An – Najah National University
Faculty of Graduate Studies

The Effect of Light Intensity on Blood Pressure, Heart Pulse Rate, Blood Oxygen Saturation and Temperature of Children in Jenin- City Schools

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Dedication

To the soul of my father, mother, brothers and sisters, my future husband and my family with love and respect.

Acknowledgements

I am very pleased to express my deep gratitude to my supervisor Dr. Issam Rashid and co-supervisor Dr. Musa El-Hasan for their supervision, guidance and insightful suggestions.

Special thanks are addressed to the managers of the schools and children for their cooperation, whom contributed considerably to the completion of this research.

My sincere thanks go to my lovely family and my future husband for their unlimited support.

الإقرار

أنا الموقعة أدناه مقدمة الرسالة التي تحمل العنوان:

The Effect of Light Intensity on Blood Pressure, Heart Pulse Rate, Blood Oxygen Saturation in Blood and Temperature of Children in Jenin- City Schools

أثر شدة الضوء على ضغط الدم ودقات القلب وتركيز الاكسجين في الدم ودرجة حرارة الاطفال في مدينة جنين - فلسطين

اقر بأن ما اشتملت عليه هذه الرسالة، إنما هي نتاج جهدي الخاص، باستثناء ما تمـــت الإشارة إليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية 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

a	After.
a.m	Before Noon.
b	Before.
BLT	Bright Light Therapy.
dB	Decibel (s) (Unit of Sound Level Using a Logarithmic Scale).
DBP	Diastolic Blood Pressure.
fig.	Figure(s).
HPR	Heart Pulse Rate.
JIS	Japanese Industrial Standards.
Lux	Unit of Illumination.
m/s	Meter Per Second.
NICU	Newborn Intensive Care Unit.
nm	Nanometer.
OSHA	The Occupational Safety and Health Administration.
p.m	After Noon.
p-value	Probability
R	Pearson Correlation Coefficient.
SBP	Systolic Blood Pressure.
SI	International System.
SpO_2%	Blood Oxygen Saturation.

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The Effect of Light Intensity on Blood Pressure, Heart Pulse Rate, Blood Oxygen Saturation and Temperature of Children in Jenin- City Schools

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Abstract

The primary aim of this study is to identify the effect of light intensity on arterial blood pressure (systolic and diastolic), heart pulse rate, oxygen saturation in blood and tympanic temperature. The study population consisted of 237 children aged (5-6)years in Jenin city. The arterial blood pressure (systolic and diastolic), heart pulse rate, oxygen saturation in blood and tympanic temperature were measured before exposure to light intensity level and after exposure for four hours. Strong positive correlation (Pearson Correlation Coefficient) was found between light intensity level and all of the arterial blood pressure (systolic and diastolic), heart pulse rate, blood oxygen saturation and tympanic temperature in the Islamic , Fatima Khatoun's and Yousif Al-Athmeh Schools. At light intensity levels less than the normal (55, 39 and 40 lux) the average Pearson Correlation Coefficient is (R = 0.659 for systolic, R = 0.387 for diastolic, R = 0.696 for heart pulse rate, R= 0.604 for oxygen saturation and R = 0.795 for tympanic temperature). At normal light intensity levels (500, 590 and 550 lux) the average Pearson Correlation Coefficient is (R = 0.798 for systolic, R = 0.670 for diastolic, R = 0.647 for heart pulse rate, R = 0.771 for oxygen saturation and R= 0.729 for

tympanic temperature). At light intensity levels more than the normal (1320, 1400 and 1500 lux) the average Pearson Correlation Coefficient is (R = 0.593 for systolic, R = 0.561 for diastolic, R = 0.675 for heart pulse rate, R = 0.722 for oxygen saturation and R= 0.744 for tympanic temperature). Finally, the study concludes that there is an effect of the light intensity levels on arterial blood pressure (systolic and diastolic), heart pulse rate, oxygen saturation in blood and tympanic temperature of school's children.

Chapter One

Introduction

Chapter One
Introduction

The electromagnetic spectrum is the range of all possible frequencies which extends from long-wavelength (low frequencies) used for radio to gamma radiation at the short-wavelength (high frequency).

The intensity of radiation is defined as the total energy per unit area per unit time. Because the total energy per unit time is power. The intensity of the radiation can also be defined as the power of the electromagnetic wave falling on a unit area (Peter J., 1995). The speed of light in vacuum, which is one of the fundamental constants of nature, is defined to be exactly 299,792,458 m/s (Anderton R., 2011).

Foot candles and lux are units of intensity that indicate the density of the light that falls on a surface. The foot candle is an older unit where one foot candle is 10.76 lux. The lux is an international system (SI) unit of illumination.

The visible light contains approximately between 380 and 780 nm which helps us to see things and do our daily activities in many places including offices, hospitals, institution and schools.

When a cell in the human retina (part of the eye) capture light which can disrupt the body's production of melatonin, which is hormone produced by pineal gland in the brain, it helps regulate other hormones and maintains the body's circadian rhythm (Guyton A., 2000).

It has been found that the daylight in factories can affect the physiological and psychological health of factory workers in windowless factories where workers have more headaches, faintness, sickness, decrease white cell activity, an absenteeism problems and depression compared to workers in factories with windows (Edwards *et al*., 2002).

Human needs an amount of lighting; it provides the teachers and students a satisfactory visual performance, the ability to write on the board, read a book and other school activities. This amount depends on several factors including: the type of work or activity performed by human, the gender of the worker and work environment.

The Occupational Safety and Health Administration (OSHA) play an essential role where it sets the occupational light standard which guarantees the human health, such as the minimum illumination intensities in lux. (Table 1.1) (OSHA 1965).

Table (1.1): Minimum illumination intensities in lux.

Level of illuminance (lux)	**Area of Operation**
32.28	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and Field maintenance areas.
53.8	General construction area lighting. Indoors: warehouses, corridors, hallways, and exit ways. Tunnels, shafts, and general underground work areas
107.6	General construction plant and shops.
322.8	First aid stations, infirmaries, and offices.

The following is a chart of recommended light intensity levels in various situations in schools according to Japanese Industrial Standards (1979): (JIS) is another organization which interested about safety of human health.

Table (1.2): Recommended light intensity levels in various situations in schools

Level of illuminance (lx)	Place
300 to 1500	Precision drawing or drafting, precision experimenting, library reading rooms and precision handicraft
200 to 750	Classrooms, library reading rooms, experiment demonstration rooms, staff rooms and gymnasia
75 to 300	Lecture halls, assembly rooms, locker rooms, corridors, stairways and restrooms
30 to 75	Warehouses and emergency stairways
2 to 10	School passages (for night)

1.1 light theory and health

Light is a part of the electromagnetic wave spectrum travelling in space with the speed of light.

Max plank's relation of light theory is:

$$E = h\nu$$

Where, E = energy of the quanta (J).

h is Plank's constant which has a value of 6.63×10^{-34} J.s.

ν is the frequency of the radiation (s^{-1}) (Frank L., 1993).

The electromagnetic waves differ in frequencies (and wavelengths). These waves can produce different effects in various materials and devices, and therefore different parts of the electromagnetic spectrum have been used for different purposes. Frequencies below 30 MHz are used for broadcasting and world-wide radio communication. Those between 30 MHz and 300 GHz (wavelength = 1 mm) are used for radar, point–to-point radio communication, and for baking in microwave oven. Waves of wavelength lying between 0.1 and 0.001 mm falling on our skin produce a sensation of heat (infra-red rays). Waves and wavelengths between 720 nm and 400 nm falling on our eyes give us a sensation of colors ranging from violet, indigo, blue, green, yellow and orange to red (visible spectrum). From 400 nm to 30 nm wavelength is the ultra-violet radiation. Soft to hard X-rays lie in the wavelength range from 1 nm to 0.01 nm, while gamma-rays range from 0.1 nm to 0.001 nm. Wavelengths below 10^{-5}nm (=10 fm) are the cosmic rays arriving on the earth's surface from the entire universe they are depicted in Fig (1.1)(Sarwate V., 1993).

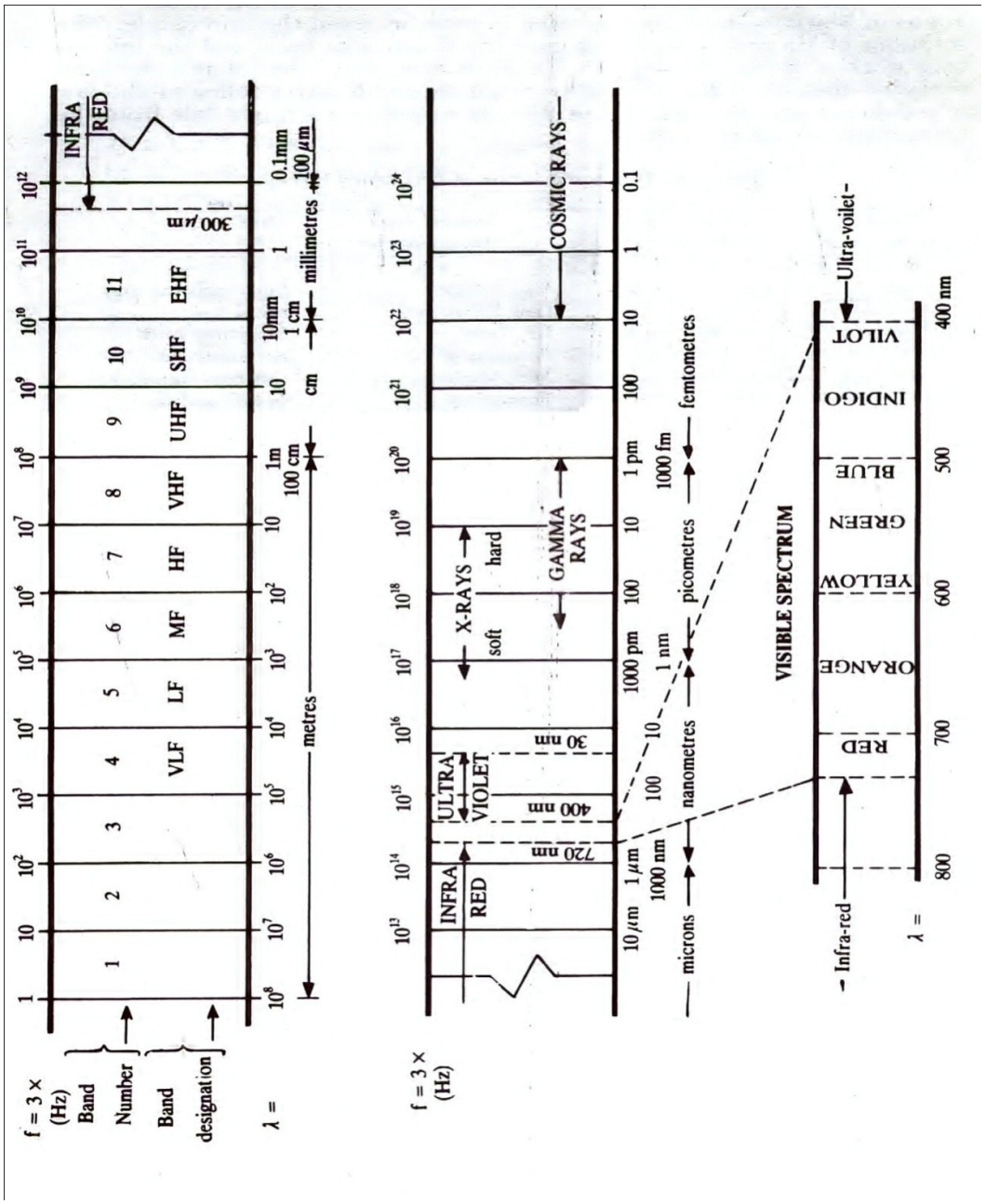

Fig (1.1) Electromagnetic wave spectrum

The amount of radiation absorbed by a sample depends on the chemical identity of the sample its thickness, and the wavelength of the radiation of the sample. In addition, Beer observed that, the amount of radiation absorbed is proportional to the concentration of dissolved substance which is given as Beer law

$I = I_0 \, exp - (\alpha x c)$

Where, $I_0 =$ the intensity of the incident radiation (J / (m^2s)).

I = the intensity of the radiation which crossed a thickness of x of the absorbing medium (J / (m^2s)).

α = absorption coefficient (litter $moles^{-1} \, cm^{-1}$) .

x = the length of the radiation path (cm).

c = the concentration of the absorbing material (moles $litter^{-1}$) (Baldini *et al*., 2005).

Health is defined by the world health organization (WHO) as "a state of complete physical, mental and social well-being and merely the absence of disease and infirmity". One can study the effect of light on health in three different ways, the first one consider the effect of light as radiation where exposure to the ultraviolet, visible, and infrared radiation produced by light sources can damage both the eye and skin. This damage is caused by both thermal and photochemical mechanisms. The second one considers the effect of light on vision through the eye. The third one is the light operating through the circadian system. This one was proved to affect sleep patterns and was believed to have a relation to the development of breast cancer in night shift workers (Peter R., 2010).

1.2 Blood Oxygen saturation

Oxygen saturation is defined as the ratio of oxhemoglobin to the total concentration of hemoglobin present in the blood.

A hemoglobin molecule can carry a maximum of four oxygen molecules. 2000 haemoglobin molecules can carry a maximum of 8000 oxygen molecules; if they together were carrying 7200 oxygen molecules, then the oxygen saturation level would be 90%.

1.3 Previous Studies

More common lighting systems in schools to acknowledge the use of neon which provides a cost effective, has a high and a long life, good color and low noise levels. However, there is an effect of light intensity on the human physiology and behavior (Webb A., 2006).

When the body is exposed to less intensity light the body produces a hormone called melatonin which is produced at night by the pineal gland in the brain. It has a role in regulating the sleep – wake cycle. Melatonin has also been shown to lower blood pressure and lower body temperature. It has also been explored as a treatment option for insomnia hypertension and cancer (Pandi et *al*, 2006).

In modern society, people are routinely exposed to electrical lighting during evening hours to partake in work and social activities. A study carried out by Joshua, of Brigham and Women's Hospital and Harvard Medical School in Boston showed that exposure to indoor light has a strong

suppressive effect on the hormone melatonin. This could have effects on sleep quality and the body's ability to regulate body temperature, blood pressure and glucose level (Joshua G., 2011).

Another study showed that the melatonin levels dropped by 71%, 67%, 44%, 38% and 16% after human was exposed to one hour of light at mid night using different level of light : 3000, 1000, 500, 350 and 200 lux intensities respectively (Mcintyre *et al*., 1989).

Exposure to bright light in evening lead to increase the mean total sleep time more than one hour, it may be an effective treatment for early morning a wakening insomnia (Lac *et al*., 1993).

Bright light therapy (BLT) helps in the treatment of non- SAD depression and circadian rhythm in demented patients when suffering from delusions or agitation. On the other hand, caution should still be used when using BLT in demented patients when agitation develops or increase during BLT (Fischer *et al*., 2002).

There are some studies that support a relationship between lighting and human performance, body temperature, human circadian pacemaker, blood oxygen saturation and melatonin.

A study was performed in China in Jen Junior college of Medicine on the effects of high intensity of light on the physiological parameters of the premature relationship with the premature infants physiological parameters and the heart pulse rate respiration. The study found that pulse

rate increased and the blood oxygen saturation decreased as the intensity of light went up (Peng *et al*., 2001).

