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CARDIAC ARRHYTHMIA IN WOMEN PERFORMING HEAVY PHYSICAL WORK

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Abstract: The objective of this work was to determine the response of the circulatory system to heavy physical work (the average energy expenditure was about 5000 kJ/shift). The tests were performed on a group of 35 women aged between 24 and 50 years, employed at a printing office as printing machine operators. The average length of employment for the group was 17 years (3–28 years). A 24-hour Holter ECG recording was taken on these women with the aid of an Oxford Medilog 3000 system. Before and after each recording, the arterial blood pressure was measured. Based on the ECG recordings, the heart rates during work, leisure time and sleep were calculated and the morphologies of the recordings were evaluated. In the group investigated, the abnormaity in 24-hour ECG recordings classified as pathology, were found in 9 women within this group. Frequent ventricular premature beats (ExV) occurred in 3 women, ventricular bigeminy in 1 women, and single R/T excitations in 1 women. Frequent premature supraventricular extrasystols (ExSV) were found in 4 women, and within this number, in 1 woman both those heart rhythm disturbances were found. The heart rhythm disturbances occurred in connection with the performed physical task. Sinusal pauses were found in 2 women and A-V Mobitz II block was found in 1 women within the group investigated. Those changes occurred at night. No resting ECG changes were observed. The high frequency of occurrence of pathological changes in the group investigated indicates that the careful control of the state of the circulatory system in people performing heavy physical work is required.

INTRODUCTION

Recently, it has been found that the development of cardiovascular diseases (CVD) is greatly influenced by factors associated with occupational activities, including both chemical and physical agents in the work environment and the type

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of work performed (1, 33). It is generally presumed that the nervous and emotional stress connected with the managerial function is one of the factors that may increase the incidence of CVD, particularly ischaemic heart disease. The results of tests performed in this respect in different occupational groups are inconsistent (14, 17, 20, 25). There, however, exists a proven relationship between work monotony and forced work rhythm, and limited decision-making and work process control. This relationship is believed to lead to an increased incidence of CVD. In workers performing such work for 10 years (e.g. in assembly line workers) the risk of myocardial infarction is 1.5 times higher for men, and 1.4 for women (6, 36, 43) comparable to that associated with tobacco smoking and hypercholesterolaemia (23, 43). The risk of CVD is influenced by work-related difficulties in maintaining good interpersonal relations. This factor is particularly significant with reference to women workers (9, 21). Other risk factors indirectly associated with occupational activities include a low social status, a low level of education and a lack of workplace social support (25, 28, 37, 44).

Another problem is the effect of heavy physical load, especially a static one, experienced during occupational activities, on the circulatory system. This is particularly dangerous for people with a lowered coronary reverse. It has been found that in people performing heavy physical work for more than 20 years, the CVD incidence rate is 5.4%, whereas for people employed elsewhere it amounts only to 1.1% (17). This finding may point to the detrimental effect of occupational physical effort (16, 18, 41). The negative effects of the lack of physical activity on CVD development have been well documented in literature (11, 24). On the other hand, physical effort, especially of the non-occupational type, is considered to be beneficial for the functioning of the circulatory system, although its role in preventing CVD, especially in women, has recently become a matter of dispute (2, 13, 29, 39, 40). The bulk of data, however, is based on the analysis of registered cases and deaths from CVD and, therefore, does not refer to those people in whom ECG abnormalities appear chiefly during work and are difficult to detect during rest.

We have, therefore, undertaken research to determine the reaction of the circulatory system to heavy physical work. The study is a part of a comprehensive research project on developing complex methodology for workload measurements at modern workposts, and which considers physical and mental loads in different occupational groups.

MATERIALS AND METHODS

The subjects were 35 women, aged 24–55 years, employed as printing machine operators and performing heavy physical work with energy expenditure equal to or higher than 5000 kJ during a workshift. The energy expenditure was determined by using the indirect calorimetry method from the measurements for exygen demand during work, performance. The subjects were selected for the study by the in-plant occupational physician who evaluated their health conditon and certified capability for heavy physical work. Detailed data on the test group are presented in Table 1.

