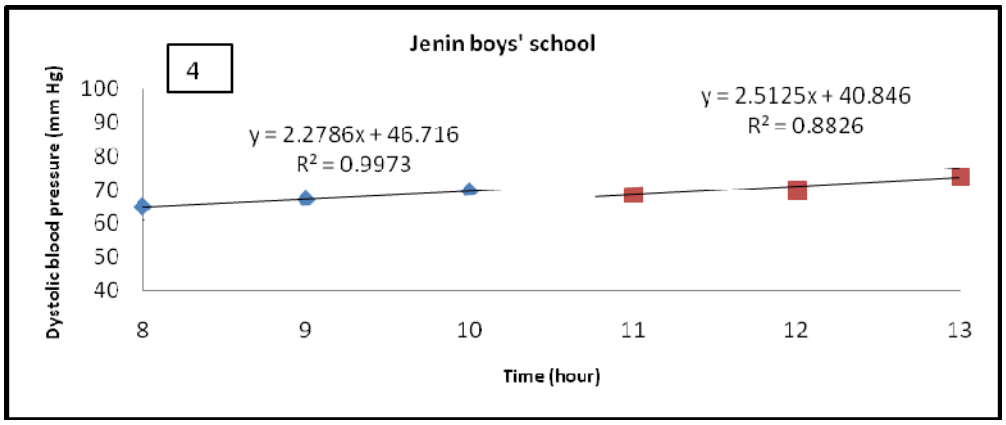
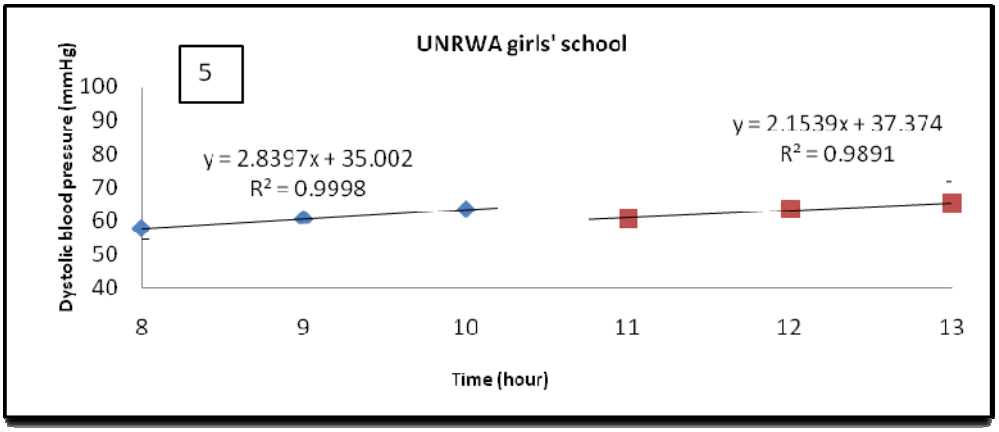
Appendix A: The following figures (1 to 6) correspond to dyastolic blood pressure (mm-Hg).