A study carried on nurses working in a newborn intensive care unit (NICU) showed that tympanic temperature were consistently higher when nurses were exposed to bright light during their shifts and their sense of well-being was improved (Figueiro *et al*., 2001).

People who are more satisfied with their lighting rate are happier, more comfortable and satisfied with their environment and their work. (Boyce *et al.*, 2003).

Exposure to early morning room light can significantly advance the timing of the human circadian pacemaker. The resulting response to such light has a non- linear relationship to illuminance and affected plasma melatonin concentrations (Jamie *et al.*, 2000).

Badia et al showed that exposure to bright light of 5000 lux elevates body temperature and light exerts a powerful, immediate effect on physiology and behavior in addition to its powerful influence on circadian organization (Badia *et al.*, 1991).

Continuous exposure of broiler chicken to high temperature and high intensity lighting significantly affect some physiological variables of blood without causing stress in the broiler (Olanrewaju *et al.*, 2010).

Exposure to light affects both men and woman. However the effect is different through the level of the absolute values of melatonin plasma

levels, whereas after bright light exposure, the suppression of plasma melatonin was 40% greater in women than in men. These findings suggest that, in human there is a sex difference in the nocturnal sensitivity of the pineal to light (Monteleone *et al.*, 1997).

1.4 Study Objectives

In this research, our objective is to study the effects of light intensity on the blood pressure, heart pulse rate, blood oxygen saturation, and tympanic temperature of children in schools in Jenin-city.

In addition, measurements of light intensity in different schools has been compared with the recommended light levels (According to the JIS standards).

Chapter Two

Methodology

Chapter Two
Methodology

2.1 The study population:

This study was done in april 2011, the population consists of children of three schools in Jenin city. These are Islamic school, Fatima Khatoun School and Yousif Al-Athmeh School.

The examined children who are aged (5-6) years have no health problems according to their school records. The number of examined children was 80 in the Yousif Al-Athmeh and Islamic school but in Fatima Khatoun School was 77 children.

The children in Yousif Al-Athmeh School are all male children. While in Fatima Khatoun School the children are all female and Islamic school is a co-education school of male and female children.

The sample size was determined according to Cochran formula (1977)

$$n = [(t^2) * (p)(q)]/(d^2)$$

Where, n = sample size,

t = value for selected alpha level of 0.025 in each tail = 1.96.

(p)(q) = estimate of variance, q = 1 - p, p = 0.9, q = 0.1.

d = acceptable margin of error for proportion being estimated = 0.04.

n = 216.

Then apply the correction formula:

m = [n] / [1+ (n/N)]

Where, m = corrected sample size

n = sample size

N = population

m = 113.

This means the size of our sample is more than sufficient for the study.

The children were examined without participating in the morning activities and before being exposed to the level of light intensity and remained in their classes during the experimental period.

Light intensity is measured in different sites of the class, values are found to be very close to the average value this approved that the light intensity was distributed at the same level on all children.

The noise pressure level was (50.5 - 55.6) dB which is considered to be quiet place where the schools are located in remote areas from the city center or any noise pollution causes.

2.2 Experimental Method:

The data was taken from each school from the beginning of the school day which differ according to the school as the following: for Fatima Khatoun and Yousif Al-Athmeh schools, the data was taken in two periods, the first set, was taken at 7:30 a.m and the second set was taken at 11:30 a.m after four hours of exposure to light intensity level.

In the third school (Islamic School) the measurements were taken at 8:30 a.m and the second period started at 12:30 p.m after exposed to the level of light intensity.

To see the effect of the different levels of intensity on children, the examined children in the three schools were exposed to the three different levels of light intensity. These three different levels of light intensity were (0 - 60), (500 -600) and (1320 - 1500) lux.

We got low light intensity levels using cartoon to cover the windows, high intensity levels were generated using additional lights in the class room.

The systolic and diastolic blood pressure, heart pulse rate, blood oxygen saturation and tympanic temperature were measured for children before being exposed to the different light intensity levels and after four hours of exposure to different light intensity levels the SBP, DBP, HPR, SpO_2% and T were measured.

2.3 Instrumentation:

1- Hioki 3423 lux Hitester Digital illumination meter was used to measure the light intensity. This instrument is suited for a wide range of application. It measures a broad range of luminosities, from the low light provided by induction lighting up to a maximum intensity of 199,900 lux.

Fig (2.1): Hioki 3424 lux Hitester Digital illumination

2- Arterial blood pressure (systolic, diastolic and pulse rate) were measured by using Automatic Blood Pressure Monitor (microlife AG, Modno.BP 2BHO, Measuring range: (30-280mmHg) with ccuracy + 2% mm-Hg, and + 2% for reading heart pulse rate with operating temperature range of +10 °C to +40 °C (Instruction for the Automatic Blood pressure Monitor, 2009).

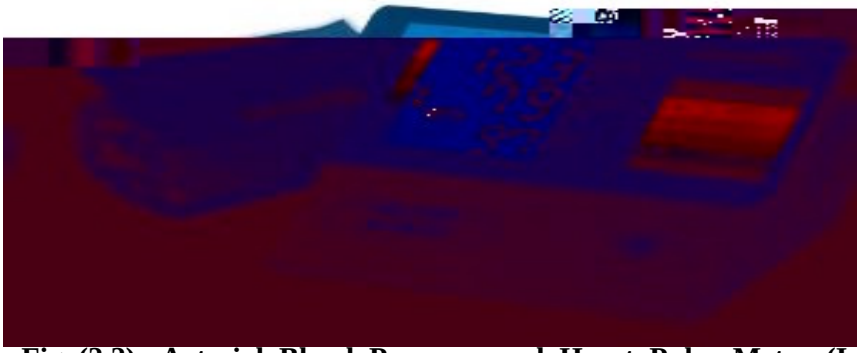

Fig (2.2): Arterial Blood Pressure and Heart Pulse Meter (Instruction for the Automatic Blood Pressure Monitor, 2009).

3- Pulse Oximeter LM-800(Finger Oximeter) with accuracy + 1%, was to measure the blood oxygen saturation of each child.

Fig (2.3): Pulse Oximeter LM-800 (Finger Oximeter).

4- The GT-302/GT-302-1 Ear Thermometer:

This instrument was used to measure human body temperature through the tympanic temperature of the ear. The display temperature range is 32.0 to 42.9 °C with accurancy range $\pm$ 0.01°C.

Fig (2.4): GT-302/GT-302-1 Ear Thermometer.

5- Sound Pressure Level Meter, was used to measure the noise level in dB.

(Quest Technologies U.S.A, Model 2900 type 2) with accuracy of $\pm$ 0.5 dB at 25 °C. This device gives the reading with a precision of 0.1dB.

Fig (2.5): Sound Pressure Level Meter model 2900 type 2(Instructions manual 1998a).

2.4 Statistical Analysis

The data was analyzed by using SPSS program. Pearson correlation factor (R) and the P-value were used as a measure of the strength of the correlation between light intensity and the systolic, diastolic blood pressure, heart pulse rate, blood oxygen saturation and tympanic temperature.

SPSS is a statistical program used for data description and analysis to find out if there is a relationship between the independent variable and the dependent variables that rely on it. It gives a lot of information such as Mean, Std. Deviation, Std. Error Mean, Sig P-value and Pearson Correlation but we are interested in Person Correlation (R) and Sig P-value.

Person Correlation (R) between two variables ranges from +1 to -1. A correlation of +1 means that there is a perfect positive linear relationships between the variables, while -1 means that there is a perfect negative linear relationship between variables. P-value less than 0.050 means there is significant relationship between two variables.

The Person correlation coefficient (R) and the probability value (P-value) were calculated by using paired sample T – test.

The results of SBP, DBP, HPR, SpO_2% and T for children before and after exposure to different levels of intensity of the light were tabulated against light intensity levels.

Chapter Three

Results

Chapter Three
Results

The population of the study was 237 children. The children aged between 5 - 6 years, with the male constituting 50.3% and the female constituting 49.7% as shown in table (3.1).

Table (3.1): The number and gender percentages of the children.

Gender	Number	Percentage
Male	119	50.3%
Female	118	49.7%
Total	237	100%

The following sections will describe the relationship between the change in light intensity levels and the changes in the average values of parameters for each school.

The collected data were tabulated in appendices (A, B, C). Each appendix consists of the following data:

1- The light intensity levels.

2- Gender of the children.

3- The (SBP, DBP, HPR, SpO_2% and T) for children before exposure to the chosen light intensity level.

4- The (SBP, DBP, HPR, SpO_2% and T) for children after exposure to light intensity level.

3.1 Measurements of the Normal Light Intensity Levels inside and Outside the Classrooms of the Selected Schools

The normal light intensity levels of the three selected schools were measured inside the classrooms. The values are shown in table (3.1.1)

Table (3.1.1): Average values of normal light intensity inside the classrooms in the three selected schools.

School	Average values of normal light intensity inside the classrooms (lux)	Max	Min	S. d
Islamic School	409	411	407	1.6
Fatima Khatoun School	585	589	580	3.5
Yousif Al-Athmeh School	423	425	420	2

The average values of the light intensity levels to all selected schools ranges between (409 - 585) lux. These measured values are accepted according to JIS (200 to 750) lux.

The average of the light intensity levels and the average of sound pressure level were measured outside the classrooms of the selected schools. The values are given in table (3.1.2).

Table (3.1.2): Averages of light intensity levels and the sound pressure levels outside the classrooms of the three selected schools.

School	Average light intensity level outside the classrooms (lux)	Max	Min	S. d	Average sound pressure level outside the classrooms (dB)	Max	Min	S. d
Islamic School	430	432	428	1.6	50.5	51.5	49	1
Fatima Khatoun School	459	461	457	1.6	55.6	56.5	54.8	0.7
Yousif Al-Athmeh School	448	450	446	1.6	53.9	56.1	52.9	1.3

Table (3.1.2) shows that the average of light intensity level outside the classrooms ranges between (430 - 459) lux. These values are similar to the case inside the classrooms.

The schools were chosen in quiet (50 - 60) dB area to minimize the effect from the noise.

3.2 Measurements of Light Intensity Levels inside Classrooms (Low, Normal and High Intensities).

In this study the children were exposed to different light intensity levels these were less, more and within JIS standards values to study the effect of light intensity levels on children. The results are given in table (3.2.1).

Table (3.2.1): The values of different light intensity levels over the three days for the three selected schools.

School	light intensity low-level on 1st day (lux)	Max	Min	S. d	light intensity normal-level on 2nd day (lux)	Max	Min	S. d	light intensity high-level on 3rd day (lux)	Max	Min	S. d
Islamic School	55	58	51	2.7	500	503	495	3.2	1320	1324	1315	3.4
Fatima Khatoun School	39	41	37	1.6	590	592	588	1.6	1400	1402	1398	1.6
Yousif Al-Athmeh School	40	42	38	1.6	550	552	548	1.6	1500	1502	1498	1.6

The conditions in three different schools in three days are the same.

3.3 Measurements of Arterial Blood Pressure (Systolic and Diastolic) in the Selected Schools under three Different Intensity Light Levels.

Systolic and diastolic blood pressures were measured of children in the three schools before and after the exposure.

3.3.1 Systolic Blood Pressure (SBP)

The average systolic blood pressure was calculated for each school before and after exposure for each day, the data summary is shown in table (3.3.1.1).

Table (3.3.1.1): Average values of SBP before and after exposure to different light intensity levels in the selected schools.

School		Light intensity levels (lux)	Average SBP before exposure (mmHg)	Max	Min	S. d	Average SBP after Exposure (mmHg)	Max	Min	S. d
Islamic School	1st day	55 (low)	110.2	127	70	9.9	107.3	125	88	8.3
	2nd day	500 (normal)	109.4	125	95	7.5	113.2	130	95	8.3
	3rd day	1320 (high)	107.6	123	92	7.9	114.5	144	76	11.0
Fatima Khatoun School	1st day	39 (low)	95.2	140	78	12.3	89.8	132	58	10.2
	2nd day	590 (normal)	93.2	140	80	12.4	100.5	132	87	7.9
	3rd day	1400 (high)	92.1	119	81	6.6	109.0	140	97	8.3
Yousif Al-Athmeh School	1st day	40 (low)	104.1	125	76	8.5	103.0	123	80	8.8
	2nd day	550 (normal)	104.7	144	53	21.5	105.6	146	71	15.5
	3rd day	1500 (high)	105.9	124	80	9.1	111.6	139	85	10.6

The table (3.3.1.1) shows that for all schools there is a decrease in the average systolic blood pressure as the light intensity level decreases from normal to low intensity levels (55, 39 and 40) lux. But an increase in average systolic blood pressure when light intensity levels increased from the normal to high intensity levels (1320, 1400 and 1500) lux.

3.3.2 Diastolic Blood Pressure (DBP)

Diastolic measurements were taken before and after exposure to different light intensity levels. They are given in table (3.3.2.1):

Table (3.3.2.1): Average values of DBP before and after exposure to different light intensity levels in the selected schools.

School		Light intensity levels (lux)	Average DBP before exposure (mmHg)	Max	Min	S. d	Average DBP after exposure (mmHg)	Max	Min	S. d
Islamic School	1st day	55 (low)	71.0	86	52	9.8	67.9	85	87	7.2
	2nd day	500 (normal)	68.9	80	57	6.7	69.2	86	53	9.2
	3rd day	1320 (high)	66.1	83	55	7.3	71.1	82	58	7.0
Fatima Khatoun School	1st day	39 (low)	62.9	106	50	9.8	60.0	82	48	6.1
	2nd day	590 (normal)	61.6	103	48	9.3	63.9	102	49	6.8
	3rd day	1400 (high)	60.0	75	48	4.3	69.3	82	60	4.5
Yousif Al-Athmeh School	1st day	40 (low)	69.6	88	53	10.6	68.9	97	49	9.0
	2nd day	550 (normal)	69.5	96	50	10.0	70.8	95	53	9.4
	3rd day	1500 (high)	69.0	86	55	8.7	73.3	91	60	8.3

The table (3.3.2.1) shows that for all schools as the light intensity level is changed from normal to low intensity levels (55, 39 and 40) lux the average diastolic blood pressure decreases. In the other hand, when light intensity levels changed from the normal to high intensity levels (1320, 1400 and 1500) lux, the average diastolic blood pressure increases.

The relationship between the light intensity and average values of the (SBP, DBP) for examined children of each school are plotted in the following figures: (3.3.1→3.3.6).

