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Prevalence of selected metabolic disorders in populations differentiated by physical activity level

In 1995 Zbigniew Jethon presented a list of biological mechanisms through which physical exercise can contribute to the prevention of ischaemic heart disease (9). On his long list there were, among others, increased insulin tolerance (an increase in the number of insulin receptors), intensification of carbohydrates metabolism and slowing of coronary vessel atheromatosis progression. It can be presumed, therefore, that increased physical activity reduces the probability of metabolic disturbances occurrence, especially these from the constellation of the Raven syndrome.

The aim of the study was to compare the prevalence of obesity, glucose tolerance disorders, dyslipidaemia, and arterial hypertension in groups of people significantly differing in the level of physical activity.

MATERIAL AND METHODS

The analysis covered the data gathered during the epidemiological study carried out by the team from Family Medicine Department on the territory of the former Lublin Province in 1998–2001 within the framework of the multicenter study program "Epidemiology of Type 2 Diabetes in a Well Demographically Defined Part of Population of 100–200 thousand persons, with random sample at the level of 3–5% of population aged 35 and more" co-financed by KBN (Committee of Scientific Studies) (10).

1,809 inhabitants of the Lublin town and 1,973 inhabitants of the Lublin Region countryside were examined. Medical history of all the examined persons was taken in the form of a standardized questionnaire that contained, among others, questions about their professional activity and physical efforts outside work. Subjects evaluated the level of effort during their work. They were asked about the sports practised at the time of the study and in the past. The analysed parts of the questionnaire are presented in Figure 1.

The subjects were measured and weighed and their body mass index (BMI) was calculated. Their arterial blood pressure in the sitting position after 10 minutes of rest was determined three times. Fasting blood samples were taken from basilica vein to determine the glucose concentration levels. Glycaemia was also measured 2 h after a 75 g oral glucose load in the subjects who had had no previous diabetes history and in whom fasting glycaemia did not exceed 8 mmol/l (144 mg/dl). Glucose concentration level was measured in full blood by means of Roche's Glucotrend glucometer.

According to our studies, such method guarantees the repeatability of results and the glucometer is a practical tool in epidemiological research (13). Total cholesterol (TC), HDL-cholesterol (HDL) and triglycerides (TG) were determined by means of the enzymatic method in fasting blood plasma taken from basilica vein. Concentration of the LDL-cholesterol (LDL) was calculated by means of the Friedewald formula (6).

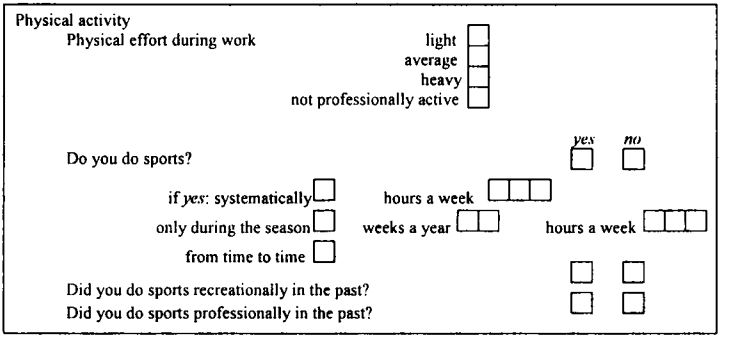

Fig. 1

Obesity was recognised in accordance with the WHO criteria at BMI ≥ 30 kg/m² (15). Arterial hypertension was assumed at ≥ 140 mmHg for systolic pressure or at ≥ 90 mmHg for diastolic pressure that would last for at least two measurements (17). Glucose tolerance disorders were recognised according to the 1985 WHO criteria (16). Type 2 diabetes (DM2) was diagnosed when the fasting blood glucose was ≥ 6.7 mmol/l (120 mg/dl) and/or was ≥ 10 mmol/l (180 mg/dl) in the 120th min after the oral glucose load. Impaired glucose tolerance (IGT) was diagnosed at the fasting glycaemia level < 6.7 mmol/l (120 mg/dl) and between ≥ 6.7 mmol/l (120 mg/dl) and < 10 mmol/l (180 mg/dl) in the 120th min after the oral glucose load. Concentration of TC ≥ 5.2 mmol/l (200 mg/dl), LDL ≥ 3.5 mmol/l (135 mg/dl), HDL < 1 mmol/l (39 mg/dl) for women and < 0.9 mmol/l (35 mg/dl) for men, TG ≥ 2.3 mmol/l (200 mg/dl) were assumed to be pathological values (4).

Based on the medical history, the following groups were selected: (1) describing their physical effort at work as light (300 persons) and (2) describing it as heavy (300 persons) and (A) declaring that they had never done any sports (500 persons) and (B) declaring current practising of sports (systematically or seasonally) and in the past (recreationally or professionally) (200 persons). Prevalence rate of obesity, arterial hypertension, IGT, DM2, hipercholesterolaemia, hipo-HDL-cholesterolaemia, hiper-LDL-cholesterolaemia and hipertriglycerideamia were compared in groups 1 and 2 as well as A and B.

