SOME OF THE NON-AUDITORY EFFECTS OF NOISE AMONG EXPOSED WORKERS IN ABOU-QURKAS SUGAR FACTORY, EL-MINIA GOVERNORATE, EGYPT.

By

*El-Khateb AS, **Refaat TM, *El-Moselhy EA,

***El-Rehany MA and ****Zayet HH.

**Community and Industrial Medicine Department, Faculty of Medicine, Al-Azhar University (Assiut).*

***Community and Industrial Medicine Department, Faculty of Medicine, El-Minia University.*

****Bio-Chemistry Department, Faculty of Medicine, El-Minia University.*

*****Industrial Medicine and Occupational Diseases Department, Faculty of Medicine, Cairo University.*

Abstract:

Noise is an important health issue that affects more than hearing. Scientific research demonstrates that health effects occur at noise levels below those that impair hearing. Some of these health effects include increased risk of cardiovascular disease, negative effects on sleep, communication, performance and behavior. Forty three healthy workers exposed to noise in different sections in Abou-Qurkas sugar factory were examined. Sound pressure levels in the work place ranged from (65 – 110 dBA). Annoyance, ear pain and heart burn were the most important complaints of the workers (93.0%, 65.1% and 44.2%, respectively). Mid-shift heart rate and blood pressure showed significant increase in comparison with pre-shift levels ($P < 0.001$). Increase in values of fasting blood sugar level and lipid profile are not statistically significant. Of the exposed subjects 81.3%, had highs levels of urinary vanillylmandelic acid (mid-shift compared with pre-shift) and the difference was statistically significant ($P < 0.001$). The study concluded that work stress due to noise is a common problem among workers exposed to noise in Abou-Qurkas sugar factory, and therefore efforts should be directed towards reducing its level and keeping it in check.

Key words: Non-auditory, Noise, sympathomimetics and stress & Sugar Factory.

Introduction:

Noise is one of the most common adverse factors in the working area. Noise provides a good example of multifaceted stressors. In addition to its cumulative effect on the cochlea, noise exposure may cause acute increase in blood pressure and interference with speech communication (Jomes and Robert, 2007). Noise is defined as unwanted sound. There are many sources of noise, and they are all damaging. When sound affects anyone who does not desire to listen, it becomes noise. Noise is intrusive, as well as harmful, to all exposed to it (Stansfeld et al., 2000).

The predominant health effect of noise is auditory damage which causes hearing loss. This is frequently caused by loud occupational noise or by loud music, as well as by loud fireworks. But besides this auditory noise effect, attention must also be paid to the non-auditory effects of noise. Non-auditory effects of noise appear to occur at levels far below those required to damage the hearing organ (WHO, 2001). Non-auditory effects of noise can be defined as "all those effects on health and well-being which are caused by exposure to noise with the exclusion of the effects on the hearing organs and effects which are due to masking of auditory information (i.e. communication problems). Such effects include performance effects, physiological responses and health outcomes, annoyance, and sleep disturbance (Babisch, 2005).

Noise exposure causes a number of predictable short-term physiological responses mediated through the autonomic nervous system. Exposure to noise causes physiological activation including increase in heart rate, elevated blood pressure, and peripheral vasoconstriction and thus increased peripheral vascular resistance. There is rapid habituation to brief noise exposure but habituation to prolonged noise is less certain (Vallet et al., 1983). Reading and memory have been reported to be impaired in schoolchildren who were exposed to high levels of aircraft noise (Hygge et al., 2002). Some studies have shown higher stress hormone levels (adrenalin and noradrenalin) and higher mean blood pressure readings in children exposed to high levels of community noise (Passchier, 2000 and Babisch, 2002).

The levels of urinary noradrenalin and adrenalin indicate sympatho-adreno-medullary activity and vary largely by physical exertion and mental stress. Therefore, the total response of urinary noradrenalin and adrenalin was used as an indicator of sympathetic nervous activity caused by workload and stress in laboratory experiments or field studies (Rodahl, 1989). A major metabolite of noradrenalin and adrenalin is vanillyl mandelic acid (VMA), which is excreted largely in urine in the free form (Kagedal and Goldstein, 1988).

In Egypt, cane sugar industry is one of the most important industries especially in Upper Egypt where climate is suitable for the cultivation of sugar cane. About 78% of the total sugar production in Egypt is from sugar cane. There is a total of nine factories for sugar production and refining in different governorates of Upper Egypt (World Bank, 1995). There is a number of sources of noise in sugar mills and cane railways, including: (a) plant associated with steam and compressed air (e.g. vents, pressure reducing valves, silencers, pipes or turbines) (b) locomotives (c) power houses (d) Other sources (e.g. associated with shredders, high speed gearboxes, fans, blowers or centrifugals) (e) miscellaneous items (e.g. vacuum breakers, air operated valves, locomotives, warning horns, bumping cane bins or truck movements) (f) workshop activities (e.g. grinding, hammering and metal cutting operations) (Australian Sugar Research Institute, 2005).

