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THERAPEUTIC ASPECTS OF INDIVIDUALLY MEASURED PHYSICAL ACTIVITY

Abstract: Insulin resistance (IR) with resultant hyperinsulinism is basically the origin of the development process from obesity to insulin-independent diabetes mellitus (NIDDM). This process contributes to a reduced physical activity that is manifested in a reduced physical ability. Under the influence of a regular individually measured physical activity of aerobic character, it is possible to increase biological efficiency of insulin and affect the process of early and evolutive atherosclerosis. Finding a more effective program of physical activity for preventing these processes is the goal of their preventive and therapeutic application.

Key words: obesity, insulin resistance, insulin-independent diabetes mellitus, physical activity, physical activity program

Introduction

The first written records about the effects of physical activity on health come from Kung Fu from ancient China and are about 500 years old. Only at the end of the last century the first scientific study on the impact of physical activity on health was published. To this aim, the criteria for the measured physical activity for health purpers has been established (1). Sedatery lifestyle prevailes in Western countries tending to spread over developing countries. A rise in chronic degenerative diseases such as cardiovascular, metabolic, hormonal, musculoskeletal system and diseases whose etiology may be associated with a reduced physical activity has been registered (1, 2). By definition, hypokinesia is insufficient level of active walking. The basic features of hypokinesy is a level of physical activity that is below the chronic irritation that allows the maintenance of functional capacity of most organ systems (3).

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Physiological characteristics of aerobic capacity

In practice, physical work capacity is often identified with aerobic capacity, and the maximal oxygen uptake (V02)max which is expressed in l/min, ml/kg/min or Matt's. The most important symptom of hypokinesy is a decrease in aerobic capacity wich is followed by the decrease in physiological and morphological processes in the body, especially those that use oxygen as an energy source during submaximal work intensity (4, 5). A reduced physical activity causes morphological and functional changes in the body, leading to a decreased muscle mass, muscle tone and strength, reduced muscle capillary density and a number of mitochondria and oxidative enzymes. Reduction in myocardial mass results in a decrease in stroke volume of the heart with increasing heart rate. It also reduces concentration of lipoprotein lipase, and increases a total and LDL cholesterol, triglycerides, reduced HDL cholesterol. A reduced number, sensitivity and efficiency of insulin receptors leads to hyperinsulinemia and hyperglycemia (2, 5, 6). Recent studies have shown an association between decreased physical activity and increased incidence of lung cancer, colon, ovarian, breast and prostate cancer (7, 8-10).

It can be concluded that the effect of low level of aerobic capacity is independent risk factor for cardiovascular, metabolic and some malignant diseases.

To eradicate adverse health effects of physical inactivity it is necessary to achieve and maintain the average level of physical fitness. All age groups must do certain physical activity to maintain "physiological fitness," which implies the optimal performance of the metabolism of fats, carbohydrates, and body mass index and functional ability of the organism (11). People function, look and feel better when lead an active life (WHO 1998) (9).

Principles of programming physical activity for health purposes

Health effects of physical activity can be expected only when there are no contraindications for its use and when physical activity is adequately measured (12). Lack of physical activity will not cause adaptive responses necessary to achieve the appropriate health effects, while overdosed physical activity causes different forms of health damage. The major goal of physical activity for health purposes is to increase aerobic capacity (VO2)max. The program of individually measured physical activity is so designed to fit biological characteristics of a person, level of aerobic fitness and health status of program participants. This is a program of adjustment, and relates to the frequency, intensity and duration of physical activity with the use of general recommendations of the form of physical activity.

American College of Sports Medicine (ACSM) has set global principles modeling of physical activity related to the intensity, frequency and duration of physical activity of aerobic caracters (13):

1. Exercise frecvency: 3 - 5 days/week.
2. Exercise intensity: 60% -90% of maximal heart rate (HR max)[2] or 50% -85% of maximal oxygen uptake (VO2max) and maximal heart rate reserve (HRmax reserve). Maximum heart rate reserve is calculated from the difference between maximum heart rate and heart rate at rest (HRmin)[3] (Karvonen, 1957).
3. Exercise duration: 20 mijn - 60 min of continuous aerobic exercise. Duration depends on the intensity of activities so that low-intensity activity should taken longer.
4. Physical activities types: physical activities that engage large muscle groups are recommended, that can be carried out continuously and are aerobic by nature such as walking, hiking, running, jogging, biking, dancing, climbing stairs, swimming, skating and games of endurance.

