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URINARY CATECHOLAMINES, BLOOD PRESSURE, SERUM CHOLESTEROL AND BLOOD GLUCOSE RESPONSE TO INDUSTRIAL NOISE EXPOSURE

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ABSTRACT

Urinary catecholamines, blood pressure, serum cholesterol and blood glucose concentration levels were studied in different groups of employees working in three engineering industry plants. Experiments were performed on 388 male subjects who were exposed to noise at work. Special attention was paid to differences in the values of these variables between people exposed to noise levels of 55 dB or below, and those exposed to 75 dB or more. The excretion of urinary adrenaline and noradrenaline was measured during the last three hours of the work shift. Determinations of serum cholesterol and blood glucose concentrations, as well as blood pressure measurements were made in an examination arranged about 1.5–3.0 hours after the work shift. Measurements of equivalent noise levels were carried out at individual workplaces. A theory was formulated that industrial noise exposure was reflected in employees as elevated noradrenaline excretion, serum cholesterol concentration and systolic blood pressure. Relatively higher systolic blood pressure, noradrenaline and cholesterol levels were found in employees whose work environmental noise level was 75 dB or more compared with persons working in environments with a noise level under 55 dB. The increase in blood glucose concentration, adrenaline excretion and diastolic blood pressure level was not as clear in the people working in noise at a level of more than 75 dB. This kind of extra-auditory response pattern in the human organism gives some evidence to support the association between occupational noise exposure and endocrine and cardiovascular disorder.

Workers in industrial plants are frequently exposed to high-intensity noise. Shatalov[20] considers the possible influence of noise to comprise not only involvement of the organ of hearing and of the nervous system, but also the cardiovascular system. Various deleterious effects of noise exposure have recently been reviewed by Schuschke[19] and Møller[17]. Changes in catecholamine excretion are found even at quite a low noise level[10], and in general such changes in the synthesis and degradation of catecholamines are produced under the influence of long-lasting acoustic stimuli[12]. Permanently elevated concentrations of blood lipid and adrenal hormones can contribute to degenerative changes in the arterial vessels and myocardial tissue[1]. The association between increased risk of coronary heart disease and elevated levels of serum cholesterol, on one hand, and of systolic and diastolic blood pressure, on the other hand, is well known[2,8]. The

following study was carried out in order to obtain more evidence of some endocrinological, biochemical and physiological responses in workers exposed to industrial noise.

SUBJECTS AND METHODS

The subjects for the study were the same as those from the METELI* research programme. The factories concerned represented a wide variety of production branches, ranging from a foundry and heavy engineering to precision engineering. The design of the whole research programme and the methods used are described in detail elsewhere[14,15].

Fasting blood samples were taken in a health examination 1.5–3.0 hours after work from 388 male subjects. The serum cholesterol concentrations were determined with the method developed by Pearson[22]. Glucose concentrations were determined with the orthotoluidine method[23] at the National Pensions Institute Laboratory in Finland. During the same health examination arterial blood pressure measurements were carried out by means of a mercury sphygmomanometer. Sympathetic-adrenal medullary activity was assessed by measuring urinary adrenaline and noradrenaline with the fluorometric technique[4]. According to a strictly fixed schedule urine samples were collected by research workers at predetermined points in the factory. The subjects were asked to void at 13.00 o'clock and urine samples were collected during the last three hours (of the same day shift) on Monday afternoon. The subjects were asked also to restrict their coffee or tobacco consumption and report any drugs used. Direct assessments of environmental noise were made by determining the equivalent noise level (Leq) in the individual workplaces included in the sample.

To study extra-auditory effects of industrial noise, workers were subdivided into a noise-exposed group (equivalent noise level more than 75 dB) and a group considered to be non-noise-exposed (equivalent noise level below 55 dB). Furthermore, it was decided to convert the primary data into percentage differences from the mean value. The difference in urinary catecholamines, blood glucose, serum cholesterol and blood pressure is given as a percentage. The grand mean of the total sample population is taken to be the initial value and comparisons between noise-exposed and non-noise-exposed groups are made on the basis of the difference expressed as a percentage of the initial values.