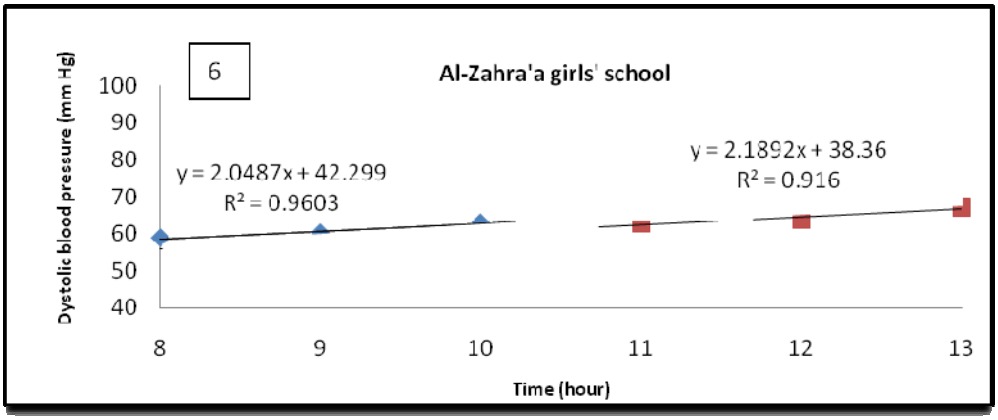






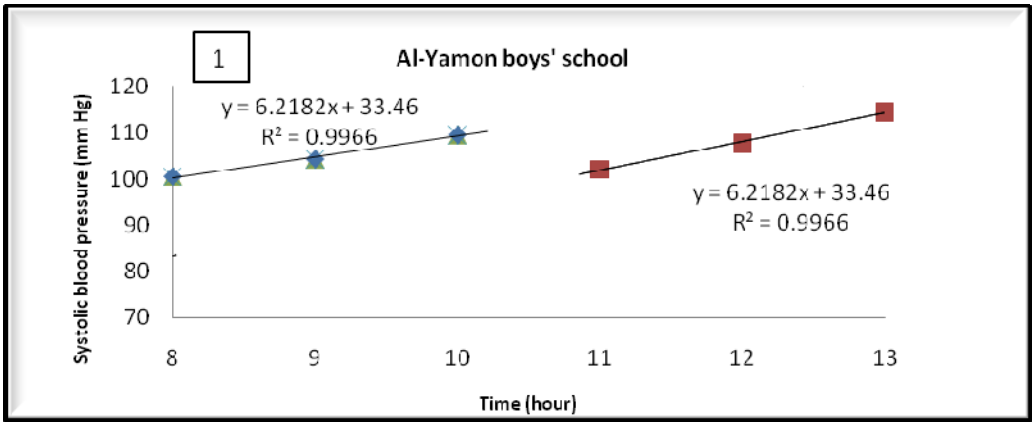


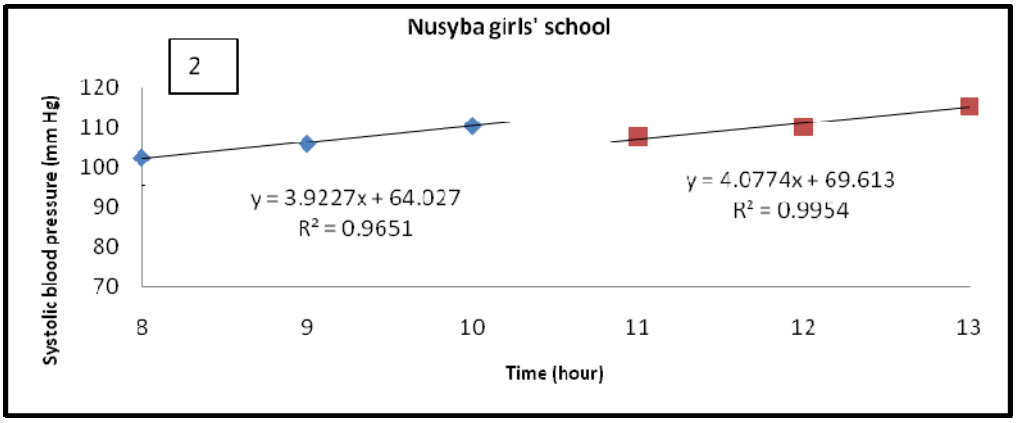


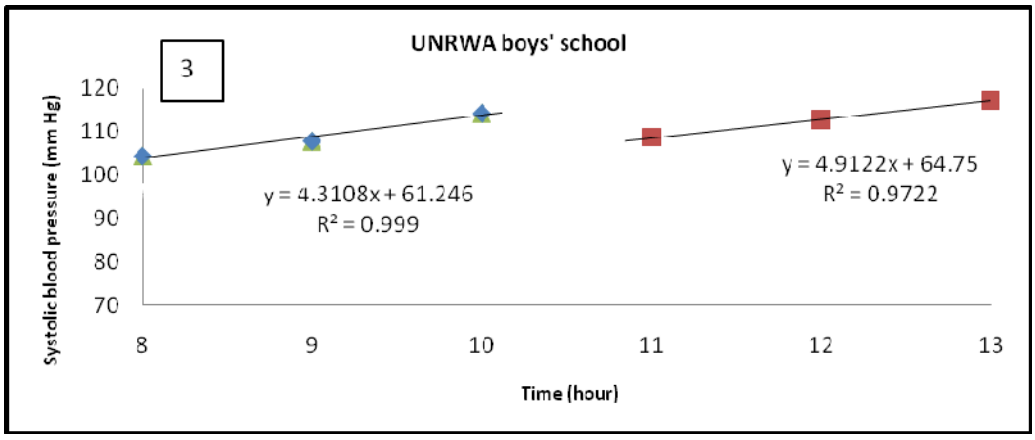


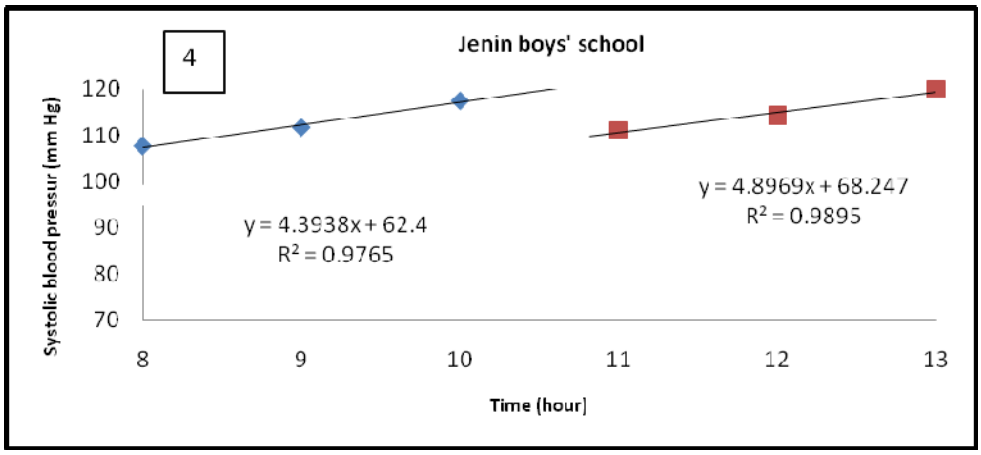
Appendix(A) : The rate of increase of dyastolic blood pressure