In practice, the measure of intensity of load over the maximum increase in pulse rate (which is considered to be identical to the measure over (VO2) max) is determined by the use of the Karvonen formula: TP = k (fC max - fC min) + fC min, where TP = training heart rate, fC max = maximum frequency of heart rate (calculated by the formula 220 - age), fC min = value pulse in bed the morning immediately after waking. Value of coefficient k is from 0.5 to 0.85% when the training load doses range from 50% to 85% of maximal heart rate increase.

For parameters fCmin, fC max, and MPP (VO2) max in each subject makes the individual "dosimeter" for the intensity is made in the following way:

a. Using the Karvonen formula the value of training heart rate is determined that corresponds to intesity of work ranging from 40% to 80% MPP. During the sessions of physical activity we applied intensity of load on a treadmill to match the intensity of load of 45% - 55% in the phase of warming and cooling, and 55% - 70% in the phase of exercise session.
b. With regard to the intensity of exercise expressed as % MPP match %(VO2) max, for each value of training heart rate in the range of 40% -80% MPP we calculate in energy prices (VO2) max is expressed in kcal (1 / (VO2) = 5 kcal).
c. Based on the analysis of memory pulses in each session of physical activity, intensity of work performed is expressed in the average values of TP and

[2] HRmax = 220 - age.

[3] HRmin - morning pulse rate was measured in bed just after waking

% MPP (% (VO2) max) and the energy cost of sessions in the total calorie consumption.

The initial level of physical fitness is an important factor in dosing exercise intensity. Individuals with low levels of physical ability can achieve significant training effects even with the training heart rate at 40 - 50% HR max reserve. Those with higher levels of aerobic fitness, require higher intensity of load. Lower to moderate intensity of physical activity of longer duration, especially recommended to adults, sedentary due to the fact that such efforts are easier to bear and and due to the possible risks caused by high intensity physical exertion (13).

Multiplying the average intensity of effort in kcal /min and its duration in minutes, we get the total energy cost of work performed in each exercise session. It is believed that the energy requirements of individual training sessions within the exercise to increase aerobic capacity, should not be less than 150kcal (13, 14).

Modeling the program for physical activity means the way to determine the duration of each session, choose exercises that will be applied, to determine their sequence, duration and number of repetitions of each exercise. Each session is to begin by warm-up exercise, to gradually increase the intensity of effort and to end each session with a gradual "cooling" (12).

Adaptive response to regular physical activity

Many epidemiological studies have confirmed that regular, individually measured physical activity protects people against chronic diseases (9). Also, there is a diversity in the application of physical activity between nations. South Asian apply less physical activity than Europeans, which affects the higher frequency of diabetes and cardiovascular risk in this population (41-43).

Regular, individually measured physical activity of aerobic character can increase biological effectiveness of insulin. This is accomplished through several mechanisms: by increasing the number of insulin receptors, their sensitivity and efficiency, by increasing the production of glucose transpotra GLUT-4 at the cell membrane of muscle and adipose tissue (16, 17).

Already after a single lap of physical activity the number and sensitivity of insulin receptors are increases by 36% (18). After a two-week program of individually measured physical activity in patients with insulin-independent diabetes an increase in maximal oxygen uptake (VO2)max was determined to improve glycemic control and many other parameters of atherogenesis (19).

It was found that single physical activity once increases insulin stimulated consumption of glucose in healthy individuals and those with IR. These effects are short-lived, so physical activity must be repeated and applied regularly over a lon-

ger period of time to have a favorable therapeutic effect (19, 20). Effects of regular physical activity on the IR, were assessed in normal subjects and patients with type 2 diabetes, regardless of the age and obesity. In healthy individuals, under the regular aerobic exercise, insulin sensitivity may be increased to the level tipical for young sedentary persons, regardless the changes in body weight and body composition structure (21, 22).

There is a diversity in the evaluation of the effects of the applied physical activity in patients with type 2 diabetes, which could be explained by the variety of the level of IR or metabolic control. Kovisto and De Fronzo have shown that applaying physical activity improves peripheral insulin sensitivity in type 2 diabetes measured as glucose consumption during hyperinsulin euglycemic clamp. So Lampan et al. found that physical activity in subjects with IR and type 2 diabetes alone does not always improve the sensitivity of skeletal muscle to insulin, but the increased (VO2) max is most likely the condition to improve glucose metabolism and insulin (23).