Statistical analysis was performed by means of the Chi square test, assuming $p < 0.05$ as the significance level.

RESULTS

Prevalence of the studied metabolic disorders in groups 1 and 2 are presented in Table 1, in groups A and B – in Table 2.

Table 1. Prevalence of the studied metabolic disorders in the groups differentiated by physical activity at work

	Light work n = 300		Hard work n = 300		p
	x	%	x	%	
Obesity	77	26	80	27	ns
Arterial hypertension	172	57	172	57	ns
IGT	60	20	78	26	ns
DM2	36	12	24	8	ns
TC ≥ 5.2 mmol/l	182	61	164	55	ns
Hypo-HDL-cholesterolaemia	76	25	54	18	<0.05
LDL ≥ 3.5 mmol/l	158	53	140	47	ns
TG ≥ 2.3 mmol/l	63	21	51	17	ns

ns – statistically insignificant

Table 2. Prevalence of the studied metabolic disorders in the groups differentiated by practising sports

	Practising sports n = 500		Not practising sports n = 200		p
	x	%	x	%	
Obesity	134	27	36	18	p<0.02
Arterial hypertension	287	57	124	62	ns
IGT	99	20	33	17	ns
DM2	44	9	17	9	ns
TC ≥5.2 mmol/l	305	61	116	58	ns
Hypo-HDL-cholesterolaemia	97	19	43	22	ns
LDL ≥ 3.5 mmol/l	250	50	97	49	ns
TG ≥ 2.3 mmol/l	86	17	40	20	ns

ns – statistically insignificant

DISCUSSION

As it can be seen from the Tables, in the groups of lower physical activity we usually found higher frequency of metabolic disorders, yet in most of the cases these differences were not statistically significant. Statistical significance features were present only in the correlation of the heavy physical work and the lower frequency of hypo-HDL-cholesterolaemia occurrence and sport with lower obesity prevalence. Lack of statistical significance may result from the too small size of the compared groups or from the fact that the subjects were not able to objectively evaluate their physical activity.

On the basis of our work, it is also not possible to state whether doing sports can prevent from the development of obesity or if the slimmer persons are more willing to practice sports. It is beyond any doubt, however, that during the physical effort metabolism is increased, and the acceleration of the resting metabolism lasts even long hours after exercises. This leads to the increase in energy expenditure, which in turn causes the decrease in fat ratio and reduction of the body mass. The fact that people regularly involved in various forms of physical activities in their free time are slimmer than these relaxing in a passive manner has been proved, among others, by Tremblay (14).

Reduction of arterial blood pressure in persons actively practising sports is probably the result of the lowering of the catecholamine level and – indirectly – through the body mass reduction. The

preventive effect of the physical activity on the arterial hypertension regardless of the sex and weight category was convincingly proved by Gang Hu in the 11-year prospective study on 17 thousands of the Finnish aged 25–64 (8). According to Blair, persons who are not physically active are subject to 30–50% higher risk of developing arterial hypertension (3).

The increase in the insulin sensitiveness and improvement of glucose tolerance are achieved through the activation of the skeletal muscles. Such effect, which can last for up to 72 hours, can be proved already after a single instance of long physical effort. After the regular physical exercises are stopped, the effect disappears within 2 weeks. In many retrospective, as well as in some prospective studies more frequent occurrence of DM2 and IGT was found in persons who were not physically active. Unfortunately, most of these studies were, as ours was, of a cross sectional and indirect nature. However, the results of a 5-year prospective study by Manson carried out on 21,271 American doctors, where he proved that the physical activity reduces the risk of developing DM2 regardless of the body mass index, seem to be convincing. This correlation was especially pronounced among the obese and was increasing along with the increase in the frequency of the undertaken physical effort (11).

It is usually stated that the non-active way of life causes the 1.35–1.45-fold increase of DM2 risk. Hu et al. showed that moderate physical effort or high physical activeness at work is related – for both women and men – with decreasing the diabetes development risk by 24–43%; physical activity on the way to and from work is also related with the decrease in diabetes development risk by 25–58% and active spending of free time is related with a drop in DM2 development risk of 37–48% (7).

Effort, through the activation of lipolysis in the fatty tissue, 'mobilizes' fatty acids and uses them in the metabolism. Many studies have proved that increased physical activity prevents lipid balance disorders. Cardoso work, for instance, showed that both men and women who took part in sports competitively had significantly lower triglycerides and higher HDL-cholesterol concentration levels than subjects from the control group that did not practice sports. Moreover, men doing sports had significantly lower LDL-cholesterol level. Prevalence of hypercholesterolaemia, hyper-LDL-cholesterolaemia, hypo-HDL-cholesterolaemia and hypertriglyceridaemia was lower in sportsmen/sportswomen but only the occurrence of hypercholesterolaemia was significantly less frequent (4). Fransson proved significantly higher HDL-cholesterol both in subjects physically active at work and in these actively spending their free time, as well as in women who did their house chores on their own (5).

