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Effect of Noise Pollution on Arterial Blood Pressure and Heart Pulse Rate of Workers in the Hospitals of Nablus City-West Bank

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This research is studying noise pollution effects on the healthcare professionals in Nablus city hospitals. The arterial systolic and diastolic blood pressure (SBP and DBP) and heart pulse rate were measured for 95 workers (55 males and 40 females) in the selected hospitals of Nablus city. The ages of the sample workers were ranging from 20 to 73 year. The Sound Pressure Level (SPL) values were first measured in all studied hospitals and were found to be high compared to the recommended value, 45.0 dB(A) in the daytime. The difference between means of SBP, DBP and HPR before and after work are 6.335 (mmHg) of SBP, 5.108 (mmHg) of DBP and 5.305 of HPR (beat\min), respectively. In this study SBP, DBP and HPR are correlated positively (p-value < 0.050) with the occupational noise levels in all studied hospitals. In addition, the Pearson coefficient correlation (R) value of SBP, DBP and HPR in all selected hospitals are correlated positively. Moreover, significant correlation was found between mean values of SBP, DBP and HPR with the duration of employment and age.

Key words: Noise pollution, blood pressure, heart rate

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INTRODUCTION

In recent years, considerable attention has been focused on noise levels generated in the different sectors of hospitals such as Operation Rooms (OR), Neonatal Intensive Care Units (NICU), Intensive Care Units (ICU) and Emergency Departments (ED) (Xie and Kang, 2009; Busch-Vishniac *et al*., 2005; Altuncu *et al*., 2009; Smykowski, 2008; Alvarez Abril *et al*., 2007; Blomkvist *et al*., 2005; Tijunelis *et al*., 2005). For example, studies in operation rooms of hospitals have reported high noise levels (Dascalaki *et al*., 2009; Liu and Tan, 2000). Moreover, in (ICU) in India hospitals, the mean equivalent sound pressure levels (L_{eq}) during the morning and evening hours have been measured to be 70.4 and 64.5 dB(A), respectively (Vinodhkumaradithyaa *et al*., 2008). In Palestine, some studies were conducted on noise pollution. For example, strong positive correlation between occupational noise pollution levels and heart pulse rate, systolic blood pressure, diastolic blood pressure and hearing threshold levels at several frequencies were found (Abdel-Raziq *et al*., 2003a; Hanini, 2002). In addition, noise pollution in factories in Nablus city have also been studied (Abdel-Raziq *et al*, 2003b). Also, noise pollution levels have been studied in different locations of Arraba region (Qamhieh *et al*., 2000) and was found to be above accepted standards.

The goal of this research is studying noise pollution effects on the healthcare professionals in Nablus city hospitals. The study consists of two major parts:- Measuring the noise levels in OR, ICU and NICU at the sample hospitals.Measuring systolic and diastolic blood pressure and heart pulse rate for staff members in the selected departments of the sample hospitals.

MATERIALS AND METHODS

Noise level measurements were carried out in five governmental and private hospitals in Nablus city. The hospitals are: Al-Watani Hospital (public), Rafidya Hospital (public), Nablus Specialty Hospital (private), AL-Injeeli Hospital (private) and Al-Ittihad Hospital (private). All hospitals have three departments, NICU, ICU and OR except Al-Watani Hospital which doesn't have operation rooms. The readings of sound pressure levels were taken during the day from 7:00 h to 18:00 h. The measurements of sound pressure levels were analyzed statistically using the SPSS and Microsoft excel program.

Results of measuring sound pressure level: The sound pressure levels in different departments are measured as follows:

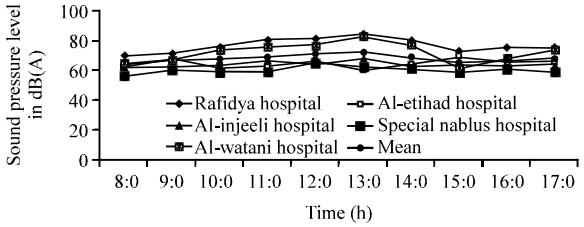

Fig. 1: Values of sound pressure levels SPL in ICU department in all studied hospitals

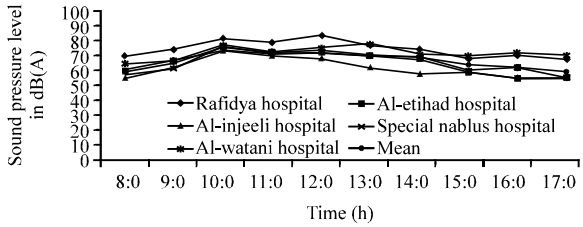

Fig. 2: Values of sound pressure levels SPL in NICU in all studied hospitals

Sound pressure levels (SPL) in intensive care units: The mean values of SPL as a function of time in the ICU department in all studied hospitals are measured and shown in Fig. 1. From Fig. 1 one can conclude the following points:

- Sound Pressure Level (SPL) values are high in all hours in ICUs in all hospitals. However, this is not surprising because the ICU department is for emergency cases that need to be monitored all the time
- The highest value of SPL from all studied ICUs is in Rafidya Hospital followed by Al-Watani Hospital. The lowest value of SPL is in Nablus Specialty Hospital. The ICU department is always full with emergency patients in the governmental hospitals (Al-Watani and Rafidya Hospitals)
- It was noticed that the ICU departments with highest SPL have large number of nurses in each work shift. This factor might have an influence on increasing the SPL in ICUs departments
- There is a clear increase in SPL values in most studied ICUs at about one o'clock (after noon). This might be explained by the fact that another shift of working staff should be replaced and the information about patient's health should be exchanged before the end of the first shift

Sound pressure levels in neonatal intensive care units (NICU): The mean values of SPL as a function of time in the NICU department in all studied hospitals are measured and shown in Fig. 2. One can notice the following:

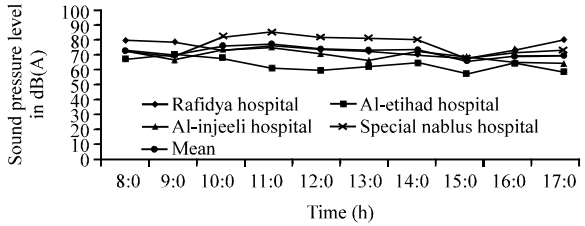

Fig. 3: Values of sound pressure levels (SPL) in OR in all studied hospitals

- The SPL values of Rafidya NICU were the highest while the lowest value of SPL was measured in Al-Injeeli NICU. The values of SPL in all NICU ranged from 54.2 to 83.8 dB(A) which are too high compared to the international standard of about 45.0 dB(A) according to the American Academy of Pediatrics (Committee on Environment Health, 1997)
- The highest value of SPL in NICU of Rafidya Hospital might be related to the fact that more than 15 incubators exist in the same room and every incubator has a lot of instruments and alarms. In addition, there are more than three nurses working in this department. Moreover, the neonate nurse station is not separated by glass walls like the NICU in Al-Watani Hospital
- The results of SPL in NICU department in Al-Watani Hospital are high. In that hospital, there are more than 10 incubators with 8 babies in the same room. The values of SPL in the NICU of Al-Injeeli, Al-Ittihad and Nablus Specialty Hospital are under the mean value of SPL in all NICUs, since there are only two babies in each hospital NICU
- The values of SPL for different NICUs in different hospitals are high between 10:00-11:00 h, because of the doctors' tour at this time
- The high values of SPL come due to the sources of noise in NICUs, such as babies crying, telephone ringing, opening and closing incubator doors, monitoring alarms and unnecessary staff conversation

Sound Pressure Levels in Operation Rooms (OR): The mean values of SPL as a function of time in the OR department in all studied hospitals are shown in Fig. 3. One can notice the following:

- The values of SPL in ORs in all hospitals were between 57.6 to 88.0 dB(A) with a mean of 71.9 dB(A). These sound levels are higher than international recommendations

Table 1: The mean values for SBP, DBP and HPR for males and females workers in all selected hospital

			Mean of SBP (mmHg)		Mean of DBP (mmHg)		Mean of HPR (beat/min)	
Hospital name	Gender	N	Before work	After work	Before work	After work	Before work	After work
Al-Watani	Male	11	119.2	126.8	76.2	84.2	82.5	88.0
	Female	6	106.8	118.2	74.2	79.8	72.5	80.2
Rafidya	Male	10	134.6	147.3	85.5	89.3	76.8	81.6
	Female	11	113.7	122.9	73.8	73.2	84.3	91.2
Nablus specialty	Male	13	128.8	136.9	75.7	85.3	75.5	83.8
	Female	9	110.3	118.6	68.3	81.2	74.7	84.1
Al-Ittihad	Male	8	134.6	147.3	85.5	89.3	76.8	81.6
	Female	7	112.1	122.4	77.3	86.7	72.1	69.9
Al-Injeeli	Male	13	123.9	134.8	78.3	88.4	82.6	87.9
	Female	7	118.4	112.9	77.4	74.6	83.0	84.7

- The highest value of SPL was in Nablus Specialty Hospital between 10:00-15:00 h. Because there are a lot of emergency danger surgeries during this time. However, the lowest value of SPL was in Al-Ittihad Hospital
- The values of SPL in any ORs were affected by the number of surgeries taking place at the same time and by the types of these surgeries

Results of measuring blood pressure and heart pulse in all selected hospital: The mean values for SBP, DBP and HPR for males and females workers in all selected hospital are presented in Table 1.