A 24-hour Holter ECG monitoring was performed using an Oxford Medilog 3000 system from two bipolar CM5 and CS1 leads. During the ECG monitoring, the subjects took notes about the character and exact duration of the tasks performed. The ECG records were evaluated automatically at a tape speed 60 times higher than

Table 1. Characteristics of the group examined

	Number of subjects		Age (years)	Duration of employment (years)	Weight (kg)	Height (cm)	Blood pressure (mm Hg)		Heart rate (beat/min) during		
							systolic	diastolic	work	leisure time	sleep
Total group	35	avg	40.7	17.8	67.9	162.7	136.7	86.9	94.2	89.1	68.1
		SD	7.5	7.4	12.0	7.0	21.9	10.4	8.6	8.2	4.9
ECG with abnormalities	9	avg	40.0	16.5	70.0	165.3	140.5	87.3	92.9	86.6	66.8
		SD	6.3	6.9	15.5	7.1	15.3	6.9	7.4	9.5	4.5
conduction disturbances	3	avg	37.3	13.3	70.7	165.3	131.7	91.6	92.5	89.8	65.7
		SD	7.1	5.0	20.8	5.4	18.4	6.2	7.6	11.9	2.5
rhythm disturbances	6	avg	40.9	17.8	69.8	165.3	143.7	85.6	93.0	85.4	67.3
		SD	5.7	7.1	13.0	7.7	12.4	6.3	7.3	8.0	4.9
normal ECG	26	avg	41.0	18.4	67.0	161.5	135.0	86.7	94.8	90.2	68.7
		SD	8.0	7.6	9.6	6.6	24.2	11.6	9.1	7.2	5.0

that employed during recording, and then proof-read to verify the occurrence of heart rhythm, conduction and repolarization disturbances. ECG records were classified as pathological according to Bjerregaard's recommendations (4). The heart rate was, in addition, determined during work (HR work), after work (HR home) and during sleep (HR sleep), using Cardio Soft software by Temed, Zabrze Poland. Before and after ECG recording each subject had their blood pressure measured in sitting position, using a mercury sphigmomanometer. The values of 160 mm for the systolic and 95 mm for the diastolic pressures were assumed to be the upper limits within normal values (49).

The body weight measurements, without shoes or overcoat were performed on medical scales. The subject' overweight was determined by comparing the body weight of the examined persons with reference tables of correct body weight for different body build types and heights (42).

A survey on leisure-time activities, which was described in detail in the previous paper (27), was also conducted.

RESULTS

Out of 35 women studied, dysrhythmia or conduction disturbances, classified as pathological, were found in the 24-hour ECG recordings of 9 subjects (Table 2). No subject showed repolarization disturbances. Premature supraventricular extra-

Table 2. Abnormalities found in 24-hour ECG recordings among group of 35 women examined

Subjects & their age (years)	Heart rhythm disturbances			Subjects & their age (years)	Conduction disturbances
	SVPBs	VPBs	Lown's Scale		
1.H.G. (47)	⩾ 50	⩾ 100 bigem	III	1.B.K. (35)	SP > 2100 ms
2.S.H. (49)		⩾ 100	III	2.K.S. (39)	SP > 2100 ms
3.B.R. (34)		R/T bigem	V	3.K.J. (32)	Blok AV II .Mobitz II (2:1)
4.S.B. (24)	⩾50				
5.K.U. (38)	⩾ 50				
6.K.A. (49)	⩾ 200				

ECG classified as pathological according to the standards adopted by the 3rd International Symposium on Holter Monitoring-Vienna 1988 (4).

Lown's categories (8)
I – occasional ventricular premature beats (VPBs)
II – frequent VPBs ⩾ 30/hour or 1/min
III – multiform VPBs
IV – repetitive VPBs
IVa – pairs (consecutive ectopics)
IVb – runs (3 or more in sequence)
V – early VPBs (R on T)

SVPBs — supraventricular premature beats.

systoles occurred in 4 and premature ventriculatr beats in 3 subjects: ventricular bigeminy in 1, single R/T contractions in 1, and both premature ventricular and supraventricular extrasystoles in 1. These disturbances always coincided with physical stress (mostly during occupational activities).

Conduction disturbances occurred at night: in 2 cases these included sinsual pauses exceeding 2000 ms and in 1 case a A–V Mobitz II (2:1) block.

The subjects with conduction disturbances were younger than the others, but the mean age for the subjects with heart arrhythmia did not differ from that of the whole group. For the subjects with heart dysrhythmia the period of employment, ranging from 8 to 12 years (mean 10 years) was also similar to that of the whole group (Table 1).

In all the test groups, the heart rate was higher during occupational activities than at leisure; the differences, however, were not statistically significant (Kolmogorov-Smirnov test). The heart rate during work (HR work) in all groups was almost the same but slightly higher values were found in persons with no abnormalities in the ECG recordings. In leisure-time, however, when the women examined were usually carrying out housework, the heart rate was the lowest in women with heart rhythm disturbances and the highest in healthy persons. The subjects with heart rhythm disturbances, who developed fatigue after work avoided heavy physical work at home. As seen from the subject's notes and the survey this group was not loaded with heavy household duties and had remarkably more leisure-time than other professional groups ($27.5^{1}/_{2}\,8.8$ h/shift). Their leisure-time was spent mostly on non-active relaxation. Detailed data on the non-professional activities of the subjects as compared with other professional groups was published in previous reports (27). During sleep, the lowest heart rates were observed in subjects with conduction disturbances. In no instance, however, the differences were statistically significant (Table 1).