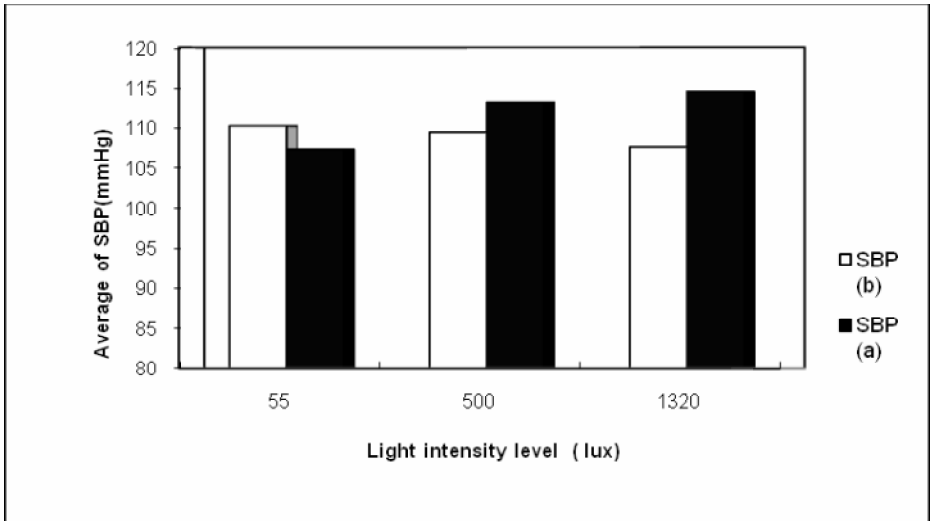

Fig (3.3.1): The relationship between average values of systolic blood pressure (SBP) versus the light intensity levels in Islamic School. (b: before, a: after)

Figure (3.3.1) shows that when the light intensity has been changed from normal (500) lux to low intensity (55) lux the systolic blood pressure (after) decreases, and when the light intensity has been changed from normal (500) lux to high intensity (1320) lux the systolic blood pressure (after) increases.

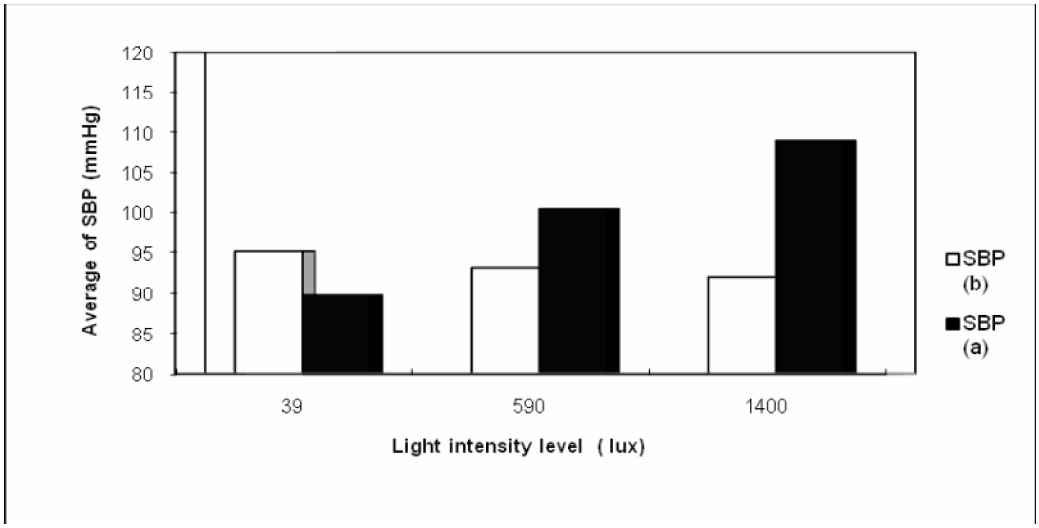

Fig (3.3.2): The relationship between average values of systolic blood pressure (SBP) versus the light intensity levels in Fatima Khatoun School. (b: before, a: after)

Figure (3.3.2) shows that when the light intensity has been decrease from normal (590) lux to low intensity (39) lux the systolic blood pressure (after) decreases, and when the light intensity has been increase from normal (590) lux to high intensity (1400) lux the systolic blood pressure (after) increases.

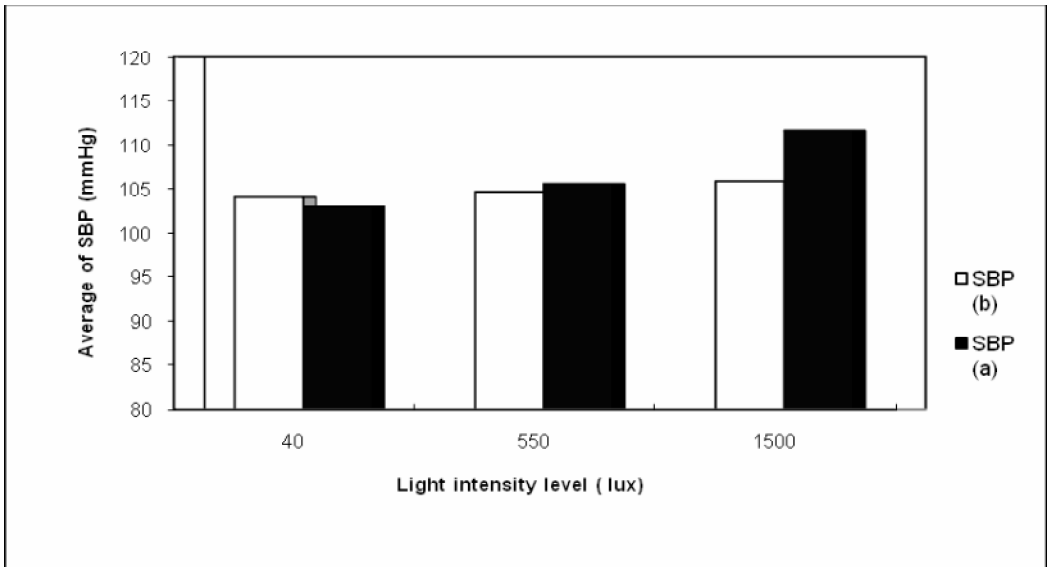

Fig (3.3.3): The relationship between average values of systolic blood pressure (SBP) versus the light intensity levels in Yousif Al-Athmeh School. (b: before, a: after)

Figure (3.3.3) shows that the systolic blood pressure (after) decreases when the light intensity has been changed from normal (550) lux to low intensity (40) lux, and when the light intensity has been changed from normal (550) lux to high intensity (1500) lux the systolic blood pressure (after) increases.

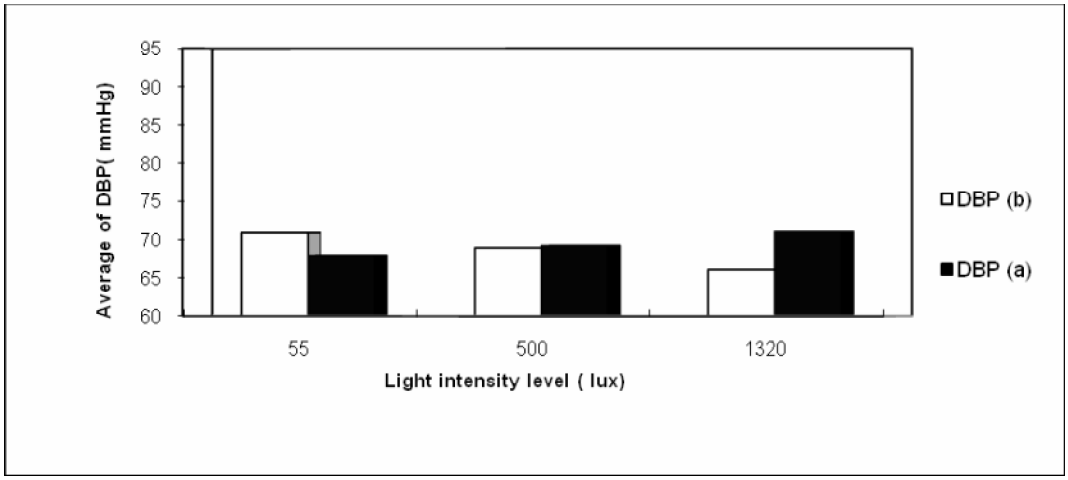

Fig (3.3.4): The relation between average values of diastolic blood pressure (DBP) versus the light intensity levels in Islamic School. (b: before, a: after)

Figure (3.3.4) shows that when the light intensity has been changed from normal (500) lux to high intensity (1320) lux the diastolic blood pressure (after) increases, and when the light intensity has been changed from normal (500) lux to low intensity (55) lux the diastolic blood pressure (after) decreases.

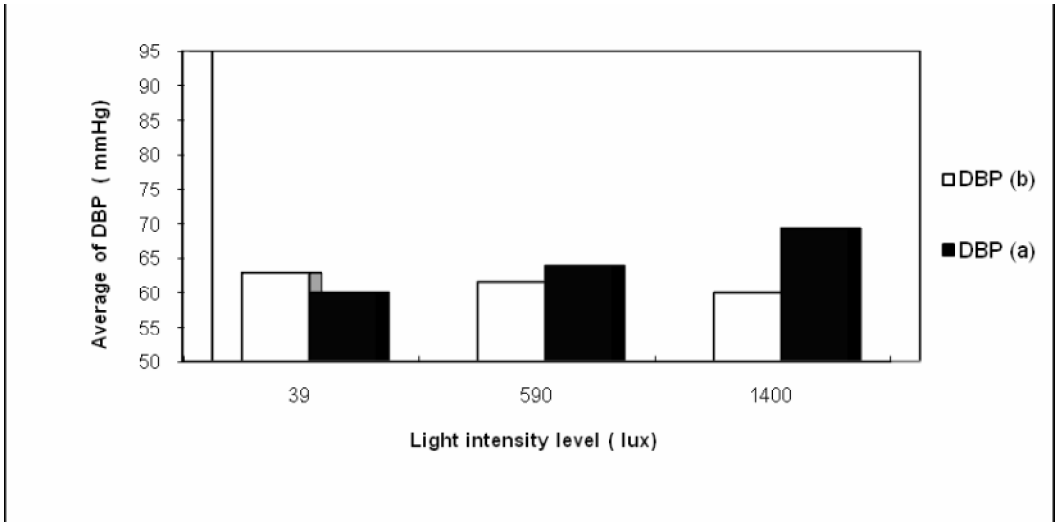

Fig (3.3.5): The relation between average values of dystolic blood pressure (DBP) versus the light intensity levels in Fatima Khatoun School. (b: before, a: after)

Figure (3.3.5) shows that as the light intensity decreases the average diastolic blood pressure after decrease, and when the light intensity increase the diastolic blood pressure increases.

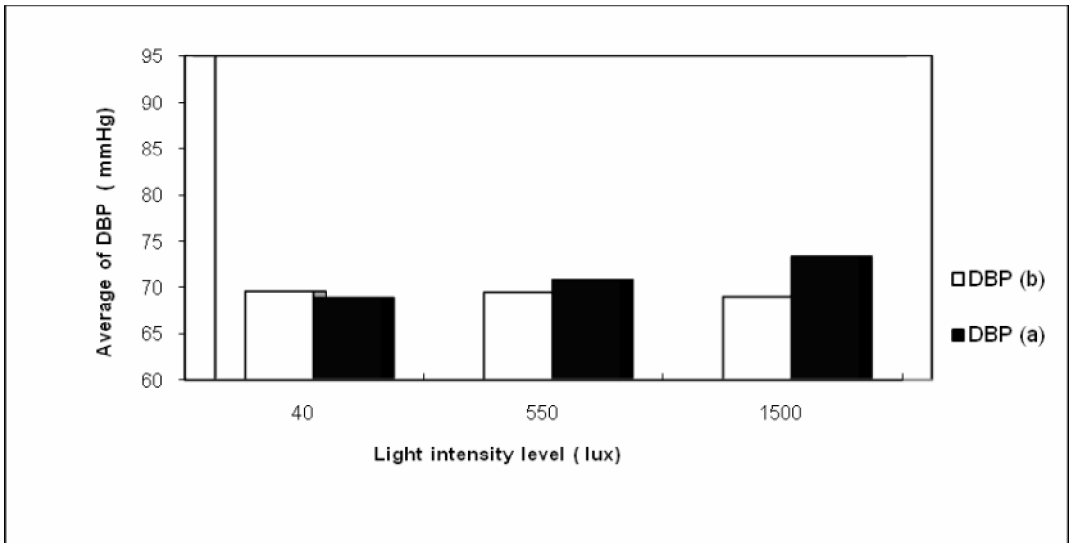

Fig (3.3.6): The relation between average values of diastolic blood pressure (DBP) versus the light intensity levels in Yousif Al-Athmeh School. (b: before, a: after)

Figure (3.3.6) shows that there is an increase in the diastolic blood pressure when the light intensity has been changed from normal (550) lux to high intensity due to the increase of light intensity and the period of exposure.

3.4 Measurements of Heart Pulse Rate (HPR) in the Selected Schools.

Heart pulse rate was measured to all children before and after exposure to different light intensity levels and shown down in table (3.4.1).

Table (3.4.1): Average values of HPR before and after exposure to different light intensity levels in the selected schools over three days period.

School		light intensity levels (lux)	Average HPR before exposure (beat/min)	Max	Min	S. d	Average HPR after exposure (beat/min)	Max	Min	S. d
Islamic School	1st day	55 (low)	88.5	120	67	12.5	86.6	115	69	10.9
	2nd day	500 (normal)	88.4	106	71	9.1	90.2	109	72	9.5
	3rd day	1320 (high)	89.6	120	70	10.1	92.9	123	73	9.8
Fatima Khatoun School	1st day	39 (low)	87.7	125	59	11.8	85.7	119	60	11.9
	2nd day	590 (normal)	84.6	103	66	8.5	87.0	103	70	7.5
	3rd day	1400 (high)	85.8	109	70	8.9	88.3	111	72	8.9
Yousif Al-Athmeh School	1st day	40 (low)	91.2	120	70	9.5	90.2	120	56	9.5
	2nd day	550 (normal)	88.7	120	70	10.0	91.2	120	56	10.1
	3rd day	1500 (high)	90.3	120	61	9.7	91.7	116	75	9.8

The table (3.4.1) shows that for all schools the average heart pulse rate values decrease as the light intensity level is changed from normal to low intensity levels (55, 39 and 40) lux. In addition, when light intensity levels changed from the normal to high intensity levels (1320, 1400 and 1500) lux, the average heart pulse rate increases.

The relation between the light intensity level and average values of the (HPR) for examined children are plotted for each school in the following figures: (3.4.1→3.4.3).

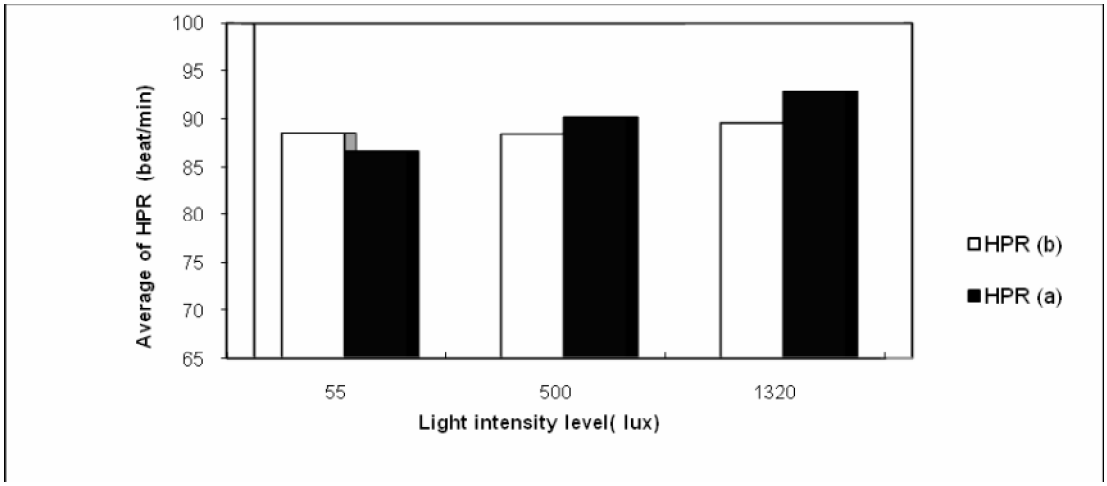

Fig (3.4.1): The relationship between average values of heart pulse rate (HPR) versus the light intensity levels in Islamic School. (b: before, a: after)

Figure (3.4.1) shows that when the light intensity has been changed from normal (500) lux to low intensity (55) lux the heart pulse rate (after) decreases, and when the light intensity has been changed from normal (500) lux to high intensity (1320) lux the heart pulse rate (after) increases.

