DYSLIPIDEMIA IN INDUSTRIAL WORKERS IN HOT ENVIRONMENTS

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SUMMARY

The aim of the study was to follow the rate and manifestation of dyslipidemia in industrial workers exposed to heat. One hundred and two male industrial workers exposed to heat and a control group of 102 male workers were studied. The microclimate components were followed and Wet Bulb Globe Temperature (WBGT) was calculated. The mean WGBT was 35.4 °C (28.4 –41.7 °C) for the studied heat exposed work places. The lipid indices: total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and triacylglycerols were assayed with enzymatic tests. TC/HDL-C ratio was calculated, too. Arterial pressure, anthropometric variables, smoking, alcohol use were followed and no significant differences between the studied groups were found. Significantly higher TC, LDL-C and TC/HDL-C were found with the heat exposed industrial workers. Odds ratio indicated higher risk in heat exposed industrial workers of becoming dyslipidemic [for TC OR=1.481 (1.097-2.002) and for LDL-C OR=1.539 (1,123-2.111)]. Regular screening of lipid profile in heat exposed workers is recommended.

Key words: lipid profile, overheat, occupational exposure, long term effects

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INTRODUCTION

Intense hot environments are prevalent in iron, steel, glass and ceramic units, rubber foundries, coke ovens, mines and other industries. Heat exposure is known to affect several physiological functions, but the long term effects on cardiovascular system are not well studied. There are data for significantly higher mortality from cardiovascular disease (CVD) among metallurgical plant workers (1) in hot environments. Later Mouline et al. (2) found about 10% lower CVD mortality in steel workers in hot jobs. Their data were confirmed by Wild et al. (3) for potash miners employed in hot environments. The study (3) also showed five times higher ischemic heart disease (IHD) mortality in workers who left hot environments for medical reasons. The latter two studies could indicate healthy workers' effect that is specific for subjects exposed to heat. Hobbesland et al. (4) found increased mortality from sudden death and hypertension-related diseases among ferroalloy plant workers, the increase in mortality was observed with longer duration of furnace work. The authors concluded that the increased mortality was related to furnace work conditions: heat, psychosocial stress, shift work, noise, carbon monoxide.

We found only a few data on the effect of hot environments on cardiovascular risk factors. Significantly higher blood pressure was found in heat exposed ferroalloy plant workers with exposure longer than 6 years (5). Our earlier data (6, 7) showed higher cardiovascular risk in workers exposed to overheat in ceramic foundry, mainly higher rate of dyslipidemia, often accompanied with overweight, smoking and ECG data for hypertrophy of the left ventricle. Our earlier studies were based on comparatively small groups without control groups, the assessment of heat exposure was poor and only a few confounding factors were followed.

The aim of the study was to follow the rate and manifestation of dyslipidemia in industrial workers exposed to heat.

METHODS

One hundred and two male industrial workers exposed to heat, aged 37.4 ± 10.7 years with length of service 17.1 ± 10.4 years (13.6 ± 10.1 years in hot environments) and control group of 102 male industrial workers of age 38.8 ± 8.1 years, length of service 18 ± 9.8 years were studied. The exposed group comprised workers from three manufacturing units. The studied subjects were shift workers, all working fast rotating shifts as follows: 72 % were working two shifts (morning/afternoon shifts; four in a row) and 28 % were working three shifts (morning/afternoon/night shifts; three in a row). The control group was matched with male subjects from the same unit with age difference up to 3 years, similar workload and identical shifts. The psychosocial factors were followed as well. The study was carried out during the hot period. All investigated subjects signed an informed consent.

