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Noise Pollution in Factories in Nablus City

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Summary
Noise pollution is becoming more and more important, especially in the industrialized and developed countries. Industrial noise is a serious environmental problem, which causes annoyance and disruption to daily activities. In the West Bank, however, there are so far no regulatory laws to limit high industrial noise levels. Due to a general lack of awareness about the ill effects of high noise levels, the owners of factories pay little attention to safety measures for their workers.
Accordingly, this study is concerned with measuring the equivalent noise levels L_{eq} in 38 factories in Nablus city and comparison with international standards of noise. The obtained mean value of these levels is 85.5 dB(A). It has been found that the L_{eq} values for 40% of the selected factories are higher than the widely-adopted international standards. These factories are considered by the workers to be noisy sources. The continuous exposure of the workers to such high noise levels can cause hearing damage, speech masking and annoyance. High-level noise not only hinders communication between workers, but depending upon the level, quality and exposure duration of the noise, it may also result in different types of physical, physiological and psychological disorders.
This study makes some recommendations and gives advice for the workers in the factories, owners of factories and for the Palestinian authorities, to relieve the noise pollution problem in factories in Nablus City.

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1. Introduction

Study of noise pollution and its effects on human beings is an increasingly expanding topic in the world. Many noise studies have been conducted to investigate the magnitude of the problem in various cities throughout the world [1, 2, 3, 4, 5, 6, 7, 8].

A general study of noise pollution carried out recently in the community of Valencia (Spain) has revealed that environmental noise is a significant problem in most cities of Spain [9].

A study of "Putting a lid on factory noise" has shown that three types of industrial noise are commonly encountered when determining exposure: constant noise levels, varying noise levels and noise pulses [10]. In Italy, a study on "Noise risk caused by machines in food plants" has shown that noise levels inside processing industries are sufficiently high to cause considerable risk hearing disorders for workers [11]. A study of "Occupational noise exposure limits for developing countries" in Pakistan has revealed that there is a criterion for steady noise of L_{eq} = 88 dB(A) for 8 hours a day and 6 days a week, with the exposure time halved for each increase in L_{eq} of 3dB(A) and an overriding limit of 115 dB(A) [12]. A study of "Noise emission levels in the coal industry" in Britain has revealed higher noise levels than the established limits for occupational noise exposure [13]. Also, in Arraba and Nablus in Palestine, the noise levels have been found to be higher than the adopted international standards [14, 15].

Noise pollution in Palestinian cities and towns is becoming more evident because of the increasing number of such sources of noise as machines, markets, vehicles and factories. In Nablus city, there are some specific issues affecting the noise level. These are: the shortage of open spaces, the heavy road traffic as a consequence of narrow streets, the refugee camps that are not subjected to regulations and health laws, and the factories that emit daily high noise. Factory noise is an important health problem in the city of Nablus, because the factories owners do not follow the widely-accepted regulations and standards for controlling the noise. No regulations for noise pollution have yet been formulated in Palestine. In the West Bank, data on noise pollution and its effects are lacking. Therefore, the aim of this study is to investigate the noise pollution by measuring the equivalent noise levels in a large sample of factories in Nablus city. The measured L_{eq} values will be compared with the standards to classify the selected factories according to noise levels. Additionally, this study suggests some recommendations and advice for the workers in the factories, owners of the factories and Palestinian local authorities.

2. Experimental Technique

L_{eq} noise levels measurements values were carried out in 38 factories spread through the city of Nablus in residen-

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Table I. Equivalent sound level values (L_{eq}) measured in 38 factories.

