Eastern Journal of Medicine 4 (1): 13-15, 1999.

Effects of industrial noise on the blood levels of superoxide dismutase, glutathione peroxidase and malondialdehyde

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Objective Effects of noise on free radical production and antioxidant defence mechanism were investigated.

Methods Plasma malondialdehyde (MDA), erythrocyte superoxide dismutase (SOD) glutathione peroxidase (GSH-Px) and ferritin levels were measured in weavers who worked at noisy workplace.

Results MDA, GSH-Px and SOD levels were significantly higher in weavers than that of the controls. There was no significant difference in ferritine levels.

Conclusions These data suggest that employees who work at noisy workplace may be under the risk of free radical mediated damage in long time duration.

Key words Noise, free radicals.

Introduction

Free radicals are reactive chemical species produced also under physiologic conditions and if not removed by antioxidant enzymes and free radical scavengers they may be toxic to the cellular components. GSH-Px and SOD are enzymes of the antioxidant defence mechanism. Free oxygen radicals (FORs), however, are used as a defensive agent by neutrophils they are also produced as a by product in many of the physiologic reactions such as oxidoreduction reactions.

Many studies have been performed to show the effects of industrial noise to hearing, psychotic status and metabolic processes (1-3). It was reported that, the functions of the pituitary-adrenal axis and the adrenal medulla were affected by occupational noise exposure (4-). Metabolism of the catecholamines is one of the sources of free radical production (8,9).

This and other possible reactions that generate FORs may contribute to the free radical production in noise exposured individuals. MDA is an end product of lipid peroxidation and usually used as a marker for free radical mediated damages.

The iron (Fe) is a transition metal and it causes free radical production in blood. Fe bound to ferritine and the ferritine molecule can contain as many as 4500 atoms of iron. Also plasma ferritine levels may be an index of free Fe which causes oxidative effects. Thus, ferritine is accepted as an antioxidant factor.

In this study we investigated the changes of free radical production and antioxidant defence in workers at noisy environment by measuring superoxide dismutase, glutathione peroxidase, malondialdehyde and ferritin levels.

Material and Method

This study was carried out on 93 workers in a yarn factory and 41 healthy controls selected from individuals who have no exposure to industrial noise. The mean age of study group was 29.9 ± 0.5 years.

Accepted for publication: 30 July 1998

noise per day. The average noise levels of the workplace was 104dB. The exposure period of noise was 4.6 ± 0.1 (ranging from 1 to 7) years.

In the control group, the mean age was 30.5 ± 0.8 years. The control group consisted of 20 female and 21 male individuals. Both the workers and controls had no systemic disease.

Venous blood samples were collected into heparinised tubes after an overnight fasting from workers and controls in the morning. Blood samples were prepared rapidly for enzymatic analysis.

MDA levels were measured by a fluorometric method described by Wasowicz et al. using 1,1,3,3 tetramethoxypropane as standart. 50 µL plasma samples were introduced into the tube containing 1 mL of distilled water. After addition of the 1 mL of the solution containing 29 mmol/L TBA in acetic acid (8.75 mol/L), samples placed in a water bath and heated for 1 hour at 95-100 °C. After the samples cooled, under running cold water, 25µL of 5 mol/L HCl was added and the reaction mixture was extracted by agitation for 5 minute with 3.5 mL of n-butanol. After centrifugation, butanol phase separated and the fluorescence of the butanol extract was measured in a spectrofluorometer (Schimadzu-RF-5000,Kyoto,Japan) using 525 nm for excitation and 547 nm for emission (10).

Erythrocyte SOD activity was estimated by use of commercial kits (Ransod kit of Randox Laboratories, UK). For SOD activity, xanthine and xanthine oxidase were used to generate superoxide radicals reacting with 2-(4-iodophenyl)3-(4-nitrophenol)-5 phenyl tetrazolium chloride (INT) to form a red

formazan dye. SOD activity was then measured at 505 nm on a spectrophotometer by the degree of inhibition of the reaction of washed hemolysed erythrocytes.

Erythrocyte GSH-Px activity was determined using the method of Paglia and Valentine (11). This method is based on that of GSH-Px catalyses the oxidation of glutathione by cumene hydroperoxide in the presence of glutathione reductase and NADPH. The oxidised glutathione is immediately converted to the reduced form with a concomitant oxidation of NADPH to $NADP^+$. The decrease in absorbance at 340 nm is measured. GSH-Px activities were expressed in international units per milliliter erythrocyte sediment.

Ferritine levels were measured by the method of microparticle enzyme immunaassay in IMX analyser.

The results were given as mean ± SEM. Student's t test was used for statistical evaluation.

Results

Age, SOD, GSH-Px, MDA and ferritine levels in workers and controls were given in Table 1and figure 1. There was statistically significant difference in MDA levels between the two groups. SOD and GSH-Px levels were also significantly higher in workers than in controls.

Table 1. Comparison of the two groups.