CONCLUSIONS

The study proved that hypo-HDL-cholesterolaemia is less frequent in hard working subjects and obesity was less frequent in subjects practicing sports. Despite the fact that the physical activity did not significantly correlate with lower prevalence of the remaining metabolic disorders, its role in the prevention of ischaemic heart disease seems to be irreplaceable.

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SUMMARY

Many of papers show that a regular, increased physical activity prevents the development of ischaemic heart disease. One of probable mechanisms of that phenomenon can be a favourable influence of effort on reduction of metabolic disturbances – the elements of the syndrome X – accelerating the development of atheromatosis and thus speeding up the development of coronary disease. The study was to compare glucose tolerance disorders, dyslipidemia and arterial hypertension prevalence in groups with significant differences of physical activity. We analysed data obtained from persons examined in our epidemiological investigations of former Lublin Voivodship (province) in the years 1998–2001. Physical activity of the examined subjects was estimated on the basis of data from a questionnaire. We compared prevalence of obesity (BMI $\geq$ 30 kg/m^2), impaired glucose tolerance (IGT) and type 2 diabetes (DM 2) (diagnosed earlier or on the basis of the 1985 WHO criteria with the oral glucose tolerance test), hypo-HDL-cholesterolemia (HDL < 1 mmol/l in women and < 0.9 mmol/l in men), hypertriglyceridemia (TG $\geq$ 2.3 mmol/l) and hypertension (RR $\geq$ 140/90) in groups: 1) qualifying one's own physical effort during work as heavy (300 persons) and 2) qualifying one's

own physical effort during work {composition} as light (300 persons) and in groups 1) practising sport at the time of study (systematically or seasonally) and in the past (professionally or as amateurs) (200 persons) and 2) never practising sport (500 persons). Groups were comparable in respect of sex and age. Statistical analysis was performed with the Chi square test. We found a lower frequency of metabolic disturbances in groups with higher physical activities, however most of these were not statistically essential. Features of statistical accuracy had only correlation of heavy physical work with less prevalence of hypo-HDL-cholesterolemia and of sport with less prevalence of obesity. We showed that hard working persons have hypo-HDL-cholesterolemia less frequently and that persons practising sports are less frequently obese.

Rozpowszechnienie wybranych zaburzeń metabolicznych w grupach o zróżnicowanym poziomie aktywności fizycznej

Wiele prac wskazuje na to, że systematyczna, zwiększona aktywność fizyczna zapobiega rozwojowi choroby niedokrwiennej serca. Jednym ze sprawiających to mechanizmów jest korzystny wpływ wysiłku na redukcję zaburzeń metabolicznych - elementów zespołu X – przyśpieszających rozwój miażdżycy, a tym samym choroby wieńcowej. Celem pracy było porównanie częstości występowania otyłości, zaburzeń tolerancji glukozy, dyslipidemii i nadciśnienia tętniczego w grupach o znacznie zróżnicowanej aktywności fizycznej. Analizą objęte zostały dane uzyskane od osób w trakcie badań epidemiologicznych prowadzonych przez pracowników Zakładu POZ na terenie dawnego województwa lubelskiego w latach 1998–2001. Aktywność fizyczną badanych ustalono na podstawie wywiadu opracowanego w formie ankiety. Porównano rozpowszechnienie otyłości (BMI $\geq$ 30 kg/m^2), upośledzonej tolerancji glukozy (IGT) i cukrzycy typu 2 (DM 2) (zdiagnozowanej wcześniej lub w oparciu o kryteria WHO z roku 1985 na podstawie doustnego testu obciążenia 75 gramami glukozy), hypo-HDL-cholesterolemii (HDL < 1 mmol/l u kobiet i < 0,9 mmol/l u mężczyzn) oraz hypertrójgliceridemii (TG $\geq$ 2,3 mmol/l) i nadciśnienia tętniczego (RR $\geq$ 140/90) w grupach: 1) określającej swój wysiłek fizyczny w czasie pracy jako ciężki (300 osób) i 2) określającej swój wysiłek fizyczny w czasie pracy jako lekki (300 osób) i w grupach: 1) uprawiającej sport na bieżąco (systematycznie lub sezonowo) i w przeszłości (rekreacyjnie lub zawodniczo) (200 osób) i 2) nigdy nieuprawiającej sportu (500 osób). Grupy były porównywalne pod względem płci i wieku. Analizy statystycznej dokonano przy pomocy testu Chi kwadrat. Stwierdziliśmy mniejszą częstość zaburzeń metabolicznych w grupach o większej aktywności fizycznej, jednak w większości przypadków różnice te nie były istotne statystycznie. Cechy istotności statystycznej miała jedynie korelacja ciężkiej pracy fizycznej z mniejszą częstością występowania hypo-HDL-cholesterolemii i sportu z mniejszym rozpowszechnieniem otyłości. Wykazano, że u osób ciężko pracujących rzadziej występuje hipo-HDL-cholesterolemia, a u osób uprawiających sport rzadziej występuje otyłość.