for the two subgroups from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock; each measurement was done in the schools indicated on the graph.

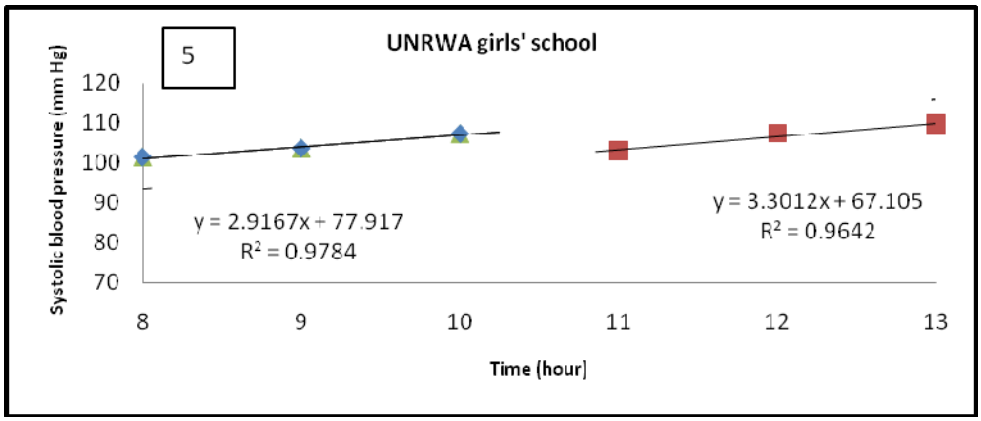
Appendix B: The following figures (1 to 6) correspond to systolic blood pressure (mm-Hg).