Categories of factories	No.	Name of Factory	Location	No. of workers	Working hours	L_{eq} [dB(A)]
Chemical	1	Al-Rajih	Residential	15	8	69.7
	2	Al-Arabia Factory	Residential	18	8	76.8
Plastic	1	Al-Aqad Company	Industrial	90	10	63.9
	2	A-Teby	Industrial	8	8	72.2
	3	Al-Aqad Washer Comp	Industrial	80	10	80.8
	4	Al-Andalus	Industrial	9	12	86.6
	5	Plastic Company	Industrial	10	8	87.8
	6	Malhes Company	Indusi-ial	220	16	88.1
	7	Al-Aqad Factory	In dustrial	10	10	96.3
Food	1	Shalhob Roaster	Residential	6	9	81.2
	2	Al-Deak	Industrial	6	8	82.6
	3	Qamhiya Tahina	Indus.&Resid.	8	8	84.1
	4	Al-Zahra	Industrial	30	8	84.4
	5	Plaza	Industrial	6	8	85
	6	Al-Sanable	Industrial	14	8	85.3
	7	Al-Araz Ice Cream	Resid.&Comm.	120	24	90.4
	8	Tammam Tahina	Indus.&Resid	8	8	91.9
Paper and Wood	1	Al-Egtesad	Commercial	8	8	79.7
	2	Al-Horriya	Commercial	4	8	83.6
	3	Al-Zaglol	Industrial	7	20	83.7
	4	Al-Nasir	Industrial	125	13	84.7
	5	Al-Wafa	Industrial	35	8	85.9
	6	Al-Najah	Commercial	8	8	86.4
	7	Cartoon	Industrial	60	13	92
	8	Hawash Company	Industrial	10	8	92.5
Metal	1	Nickel and Golvan	Indus.&Comm.	5	8	83.9
	2	Aluminum	Agricultural	50	10	84.5
	3	Glass	Indus.&Resid.	18	8	88.3
	4	Cans	Industrial	40	9	89.7
Concrete Production	1	Al-Ekhaa Flags	Industrial	14	9	82.2
	2	Concrete Company	Industrial	40	14	86.8
	3	Production for Flags	Agricultural	15	8	89.2
	4	Production for Bricks	Agricultural	15	8	98.7
Stonecutter	1	Al-Khayat	Industrial	5	8	93.2
	2	Al-Foriki	Indus.&Resid.	5	9	95.6
	3	Al-Aghbar	Industrial	4	8	95.8
	4	Sbeah	Indus.&Resid.	6	8	96.6
	5	Al-Sakhel	Industrial	12	8	97

tial, commercial, and industrial areas. The factories have been classified into 7 categories based on products such as: chemical, plastic, food, paper and wood, metal, concrete production, and stonecutter. The factories within each type of industry were selected randomly making sure that both large and small factories were included. Each measurement was carried out twice during normal working hours, firstly time between 10:00 and 11:30AM, and secondly time between 12:30 and 14:00PM, under ideal meteorological conditions, over the period May to September 2001. No significant problems occurred during the measurements and observations. The noise levels were measured using the Quest model 2900, type 2 integrating and logging sound level meter. The accuracy of this instrument is ± 0.5 dB(A) at 25 °C and its precision is 0.1 dB(A) [16]. The A-weighted levels L_{eq}, L_{dn}, L_5, L_{10}, L_{50}, and L_{90} were read directly from the sound level meter. These measurements were taken inside factories (indoor), and the sound level meter was placed in the gathering place of workers. The results obtained were compared with the standard scales to find out whether or not they satisfy the usual standards. The data were analyzed statistically by using the SPSS program.

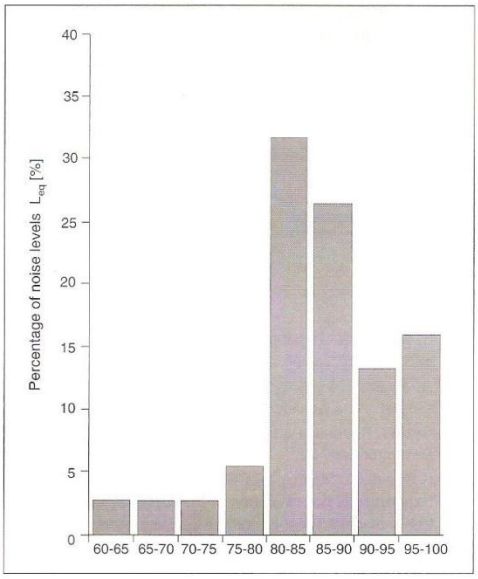

Figure 1. Values of noise levels.