The following points can be concluded from Table 1:

- There is an obvious increase in average values for SBP, DBP and HPR after work for all studied male workers
- There is an increase in average values for SBP, DBP and HPR after work for most studied female workers. Some exceptions were noticed which might be personal related

Discussion for blood pressure and heart pulse rate: The Pearson's correlation coefficient (R) and the probability value (p-value) were calculated by using Paired Sample T-test and One-Way ANOVA test for all sample workers in all studied hospitals. Table 2 and 3, show the dependent variables, the correlation coefficient (R) and the p-values in all hospitals.

Since the R values in Table 2 are more than 0.546 the degree of linear dependence between the variables is strong positive correlation in all hospitals for SBP, DBP and HPR. The p-value for all variables in all hospitals is <0.050. The Mean values of SBP, DBP and HPR for the sample workers and Pearson correlation coefficients and p-values in NICU, ICU land OR departments are shown in Table 3.

Table 2: R and p-values of the studied variables in all sample hospitals

Hospital	No. of workers	SPL in dB(A)	Dependant variables	R	p-value Sig. (2-tailed)
.Al-Watani	17	72.2	SBP(mmHg)	0.546	0.040
			DBP(mmHg)	0.695	0.001
			HPR(beat\min)	0.658	0.002
Rafidya	21	77.8	SBP(mmHg)	0.599	0.002
			DBP(mmHg)	0.643	0.044
			HPR(beat\min)	0.714	0.000
Special nablus	22	67.4	SBP(mmHg)	0.906	0.000
			DBP(mmHg)	0.617	0.002
			HPR(beat\min)	0.693	0.000
Al-Ittihad	15	64.0	SBP(mmHg)	0.846	0.000
			DBP(mmHg)	0.695	0.030
			HPR(beat\min)	0.869	0.000
Al-Injeeli	20	64.1	SBP(mmHg)	0.744	0.000
			DBP(mmHg)	0.799	0.000
			HPR(beat\min)	0.762	0.000

Table 3: R and p-values of the studied variables in NICU, ICUl and OR

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

The following points can be concluded from Table 3:

- The difference between means of SBP, DBP and HPR before and after work are 6.335 (mmHg) of SBP, 5.108 (mmHg) of DBP and 5.305 of HPR (beat/min), respectively
- Strong positive correlation between SPL and SBP, DBP and HPR for workers working in all departments
- All the p-values are lower than 0.050 which shows significance evidence that rejects the null hypothesis

CONCLUSION

The overall results in this study indicate the following main points:

- The mean SPL values in all studied hospitals departments during the selected days are ranged from 60.0 to 83.0 dB(A) in NICU, from 60.0 to 76.0 dB(A) in ICU and from 63.0 to 76.0 dB(A) in OR. These SPL measured values are higher than measured ones in (ICU) in India hospitals. The mean equivalent sound pressure levels (L_{eq}) during the morning and evening hours have been measured to be 70.4 and 64.5 dB(A), respectively
- The mean SPL values in all studied hospitals ranged from 64.0 to 77.8 dB(A). Accordingly, all the sample workers are being exposed to continuous high noise in all hospitals
- There is a strong positive correlation between noise and blood pressure and heart pulse rate in all hospital departments. All the tests show that there is an increase in SBP, DBP and HPR for workers in all studied hospitals
- The results of this study are consistent with other finding's studies that found the average rise in systolic blood pressure was 2.46 mm-Hg, while it was 3.06 mm-Hg for diastolic blood pressure (Mahmood *et al*, 2007). Another study showed that there a mean increase of 2.5 mm-Hg for both systolic and diastolic blood pressure(Talbott *et al*., 1999). It was found that the exposure to noise caused increase in pulse rate by average 4.7 beats/minute for workers in noisy factories (Fogari *et al*., 2001)

There are some suggestions which can be applied to reduce noise pollution in hospitals:

- Hospital designers have to come up with designs that increase the area of the departments to increase spaces between patients from one side and between patients and medical equipments from the other side
- The nurse station inside each department must be separated by glass walls
- Noise from telephones can be lowered by reducing the volume of their rings
- Noise caused by machines can be reduced through applying several mechanical adjustments, conducting maintenance, or buying new less noisy equipments
- Noise from reflecting surfaces can be reduced by covering all surfaces with antireflection materials of high noise absorbance
- The external noise can be reduced by using well isolating walls and double glass windows

Finally, this study was aimed to provide useful data for decision makers to improve the status of hospital environments. However, additional researches are needed to support this study.

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