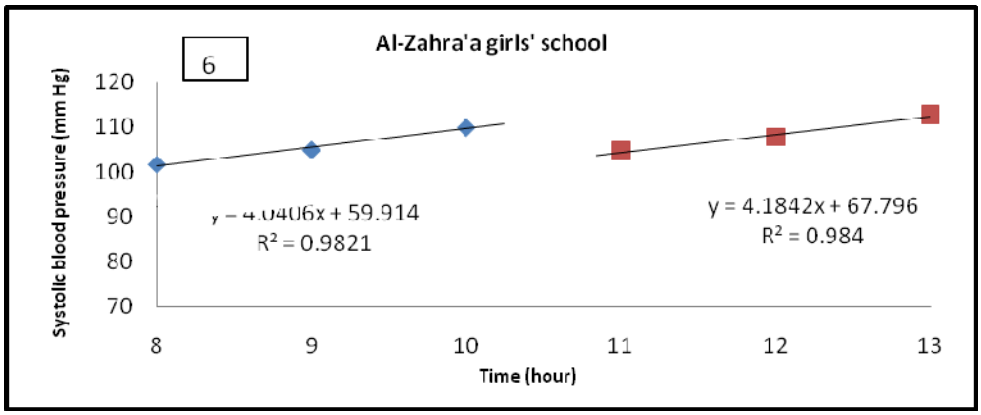






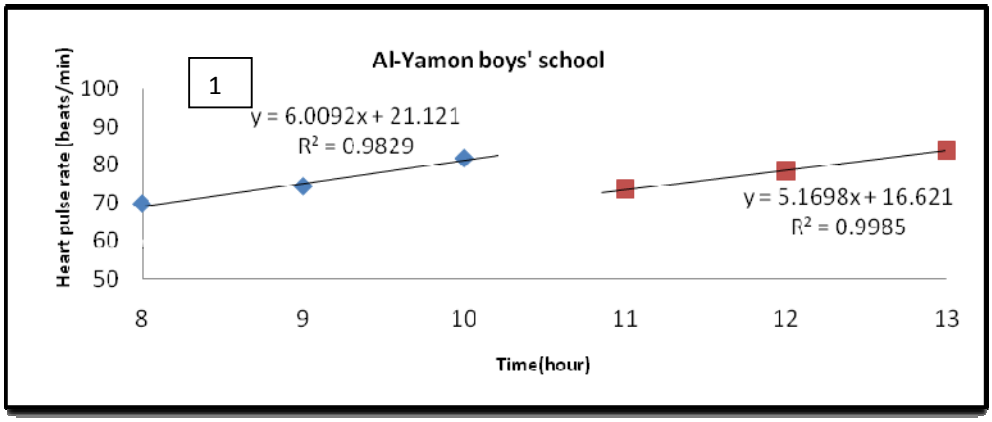


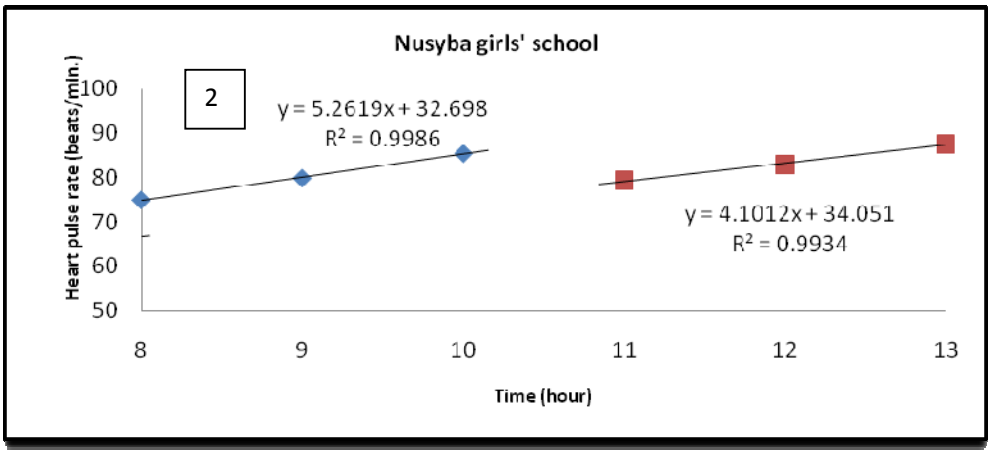


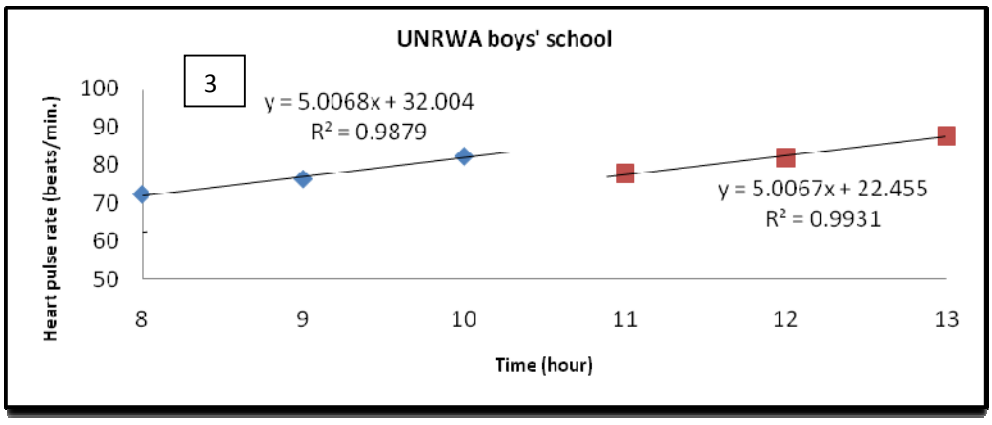


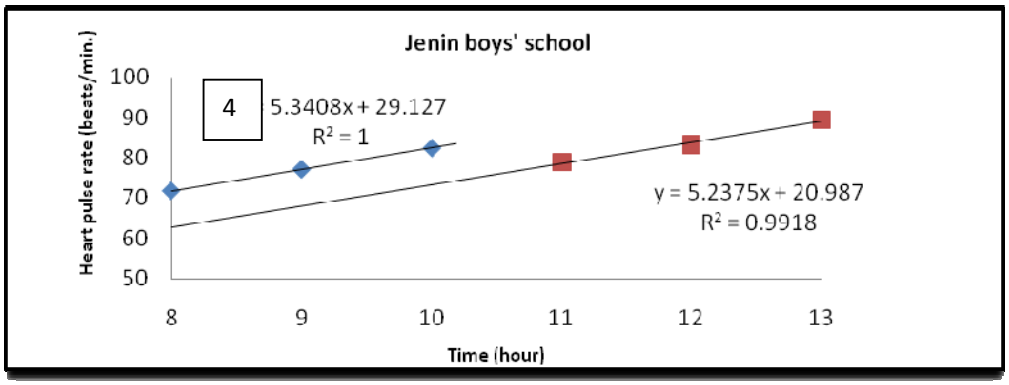
Appendix (B) : The rate of increase of systolic blood pressure for the two subgroups from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock; each measurement was done in the school indicated on the graph.

