Health hazards among a sample of workers exposed to a combination of noise and organic solvents in a fermentation factory in Egypt

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Abstract: Background: Exposure to noise can induce hearing impairment among industrial workers. Studying the impact of combined exposure to both industrial pollutants such as noise and organic solvents on hearing was scarcely pointed. **The aim** was to study the risk of hearing loss among a sample of fermentation plant workers in Egypt exposed to both noise and a mixture of organic solvents. **Materials and Methods:** The exposed group consisted of 110 workers in a fermentation plantdivided into two groups. Group A (50 workers,) exposed to noise only, group B (60 workers) exposed to noise and mixture of organic solvents, The control group (group C;30 workers) were matched to the exposed group in age, sex, socioeconomic status, smoking habit and systolic blood pressure but were neither exposed to noise nor organic solvents. All studied sample were subjected to complete medical examination and audiometric examination using pure tone Audiometer (GS.Model 1703). The characteristic V-notch in the audiogram was used as early sign of hearing loss. Noise level at work place was carried out using a calibrated Precision sound level meter type 2232. **Results:** Noise level was comparable in groups A&B but significantly higher than in control work places. Thirty six percent of exposed workers suffered from hearing loss versus 3.3 percent in the control group ($p < 0.001$). Hearing loss was significantly higher among group B (24%) than group A (18%) ($p< 0.05$). Results showed that both exposed groups had higher hearing loss than normal control. Workers exposed to both noise and organic solvents suffered from the highest proportion of hearing loss compared to those exposed to noise alone, therefore we **concluded** that solvents may interact synergistically with noise. [Nature and Science 2010;8(6):95-99]. (ISSN: 1545-0740).

Key words: Noise- organic solvents- hearing loss.

INRODUCTION

Noise may be considered very likely the most common ototoxic factor. Noise-induced hearing loss (NIHL) has been widely investigated in industrial and non-industrial fields WHO, (1980);Wilson et al., (1999) and Quaranta et al., (2000) Combination effect of noise and organic solvents in industry remains unclear, organic solvents have been widely used in industry, research and household works. In industry, they are used in plastics, rubber, paints, artificial silk and leather manufacture. An appreciable amount of solvents can be absorbed through inhalation and intact skin. Being mostly volatile, they can be toxic to most parts of human body Lynge et al., (1997); Fuente and McPherson, (2006); Matsuoka, (2007); Ebbehoj et al., (2008) and Herpin et al., (2009).

In industry, workers are mostly exposed to a mixture of solvents at the same time. Hunter (1979); Kowalska et al.,(2000) had reported that among health hazards of exposure to organic solvents in conjunction with noise is hearing loss. On experimental animals (rats), Johnson (1993) reported that combined exposure showed clear potentiation of ototoxicity and recently Vyskosil et al., (2008) observed in rats, that trichloroethylene affects the auditory function mainly in the cochlear mid- to high-frequency range with a lowest observed adverse effect level (LOAEL) of 2000 ppm. No studies on ototoxic interaction after combined exposure to noise and organic solvents were identified in humans .Sufficient data on solvents exposure of workers are necessary to make a definitive conclusion. The aim of this study was to verify the risk of hearing loss among a sample of the fermentation plant workers exposed to noise, as well as a mixture of organic solvents.

Materials and methods:

This controlled study was conducted on a sample of industrial workers at a fermentation plant in 2007. The materials of this study included three groups of workers. Group A consisted of 50 workers exposed to industrial noise. Group B consisted of 60 workers in the mixing and painting sections exposed to noise and a mixture of organic solvents (Toluene, xylene, butylacetate and ethylalcohol). The exposed workers were working for 42 hours per week. The control group included 30 workers (firemen, garage workers, and workers in the power supply station). They were neither exposed to noise nor to organic solvents. The exposed and control workers were matched for age, sex (all males) and socioeconomic status.

All workers were subjected to the same questionnaire including personal, occupational,

and present histories. Clinical examination followed with special stress on systolic blood pressure and hearing impairment.

Finally, environmental study of noise level at work place was carried out using "Bruel and Kjaer" precision sound level meter type 2232. The necessary calibration and calculation were carried out in order to obtain an accurate weighted noise level (dB/ A). Audiometry then followed for every worker using a simple, accurate audiometric recording pure tone audiometer. The testing was carried out after 24 hours of the last exposure to overcome Temporary Threshold Shift (TTS). A 0.5 dB correction for each year above the age of 50 was made whenever needed. The characteristic V-notch in the audiogram at 4000 Hz was used as an early sign of hearing loss, Harris, (1979).

RESULTS:

Results were tabulated and statistical analysis of data. P-value of 0.05 or less was considered statistically significant.

Table (1) shows the general characteristics of the studied individuals which were divided into three groups; exposed (A and B) and control group(C). They were all matched for age, sex (all males) and socioeconomic status. All workers did not differ in their smoking habits (p >0.001).In addition table (1) illustrated the statistical analysis of the noise level at the three working places was significantly higher in the workplaces of the two exposed groups than the control one.