Aim of the study:

To detect the possible non-auditory effects of noise on exposed workers employed in different sections of Abou-Qurkas sugar factory, through biochemical, hormonal and metabolic assessment.

Subjects and methods:

Forty three healthy workers in Abou-Qurkas sugar factory exposed to noise in different sections were examined from January to December 2011. The sound pressure levels in the work place ranged from (65 – 110 dBA). The study followed guidelines of the research ethics committe with an informed consent of the studied workers and acceptance to continue in the study.

All subjects were interviewed using a previously prepared questionnaire (serial number, personal history, occupational history, special habits, systemic diseases, past history of ear troubles, head injuries, drug intake and symptoms and signs related to increase of stress hormone) and were subjected to measuring blood pressure (pre-shift and mid-shift, systolic and diastolic), evaluation of blood sugar level, total cholesterol, triglycerides, high density lipoprotein, low density lipoprotein and urinary vanillylmandelic acid (VMA). For each worker a urine sample was obtained in a sterilized test tube for analysis of VMA in urine. The sample was taken twice, once in the early morning of the work shift and again at the middle of the shift. The VMA ELISA (Enzyme Linked Immunosorbent Assay) kit used is designed for in vitro quantitative measurement of (VMA) concentration in patients' urine. (DRG international, Inc.).

Results and Discussion

Demographic characteristics of the sample used in this study are presented in table (1); all participants were married males with ages ranging from 25 – 59 years (mean age 42.4, S.D. ± 8.0). Most workers came from rural areas near the factory (67.4 %, 29 out of 43). Almost two thirds of them (60.5 %, 26 out of 43) were non-smokers.

Table (1): Personal characteristics of the studied population in different noisy sections of Abou-Qurkas factory for sugar industry.

Personal Characteristics	*Number (43)*	*Percentage*
Age group (years): 25 - 34	8	18.6%
35 - 44	18	41.9%
45 - 54	11	25.6%
55 and more	6	14.0%
Range	25 - 59	--------
Mean age	42.4	---------
S. D.	± 8.0	---------
Sex: Male	43	100.0%
Female	0	0.0%
Marital state (married)	43	100.0%
Address: Urban	14	32.6 %
Rural	29	67.4 %
Smoking: Non-smokers	26	60.5%
Smokers	12	27.9%
Ex Smokers	5	11.6%

More than 60.5 % (26 out of 43) were non-smokers, 27.9 % (12 out of 43) were smokers and 11.6 % (5 out of 43) ex-smokers. The smoking index in the exposed workers ranged from (0-190) with a mean of 21.3 ± 33.4. Siha, (1988) studied some work-related disease in tobacco industry and reported that smoking was associated with tension and anxiety and was most frequent among employees who complained of occupational stress.

Table (2): Pulse and blood pressure (systolic and diastolic) of the exposed workers.

Examination	Pre-shift	Mid-shift	t test	P value
Pulse: Range **Mean** **SD**	68 – 102 79.72 ± 6.2	74 – 104 81.94 ± 6.16	-7.513	0.01
Systolic blood pressure **Range** **Mean** **SD**	110 – 140 126.30 ± 6.98	110 – 148 138.67 ± 8.04	-5.774	0.001
Diastolic blood pressure **Range** **Mean** **SD**	70 – 95 82.30 ± 5.50	70 – 98 86.56 ± 5.48	-7.026	0.001

As regards the pulse rate, table (2) shows that the pre-shift range was 68 – 102 beats/min. with a mean 79.72 and S.D. ± 6.2. The mid-shift range was 74 – 104 beats/min. with a mean of 81.94 ± 6.16. The difference between pre-shift and mid-shift was statistically significant (P < 0.01).

Lundberg and Forsman (1980), found absolute measures of noradrenalin were significantly positively correlated with heart rate. On the other hand Gendi, (2003) shows a non-significant difference of pulse rate between the exposed workers and the control group. Saha et al., (1996) who conducted a study on workers in a thermal power station who were exposed to noise emitted by turbines and boilers which ranged from 90 – 113 dBA and found that changes in heart rate showed non-significant increase with increased duration of exposure to noise.

Table (2), also presents results of blood pressure measurements of the exposed workers. The pre-shift diastolic pressure ranged from 70 – 95 mmHg. with a mean of 82.30 and S.D. ± 5.50, the pre-shift systolic pressure ranged from 110 – 140 mmHg. with a mean of 126.30 and S.D. ± 6.98. The mid-shift diastolic pressure ranged from 70 – 98 mmHg. with a mean of 86.56 ± 5.48, the mid-shift systolic pressure ranged from 110 – 148 beats/min. with mean of 138.67 ± 8.04.