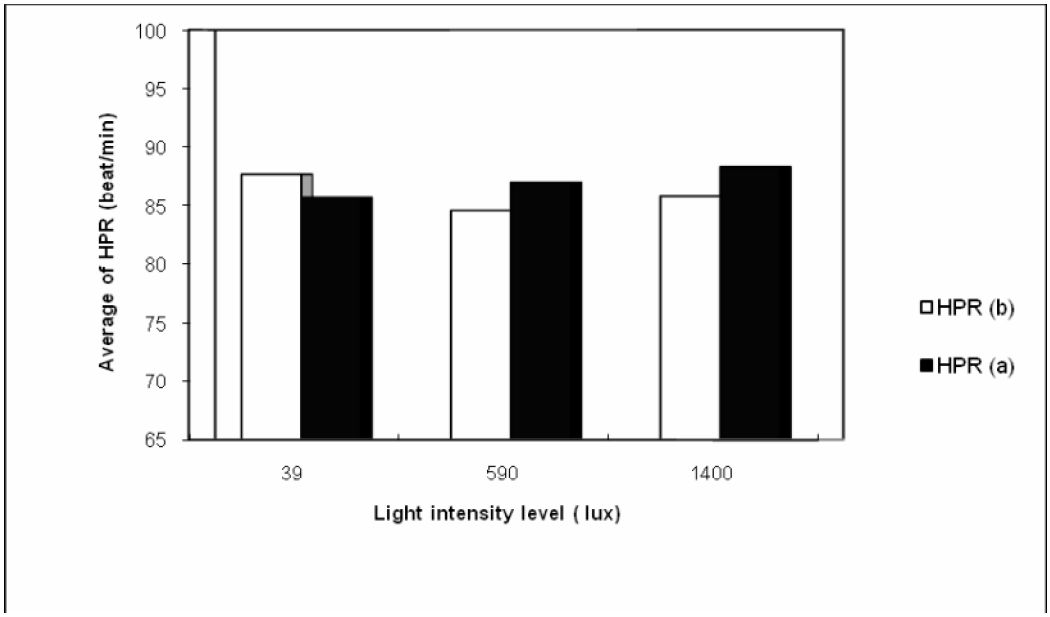

Fig (3.4.2): The relationship between average values of heart pulse rate (HPR) versus the light intensity levels in Fatima Khatoun School). (b: before, a: after)

Figure (3.4.2) shows that the heart pulse rate decrease at low light intensity level (39) lux, and increase at high light intensity levels (1400) lux.

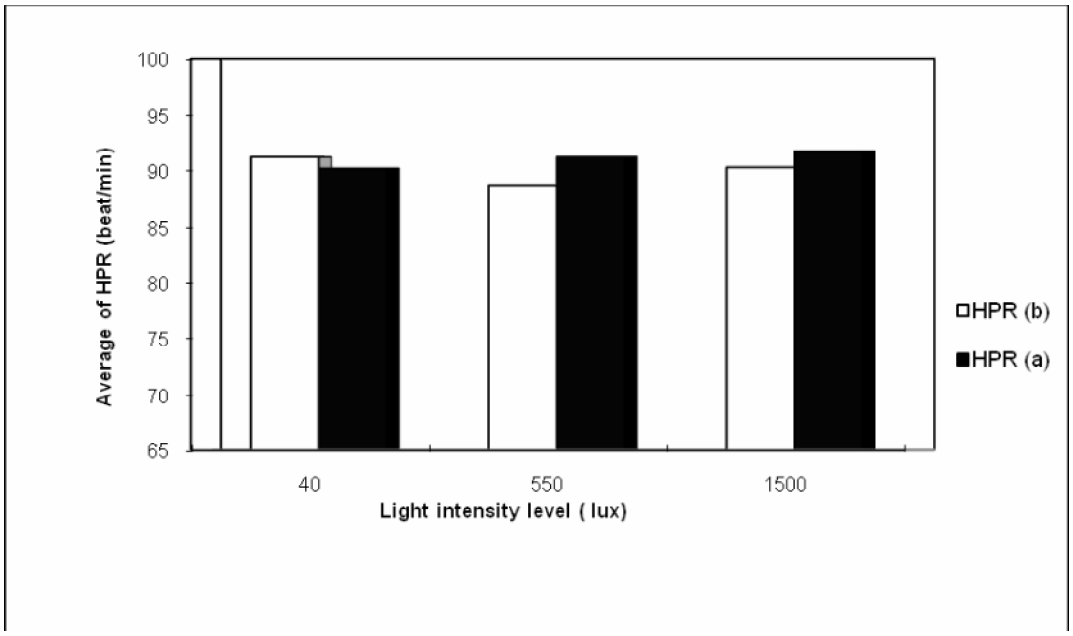

Fig (3.4.3): The relationship between average values of heart pulse rate (HPR) versus the light intensity levels in Yousif Al-Athmeh School. (b: before, a: after).

Figure (3.4.3) shows that when the light intensity has been changed from normal (550) lux to high intensity (1500) lux the heart pulse rate (after) increases, and when the light intensity has been changed from normal (550) lux to low intensity (40) lux the heart pulse rate (after) decreases.

3.5 Measurements of Blood Oxygen Saturation.

Blood oxygen saturation was measured for the examined children of the three selected schools before and after exposure. The data are given in table (3.5.1).

Table (3.5.1): Average values of SpO_2% before and after exposure to light intensity levels in the selected schools.

School name		Light intensity levels (lux)	Average SpO_2% before exposure	Max	Min	S. d	Average SpO_2% after exposure	Max	Min	S. d
Islamic School	1st day	55 (low)	98.0	99	96	0.9	97.4	99	96	0.9
	2nd day	500 (normal)	98.0	99	96	0.9	97.0	99	95	0.9
	3rd day	1320 (high)	97.7	99	95	1.0	96.9	99	95	1.1
Fatima Khatoun School	1st day	39 (low)	98.4	99	97	0.6	97.4	98	96	0.6
	2nd day	590 (normal)	97.9	99	97	0.8	96.6	98	94	0.7
	3rd day	1400 (high)	98.3	99	97	0.7	97.3	98	96	0.7
Yousif Al-Athmeh School	1st day	40 (low)	97.5	99	90	1.3	96.8	99	84	3.4
	2nd day	550 (normal)	97.8	99	96	0.9	96.7	99	92	1.3
	3rd day	1500 (high)	97.8	99	96	1.0	97.1	99	90	1.6

Table (3.5.1) shows that blood oxygen saturation of the children decreases with any light intensity changes whether increases or decreases.

The relationship between the light intensity level and average values of the SpO_2% for examined children are plotted for each school in the following figures: (3.5.1→3.5.3).

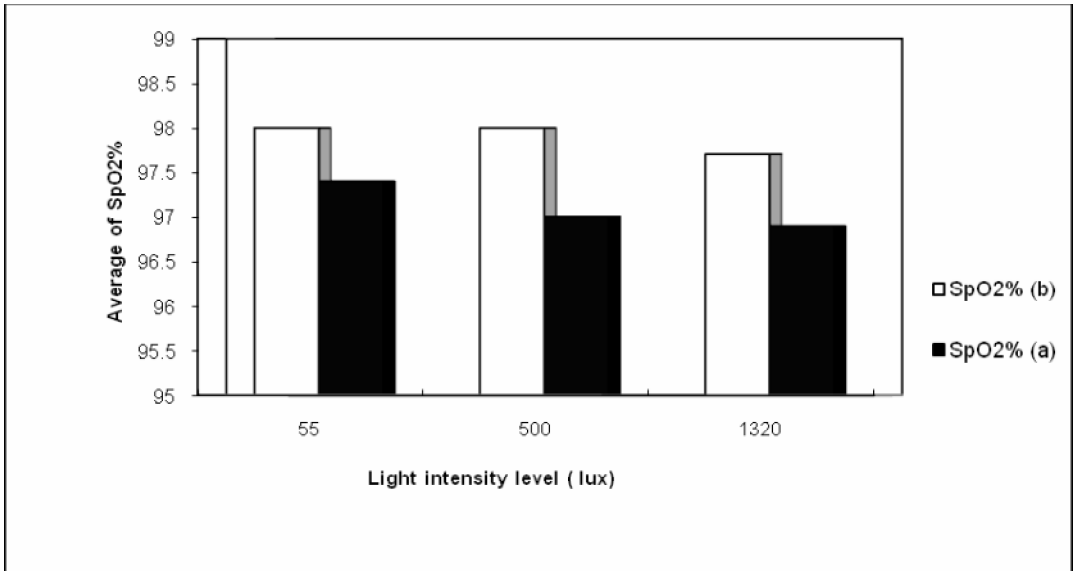

Fig (3.5.1): The relationship between average values of blood oxygen saturation (SpO2%) versus the light intensity levels in Islamic School. (b : before, a: after)

Figure (3.5.1) shows that in Islamic school as light intensity increases from normal (500 lux) or decreases from normal (500 lux) average of SpO_2% (after) decreases.

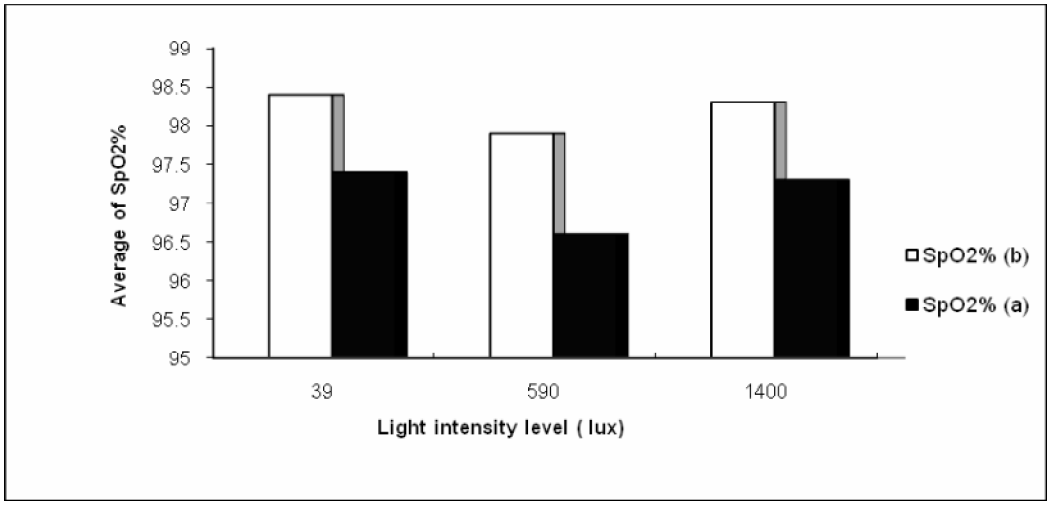

Fig (3.5.2): The relationship between average values of blood oxygen saturation (SpO2%) versus the light intensity levels in Fatima Khatoun School. (b: before, a: after)

Figure (3.5.2) shows that the average of SpO_2% of the children in Fatimah Khatoun School decrease when the light intensity level is increased.

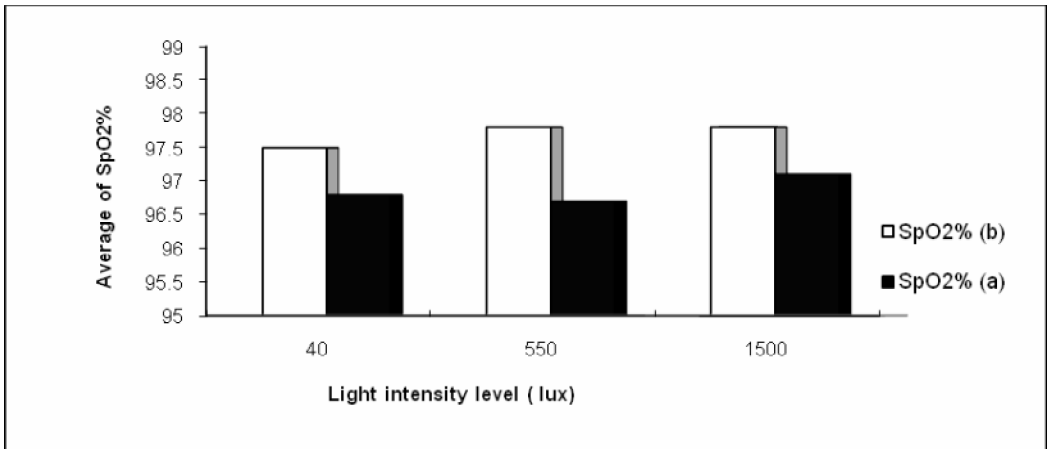

Fig (3.5.3): The relationship between average values of blood oxygen saturation (SpO2%) versus the light intensity levels in Yousif Al-Athmeh School. (b: before, a: after).

Figure (3.5.3) shows that in Yousif Al-Athmeh School as light intensity increases or decreases from normal (550 lux) average of SpO_2% (after) decreases.

3.6 Measurements of Tympanic Temperature (T).

Tympanic temperature was measured before and after exposure for each child and listed in table (3.6.1).

Table (3.6.1): Average values of T before and after exposure to light intensity levels in the selected schools.

School		Light intensity levels (lux)	Average T before (°C)	Max	Min	S. d	Average T after (°C)	Max	Min	S. d
Islamic School	1st day	55 (low)	36.31	37.5	35	0.6	36.22	37.2	35.1	0.4
	2nd day	500 (normal)	36.32	37.1	35.1	0.4	36.33	37.2	35.3	0.4
	3rd day	1320 (high)	36.23	37	35.1	0.4	36.42	37.2	35.5	0.3
Fatima Khatoun School	1st day	39 (low)	36.35	37.5	35	0.6	36.24	37.2	35.1	0.5
	2nd day	590 (normal)	36.30	37.5	35.8	0.3	36.40	37.2	35.5	0.3
	3rd day	1400 (high)	36.34	37	35.8	0.3	36.44	37.5	35.9	0.3
Yousif Al-Athmeh School	1st day	40 (low)	36.31	37.1	35.2	0.4	36.18	37.1	35.2	0.4
	2nd day	550 (normal)	36.25	37	35.4	0.3	36.34	37.1	35.5	0.3
	3rd day	1500 (high)	36.25	37.1	35.3	0.4	36.40	37.2	35.4	0.4

Table (3.6.1) shows that for all schools the average tympanic temperature values decrease as the light intensity level is changed from normal to low intensity levels (55, 39 and 40) lux. Also, the average tympanic temperature increases as light intensity levels is changed from the normal to high intensity levels (1320, 1400 and 1500) lux.