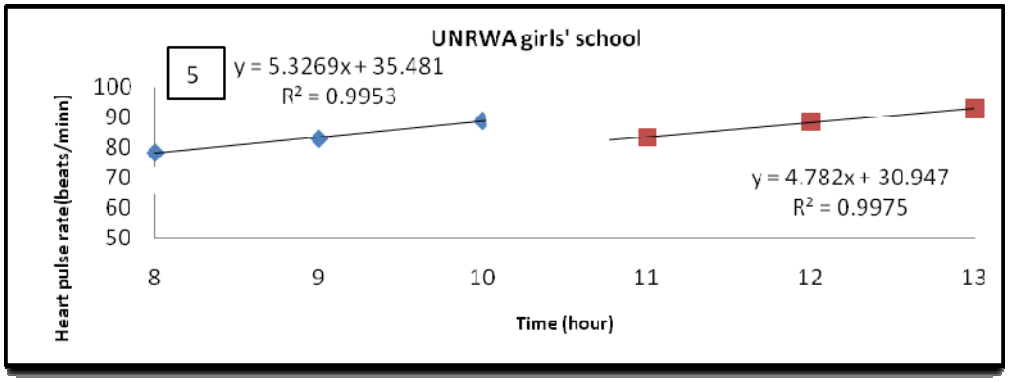
Appendix C: The following figures (1 to 6) correspond to heart pulse rate (beats/min.) .

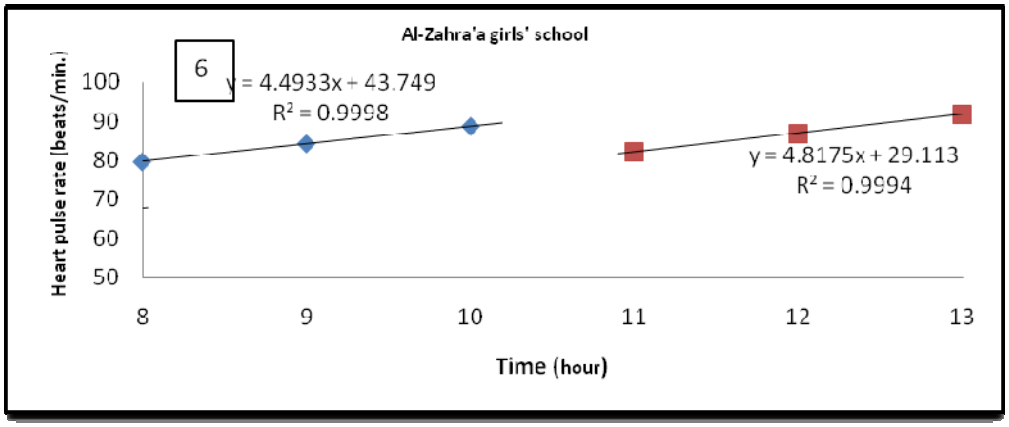












Appendix (C) : The rate of increase of heart pulse rate for the two subgroups from 7:00 to 10:00 o'clock and from 10:00 to 13:00 o'clock; each measurement was done in the school indicated on the graph.