RESULTS

The mean age and relative weight of employees as well as the standard deviations for these parameters in all noise-exposed and non-noise-exposed groups are given in Table 1. The table shows that, as a whole, the groups do not differ significantly in respect to age and weighting parameters.

The percentage differences in mean urinary adrenaline, noradrenaline, blood glucose, serum cholesterol and blood pressure levels between noise-exposed and

*METELI was a collaborative project of a multidisciplinary research team carried out in 1971–1976. The project was financed by the Social Science Research Council of the Academy of Finland and by the Ministry of Education.

TABLE 1
Mean and standard deviations (±S.D.) of age and relative weight of employees in the non-noise--exposed and noise-exposed groups in different age classes.

Exposure group	25 years			26–45 years			46–64 years		
	n	age	weight	n	age	weight	n	age	weight
Non-noise-exposed (Leq under 55 dB)	36	24±4	100±12	61	33±5	106±11	21	51±4	110±10
Noise-exposed (Leq above 75 dB)	70	23±2	102±13	60	33±5	109±11	44	52±5	108±14
Total sample population	134	23±3	101±13	160	33±6	107±11	94	51±4	109±14

non-noise-exposed subgroups are given in Figure 1. Employees working in noise with a level of more than 75 dB have a noticeably high noradrenaline output. When relating the excreted average level of each subgroup to the calculated grand mean of the total sample population, noise exposure is found to increase the liberation of noradrenaline into urine in all age classes. In the youngest age class the difference between noise-exposed and non-noise-exposed group is 18.2%, in the middle age class 21.1% and in the oldest age class 19.0%. On the other hand, there is a marked relative elevation of adrenaline in all non-noise--exposed groups, whereas in all noise-exposed groups the mean urinary adrenaline secretion is relatively lower. Quite a clear difference in glucose levels is observed between noise-exposed and non-noise-exposed groups. The proportionate difference is clearest for the oldest subjects, where the mean cholesterol level of the non-noise-exposed is 5.0% higher than that of the noise-exposed. The serum cholesterol level of non-noise-exposed employees is definitely lower than that of noise-exposed employees, especially in the middle and oldest age classes. There is tendency towards an increased serum cholesterol content among people working under an environmental noise level of 75 dB or more. Relative systolic blood pressure levels are sligthly higher in all exposed groups than in non-exposed groups. However, the greatest difference can be found between the two groups in the oldest subjects. Compared with the grand mean, the systolic blood pressure is 6.5% higher in persons subjected to noise and 3.8% higher in those who are not expected to work under a noise load. Except in the youngest age class the differences between group values for the diastolic blood pressure remain unmarked.

DISCUSSION

The results of this cross-sectional study prove that metabolic disturbances may be produced under the influence of noise exposure. In particular our findings demonstrate increased liberation of urinary noradrenaline, a rise in cholesterol concentration and systolic blood pressure in groups exposed to environmental noise at work. The proportionate increases in these values