The relationship between the light intensity level and average values of the tympanic temperature for examined children are plotted for each school in the following figures: (3.6.1→3.6.3).

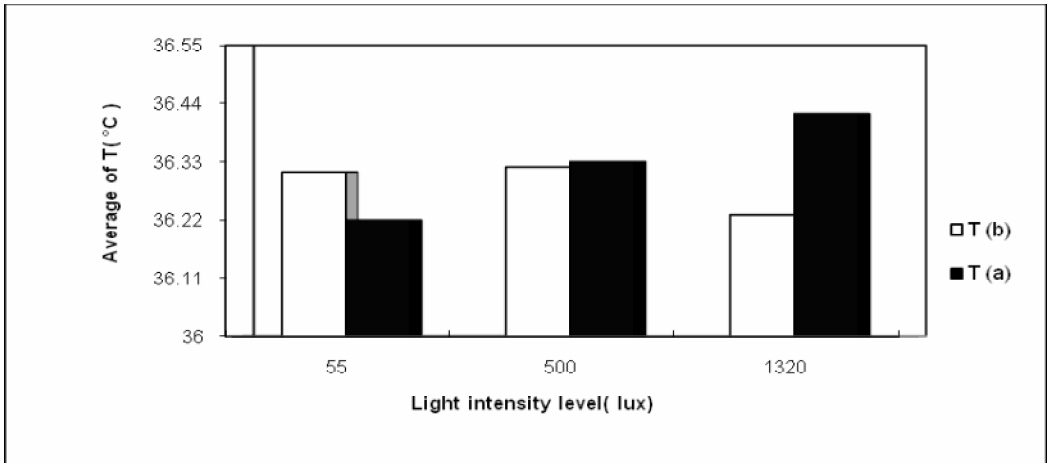

Fig (3.6.1): The relationship between average values of tympanic temperature (T) versus the light intensity levels in Islamic School. (b : before, a: after)

Figure (3.6.1) shows that when the light intensity has been changed from normal (500) lux to low intensity (55) lux the tympanic temperature (after) decreases, and when the light intensity has been changed from normal (500) lux to high intensity (1320) lux the tympanic temperature (after) increases.

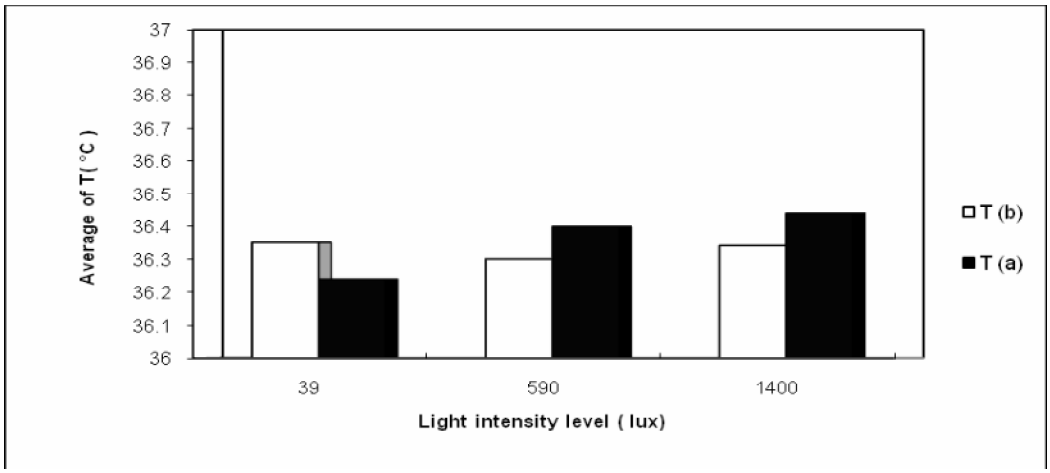

Fig (3.6.2): The relationship between average values of tympanic temperature (T) versus the light intensity levels in Fatima Khatoun School. (b: before, a: after)

Figure (3.6.2) shows that the tympanic temperatures decrease at low light intensity level (39) lux, and increase at high intensity level (1400) lux.

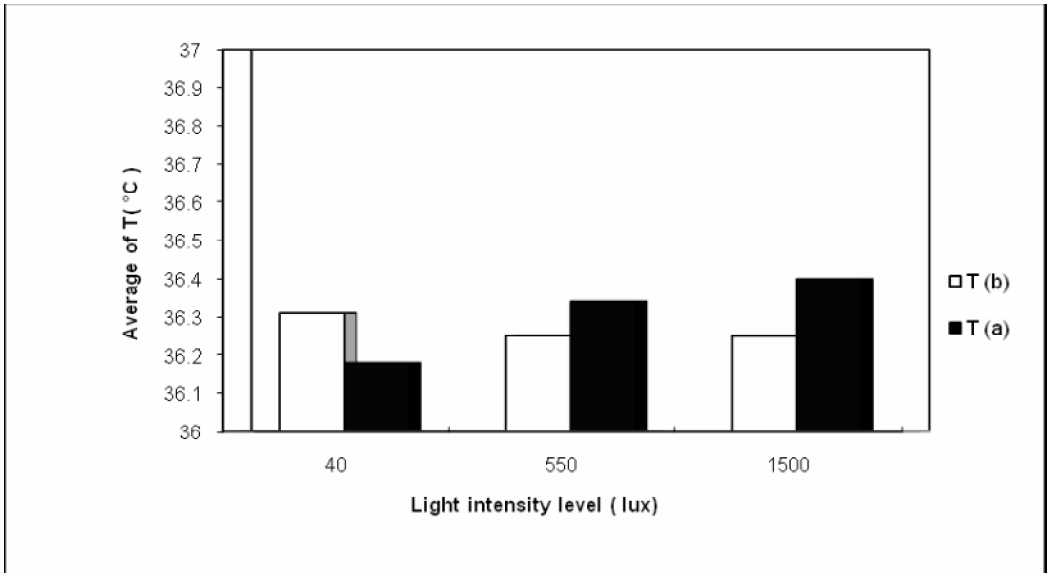

Fig (3.6.3): The relationship between average values of tympanic temperature (T) versus the light intensity levels in Yousif Al-Athmeh School. (b: before, a: after)

Figure (3.6.3) shows that when the light intensity has been changed from normal (550) lux to low intensity (40) lux the tympanic temperature (after) decreases, and when the light intensity has been changed from normal (550) lux to high intensity (1500) lux the tympanic temperature (after) increases.

Chapter Four

Data Analysis and Discussion

Chapter Four
Data Analysis and Discussion

4.1 Data Analysis

In this study, this program was used to analyze the data and tabulate them as shown in tables (4.1.1), (4.1.2), (4.1.3) and (4.1.4).

Table (4.1.1): Pearson correlation and sig p-values for systolic and diastolic in all selected schools.

The name of the school	Light intensity levels	Dependent variable	Pearson Correlation (R)	Sig P-value
Islamic	55	SBP	0.675	0.000
		DBP	0.369	0.001
	500	SBP	0.785	0.000
		DBP	0.393	0.000
	1320	SBP	0.207	0.065
		DBP	0.481	0.000
Fatima Khatoun	39	SBP	0.715	0.000
		DBP	0.393	0.000
	590	SBP	0.720	0.000
		DBP	0.642	0.000
	1400	SBP	0.852	0.000
		DBP	0.473	0.000
Yousif Al-Athmeh	40	SBP	0.586	0.000
		DBP	0.400	0.000
	550	SBP	0.888	0.000
		DBP	0.976	0.000
	1500	SBP	0.719	0.000
		DBP	0.730	0.000

Table (4.1.1) shows that there is positive Correlation (R) between the independent variable (light intensity level) and the dependent variables (SBP, DBP). This relation between the dependent and independent variables is significant except for the systolic blood pressure value seen in Islamic school the third day.

Table (4.1.2): Pearson correlation and sig p-values for heart rate pulse in all selected schools.

The name of the school	Light intensity levels	Dependent variable	Pearson Correlation (R)	Sig P-value
Islamic	55	HPR	0.892	0.000
	500	HPR	0.937	0.000
	1320	HPR	0.961	0.000
Fatima Khatoun	39	HPR	0.916	0.000
	590	HPR	0.912	0.000
	1400	HPR	0.961	0.000
Yousif Al-Athmeh	40	HPR	0.279	0.012
	550	HPR	0.091	0.424
	1500	HPR	0.102	0.370

From table (4.1.2) it is noticed that there is a strong correlation between the light intensity and HPR as the Pearson Correlation Coefficient (R) is > 0.892 in both schools and this relation is significant as P-value for HPR is 0. In Yousif Al-Athmeh there is weak positive correlation as the Pearson Correlation Coefficient (R) for HPR is < 0.279.

Table (4.1.3): Pearson correlation and sig p-values for blood oxygen saturation in all selected schools.

The name of the school	Light intensity levels	Dependent variable	Pearson Correlation (R)	Sig P-value
Islamic	55	SpO_2	0.687	0.000
	500	SpO_2	0.753	0.000
	1320	SpO_2	0.839	0.000
Fatima Khatoun	39	SpO_2	0.968	0.000
	590	SpO_2	0.815	0.000
	1400	SpO_2	1	0.000
Yousif Al-Athmeh	40	SpO_2	0.157	0.165
	550	SpO_2	0.745	0.000
	1500	SpO_2	0.327	0.003

The table (4.1.3) shows that there is a strong positive correlation as the Pearson Correlation Coefficient (R) for oxygen saturation is > 0.687. In addition this correlation is significant since the P-value equal 0.000.

But in Yousif Al-Athmeh school there is weak correlation since the Pearson Correlation Coefficient (R) for oxygen saturation is 0.157. This correlation is not significant for the first day (P-value = 0.165) but significant for the third day (P-value= 0.003).

Table (4.1.4): Person correlation and sig p-values for tympanic temperature (T) in all selected schools.

The name of the school	Light intensity levels	Dependent variable	Person Correlation (R)	Sig P-value
Islamic	55	T	0.729	0.000
	500	T	0.287	0.010
	1320	T	0.318	0.004
Fatima Khatoun	39	T	0.686	0.000
	590	T	0.925	0.000
	1400	T	0.926	0.000
Yousif Al-Athmeh	40	T	0.971	0.000
	550	T	0.974	0.000
	1500	T	0.953	0.000

Table (4.1.4) shows that there is a significant strong positive correlation since The Person Correlation (R) for T is > 0.686, and P-value = 0.000. In addition there are some points are in a good positive correlation where R (0.287 and 0.318).

4.2 Discussion

Our study cases were carried out in three schools in Jenin City– Palestine. The arterial blood pressure (systolic and diastolic), heart pulse

rate, blood oxygen saturation and tympanic temperature of the children before and after being exposed to light intensity levels were measured. The children were exposed to different light intensity levels.

A hypothesis by some researchers was set from the beginning that there is an effect of light intensity levels on arterial blood pressure (systolic and diastolic) and tympanic temperature. An experiment was done on 116 healthy volunteers aged 18-30 years who were exposed to room light or dim light in the eight hours preceding bedtime to find the effect of light intensity on body temperature and blood pressure. Measurements were done in five consecutive days. Their results showed that exposure to room light before bedtime shortened melatonin duration by about 90 minutes when compared to dim light exposure. Furthermore, exposure to room light during the usual hours of sleep suppressed melatonin by greater than 50 percent. This could, in turn, have effects on sleeping quality and the body's ability to regulate body temperature, blood pressure (Joshua G., 2011).

Also, a study was carried on nurses working in a Newborn Intensive Care Unit (NICU). Nurses who served as their own controls where exposed to bright light for periods (fifteen minutes) at the start, middle, and end of their shifts. The results showed that tympanic temperatures were consistently higher when nurses were exposed to bright light during their shifts (Figueiro *et al*., 2001). Our study results showed an increase on arterial blood pressure (systolic and diastolic) and tympanic temperature for children after four hour of exposure to high light intensity levels. In

addition, the arterial blood pressure (systolic and diastolic) and tympanic temperature decrease after four hours of exposure to low light intensity levels (see table (3.3.1.1), (3.3.2.1), (3.6.1)). These results agree with the work of (Joshua G., 2011). This increment on arterial blood pressure and tympanic temperature is due to decreasing of melatonin hormone because of an increment in light intensity levels.

In china, a study was performed and found that Light intensity had a significant statistical relationship ($p = 0.00$) with the premature infants' physiological parameters. The study showed that the heart rate and respiration rate increased, where the blood oxygen saturation decreased as the intensity of light went up. (Peng *et al*., 2001). In our study, the blood oxygen saturation decreased after the exposure to low and high light intensity levels (see table (3.5.1)). This result is in good agreement with Peng *et al* study. The decrement of blood oxygen saturation is due to decrease of melatonin hormone.

In addition, the heart pulse rate increases after exposure to various light intensity levels (see table (3.4.1)), this increment is due to the four hours exposure to light intensity levels. The obtained results from measurements and statistical analysis provide a strong conviction for the assumed hypotheses for children in their schools.

Our results of tympanic temperature, systolic and diastolic arterial blood pressures and heart pulse rate showed consistently increase as light

intensity increase. The blood oxygen saturation decreases as the intensity of light increase or decrease.

All the parameters which have been measured were not exceeding the pathologic levels.

4.3 Conclusion and Recommendation

Our study had shown that there is no significant difference between female and male, may be because our population are children (5-6 years) old.

The normal average values of the light intensity inside classrooms to all selected school are accepted according to JIS.

As a conclusion, exposures to light intensity levels have affected arterial blood pressure (systolic and diastolic), heart pulse rate, oxygen saturation in blood and tympanic temperature.

Further works are suggested to study the effect of high level of light intensity on the studied parameters (arterial blood pressure, heart pulse rate, oxygen saturation in blood and tympanic temperature).