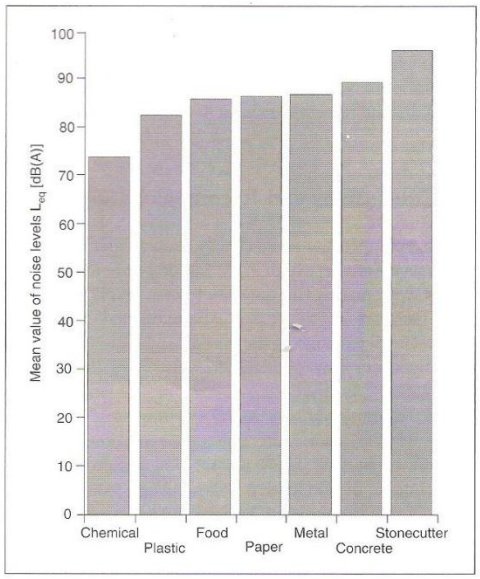

Figure 2. Mean value of noise levels vs categories of factories.

Table II. The percentage of L_{eq}-intervals.

Interval, [dB(A)]	Number of Factories	% of L_{eq}
$60 < L_{eq} < 65$	1	2.6
$65 < L_{eq} < 70$	1	2.6
$70 < L_{eq} < 75$	1	2.6
$75 < L_{eq} < 80$	2	5.3
$80 < L_{eq} < 85$	12	31.6
$85 < L_{eq} < 90$	10	26.3
$90 < L_{eq} < 95$	5	13.2
$95 < L_{eq} < 100$	6	15.8

Table III. Noise exposures in the categories of factories.

Category	Numb. of Workers	Av. work. hours	Mean L_{eq} [dB(A)]
Chemical	33	8	73.3
Plastic	427	10.5	82.2
Food	198	10.13	85.6
Paper and Paper	257	10.8	86.1
Metal	113	8.5	86.6
Concrete Production	84	9.75	89.2
Stonecutter	32	8.2	95.6

3. Results and Analysis

The locations of the factories, number of workers, and working hours in each factory are given in Table I. There were 1144 workers in the chosen sample of factories at different locations. It was observed that 68% of workers work for longer than 8 hours a day. It should be noticed that nine factories are located in residential areas. The L_{eq} values were measured in 38 factories in the Nablus area. Table I presents also the value of L_{eq} for each factory in all categories. These values are the averages of L_{eq} registered at every minute by the sound level meter. The percentage of the measured L_{eq} values falling into determined intervals is calculated and tabulated in Table II. A plot of the percentages of the L_{eq} values in different factories is shown in Figure 1. About 2.6% of the total of factories considered in our sample had L_{eq} in the range from 60 to 65 dB(A), generally considered as "acoustically undesirable" for the workers. In 37 factories (about 97.4% of the total sample), the values of L_{eq} exceed 65 dB(A), a noise level usually considered as "unacceptable" for the workers. It should be also observed that in about 92.2% of factories, the L_{eq} values exceed 75 dB(A), which is an extremely high value for an industrial area. These measured values are compared to the record issued by the Organization for Economic Cooperation and Development [8]. The number of workers, average working hours and their mean value are given in Table III. One observes that the chemical factories have the smallest mean L_{eq}, because the production machines used are quiet. On the other hand, the stonecutters are the most noisy sources. The plastics factories contain 37% of total workers who are exposed for a very long time to high noise levels. In food factories, the relative positions of the machines are too close to each other, so they emit continuously high noise levels. 23% of total workers are working in paper and wood factories, exposed to high noise levels daily. Moreover, the average number of working hours there is about 10.8, which is the longest among all the cat-

egories. In metal and concrete factories, the L_{eq} mean values are very high because of the large size of the machines. The diagram of mean noise level for different categories of factories in Nablus city is shown in Figure 2. The figure shows that the stonecutters have the highest noise levels of all.

4. Conclusions and Recommendations

The present measurements clearly showed that noise pollution levels are very high in the factories where measurements were made. The measured noise levels in 15 out of 38 factories are higher than the established of standard noise. The percentage of the workers who are exposed to noisy factories and quiet factories are respectively 49% and 51%.

The recommendations to relieve the noise pollution problem in the factories are: quieten the machines by using acoustic barriers to shield, deflect, and absorb the noise, and reducing or eliminating noise leakage paths, spacing the machines further apart, limiting the exposure time, and using ear protectors. Finally, the responsibilities of the authorities are: setting up industrial noise surveys and ordinances, planning for noise control programs for industrial or residential areas, following safety and health regulations, following maintenance of the machines. In general, the continued actions of autonomous and local administrations on the subject are essential.

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