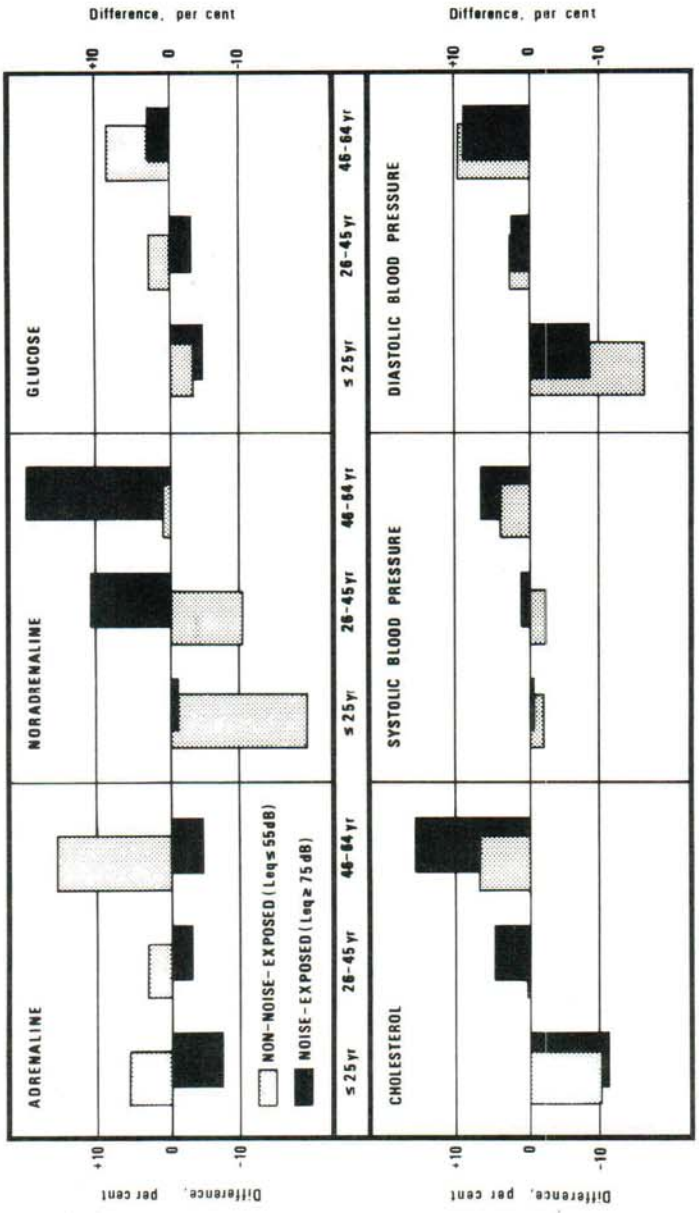

FIG. 1.—Mean percentage differences in noise-exposed and non-noise-exposed groups when compared with the grand mean (O-line) of the total population (n = 388).

constitute evidence to support the concept that noise may be one of the important risk factors in hypertension and cardiovascular disorders. According to a generally accepted theory, the release of catecholamines is the expression of the "stress" state of the body[3,16]. Adrenaline reflects changes in general well-being and arousal, and noradrenaline is primarily associated with factors affecting blood-pressure homeostasis[5]. However, some observations have shown that both hormones, for example, mobilize fat. Thus the release of catecholamines elicited by noise may increase the mobilization of free fatty acids from adipose tissue, with elevation of circulating cholesterol[1]. Changes in blood glucose levels could be brought about by changes in adrenal activity. In addition, both our findings and previous reports show that the cholesterol concentration increases and the glucose level decreases in the blood of employees working in noisy environments[6,7,9,18,21]. However, to formulate an explanation for these findings is not easy and further investigations are needed. Firstly, in studying workers in metal factories such as the ones in Finland it is important to remember that noise exposure is often accompanied by exposure to a variety of other potentially noxious physical or chemical factors[11]. Secondly, in industry workers are often exposed to a number of other job-related stress factors, and so such features as degree of repetitiveness, duration of work cycle, work posture, machine vs. man-paced work, have been demonstrated to be reflected in either adrenaline or noradrenaline excretion[5]. In paying attention to this study it is difficult to say exactly to what degree the differences in timing the endocrinological and biochemical analysis may reflect themselves in different results. It should be kept in mind that the differences in the excretions of noradrenaline in urine during sleep at night have been found to be related to differences in physical strain of daily work[13]. It may therefore be assumed that continuation of endocrine arousal might eliminate to some degree the effect of the discrepancy in the timing of our determinations. In any case, a multicomponental approach will, in fact, be applied in further statistical analyses of the material collected for this study.

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