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Appendix A

Light intensity level: 1320 lux										Islamic School																	
After							Before																				
T (a) (℃)	SpO2% (a)	HPR (a) (beat/min)	)(DBP(a) mmHg	SBP(a) (mmHg)	T (b) (℃)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	T (a) (℃)	SpO2% (a)	HPR (a) (beat/min)	DBP(a)(mmHg)	SBP(a) (mmHg)	T (b) (℃)	SpO2% (b)	HPR (b) (beat/min)	)(DBP(b) mmHg	SBP(b) (mmHg)	T (a) (℃)	SpO2% (a)	HPR (a) (beat/min)	)(DBP(a) mmHg	SBP(a) (mmHg)	T (b) (℃)	SpO2% (b)	HPR (b) (beat/min)	DPB (b) (mmHg)	SBP(b) (mmHg)	SEX
36.6	97	107	82	119	36.5	98	99	70	115	36.5	98	88	76	127	36.4	99	85	74	120	36.2	98	100	75	117	36	99	119	76	115	F
36.2	98	90	77	127	36.1	99	86	60	105	36.3	97	78	80	115	36.1	97	76	75	110	36.5	96	78	63	122	36.7	97	85	82	125	F
36.6	96	95	65	104	36.5	95	93	65	100	35.8	96	93	82	99	36.5	98	95	70	102	36	98	98	62	125	36.2	99	91	60	103	F
36.2	97	104	67	110	36	98	100	63	107	36.2	96	96	60	109	36.6	97	93	60	100	36.5	97	85	65	102	37	97	79	64	109	M
36.5	98	106	77	124	36.4	99	98	65	112	36.9	98	106	64	121	36.9	99	102	75	118	35.9	97	105	67	108	36.1	99	109	80	120	M
36.6	96	105	65	113	36.5	96	100	65	110	36.6	99	80	67	95	36.8	99	84	68	101	36	99	72	69	102	35.9	98	77	67	106	F
36.1	97	123	80	119	35.9	98	120	76	120	36	97	77	76	115	36.8	96	72	73	105	36	97	75	78	117	36.2	98	69	76	119	F
36.2	96	93	70	123	36	97	90	58	99	36.2	95	103	80	117	36.6	96	98	66	111	36.2	99	95	60	118	36.4	99	104	79	123	M
36.2	96	104	81	126	36.5	96	98	64	108	36.7	97	104	82	125	36	98	96	78	117	36	98	73	66	120	36.2	99	80	81	126	F
36.9	98	94	65	111	36.1	99	97	63	112	36	98	105	60	110	36.8	99	100	60	99	36.4	98	69	60	103	36.8	98	74	64	111	F
36.8	95	92	65	113	35.6	96	90	65	115	35.8	99	89	64	110	36.6	99	87	60	100	36.8	97	90	69	108	37.1	97	99	67	113	M
36.9	95	99	82	117	37	96	96	78	123	37	98	92	77	130	36.8	99	90	80	125	36.4	98	105	80	115	37	99	120	75	117	M
36.7	96	92	72	124	35.6	97	89	57	98	35.8	98	84	80	103	36.5	99	86	75	110	36.2	97	79	62	117	36.7	98	81	79	124	M
36.5	98	103	80	127	36	99	99	61	103	36.2	96	107	82	121	36.4	98	103	78	115	36.4	96	80	62	125	36.4	98	85	81	127	M
36.8	97	104	69	105	36.7	98	100	63	103	36.8	97	99	58	113	36.7	98	95	64	107	36	99	90	65	99	37	98	94	60	105	F
36.5	95	103	66	111	36.4	96	99	60	110	36.9	98	77	61	110	36.2	99	72	62	103	36.2	98	72	62	103	36.4	98	76	64	111	F
36.2	96	95	65	114	36	96	90	65	112	36.2	97	89	63	109	36.8	99	94	70	118	36.2	96	98	67	106	36	97	104	66	114	F
36.2	98	102	81	118	36.1	97	100	75	120	36.2	99	95	77	123	36.9	99	92	74	115	35.8	96	85	78	114	36	97	90	76	118	M
36.6	95	96	78	123	36.5	96	99	76	112	36.8	97	91	80	120	36.9	98	89	77	117	35.8	97	86	66	118	36.7	98	88	80	123	M
37	99	79	75	125	36.9	98	75	70	106	37	97	83	83	110	36.9	98	84	78	115	36	96	79	72	120	36.7	97	81	82	125	M
36.6	95	101	60	103	36.5	96	99	60	100	36.6	97	96	60	105	36.9	97	94	57	99	36.5	97	95	62	99	36.7	96	100	59	103	M
35.9	96	86	70	109	35.8	97	80	63	112	35.8	96	109	63	122	36.8	97	102	65	116	36.1	96	92	64	103	36.5	97	95	63	109	F
36.6	95	89	69	112	36.5	96	84	63	100	37.2	96	98	65	111	36.7	98	96	65	104	35.6	98	85	65	106	36.9	99	87	66	112	F
36.8	97	85	72	135	36.9	98	80	55	92	37	98	89	86	125	36.6	99	86	67	120	36.8	99	70	60	115	36	99	74	78	120	F
36.6	98	93	68	130	35.1	98	90	62	101	35.4	97	72	80	107	36.5	98	75	70	111	37	98	95	64	120	37.4	99	101	81	125	F
36.4	97	80	82	124	35.2	98	78	70	111	35.4	96	106	82	123	36.4	97	104	78	117	35.6	98	73	71	110	36	99	70	84	116	F
37.2	96	93	65	117	36	97	88	60	115	36.1	98	86	60	115	37	99	84	63	112	36	97	90	62	102	36.5	98	95	61	117	F
36.6	96	96	69	123	36.4	97	93	55	94	36.6	96	99	64	127	36.4	96	95	62	120	36.7	98	79	58	112	37	96	85	64	115	F
36.4	97	87	73	116	37	98	86	65	120	37	98	80	67	111	36	99	72	65	105	36.8	96	77	66	105	37	97	82	66	107	F
36.8	98	83	74	124	36.7	99	79	60	96	36.7	97	84	76	122	36.6	98	80	70	119	36	96	100	63	117	36.4	96	104	77	116	F
36.2	99	93	69	129	36.2	99	91	60	100	36.4	98	101	80	119	35.9	99	98	65	114	37	98	82	60	115	37.4	99	86	80	119	F
37	97	83	75	131	36.5	98	80	70	115	36.6	97	94	82	115	36.9	99	96	77	120	36.1	98	70	72	117	36.5	99	72	82	120	M
36	96	90	63	107	36	97	87	80	105	36.2	99	95	60	106	35.9	99	93	60	100	36.7	96	78	82	103	36	97	80	59	107	M
36.2	96	95	65	111	36.5	97	92	62	107	36.6	96	100	64	102	36.1	99	102	64	100	36.9	97	105	65	108	36.8	97	109	63	111	M
37	98	96	76	114	35.9	99	90	66	111	36	97	95	67	130	37	98	90	70	120	36.1	99	72	69	112	37	98	75	65	114	M
36	98	93	65	117	36	99	89	75	115	36.1	98	84	65	100	35.8	99	86	68	104	36.5	98	98	79	105	36.8	99	100	76	110	F
36.5	96	90	74	123	36	97	85	75	120	36	97	89	80	108	36.4	99	85	65	99	36	98	93	80	110	36.1	99	94	80	115	M
36.3	98	88	65	126	36.2	99	91	80	123	36.4	97	102	85	111	36	98	106	79	120	36	97	80	75	120	36.1	98	83	82	126	F
36	97	76	64	102	36.4	98	74	60	106	36.5	96	92	60	117	35.9	97	88	60	110	36.9	96	103	62	100	36.6	96	106	59	102	F
36	95	83	70	108	36.8	96	82	62	103	36.9	97	99	53	121	35.9	98	94	66	115	35.1	98	85	63	99	35	97	87	63	108	F
35.6	98	74	68	111	36.4	99	70	67	115	36.5	96	88	59	103	35.6	97	87	65	98	36.1	98	101	70	112	36.2	98	99	65	111	F
36.2	97	95	78	116	36.2	98	89	73	110	36.4	96	94	81	107	36	97	93	75	102	36	99	95	75	120	36.1	99	93	76	116	F
36.5	98	86	80	120	36.4	99	82	77	115	36.5	96	103	78	110	35.6	97	100	77	104	36.4	96	88	80	119	36.5	96	90	80	120	F
36.1	96	101	82	123	36	97	97	83	120	36.1	97	84	64	123	35.9	96	80	80	118	37	98	99	85	115	37	99	102	82	123	F
36.2	97	92	58	102	36.2	98	84	63	110	36.4	97	80	65	102	36	98	84	60	107	36.7	98	103	65	103	37	99	99	59	102	M
36.4	95	83	65	89	36.2	96	79	62	101	36	98	99	61	107	36.2	99	96	63	99	35.5	97	75	64	95	36	98	68	52	89	M
37.1	97	80	72	109	35.8	98	75	65	104	36	97	94	75	119	37	99	90	67	110	35.9	97	90	68	107	35.4	98	88	70	109	M
36.9	98	93	75	123	36	99	85	55	96	36.1	98	88	71	109	36.8	99	86	65	100	36	96	76	57	110	36.2	97	80	84	115	F
36.8	97	86	65	100	36.5	98	76	59	95	35.8	98	79	75	103	36.7	99	81	68	112	35.6	99	73	60	103	35.2	98	71	60	100	F
36.7	98	99	68	107	36.1	99	95	63	109	36.2	97	90	55	117	36.5	98	88	65	113	36	98	70	65	98	36.1	99	74	63	102	F
36	96	96	73	109	35.6	97	93	65	112	35.8	97	78	60	110	35.9	98	75	70	105	36.1	99	89	67	101	36.2	99	92	66	106	M
37	95	79	80	117	36.8	96	81	77	120	36.9	96	95	64	117	37.1	97	93	78	115	35.2	99	80	75	108	35.9	99	84	76	110	M
36	98	73	81	122	37	99	71	78	119	37.1	97	92	76	125	35.8	97	87	75	118	36.1	97	78	80	102	36.4	99	75	80	104	F
36.9	97	84	78	125	35.6	98	88	78	119	36.7	97	90	78	117	36.6	96	92	80	120	37	97	98	77	101	37.5	98	101	82	103	M
35.6	98	98	64	100	36	99	94	60	98	36	97	83	60	114	35.4	98	76	60	103	35.6	98	78	62	99	35	98	80	58	100	M
36.4	99	100	60	105	36.3	99	99	57	100	36.3	96	86	59	117	36.2	97	83	58	108	36	96	89	60	99	35.6	97	92	61	99	M
36.9	97	104	59	108	36.8	98	102	62	110	36.9	97	80	64	98	36.8	98	87	60	100	35.4	97	75	64	100	35.1	98	71	63	105	M
36.1	96	87	80	115	36	97	84	80	120	36	96	104	60	121	35.9	97	106	78	118	36.8	98	89	83	100	36.7	99	100	77	115	M
36.9	97	98	72	119	36.8	98	95	75	115	37.1	98	88	63	114	37.1	99	85	70	110	35.9	98	79	79	109	35.4	99	85	80	110	F
36.2	98	93	64	121	36.1	98	90	61	103	36.2	98	86	78	119	36.2	99	82	60	113	36.1	97	95	63	110	36	98	99	82	115	M
36.5	99	75	60	100	36.7	99	70	60	95	36.4	97	93	74	105	36.4	99	95	63	107	35.6	97	89	62	102	35.3	98	84	60	100	M
36.5	98	90	60	104	36.4	99	86	60	106	36.3	98	95	63	95	36.2	99	101	70	100	36.2	97	90	65	99	36.1	97	86	63	101	M
36.2	97	74	67	107	36.1	99	70	63	95	36.4	98	83	66	110	36.7	99	80	65	106	36	96	98	66	100	35.9	97	95	66	102	M
36.1	96	86	82	112	36	99	84	82	100	36	97	103	60	121	35.8	98	98	79	115	36.7	96	70	83	99	36.5	97	74	80	100	M
36.2	97	103	64	76	35.5	98	107	60	107	35.6	96	76	67	102	36	98	72	60	95	37.1	97	95	60	109	37.5	98	80	53	70	M
36.1	96	98	80	126	37	97	96	60	101	36	97	91	62	117	35.9	98	88	75	110	36.7	97	87	62	110	36.4	98	83	86	112	F
36.9	97	99	75	144	36.9	98	102	70	112	36.8	96	74	70	110	36.8	97	79	77	114	36	97	85	66	111	35.8	98	97	84	120	F
36.2	97	93	74	115	36	98	87	71	110	35.3	96	89	63	106	35.4	97	85	70	100	35.9	98	115	75	109	35.2	99	120	71	110	M
35.5	98	98	70	95	35.2	99	96	61	100	35.4	95	80	58	103	35.1	96	81	65	99	36	98	105	62	90	36.4	99	103	56	95	M
35.6	96	84	59	114	36	97	79	57	110	36.2	98	72	59	115	35.2	99	74	60	120	36.7	98	92	60	112	37	99	93	55	102	M
36.5	97	101	66	106	36.4	98	98	61	100	36.5	97	88	58	120	36.5	98	84	65	113	36.8	98	80	63	100	36.2	99	82	63	100	F
36.9	96	105	75	111	37	97	100	73	115	37.1	97	101	74	118	36.8	98	95	70	107	35.9	98	90	75	99	35.4	98	95	75	107	F
36	98	123	82	125	35.9	99	120	72	112	36.8	97	75	75	120	36.4	98	71	80	115	36.1	97	76	76	112	36.2	98	80	85	120	M
36.7	96	96	65	95	36.5	96	90	62	99	36.6	98	78	82	101	35.4	99	80	65	100	37.2	98	85	65	107	37	98	75	57	95	M
36.2	98	103	79	124	36.1	97	98	63	103	36.2	98	104	57	120	36.5	99	98	75	112	35.9	98	75	68	95	35.6	99	82	85	115	F
35.7	99	85	68	101	35.6	98	86	63	107	35.9	98	75	82	107	35.8	99	77	70	110	36.3	96	76	60	103	36	97	71	60	99	F
36.9	97	84	65	99	36.8	98	82	73	100	36.2	96	88	82	108	36	97	86	60	102	36.7	97	83	74	88	36.8	98	67	59	89	M
36.4	98	95	80	125	36.3	99	91	63	104	36.3	97	79	57	123	36.2	97	76	77	119	36	98	99	65	95	35.6	99	102	86	112	F
36.7	98	82	72	110	35.6	99	72	78	115	36.2	96	86	76	109	36.1	97	83	70	100	36.9	98	105	80	100	37	99	99	76	104	M
36	98	95	78	121	36	98	90	56	95	36	97	103	58	115	35.8	99	101	74	109	35.9	98	80	58	97	35.2	99	85	83	110	F
36.421	96.95	92.95	71.1625	114.5625	36.2338	97.7375	89.6125	66.125	107.6625	36.333	97.075	90.25	69.25	113.2	36.3275	98.0375	88.425	68.9625	109.4875	36.2238	97.425	86.6375	67.925	107.3125	36.31	98.05	88.575	71.075	110.2875	