Average blood pressure values, both systolic and diastolic, were normal. However, among the subjects who did not show any significant changes in the Holter ECG recordings, the elevated blood pressure was found in 5 subjects, one of whom had been treated for hypertension in the past. Among the subjects with heart rhythm disturbances, only one had the elevated blood pressure (175/95). In subjects with conduction disorders, arterial blood pressure was lower than in the remaining subjects (Table 1).

Overweight was found in 21 (60%) women examined. An overweight in excess of 20% to correct body weight which, according to Tatoń, is considered to be obesity, was found in 6 women, 10–20% overweight in 9, and below 10% in 6 women. In the group with Holter ECG abnormalities, the normal weight/overweight proportion was similar to that in the whole test group.

Many of the group were habitual cigarette smokers; 24 subjects admitted to be smokers, including 10 who smoked more than 20 cigarettes daily, while the ramaining ones smoked 10 cigarettes daily. Only 4 people smoked for a period shorter than 10 years (5 to 9 years). In the group of 12 subjects with heart rhythm and conduction disorders, the proportion of women smokers was still higher (8 smokers).

DISCUSSION

From the papers on the analysis of ambulatory Holter ECG recordings appears that the occurrence of heart rthythm disturbances is not always considered to be pathology (7, 15, 32). Premature ventricular extrasystoles (up to 10 per 24 hours) were found to occur, depending on the source of data, in 17–76% of healthy people and 10–50 ExV per 24 hours in 32% of people. Supraventricular extrasystolia (20 ExSV per 24 hours) were more common and occurred in 17–92% of males and 39% of females examined (12, 30). The frequency of these two types of heart rhythm disturbances increased with age (30, 34, 46).

In the group of women examined, however, we found heart rhythm disturbances, whose type and number in individual women indicated pathology. It is worth noting that no heart rhythm disturbances had been detected in routine ECG recordings in women who experienced those disturbances during the 24-hour Holter recording; repeated Holter ECG recordings, however, confirmed the existence of the disturbances.

The pathologies observed in Holter ECG seem to be associated with heavy physical work as we have also found similar results in the group of males performing heavy physical tasks (35). However, in those professions where work performance is characterized by smaller energy expenditure (shop-attendants and textile machine operators) the percentage of persons with Holter ECG abnormality was much lower – about 7% (5).

The background of the ECG changes observed in our study is not clear. The increased activity of the adrenergic system associated with physical effort, which was proven by an elevated noradrenaline and adrenaline concentration in blood and which was particularly pronounced during static physical effort may be one of the possible explanations for the described disturbances. It is known that an increase in the myocardial noradrenaline concentration may lead to ventricular heart rhythm disturbances, including ventricular tachycardia (VT) (45, 48). An additional elevation of the noradrenaline level may also be associated with myocardial anoxia caused both by atherosclerotic changes and by coronary vessel contraction resulting from physical (pain) or mental (fear, sense of danger) stimuli. What is more, anoxia increases heart susceptibility to the arythmogenic action of noradrenaline (38, 47). The coexistence of heavy physical effort and stressogenic work-related stimuli (e.g. limited ability to control the work process) may be an explanation of the heart rhythm disturbances observed by us during occupational activities, as well as of the absence of pathological changes in the resting ECG. The heart arrhythmia has already been observed in people with no organic changes in the circulatory system under stressful conditions, such as addressing the public, car racing or while undergoing psychological test (47). The disturbances of the automatism of the sinus node and the atrioventricular block were found to occur in young women during their sleep and, in our opinion, it may be atrtributable to vagotonia which is characteristic of sleep, and to the adaptation to heavy physical work. Changes of that type, although considered to be pathological in the general population according to generally accepted standards, may sometimes appear in healthy people, especially in those subjected to heavy physical effort, e.g. in sportsmen (3, 10, 22, 26, 31).

The arterial blood hypertension found in many of the subjects is, in our opinion, also largely attributable to heavy physical efforts, especially those of the static type.

This could be the reason why hypertension was much more frequent in this group of subjects than in the age-matched female population of textile workers in Lodz (19). Our results indicate that great care is required in selecting candidates for heavy physical work, in addition to carrying out a thorough examination of their circulatory function, with special emphasis on the system's reaction to physical effort.

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