De Fronzo has proved that reduction of IR depends on basal levels of inulin, before the application of physical activity. Reduction of insulin secretion after administration of physical activity is more pronounced in patients with initially high levels of insulin and C-peptide. The effect of physical activity for 3 months on insulin secretion was measured, without changes in body weight. The high level of basal insulin was reduced due to an improvement of peripheral insulin sensitivity. In relation to this group of patients in patients with type 2 diabetes and with initially low levels of insulin, despite a high degree of IR, the effect of physical activity on changes in basal insulin concentration was significantly lower. Glucose tolerance in all patients was improved due to increased peripheral insulin sensitivity. In a study in which metabolic efficiency was measured by determination of insulinaemia during stimulation for 5 hour OGTT, after a ten-day program of individually prescribed physical activity in type 2 diabetes, it was found that biological effectiveness of insulin reduction and the area under the curve stimulated increased by 33.1% with the correction of late hypersecretory peak (24).

Lampan at al. have shown that people with type 2 diabetes have a lower level (V02)max compared to healthy subjects (23, 24). In a state of poor metabolic control in diabetics, exercise does not improve maximum oxygen consumption or metabolic control, which may worsen, because these patients can not reach a sufficient intensity of physical effort that is necessary for achieving positive effects (25, 31-33).

In type 2 diabetic patients with first degree of obesity, after the first session of exercise, increased insulin stimulated glucose consumption by 22% and after six weeks of programmed muscle activity by 42% (26, 34-36). Improvement of insulin sensitivity under the influence of programmed physical activity only 12 to 48 hours after the last exercise session, virtually disappears after three to five days of rest.

In most papers it has been suggested that the increase in insulin sensitivity under the influence of programmed exercise of aerobic character is proportional to the increase in achieved aerobic fitness. Eriksson et al. have shown that a 12-week program of circuit training of individual muscle groups with load, without increasing the (VO2) max, affect the increase in insulin sensitivity by 38% (27, 28). Recent studies suggest that physical activity with load individual muscle groups, if properly selected and measured can influence the reduction of IR. These activities stimulate muscles in a way that is different from the stimulation of aerobic training and that for yet unknown mechanisms contribute to further increase the insulin-induced glucose consumption. This is the reason why the IR in the treatment is more recommended combination of aerobic exercise and circuit traning with the burden of individual muscle groups of moderate intensity, frequency of three to five sessions per week and duration of each session from 15 to 60 min (28-30).

In a survey conducted in 2000 using a two-week program of individually measured physical activity in obese insulin-dependent diabetic patients, significantly increased the aerobic capacity ($p < 0.05$) and decrease insulin resistance ($p < 0.001$) in percentage of 96.7% (4, 37-39). Increase in insulin sensitivity improves metabolic control, decreases blood glucose $p< 0.05$ by 26.43%, decreases plasma lipoprotein fractions - (triglycerides $p < 0.05$ by 21.3%, and LDL holestrola $p < 0$, 05 by 16.43%) and reduces coagulation factors (factor X $p < 0.05$ by 12.3%) with an acceleration in fibrinolysis and increased activity of PAI-1 $p < 0.01$ respectively by 30.8%. The physical activity program included sessions of walking on a treadmill, 5 days per week, duration 35 min. The sessions included 3 parts: The first part of 5 minutes warming with intensity of 45 -55% (VO) max, the second part training activity 25min work intensity of 55-75% (VO2) max and the third part cooling 5 min intensity of 45 - 55% (VO2) max. The results contributed to the finding of more efficient models of physical activity to reduce insulin resistance and the establish metabolic control in insulin-independent diabetes. These goals can be achieved even after a 14-day of the programmed individually measured physical activity (4, 37-39).

The effect of different types of physical activity is still unknown (40). The study performed by Erokssona et al. in 2003 proved that moderate and severe physical activity or occupational physical activity and recreational physical activity lead to a reduced risk of type 2 diabetes. Simultaneous use of two or three types of physical activities significantly reduces the risk of diabetes than the use of only one type of physical activity. It is believed that the optimal terapeutic approach in obese patients with type 2 diabetes is application of a combination of physical activity and caloric restrictions (41, 42).

Conclusion

To know about the wide preventive and therapeutic health effects of obtaining and maintaining the average level of physical fitness is a great achievement of modern medicine. The World Health Organizations, together with the International Association for Sports Medicine, promoted the declaration titled "Physical Activity and Health" and pointed to its global significance. The World Health Organization also promotes its principles of the application of physical activity and diet at schools. The use of healthy foods and increased physical activity among school children are also promoted for health care and prevention of diabetes (30, 31). Our aim is to implement a programmed physical activity in order to improve health (9).

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