Light intensity level: 500 lux

Light intensity level: 55 lux

Appendix B

Light intensity level: 1400 lux Fatima Khatoun School

After					Before					After					Before					After					Before				
T (a) (°C)	SpO2% (a)	HPR (a) (beat/min)	)(DBP(a) mmHg	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	T (a) (°C)	SpO2% (a)	HPR (a) (beat/min)	DBP(a)(mmHg)	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	T (a) (°C)	SpO2% (a)	HPR(a) (beat/min)	DBP(a) (mmHg)	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	SEX
36.9	98	110	80	130	36.8	99	104	63	102	36	98	100	65	110	35.9	99	102	61	102	36.4	98	106	66	100	37	99	100	60	100	F
36.6	97	85	70	104	36.5	98	81	63	90	36.2	97	82	64	100	36	99	80	60	94	36.2	97	85	61	92	36.7	98	87	62	94	F
36.6	97	80	74	105	36.5	98	73	64	88	36.1	96	77	66	96	35.9	98	75	63	85	36.4	98	99	63	75	36.4	99	102	64	78	F
36.3	97	85	60	100	36.2	98	80	48	81	36.1	96	98	51	88	36	97	100	48	80	36	98	101	48	80	37	99	105	50	85	F
36.9	97	104	77	107	36.8	98	102	67	93	36.3	96	73	68	98	36.2	97	70	66	90	36.2	98	100	67	91	36.4	99	96	69	95	F
37	98	83	80	117	36.9	99	80	68	100	36.4	97	87	70	104	36.3	99	83	66	95	36.2	97	86	67	99	36	98	84	67	98	F
36.5	98	90	70	103	36.4	99	88	55	85	36.7	96	84	55	90	36.5	97	80	53	83	35.8	97	65	53	83	36	98	69	53	84	F
36.6	98	95	73	108	36.5	99	93	61	93	36.8	96	80	63	100	36.6	97	75	61	95	35.8	97	85	61	95	36.7	97	77	63	98	F
36.8	98	85	69	105	36.7	99	80	59	91	36.5	96	76	64	97	36.4	97	73	60	90	36	98	70	58	85	36.7	99	82	60	91	F
36.6	98	92	78	115	36.5	99	88	61	95	36.2	98	86	72	99	36	99	77	69	91	36.5	98	70	70	90	36.7	99	83	70	92	F
36.6	97	85	70	109	36.5	98	80	63	97	36.6	97	87	68	106	36.5	98	80	64	95	36.1	98	85	64	94	36.5	99	87	65	97	F
36.5	97	88	75	110	36.4	98	85	65	95	36.4	97	96	69	104	36.2	99	90	66	95	35.6	97	98	66	95	35.9	98	80	77	106	F
36	97	95	74	99	36.8	98	90	65	85	36.5	98	78	70	96	36.4	99	71	66	87	36.8	97	106	62	80	36	98	104	65	85	F
36.7	97	88	65	98	36.6	98	84	58	85	36.3	97	70	57	87	36.2	99	66	56	80	37	98	96	57	80	37.4	99	103	57	81	F
36.5	97	95	74	103	36.4	98	92	65	90	**35.6**	97	74	69	101	36	98	68	67	93	35.6	98	100	67	90	36	99	104	68	95	F
36.9	98	85	70	108	36.8	99	83	59	90	36.9	96	90	64	98	36.7	97	103	61	89	36	98	96	58	84	36.5	99	82	61	90	F
36.7	98	86	68	100	36.8	99	85	53	83	36.2	96	90	57	87	36.1	97	86	55	80	36.7	97	70	52	80	37	98	66	53	84	F
36.8	98	90	68	109	36.9	99	88	60	93	36.8	97	81	64	100	36.5	98	80	61	90	36.8	97	60	62	93	37	98	59	63	94	F
36.5	98	108	65	136	36.4	99	107	60	119	36.3	96	80	60	132	36.2	98	77	59	115	36	97	110	60	132	36.4	98	107	60	120	F
36.6	98	83	65	100	36.5	99	80	57	84	36.2	94	90	59	92	36.1	97	87	56	83	37	97	90	57	83	37.4	98	93	58	86	F
36.7	98	80	72	105	36.6	99	77	66	91	36.2	96	95	70	103	36	97	90	66	90	36.1	98	82	65	90	36.5	99	83	67	94	F
36.6	98	93	72	109	36.8	99	90	66	90	36.5	97	96	68	100	36.4	99	93	65	87	36.7	98	102	64	86	36	99	107	66	90	F
37.2	96	90	68	103	36.9	97	88	56	84	36.6	96	96	60	97	36.4	97	94	55	85	36.9	98	99	57	87	36.8	99	106	57	86	F
36.9	97	82	70	110	36.8	98	80	58	90	37	96	90	63	104	36.9	97	86	58	89	36.1	97	95	61	95	37	98	103	60	93	F
36.8	97	72	70	102	36.5	98	75	64	88	36	96	76	49	89	35.9	97	75	103	123	36.5	98	96	64	90	36.8	99	89	63	92	F
37.1	98	93	65	104	36.9	99	90	57	87	36.7	96	83	60	99	36.5	97	80	55	88	35.5	98	99	55	90	37.1	99	104	56	91	F
37.5	97	79	67	120	37	98	88	60	105	36.5	96	94	64	103	36.4	98	90	60	95	37	98	88	49	89	37.5	99	85	106	125	F
37	96	95	74	114	36.8	97	94	62	94	36.1	98	93	64	102	36	99	91	60	90	36.9	97	81	58	88	36.6	98	86	59	90	F
37.1	96	88	75	108	37	97	85	64	95	36.3	97	90	63	100	36.2	99	87	60	92	35.1	97	100	58	87	35	98	109	58	90	F
36.6	97	75	68	112	36.4	98	72	60	96	35.9	97	85	62	101	35.8	99	88	60	95	35.2	97	102	60	95	36.2	98	100	62	98	F
36.7	98	92	67	105	36.5	99	90	60	91	36.5	96	90	65	99	36.4	98	88	62	91	36	98	91	62	93	37	99	82	65	97	F
36.8	96	95	69	106	36.6	97	100	60	90	37	97	92	64	100	36.9	98	90	58	88	36.4	98	75	57	87	36.8	99	77	58	90	F
36.5	97	90	69	111	36.2	98	87	57	94	35.5	96	88	64	108	36	98	86	60	97	37	97	98	61	69	37	98	93	63	100	F
36.4	98	80	68	107	36.2	99	85	57	90	37.1	96	88	61	100	36.9	97	88	55	84	36.7	98	80	51	80	37	98	84	55	85	F
36.7	97	90	66	105	36.6	98	88	60	89	37	98	82	75	106	36.8	99	80	65	135	35.5	98	78	65	92	36	99	84	65	94	F
36.9	97	92	67	101	36.8	98	90	56	85	36.2	96	82	59	94	36	98	83	55	82	35.9	96	75	53	80	35.4	97	77	54	82	F
36.4	97	111	66	140	36.3	98	109	67	107	36	97	96	58	101	36.1	99	94	55	93	36	98	72	75	106	36.2	99	75	66	140	F
36.2	98	78	73	112	36.1	99	73	64	94	35.9	96	90	66	104	35.8	97	95	62	95	35.6	98	85	60	91	35.2	99	89	64	99	F
36.1	98	75	60	98	36	99	77	55	85	37.2	97	86	63	101	37	99	85	58	90	36	98	71	66	100	36.1	99	75	64	95	F
35.9	98	85	70	109	35.8	99	82	61	94	37	96	103	65	104	36.8	97	100	60	91	36.1	97	76	59	90	36.2	98	80	60	92	F
36.3	98	83	67	100	36.2	99	81	58	86	37	97	90	102	130	37.5	99	88	101	122	35.2	96	88	59	85	35.9	97	90	61	88	F
36.1	98	90	73	110	36	99	85	64	94	37	98	94	66	98	36.9	99	89	63	90	36.1	97	99	65	90	36.4	98	106	65	91	F
36.6	98	81	82	126	36.4	99	79	60	100	36.5	97	100	66	104	36.4	98	93	62	93	37	97	75	49	89	37.5	98	79	105	125	F
36.3	97	72	60	100	36.2	98	70	53	86	36.8	97	96	53	90	36.6	98	92	50	83	35.6	97	99	52	83	35	98	103	54	105	F
36.1	96	90	68	112	36	97	88	60	90	37	96	75	61	96	36.9	97	70	57	85	36	96	89	55	83	35.6	97	94	58	87	F
36.1	97	75	64	107	36	98	73	56	93	36	98	88	57	99	35.9	99	81	55	93	35.4	96	80	57	94	35.1	97	85	57	95	F
36	97	83	75	103	35.9	98	80	64	87	36.6	97	83	60	90	36.5	98	80	58	82	36.8	96	85	62	87	36.7	97	90	63	90	F
36.7	96	75	67	109	36.6	97	71	61	95	36.4	97	97	66	103	36.2	98	95	60	94	35.9	97	119	61	96	35.4	98	125	63	100	F
36.3	96	85	69	97	36.2	97	83	58	82	35.9	96	89	59	100	35.8	98	86	55	90	36.1	98	77	55	90	36	99	80	56	94	F
36.1	96	105	70	110	36	97	101	59	93	36.6	96	80	80	125	36.4	97	73	85	140	35.6	98	81	58	89	35.3	99	85	59	91	F
36.1	97	80	68	109	36.2	98	75	58	91	36	98	83	64	101	35.9	99	72	60	92	36.2	98	95	60	90	36.1	99	99	60	93	F
35.9	98	93	80	125	35.8	99	88	48	87	36.4	96	78	65	103	36.2	98	80	59	94	36	98	85	56	90	35.9	99	88	57	95	F
36.1	98	74	70	112	36	99	72	64	97	36.2	97	90	63	100	36.1	98	88	61	94	36.7	97	81	80	125	36.5	98	85	90	136	F
35.9	98	83	65	109	35.8	99	80	55	90	36.3	96	93	62	98	36.2	97	90	60	92	37.1	97	75	60	91	37.5	98	78	61	94	F
36.4	98	80	64	104	36.3	99	77	57	88	36.7	96	85	63	94	36.5	97	81	58	85	36.7	97	90	58	80	36.4	98	93	60	85	F
36.1	98	85	69	100	36	99	83	60	85	36.6	97	102	65	94	36.5	98	100	60	84	36	97	93	61	84	35.8	98	95	63	85	F
36.3	98	86	68	103	36.2	99	84	60	88	36.3	96	88	64	98	36.2	97	85	59	86	35.9	98	82	56	86	35.2	99	85	60	90	F
36.2	98	93	66	107	36.1	99	90	61	93	36.4	96	75	64	99	36.2	97	73	61	90	36	98	73	58	90	36.4	99	75	60	92	F
36	98	90	70	111	35.9	99	88	62	94	36.6	96	86	65	103	36.4	97	85	62	95	36.7	98	80	63	88	37	99	85	63	90	F
36.1	98	88	71	113	36	99	87	60	94	36.1	96	90	62	97	36.2	97	88	58	90	36.8	98	87	59	90	36.2	99	89	60	93	F
36	98	85	67	108	35.9	99	82	58	90	36.1	98	75	60	100	36	99	72	55	87	35.9	98	70	55	85	35.4	99	72	57	90	F
36.3	98	90	65	110	36.2	99	88	59	94	36.3	96	87	71	112	36.2	98	85	89	140	36.1	97	93	58	87	36.2	98	95	60	90	F
36.2	98	100	70	104	36.1	99	98	62	97	36.6	96	88	60	98	36.5	98	80	59	93	37.2	97	77	59	90	37	98	80	60	94	F
35.9	97	105	67	120	35.8	98	104	58	98	36.4	97	94	62	103	36.2	98	93	60	95	35.9	97	74	64	95	35.6	98	77	64	96	F
36.3	97	90	66	101	36.2	98	88	58	85	36.5	97	88	59	92	36.4	98	84	56	84	36.3	97	72	71	112	36	98	75	90	139	F
36.1	97	85	71	113	36	98	83	60	94	36.1	97	80	60	100	36	99	77	58	88	36.7	97	85	54	88	37	98	88	55	90	F
36.4	96	88	69	116	36.3	97	85	60	100	36.2	96	90	64	102	36.1	97	89	62	96	36	98	84	58	90	35.6	99	86	60	94	F
35.9	97	107	71	112	35.8	98	105	62	95	36.2	97	90	63	103	36.3	98	88	60	91	36.9	97	70	60	89	37	98	72	60	90	F
36.2	96	105	65	105	36.1	97	100	58	90	36.7	96	86	63	98	36.5	98	85	58	89	35.9	97	87	56	58	35.2	98	90	58	88	F
36.3	96	83	73	114	36.2	97	80	61	95	36.2	98	82	63	100	36.1	99	81	60	92	36.2	98	80	61	94	36.3	99	81	62	95	F
36.2	98	82	61	103	36	99	77	56	90	36.5	98	93	56	96	36.4	99	90	55	90	36	98	72	55	88	35.9	99	75	56	91	F
36.6	98	78	68	107	36.5	99	75	58	90	36.6	96	81	82	119	36.5	97	78	88	125	36.7	97	85	57	91	36.7	98	89	60	95	F
36.6	98	92	73	110	36.4	99	88	61	92	36.3	96	81	64	101	36.2	97	80	60	89	36.1	98	72	60	91	37.2	99	75	61	92	F
36.5	98	100	67	126	36.4	99	99	75	116	35.9	96	102	61	89	35.8	97	100	58	80	37	98	95	59	82	36.7	99	99	60	84	F
36.2	98	93	69	118	36.1	99	88	64	95	36.3	96	78	65	103	36.1	97	75	61	91	36.7	98	83	82	119	37	99	85	85	124	F
36.2	98	95	62	100	36	99	90	49	85	36.6	97	84	64	103	36.5	98	95	60	95	36	97	75	49	84	35.9	98	79	52	90	F
35.9	98	88	71	116	35.8	99	80	60	95	36.2	98	90	60	102	36.1	99	88	54	90	37	97	70	60	93	36.9	98	72	60	95	F
36.4442	97.38961	88.36363636	69.37662338	109.0519481	36.3416	98.38961	85.81818182	60.01298701	92.1038961	36.4078	96.61039	87.07792208	63.9220779	100.5584416	36.3026	97.922078	84.61038961	61.6493506	93.25974026	36.2429	97.428571	85.7142857	60.01298701	89.8961039	36.35844	98.4026	87.75324675	62.9610389	95.22077922	