Appendix D:

Note: In the following tables (1 to 7) the numbers under the school column indicate the following:-

1 = Al-Yamon Primary School for Boys

2 = Nusyba Al-Mazinya Primary School for Girls

3 = Jenin Camp Primary School for Boys

4 = Jenin Primary School for Boys

5 = Jenin Camp Primary School for Girls

6 = Al-Zahraa Primary School for Girls

Table(1): The mean SPL values in (dB) for the six schools during six continues hours from January to May.

School	Time (hour)						
	8.00	9.00	10.00	11.00	12.00	13.00	Total
1	75.4000	84.1000	78.6000	73.1000	74.6000	73.4000	76.5333
2	75.3000	77.7000	79.4000	76.8000	76.4000	80.4000	77.6667
3	76.5000	77.6000	75.1000	75.2000	76.7000	72.7000	75.6333
4	74.0000	75.7000	77.2000	74.0000	75.5000	74.2000	75.2500
5	73.4000	75.3000	76.8000	75.3000	75.5000	75.2000	75.2500
6	77.0000	79.0000	82.2000	79.5000	76.8000	80.4000	79.1500
Total	75.1667	78.1667	78.1500	75.8667	75.9167	76.2167	76.5806

Table (2): The mean SBP values in (mm-Hg) for the six schools during six continues hours from January to May.

School	Time (hour)						
	8.00	9.00	10.00	11.00	12.00	13.00	Total
1	100.5139	104.2877	109.5616	102.0704	107.6575	114.5068	106.4667
2	102.3929	105.9880	110.5476	107.6071	110.2381	115.4524	108.7097
3	104.5270	108.0000	114.3514	108.7432	112.8219	117.3649	110.9706
4	107.7125	111.7375	117.5063	111.1250	114.3375	119.9125	113.7140
5	101.5000	103.6667	107.3333	103.0513	107.4545	109.6538	105.4390
6	101.5775	104.8378	109.9459	104.6757	107.7703	112.7568	106.9637
Total	103.0915	106.4577	111.5519	106.3059	110.0889	114.9719	108.7542

Table (3): The mean DBP values in (mm-Hg) for the six schools during six continues hours from January to May

School	Time (hour)						
	8.00	9.00	10.00	11.00	12.00	13.00	Total
1	58.0278	58.9452	63.8219	58.4789	63.4658	67.6301	61.7517
2	59.3571	61.9157	65.5714	64.8571	66.5833	69.2024	64.5865
3	60.8243	64.3699	67.3784	66.0000	67.9041	71.3649	66.3077
4	65.0125	67.0875	69.5696	69.0125	69.9375	74.0375	69.1086
5	57.7436	60.5128	63.4231	60.9359	63.4805	65.2436	61.8865
6	58.9296	60.2568	63.0270	62.8243	63.8649	67.2027	62.7098
Total	60.0305	62.2278	65.4978	63.7896	65.9262	69.1490	64.4438

Table (4) : The mean HPR values in(beats/min.)for the six schools during six continues hours from January to May

School	Time (hour)						
	8.00	9.00	10.00	11.00	12.00	13.00	Total
1	69.6528	74.2877	81.6712	73.6056	78.4247	83.9452	76.9632
2	74.9048	79.8313	85.4286	79.3571	82.8810	87.5595	81.6640
3	72.3784	76.4247	82.3919	77.7703	82.0548	87.7838	79.8032
4	71.8500	77.2000	82.5316	78.8750	83.2875	89.3500	80.5115
5	78.3077	83.0000	88.9615	83.4103	88.6104	92.9744	85.8715
6	79.6620	84.2568	88.6486	82.1757	86.7838	91.8108	85.5964
Total	74.4553	79.2039	84.9654	79.2711	83.6985	88.9266	81.7651

Table(5): Multiple Comparisons for the six schools of dépendent Variable SBP (mm- Hg)