Table (1): General characteristics of workers under study and comparative noise level

Variable	**Exposure Group**		**Control group**	***p-value***
	Group A *n= 50*	Group B *n= 60*	Group C *n= 30*	
-Age (years) Mean ± SD	28.0 ±7.1	30.2 ±4.9	31.3 ±5.6	>0.001
Smoking Smokers (%)	60	53.3	46.6	>0.001
Noise Level dB / A	107.5	105.5	54.0	<0.001

Table 2 shows the recording of the systolic blood pressure for all workers. They showed no statistical difference (p >0.05).

Table 2: Systolic blood pressure of the exposure groups (group A and group B) and the control group

Variable	**Exposure Groups**		**Control group**	***p-value***
		Group A *n= 50*	Group C *n= 30*	
Systolic blood pressure Mean ± SD		134.0 ±7.3	130.2 ± 6.7	>0.05

Results in table (3) showed a significant difference (p <0.005) on comparing the exposed groups and control group when using the v-notched audiograms at 4000 Hz.

Table (3): V-notched audiograms among the Exposure and the Control groups (at 4000 Hz)

Variable	**Exposure Group** Group A and group B *n=110*	**Control Group** Group C *n= 30*	***p-value***
v-notch			
n	40	1	<0.001
%	36.6	3.3	

Table 4 and 5 compared between the average hearing loss among the two exposed groups and/or control. The difference was statistically significant.

Table (4): Comparison between the average hearing loss in the exposure groups i.e. Group A (noise only) and Group B (noise/ organic solvents)

Variable	Exposure Group		*p-value*
	Group A noise only *n= 50*	Group B noise / organic solvents *n= 60*	
Hearing loss Mean ±SD	18.2 ±4.2	24.2 ±9.8	< 0.05

TABLE 5: Comparison between the average hearing loss in the exposure groups i.e. Group A (noise only) and Group B (noise/ organic solvents) with the control group.

Variable	Exposure Group		Control group	*p-value*
	Group A Noise only *n= 50*	Group B noise / organic solvents *n= 60*	Group C *n= 30*	
Hearing loss Mean ± SD	18.2 ±4.2	24.2 ±9.8	11.4 ±3.0	< 0.05

DISCUSSION:

The damage of one or more of the body systems caused by exposure to organic solvents in industry has been widely investigated. Hathout (1971) has reported mild symptoms such as headache, vertigo, fatigue and numbness in exposed workers. Severe symptoms like drowsiness, stupor and even coma have been reported. The result obtained from the study performed by Uzma et al., 2008 indicated that there is a significant toxic effect of solvents and air pollutants on respiratory, hematological and thyroid functioning of workers exposed for longer duration.

Loquet et al., (1999) and Hoet and Lison (2008) reported that combined exposure to noise and solvents showed clear potentiation of ototoxicity in experimental animals. This had initiated this study of this combination on a sample of exposed industrial workers. The exposed and control workers were matched in age, sex, socioeconomic status and smoking habits. The only variable was the industrial exposure to noise and/or organic solvents as environmental pollutants. Studying the systolic blood pressure for the workers under investigation showed no difference as a health hazard. This was also reported by other investigators; Hathout (1971); Amer, (1983); Manninen and Aro (1979) and Hirai et al., (1991). However, Johnson and Hannson (1977); Rizk et al., (1986); Fogari et al., (1994) and Lee et al., (2009) have reported raised blood pressure due to prolonged exposure to noise.

The V-notched audiograms was used in our study as an early sign of hearing loss, as described earlier in literature among the exposed workers Harris (1979). In our study, a significantly higher proportion of v-notch among the exposed than the control workers ($p< 0.001$) at 4000 Hz was found. This was in agreement with previous reports of Amer (1983) and Rizk et al., (1986).The average hearing loss was significantly higher among group B compared with group in spite of the fact that noise level (dB) was almost the same in both work places. This finding is in agreement with Quaranta et al., (2000); Sliwinska-Kowalska et al., (2004) and Hodgkinson and Prasher, (2006). The presence of volatile organic solvents in air of the sections investigated in concentrations exceeding the maximum allowable concentrations may explain the potentiation of ototoxicity of group B workers Hathout (1971). In addition, Chang et al., (2006) suggested that toluene exacerbates hearing loss in a noisy environment, with the main impact on the lower frequencies. The significant difference in hearing loss between the exposed and the control groups goes with the fact that noise level was significantly higher in the workplace of the exposed workers. The same finding was previously reported by Beshir et al., (2001);Ritter and Perkins(2001) and Bohnker et al., (2002a)

These findings confirm the assumption of the potentiation of the ototoxic health hazard of organic solvents in exposed industrial workers. Effective intervention is needed to improve industrial safety of individuals experiencing ototoxic effects of solvents. However, more research is required to verify the mechanism of action of the two pollutants namely noise and organic solvents and exposed workers in an Egyptian industry.

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4/1/2010