Appendix C

Light intensity level: 1500 lux					Yousif Al-Athmeh School					Light intensity level:550 lux						Yousif Al-Athmeh School				Light intensity level: 55 lux					Yousif Al-Athmeh School			
After					Before					After					Before					After					Before			
T (a) (°C)	SpO2% (a)	HPR (a) (beat/min)	DBP(a)(mmHg)	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP (b) (mmHg)	SBP(b) (mmHg)	T (a) (°C)	SpO2% (a)	HPR (a) (beat/min)	DBP(a)(mmHg)	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	T (a) (°C)	SpO2% (a)	HPR(a) (beat/min)	DBP(a) (mmHg)	SBP(a) (mmHg)	T (b) (°C)	SpO2% (b)	HPR (b) (beat/min)	DBP(b)(mmHg)	SBP(b) (mmHg)	SEX
36.8	98	104	62	103	36.7	99	105	61	100	36.2	99	99	62	102	36	99	102	60	100	35.9	96	99	68	110	36	98	105	59	99	M
36	97	99	66	102	35.9	98	80	68	100	36.6	96	86	65	113	36.5	97	101	68	110	36	98	86	55	98	36.1	97	80	65	104	M
37	98	103	75	112	36.9	99	93	72	110	36.3	93	101	95	113	36.2	96	99	96	110	36	99	93	72	114	35.8	98	101	74	116	M
35.9	96	79	73	95	35.8	97	86	75	92	36.3	98	100	58	102	36.2	99	74	55	99	35.8	97	100	58	100	35.9	96	86	53	91	M
37.1	99	75	75	113	37	99	90	70	110	36.5	98	98	73	106	36.4	97	76	70	110	36.8	98	98	68	106	36.9	99	90	72	111	M
37	98	100	70	107	36.8	99	120	61	105	36	95	100	82	121	35.9	96	94	80	126	36.3	99	100	82	120	36.4	98	120	84	125	M
36.2	96	88	71	103	36	98	81	64	100	36.2	97	120	63	106	36.1	98	85	58	111	35.9	96	120	58	99	36	98	81	62	103	M
36.9	99	97	80	116	36.7	98	94	75	115	36.6	96	90	73	110	36.4	97	95	70	115	36.4	98	90	80	123	36.5	99	94	76	117	M
36	99	99	63	100	35.9	99	100	60	95	36.8	97	98	68	100	36.6	98	96	65	103	35.9	99	98	65	110	36	99	100	60	99	M
36.3	98	94	69	122	36.1	97	95	62	121	36	97	97	65	120	35.9	98	90	60	126	36	97	97	60	110	36.1	98	95	64	119	M
36.1	97	85	68	104	35.9	99	86	63	102	36.3	98	90	66	105	36.2	99	88	63	107	36.1	99	90	59	101	36.2	97	86	65	106	M
37.1	97	102	62	103	36.9	97	99	59	99	36.1	98	96	77	125	36	99	100	75	131	36.3	97	96	70	122	36.4	97	99	77	110	M
36	99	98	63	101	35.9	99	101	60	100	36	98	89	65	103	35.9	99	95	64	110	35.7	99	89	59	99	35.8	99	101	60	103	M
36.9	98	84	64	104	36.8	97	109	59	101	36.6	96	99	75	120	36.5	97	80	80	111	36.7	97	99	80	118	36.8	98	109	83	105	M
37.1	99	90	75	112	37	98	96	73	110	36	97	100	76	117	35.9	98	87	72	121	37	98	100	73	110	36.9	99	96	75	115	M
36	97	104	62	95	35.8	97	99	60	90	35.9	97	109	55	95	35.8	98	99	53	100	35.9	97	99	73	110	36	97	109	55	92	M
36.8	97	87	65	124	36.6	99	82	62	107	36.2	97	90	84	119	36	98	85	82	125	36.7	99	90	78	119	36.8	97	82	83	121	M
36.1	99	94	84	135	36	99	99	70	115	36.9	98	100	72	116	36.8	98	93	74	112	36	99	100	69	110	36.1	99	99	77	115	M
36.2	97	98	68	116	36	99	93	55	92	36.2	96	99	81	125	36	97	96	80	132	36	97	99	75	110	36.2	99	93	81	122	M
36.2	98	107	61	123	36	96	85	59	105	36.4	95	75	75	101	36.2	97	104	73	107	36	96	75	60	100	36.2	98	85	70	106	M
35.8	97	96	62	114	35.6	98	91	59	99	36.9	96	99	79	119	36.8	98	94	83	111	36.1	98	99	63	101	36.3	97	91	80	117	M
36.1	97	97	63	130	36	96	74	59	102	36.5	98	80	85	120	36.4	99	95	82	122	36	96	80	80	117	36.1	97	74	82	121	M
36.2	99	85	72	131	35.9	99	82	71	111	37.1	97	84	70	110	37	98	81	69	117	36.1	98	84	59	101	36.3	99	82	71	111	M
36.6	96	92	62	118	36.4	98	70	60	99	36.2	96	80	65	95	36	97	87	60	100	36.9	96	80	69	110	37	98	70	53	91	M
36	99	88	74	127	35.9	99	89	70	110	36.1	98	90	73	110	36	99	90	70	120	35.9	98	90	63	100	35.7	99	89	73	114	M
36.5	97	91	65	126	36.3	98	92	60	100	36.6	97	78	88	120	36.6	96	88	85	122	36	97	78	75	115	36.5	98	92	85	110	M
35.8	96	79	61	120	35.6	98	97	60	100	36.8	99	88	60	95	36.9	99	74	58	103	35.3	98	88	68	101	35.2	96	97	57	99	M
36	99	76	82	139	35.9	97	84	80	118	37	97	93	73	146	36.9	98	75	75	135	35.9	97	93	75	115	36	99	84	84	100	M
36.3	97	95	73	119	36.2	98	79	70	110	37.1	96	86	71	110	36.9	99	93	70	115	36	98	86	74	114	36.1	97	79	73	109	M
37.1	97	108	82	122	37	99	75	80	115	36	99	79	82	115	35.9	99	102	80	122	36.8	97	79	76	112	36.9	99	75	83	95	M
36.2	97	83	67	122	36.1	98	85	65	100	36.3	97	91	61	110	36.2	98	80	60	107	36.2	98	91	71	109	36.3	97	85	67	101	M
36.8	96	75	63	100	36.7	96	76	60	95	36.1	98	80	58	95	36	97	70	55	106	36.5	96	80	70	106	36.7	96	76	55	93	M
36.6	99	84	80	126	36.5	97	95	77	124	35.9	96	87	83	120	35.8	96	82	85	126	36	97	87	78	119	36.2	99	95	86	107	M
36	97	100	88	115	35.9	98	93	86	110	36.3	97	92	63	110	36.2	98	93	62	116	35.7	98	92	65	113	35.9	97	93	61	116	M
36	99	81	91	116	35.9	99	81	85	115	36.1	96	90	77	115	36	98	80	75	117	35.9	99	90	64	113	36	99	81	76	103	M
37	96	106	79	106	36.9	97	71	65	100	36.5	95	89	55	100	36.4	96	104	60	95	36.9	96	89	66	118	37.1	97	71	58	101	M
36.2	96	97	80	100	36	99	88	75	99	36.4	96	90	83	140	36.5	97	94	80	144	35.6	96	90	78	104	35.8	99	88	84	106	M
36.9	97	100	84	112	36.8	99	94	70	110	35.9	96	84	73	110	35.8	97	95	73	112	36.8	99	84	64	95	36.9	97	94	71	100	M
35.6	96	105	75	110	35.4	97	99	70	100	36.6	97	100	64	95	36.5	98	103	62	101	35.6	96	100	76	90	35.8	96	99	60	99	M
36.4	98	90	82	114	36.2	99	102	80	111	36.1	96	94	78	120	36	98	86	80	117	36	98	94	76	96	36.2	98	102	81	101	M
37	97	76	82	112	36.8	97	84	80	110	37.1	98	85	68	106	37	98	74	65	110	36.6	97	85	80	101	36.8	97	84	60	108	M
36	96	91	80	125	35.9	98	95	76	123	36.6	98	101	81	130	36.5	99	79	80	132	35.9	96	101	81	99	36.2	98	95	81	102	M
37.2	99	96	67	102	37.1	99	72	85	100	36.5	98	81	62	99	36.6	99	93	60	105	37.1	99	81	64	95	37	99	72	58	99	M
36.3	97	97	82	111	36.2	99	80	67	110	36.6	98	88	82	120	36.5	99	94	83	125	36.2	97	88	64	99	36.3	99	80	81	103	M
36.8	97	75	85	117	35.6	98	96	60	116	36.5	93	98	62	111	36.4	96	72	60	116	36.5	98	96	63	113	36.8	97	98	61	115	M
36.9	96	100	68	107	36.7	97	96	60	105	36.2	97	82	67	100	36.1	98	94	65	107	36.7	96	82	63	99	36.9	96	96	60	101	M
36	96	96	67	100	35.9	99	93	60	95	36.6	96	91	60	95	36.5	98	87	58	108	35.9	93	91	74	94	36	96	93	56	95	M
37	97	104	60	99	36.9	96	100	55	94	36.7	97	72	88	125	36.6	98	103	85	131	36.9	99	72	80	99	37	97	100	80	101	M
36.4	99	85	75	120	36.3	97	102	81	117	37	96	90	82	129	36.9	98	87	80	132	36.2	98	90	76	103	36.4	99	102	79	105	M
36.2	98	102	85	103	36	97	85	83	100	36.9	97	90	62	100	36.8	98	95	60	105	36	85	90	82	99	36.2	98	85	61	103	M
36.2	96	87	83	121	36	96	87	65	120	36.9	97	94	69	120	36.8	98	85	70	122	35.8	87	94	63	100	36	96	87	66	101	M
36	96	95	74	99	35.9	98	90	60	95	36.7	98	96	60	95	36.6	99	93	59	104	35.9	90	96	53	91	36	96	90	55	96	M
36.2	97	84	75	102	36	97	85	72	110	35.9	98	90	70	114	36	99	81	73	111	36.1	85	90	56	89	36.2	97	85	72	100	M
36	96	88	75	101	35.8	97	86	80	100	36.9	97	90	63	101	36.8	98	80	60	108	35.7	86	90	58	99	36	96	86	61	103	M
37	98	86	72	114	36.9	97	99	70	112	36.9	98	102	81	130	36.8	99	84	80	135	36.8	99	102	79	98	37	98	99	82	95	M
35.9	96	92	79	116	35.8	97	100	85	115	36.5	96	96	69	116	36.4	97	90	65	132	35.6	99	96	65	103	35.9	96	100	64	116	M
35.7	97	87	77	112	35.6	98	90	60	110	36.1	98	86	63	110	36	99	86	61	118	35.9	90	86	63	101	36	97	90	60	108	M
35.4	96	102	88	101	35.3	99	103	70	120	36.1	97	86	72	122	36	98	94	70	129	35.2	98	86	76	95	35.4	96	103	68	99	M
35.8	98	93	68	100	35.7	96	95	63	95	36.4	98	75	62	99	36.5	97	87	58	110	35.6	95	75	66	88	35.8	98	95	60	99	M
35.4	98	95	79	113	35.3	97	84	67	110	36.3	96	84	73	110	36.2	98	91	70	73	35.3	84	84	60	100	35.4	98	84	65	112	M
36.7	98	76	63	99	36.5	99	106	62	95	36	97	104	58	99	35.9	98	70	55	58	36.5	99	104	67	95	36.7	98	106	53	95	M
36.7	94	91	78	101	36.5	97	87	65	100	36.7	98	104	60	80	36.6	99	87	62	60	36.5	98	104	62	100	36.7	97	87	60	104	M
36.5	94	116	81	112	36.4	97	82	80	110	36	94	96	88	110	35.9	96	120	90	88	36.3	99	96	60	91	36.5	97	82	88	95	M
36.5	98	95	80	114	36.3	98	90	77	111	36.1	96	70	77	100	36	97	94	75	77	36.4	99	70	63	101	36.5	98	90	80	112	M
36.9	91	103	62	85	36.6	97	86	65	80	35.5	95	81	53	75	35.4	96	101	50	53	36	98	81	58	80	35.9	97	86	53	76	M
36.5	97	104	87	125	36.2	99	95	85	122	36.2	98	87	82	90	36.1	99	99	80	82	36.3	99	87	78	100	36.5	99	95	86	95	M
36.1	96	77	81	95	36	99	88	80	91	36.3	96	90	79	83	36.2	97	74	82	79	35.8	99	90	78	107	36	99	88	84	110	M
36.9	97	86	68	116	36.8	99	94	65	114	36	97	84	69	71	35.8	98	84	68	69	36.8	99	84	64	99	36.9	97	94	71	101	M
36	96	101	62	100	35.9	99	93	60	95	36	98	91	63	80	35.8	99	95	62	63	36.1	99	91	74	93	36	96	93	56	95	M
36.1	96	76	67	112	36.5	98	87	64	110	36	96	107	60	80	36.2	97	71	58	60	36.4	99	107	61	101	36.5	96	87	55	103	M
36.1	90	83	63	116	36	96	61	60	111	36	97	56	62	75	35.9	98	80	60	62	35.8	98	56	97	94	35.9	90	104	63	96	M
37.2	96	105	81	115	37	96	93	80	110	36	97	96	74	85	35.9	98	98	73	74	36.9	99	96	66	95	37	96	93	75	98	M
37.1	96	76	70	110	37	97	90	67	106	36	98	79	77	85	35.8	99	72	75	77	36.9	99	79	49	90	37	96	90	85	95	M
37	99	80	72	132	36.8	98	99	70	120	36.2	96	98	71	90	36.1	99	76	70	85	36.8	99	98	68	103	36.9	99	99	72	104	M
36.8	98	85	83	103	36.7	99	100	85	100	36.2	97	100	82	90	36.4	99	88	81	82	36.7	99	100	82	105	36.8	98	100	84	107	M
36	98	83	81	105	35.9	96	81	64	100	36	96	120	63	75	35.9	98	79	60	63	35.9	99	78	58	99	36	98	81	62	101	M
36.7	99	87	82	111	36.5	98	85	80	110	36	95	90	78	85	35.8	97	85	77	78	36.5	99	90	80	101	36.6	99	94	76	104	M
36	99	106	67	102	35.9	99	100	70	100	36.1	96	98	59	100	36	97	109	58	95	35.9	99	95	65	95	36	99	100	60	107	M
36.2	97	85	77	120	36	98	95	75	115	35.8	98	97	65	105	35.9	97	81	66	100	36	99	93	60	95	36.2	98	95	64	98	M
37.2	98	82	82	123	37	99	80	80	120	36.3	92	86	84	90	36.2	96	80	80	84	36.7	99	77	90	98	36.9	98	80	82	100	M
36.405	97.1	91.7875	73.3625	111.6	36.2513	97.8625	90.3	69.0375	105.925	36.3425	96.7625	91.2625	70.8875	105.675	36.25125	97.8375	88.7125	69.575	104.7	36.18375	96.8625	90.2875	68.975	103.0625	36.31125	97.5375	91.2	69.675	104.125	

جامعة النجاح الوطنية
كلية الدراسات العليا

أثر شدة الضوء على ضغط الدم ودقات القلب وتركيز الأكسجين في الدم ودرجة حرارة الأطفال في مدينة جنين - فلسطين

إعداد
هديل محمود حسن أبو راس

إشراف
أ. د. عصام راشد
د. موسى الحسن

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

2012م

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الملخص

هدفت هذه الدراسة الى التعرف على تأثير شدة الاضاءة على كل من ضغط الدم (الانقباضي و الانبساطي)، ونبض القلب، نسبة الاكسجين في الدم ودرجة الحرارة وتكون مجتمع الدراسة من 237 طفل تتراوح اعمارهم (5-6) سنوات في مدينة جنين. تم اجراء قياسات لضغط الدم الانقباضي و الانبساطي، ودقات القلب، نسبة الاكسجين في الدم ودرجة الحرارة قبل التعرض لشدة الاضاءة وبعد التعرض لمدة اربع ساعات متواصلة. وجد معامل ارتباط قوي (معامل بيرسون) بين شدة الاضاءة وكل من ضغط الدم الانقباضي والانبساطي، دقات القلب، نسبة الاكسجين في الدم ودرجة الحرارة في المدرسة الاسلامية، مدرسة فاطمة خاتون ومدرسة يوسف العظمة.عندما كانت شدة الاضاءة اقل من المستوى الطبيعي (55، 39 و 40 لوكس) كان معدل معامل بيرسون هو(R =0.387 لضغط الدم الانقباضي، R = 0.659 لضغط الدم الانبساطي، R = 0.696 لدقات القلب، R = 0.604 لنسبة الاكسجين في الدم و R = 0.795 لدرجةالحرارة).وعندما كانت مستوى شدة الاضاءة ضمن القيم الطبيعية (500 ، 590 و550 لوكس) كان معدل معامل بيرسون هو(R = 0.670 لضغط الدم الانقباضي، R = 0.798 لضغط الدم الانبساطي، R = 0.647 لدقات القلب، R = 0.771 لنسبة الاكسجين في الدم و R = 0.729 لدرجةالحرارة). عندما كانت شدة الاضاءة اكثر من المستوى الطبيعي (1320، 1400 و 1500 لوكس) كان معدل معامل بيرسون هو(R=0.561) لضغط الدم الانقباضي، R = 0.593 لضغط الدم الانبساطي، R = 0.675 لدقات القلب، R = 0.722 لنسبة الاكسجين في الدم و R = 0.744 لدرجة الحرارة). و اخيرا، فقد خلصت الدراسة ان هناك تاثير لمستوى الاضاءة على ضغط الدم الانقباضي والانبساطي، دقات القلب ،نسبة الاكسجين بالدم ودرجة الحرارة.