The difference between pre-shift and mid-shift, systolic and diastolic pressure proved to be highly statistically significant (P < 0.001). This result agrees with Gendi, (2003) who reported a highly statistically significant difference on comparing the blood pressure (systolic and diastolic) of the exposed workers before and at mid-shift work in a group of male shift workers exposed to heat and noise in a process of glass melting. This is not concomitant with the result obtained by Cavatorta et al., (1987) who found that average values of systolic and diastolic arterial pressure showed no significant variations between the different times among a group of healthy male workers in a glass factory who were exposed to high environmental noise levels (more than 90 dBA), compared to a second group exposed to low noise levels (less than 78 dBA). Saha et al., (1996) found a statistically significant increase in systolic and diastolic blood pressure in the group exposed more than 20 years to noise stress.

Helal, (2000) studying the effects of noise among laundry workers at Kasr El Eini hospital, noticed the effect of noise on cardiovascular parameters as heart rate, systolic and diastolic blood pressure among the exposed group before and mid shift and found a statistically significant difference between pre- and mid-shift results. Rosenman, (1990) noted that increase in heart rate, systolic and diastolic blood pressure with exposure to noise may be due to activation of the hypothalamus-hypophysis-adrenocortical axis and the sympathetic nervous system, resulting in generalized vascular spasm and increase in blood pressure. Release of adrenocortical hormones and sympathomimetic mediators leads to increased heart rate.

Table (3): Sound pressure levels at work site and net result of vanillylmandelic acid.

Sound pressure level at work site (dBA)	Net result of vanillylmandelic acid						Total	
	decreased		no difference		increased			
	No.	%	No.	%	No.	%	No.	%
Less than 90	1	12.5%	2	25.0%	5	62.5%	8	18.6%
90 - 99	-----	-----	2	9.5%	19	90.5%	21	48.8%
+ 100	1	7.1%	2	14.2%	11	78.7%	14	32.6%
Total	2	4.7%	6	14.0%	35	81.3%	43	100%

$\chi 2 = 3.78$ P value = 0.43 No.= number

As regard the urinary vanillylmandelic acid, 81.3% (35 out of 43) of exposed subjects had high mid-shift urinary vanillylmandelic acid compared to pre-shift level. Table (3), shows that the production, mill house and work shop sections had the highest values (exposed to sound pressure level between 90 – 99 dBA) as 19 out of 21 (90.5%) had higher vanillylmandelic acid levels followed by boiler house, air evacuation and turbines sections and lastly security and administrators sections, but these results are statistically insignificant. Abdel Aziz et al., (1982) examined drivers and noticed increase in biochemical parameters (catecholamines and urinary vanillylmandelic acid) on working days than in leave days, both leave and working days level presented higher excretory levels for hypertensive than for normotensive drivers.

Comparing the values of vanillylmandelic acid in urine before the shift and mid-shift of each age group (table 4) of exposed workers, we find that a highly statistically significant difference with age group 35 : 44 years and age group more than 55 years. The highest percentage of increase in urinary vanillylmandelic acid was noted in workers with duration of exposure from 21 – 30 years 90.0% (9 out of 10) and it is statistically insignificant (table 5).

Table (4): Age groups and net result of vanillylmandelic acid pre-shift and mid-shift.

Age groups (years)		Vanillylmandelic acid				
		Range	mean	SD	t value	P value
25 - 34	Pre-shift	0.06 - 1.4	0.60	± 0.47	-2.293	0.056
	Mid-shift	0.09 - 2.4	0.97	± 0.71		
35 - 44	Pre-shift	0.09 - 1.71	0.83	± 0.53	-5.739	0.000
	Mid-shift	0.51 - 2.62	1.40	± 0.55		
45 - 54	Pre-shift	0.10 - 1.80	0.73	± 0.44	-1.973	0.077
	Mid-shift	0.20 - 5.69	1.64	± 1.40		
55 and more	Pre-shift	0.03 - 1.02	0.49	± 0.49	-2.976	0.031
	Mid-shift	0.46 - 1.30	0.93	± 0.52		

Table (5): Duration of exposure and result of vanillylmandelic acid.

Duration of exposure (years)		Vanillylmandelic acid				
		Range	mean	SD	t value	P value
less than 10 (5 out of 8)	Pre-shift	0.06 - 1.41	0.64	± 0.52	-2.986	0.020
	Mid-shift	0.09 - 1.59	0.87	± 0.51		
11 – 20 (21 out of 25)	Pre-shift	0.09 - 1.80	0.80	± 0.50	-4.939	0.000
	Mid-shift	0.20 - 2.61	1.39	± 0.63		
21 – 30 (9 out of 10)	Pre-shift	0.03 - 1.02	0.57	± 0.40	-2.155	0.060
	Mid-shift	0.49 - 5.69	1.56	± 1.50		

Recommendations:

The study recommends the following to protect from auditory and most known possible non-auditory effects of noise:

- Pre-employment medical examination to exclude individuals with health problems that would be aggravated by noise exposure.
- Environmental monitoring to check sound pressure levels periodically and to institute control measures when necessary.
- Periodic medical evaluation for early detection of hearing affection and other non-auditory effects.
- Heath education programs at all levels.
- Proper maintenance of machinery with the purpose of reduces noise.
- Use of personal protective device where indicated.

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