(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-2.24307	.70560	.073	-4.5925	.1063
	3.00	-4.50392(*)	.72783	.000	-6.9274	-2.0805
	4.00	-7.24732(*)	.71375	.000	-9.6239	-4.8708
	5.00	1.02769	.71810	.842	-1.3633	3.4187
	6.00	-.49705	.72824	.993	-2.9218	1.9277
2.00	1.00	2.24307	.70560	.073	-.1063	4.5925
	3.00	-2.26085	.70260	.066	-4.6003	.0786
	4.00	-5.00425(*)	.68800	.000	-7.2951	-2.7134
	5.00	3.27077(*)	.69251	.000	.9649	5.5766
	6.00	1.74602	.70302	.291	-.5948	4.0868
3.00	1.00	4.50392(*)	.72783	.000	2.0805	6.9274
	2.00	2.26085	.70260	.066	-.0786	4.6003
	4.00	-2.74340(*)	.71078	.011	-5.1101	-.3767
	5.00	5.53162(*)	.71515	.000	3.1504	7.9128
	6.00	4.00687(*)	.72533	.000	1.5918	6.4220
4.00	1.00	7.24732(*)	.71375	.000	4.8708	9.6239
	2.00	5.00425(*)	.68800	.000	2.7134	7.2951
	3.00	2.74340(*)	.71078	.011	.3767	5.1101
	5.00	8.27502(*)	.70082	.000	5.9415	10.6085
	6.00	6.75027(*)	.71120	.000	4.3822	9.1183
5.00	1.00	-1.02769	.71810	.842	-3.4187	1.3633
	2.00	-3.27077(*)	.69251	.000	-5.5766	-.9649
	3.00	-5.53162(*)	.71515	.000	-7.9128	-3.1504
	4.00	-8.27502(*)	.70082	.000	-10.6085	-5.9415
	6.00	-1.52475	.71557	.475	-3.9074	.8579

6.00	1.00	.49705	.72824	.993	-1.9277	2.9218
	2.00	-1.74602	.70302	.291	-4.0868	.5948
	3.00	-4.00687(*)	.72533	.000	-6.4220	-1.5918
	4.00	-6.75027(*)	.71120	.000	-9.1183	-4.3822
	5.00	1.52475	.71557	.475	-.8579	3.9074

*** The mean difference is significant at the .05 level.**

Table (6): Multiple Comparisons for the six schools of dependent Variable DBP (mm-Hg)

(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	**2.00**	**-2.83476(*)**	**.62070**	**.001**	**-4.9015**	**-.7680**
	3.00	**-4.55597(*)**	**.64025**	**.000**	**-6.6878**	**-2.4241**
	4.00	**-7.35684(*)**	**.62787**	**.000**	**-9.4474**	**-5.2662**
	5.00	**-.13479**	**.63170**	**1.000**	**-2.2381**	**1.9686**
	6.00	**-.95803**	**.64061**	**.816**	**-3.0911**	**1.1750**
2.00	**1.00**	**2.83476(*)**	**.62070**	**.001**	**.7680**	**4.9015**
	3.00	**-1.72121**	**.61806**	**.171**	**-3.7791**	**.3367**
	4.00	**-4.52208(*)**	**.60522**	**.000**	**-6.5373**	**-2.5069**
	5.00	**2.69997(*)**	**.60919**	**.001**	**.6716**	**4.7284**
	6.00	**1.87673**	**.61843**	**.101**	**-.1824**	**3.9359**
3.00	**1.00**	**4.55597(*)**	**.64025**	**.000**	**2.4241**	**6.6878**
	2.00	**1.72121**	**.61806**	**.171**	**-.3367**	**3.7791**
	4.00	**-2.80087(*)**	**.62526**	**.001**	**-4.8828**	**-.7190**
	5.00	**4.42118(*)**	**.62910**	**.000**	**2.3265**	**6.5159**
	6.00	**3.59794(*)**	**.63805**	**.000**	**1.4734**	**5.7225**
4.00	**1.00**	**7.35684(*)**	**.62787**	**.000**	**5.2662**	**9.4474**
	2.00	**4.52208(*)**	**.60522**	**.000**	**2.5069**	**6.5373**

	3.00	2.80087(*)	.62526	.001	.7190	4.8828
	5.00	7.22205(*)	.61649	.000	5.1693	9.2748
	6.00	6.39881(*)	.62563	.000	4.3157	8.4819
5.00	1.00	.13479	.63170	1.000	-1.9686	2.2381
	2.00	-2.69997(*)	.60919	.001	-4.7284	-.6716
	3.00	-4.42118(*)	.62910	.000	-6.5159	-2.3265
	4.00	-7.22205(*)	.61649	.000	-9.2748	-5.1693
	6.00	-.82324	.62947	.888	-2.9192	1.2727
6.00	1.00	.95803	.64061	.816	-1.1750	3.0911
	2.00	-1.87673	.61843	.101	-3.9359	.1824
	3.00	-3.59794(*)	.63805	.000	-5.7225	-1.4734
	4.00	-6.39881(*)	.62563	.000	-8.4819	-4.3157
	5.00	.82324	.62947	.888	-1.2727	2.9192