	Workers (n: 93)	Control (n: 41)	p
Age (year)	29.9 ± 0.5	30.5 ± 0.8	>0.05
SOD (U/mL)	214.8±8.1	169.7±4.7	<0.001
GSH-Px (IU/mL)	69.8±3.4	49.5±1.6	<0.01
MDA (nmol/mL)	6.07 ± 2.4	4.23±1.3	<0.001
Ferritin (ng/mL)	94 ± 6.3	102±6.5	>0.05

However, the mean values of ferritine concentrations were not significantly different between workers and controls.

Discussion

In a field study on truck drivers, a significant increase of the urine vanilylmandelic acid (VMA) levels has been found after 8 h of driving at a noise level of 85dB (12). And also, a significant elevation of norepinephrine blood levels has been shown in brewery workers on the days when they didn't wear hearing protectors, compared to the shifts when noise protecting devices were used (13). It was reported that the autooxidation of cathecolamines had an additive effect to endogene oxidative stress (3,13). Urine VMA is a metabolic product of cathecolamines and is a marker of cathecolamine levels.

Belojevic et al. reported that urine VMA and 17 hydroxy corticosteroid levels in weavers had no significant changes, both concerning the different occupational noise exposure and the periods of a working day (3).

In this study, the high SOD activity may be attributed to increased superoxide anion production in blood. GSH-Px is a major antioxidative enzyme in many tissues and has been speculated to be a major antioxidative mechanism in the brain (15). GSH-Px metabolizes H_2O_2 to H_2O. In our study, the increase in both two enzymes suggested that there were an oxidative stress in workers at noisy environment.

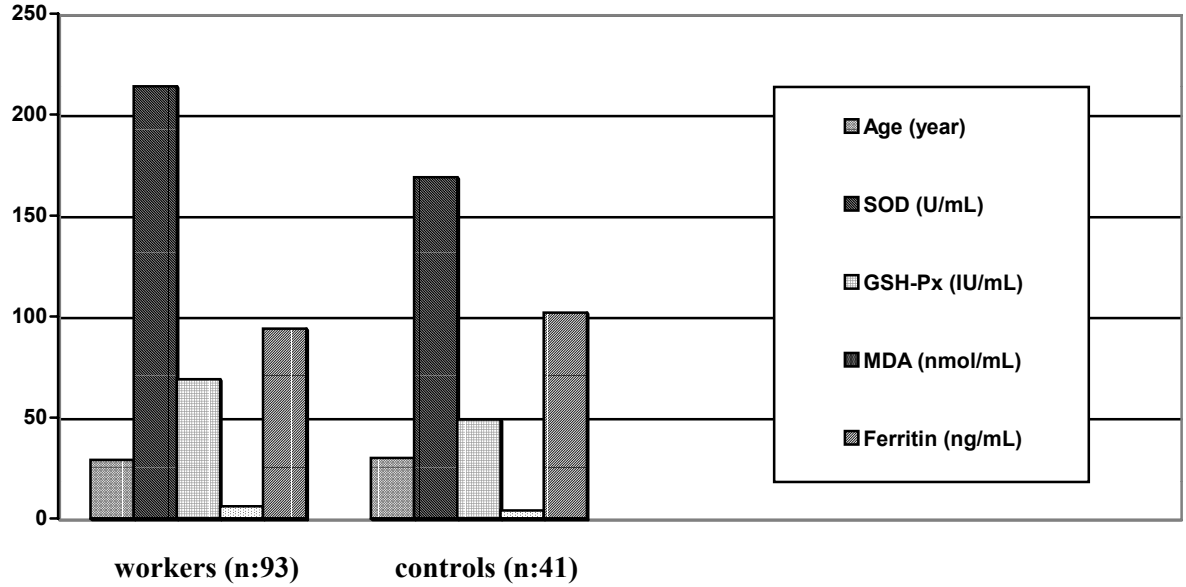

Figure 1 : Comparison of workers at noisy environment and controls

MDA levels were measured as an index of damage to polyunsaturated fatty acids. As MDA levels were high in workers , the damage was obviously high. And also both two enzymes were high in workers where as MDA levels particularly high the workers. Perhaps the enzymatic antioxidative capacity may be insufficient in these workers at noisy environment. Similar to our findings, Liu reported that MDA levels increased after blast trauma in an animal study (14).

Although it has been shown that metabolic changes might occur also at the lower (80-95 dB) noise levels (1) , we preferred to perform this study in a factory that its noise level is relatively higher. Because this is the level of noise that workers usually exposure to that at many of the factories.

Since ferritin is an iron storage protein, it's known as an antioxidant agent. Increased superoxide anions can cause iron release from ferritin. Iron is a transition metal that initiate lipid peroxidation and hydroxyl radical generating reactions such as Haber-Weiss reaction. In contrast, SOD can inhibit this release. In this study, althought the SOD levels were higher in study grup than the controls, the ferritin levels were not different in two groups.

In our study, the results showed that occupational noise significantly affected the SOD and GSH-Px activities and MDA levels in workers. These data suggested that free radical production and subsequently the reactions of lipid peroxidation increased in workers as compared to the controls.

We believed that free radicals may contribute to the formation of some metabolic changes seen in workers at noisy environment. Consequently, it was considered that noise exposured workers were under the risk of free radical mediated damage.

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