The microclimate components were measured twice at 31 heat exposed work places with Testoterm 452 (air temperature from –20 °C to +70 °C, air velocity 0–10m/s, relative air humidity 0–100%) and assessed according to Bulgarian National Standards (8, 9). The microclimate at 12 unexposed work places was followed, too. At heat exposed working places mean air temperature of 37.3 °C (29.8–47.3 °C), air velocity 0.76 m/s (0.33–2.25 m/s), relative humidity 17.55 % (12.8–25.6 %) were measured. At the working places without heat exposure the mean air temperature was 29.2 °C (25–32.7 °C), air velocity 0.42 m/s (0.09–0.62 m/s), relative humidity 24.8 % (17.6–32.4%).

The Wet Bulb Globe Temperature (WBGT), defined as

$$WBGT = 0.7t_{WB} + 0.3t_{GT}$$

where t_{WB} is wet bulb temperature and t_{GT} is globe temperature, was calculated for heat exposed indoor locations (10). The mean

WGBT 35.4°C (28.4–41.7°C) was calculated for the studied heat exposed work places.

Blood for analysis was obtained after an overnight fast. The lipid profile included the following indices: total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), triacylglycerols and TC/HDL-C ratio. The assessment of the lipid indices was performed with enzymatic tests. The HDL was separated by precipitation of LDL and VLDL and the cholesterol was assayed in the HDL fraction. The LDL-C was calculated using the formula of Friedewald for triacylglycerols < 4.3 mmol/l. The ratio TC/HDL-C was calculated, too.

The arterial pressure, body mass index (BMI), waist/hip ratio, smoking habits, family history for cardiovascular disease, etc. were also followed. The arterial pressure was measured with Hg sphygmomanometers two times in a period of three months. The hypertension was defined using the JNC VI (11), as well as preliminary physicians diagnosis. Weight, height and circumferences at the narrowest part of the waist and the broadest part of the hip were recorded, and the BMI and waist/hip ratio were calculated.

The data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Analysis of variance (one-way ANOVA), correlation analysis, χ^2 and odds ratio were applied.

RESULTS

Significantly higher values of TC ($F_{(1,203)}$ = 9.372, p = 0.003), LDL-C ($F_{(1,203)}$ = 11.932, p = 0.001) and TC/HDL-C ($F_{(1,203)}$ = 6.310, p = 0.013) in subjects falling into the heat exposed group were found (Fig. 1). The interrelations between the studied lipid indices were well expressed. Also, the TC correlated significantly with the age (r=.19, p=0.03) and duration of work in hot environments (r=.22, p=0.01). Similar correlation relations with the age and work duration in hot environments were found for LDL-C (r=.17, p=0.05 and r=.19, p=0.03 respectively).

Significantly higher rate of TC > 5.2 mmol/l, LDL-C > 3.4 mmol/l and TC/HDL-C ratio >5 was found with the heat exposed group, with the highest significance for LDL-C (Table 1). The odds ratios indicated higher risk in the heat exposed workers of becoming dyslipidemic [for TC OR=1.481 (1.097–2.002) and for LDL-C OR= 1.539 (1,123–2.111)].

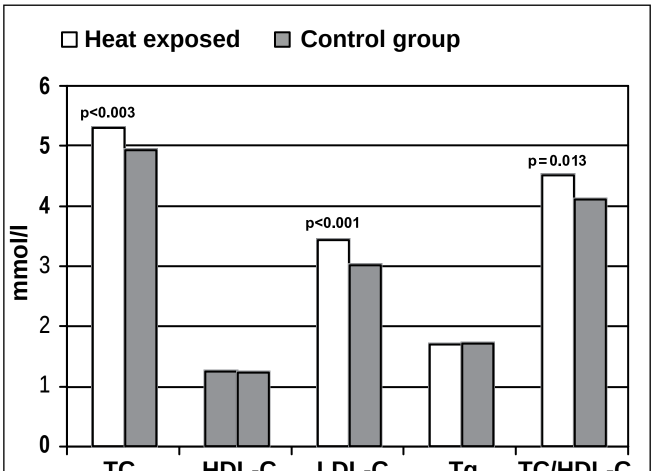

Fig. 1. Lipid profile in heat exposed industrial workers and control group.