*** The mean difference is significant at the .05 level.**

Table (7): Multiple Comparisons for the six school of dependent Variable HPR (beats/min.) Scheffe

(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-4.70080(*)	.85720	.000	-7.5550	-1.8466
	3.00	-2.83995	.88421	.067	-5.7841	.1042
	4.00	-3.54826(*)	.86711	.005	-6.4354	-.6611
	5.00	-8.90830(*)	.87239	.000	-11.8131	-6.0035
	6.00	-8.63315(*)	.88471	.000	-11.5789	-5.6874
2.00	1.00	4.70080(*)	.85720	.000	1.8466	7.5550
	3.00	1.86085	.85356	.447	-.9812	4.7029
	4.00	1.15253	.83582	.863	-1.6305	3.9356
	5.00	-4.20750(*)	.84131	.000	-7.0088	-1.4062

	6.00	-3.93236(*)	.85407	.001	-6.7761	-1.0886
3.00	1.00	2.83995	.88421	.067	-.1042	5.7841
	2.00	-1.86085	.85356	.447	-4.7029	.9812
	4.00	-.70831	.86350	.984	-3.5835	2.1669
	5.00	-6.06835(*)	.86881	.000	-8.9612	-3.1755
	6.00	-5.79320(*)	.88117	.000	-8.7272	-2.8592
4.00	1.00	3.54826(*)	.86711	.005	.6611	6.4354
	2.00	-1.15253	.83582	.863	-3.9356	1.6305
	3.00	.70831	.86350	.984	-2.1669	3.5835
	5.00	-5.36004(*)	.85139	.000	-8.1949	-2.5252
	6.00	-5.08489(*)	.86401	.000	-7.9618	-2.2080
5.00	1.00	8.90830(*)	.87239	.000	6.0035	11.8131
	2.00	4.20750(*)	.84131	.000	1.4062	7.0088
	3.00	6.06835(*)	.86881	.000	3.1755	8.9612
	4.00	5.36004(*)	.85139	.000	2.5252	8.1949
	6.00	.27515	.86931	1.000	-2.6194	3.1697
6.00	1.00	8.63315(*)	.88471	.000	5.6874	11.5789
	2.00	3.93236(*)	.85407	.001	1.0886	6.7761
	3.00	5.79320(*)	.88117	.000	2.8592	8.7272
	4.00	5.08489(*)	.86401	.000	2.2080	7.9618
	5.00	-.27515	.86931	1.000	-3.1697	2.6194

*** The mean difference is significant at the .05 level**.

جامعة النجاح الوطنية

كلية الدراسات العليا

اثر التلوث الضوضائي على ضغط الدم ، نبض القلب، ومستوى السمع لدى الأطفال في مدارس مدينة جنين

إعداد

ربا محمد أنيس سعيد

إشراف

د. زيد نعيم قمحية

د. عصام راشد

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

2010

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الملخص

توضح هذه الدراسة علاقة وتأثير مستوى التلوث الضوضائي على ضغط الدم الشرياني (الانقباضي والانبساطي)، وعلى دقات القلب لدى أطفال المدارس.

اشتملت العينة على ست مدارس مختلفة اختيرت عشوائياً من محافظة جنين. وأظهرت الدراسة ان مستوى ضغط الصوت في جميع مدارس العينة كان فوق الموصى به حسب منظمة الصحة العالمية، لذلك اعتبرت المدارس أنها مناطق معرضة لإزعاج كبير يؤثر على الطلاب.

من نتائج التحليل الإحصائي ودراسة العلاقة بين مستوى الصوت وجدنا أن هناك ارتباطاً وثيقاً بين مستوى ضغط الصوت وبين ضغط الدم الانبساطي والانقباضي (ر=0.258 و ر=0.283 على التوالي). كذلك كان متوسط التغير في ضغط الدم الانبساطي والانقباضي حوالي 4.60 و 2.74 ملم زئبق لكل ديبي/ساعة على التوالي. أيضا هناك تغير في مستوى دقات القلب بمعدل زيادة 5 نبضات كل دقيقة لكل 75 ديبي/ساعة.