No significant differences for both systolic and diastolic blood pressure (Table 2) between the heat exposed industrial workers and the control group were found. The BMI was slightly higher in the heat exposed workers, but the difference did not reach significance. The waist/hip ratio did not show differences between the studied groups, too. The rate of smoking was high in both studied groups, higher in the control one (48.3% v.s. 46.4% in the heat exposed workers). There were no considerable differences in the self reported degree of smoking (24.3% of the heat exposed workers smoked 10–20 cigarettes/day and 15.9 % more than 20 cigarettes/day while in the control group 27.8 % smoked 10–20 cigarettes/day and 16.2% more than 20 cigarettes/day). 16.8% of the heat exposed workers had smoked for more than 20 years v.s. 18.3% of the control group. There was no difference in the proportion of self reported drinkers between the investigated groups, nor in the number of beverages per week among the alcohol users.

Table 1. *Frequency of level of serum lipids indicating cardiovascular disease risk in heat exposed industrial workers.*

Indices	Heat exposed group	Control group	χ^2	Corrected χ^2	P
TC > 5.2 mmol/l	52.9 %	34.3 %	7.195	7.160	.007
HDL-C < 1 mmol/l	23.5 %	22.5 %	0.028	0.028	NS
LDL-C > 3.4 mmol/l	50.0 %	30.4 %	8.157	8.117	.004
Triacylglycerols > 1.7 mmol/l	34.3 %	36.3 %	0.086	0.085	NS
TC/HDL-C > 5	39.6 %	22.2 %	7.062	7.026	.008

Table 2. *Arterial pressure and anthropometric characteristics of heat exposed industrial workers and control group*

Indices/ Groups	Heat exposed workers	Control group
Systolic blood pressure (mmHg)	129.3 ± 17.1	126.3 ± 19.5
Diastolic blood pressure (mmHg)	84.1 ± 10.5	81.9 ± 11.3
BMI (kg/m^2)	26.5 ± 4.3	26.6 ± 3.9
Waist/hip ratio	0.89 ± 0.09	0.9 ± 0.07

DISCUSSION

The present study confirmed our previous findings (6, 7) concerning the higher rate of dyslipidemia in heat exposed industrial workers. Our data show significantly higher values of TC, LDL-C and TC/HDL-C among the studied heat exposed industrial workers in comparison to the control group. The study comprised only male subjects, adjusted for age and social status, found to be important confounders (12). The arterial pressure and anthropometric variables were followed and showed no significant differences between the studied groups. The self-reported frequency of smoking, the intensity and duration of smoking and alcohol consumption did not differ between the groups, too.

The shift work can contribute to dyslipidemia with desynchronization of meal uptake and metabolism (13, 14) and that is why the heat exposed subjects and the control group were matched for shift schedules. The studied groups did not differ in terms of the shiftwork duration. The work load and psychosocial factors were controlled, too (unpublished data). The risk of becoming dyslipidemic was greater for the heat exposed subjects as proved by odds ratio, with the greatest significance for LDL-C, followed by TC. We suppose that the variations of TC and LDL-C were mediated to some extent by the stress system. Data for marked increase in the secretion rates of cortisol and catecholamines under overheat have been reported (15, 16, 17). The occupational stress related cortisol secretion has been shown to interact with cardiovascular risk factors (18, 19, 20).

We would like to mention that the TC and LDL-C correlated more significantly with the work duration in hot environments than with the age of the exposed workers, but no discrimination between the age and work duration in hot environments could be carried out during our study.

Summing up, our data suggest that the long term work in hot environments is associated with greater chance of becoming dyslipidemic. Significantly higher values of TC, LDL-C and TC/HDL-C were found with the heat exposed industrial workers in comparison to the control group. The extent of the unfavorable changes in the serum lipids was related to the duration of the work in hot environments. Regular screening of lipid profile in heat exposed workers is recommended with its frequency increasing with the duration of work in hot environments.

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