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The physical rehabilitation for the patients with metabolic syndrome

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Abstract

Metabolic syndrome is a complex chronic disease that requires continuous medical care and in which, beyond glycemic and cardiovascular control, many strategies to reduce multifactorial risks are required.
Moderate or intense exercise is recommended by the American Diabetes Guide at all stages of diabetes and metabolic syndrome being able to prevent complications of the disease and optimize the quality of life of patients.
Movement therapy works on the pathogenic links of diabetes, hypertension, and ischemic heart disease, improving mobility, strengthening muscles, and improving the coordination and balance of these patients. The present paper specifies the practical aspects of establishing and individualizing kinetic programs in metabolic syndrome, trying to answer the questions: how much, how, and in what way is physical rehabilitation in metabolic syndrome patients performed? The principles of the kinetic programs are presented, but also the basic rules for the application of the rehabilitation program and, of course, the ways of achieving the isotonic or isometric effort in the patient with diabetes/metabolic syndrome.
Of course, the contraindications and the precautions related to the physical training of metabolic syndrome patients cannot be missing.

Keywords: Metabolic syndrome, diabetes, physical training, heating, actual training, cooling, heart training frequency, the scale of self-perception of the intensity of the effort, isotonic effort, isometric effort.

Metabolic syndrome is a complex chronic disease, requiring continuous medical care, with strategies to reduce multifactorial risks, beyond glycemic and cardiovascular control [1].

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Chronic hyperglycemia is associated with the appearance of lesions, dysfunction and insufficiency of various organs, being:

- the main cause of blindness in people aged 20-74 years [2];
- the main cause of BRC requiring renal function replacement therapy [2];
- the main cause of non-traumatic amputations [2].

The American Diabetes Association (ADA) recommends moderate or intense physical training for

patients with type 2 diabetes mellitus (DM 2) as an important factor in achieving and maintaining glycemic control [1].

Physical rehabilitation is an integral part of Diabetes Self Management Education and Support (DSMES) and should be encouraged in all patients with diabetes [3].

Physical exercise is indicated in all the evolutionary stages and is part of the therapeutic objectives in DM:

- prevention of complications;
- optimizing the quality of life;
- movement therapy acts on the pathogenic links of DM - into the SMART program (specific, measurable, achievable, realistic, in time) [4].

Physical training has stated objectives for patients with metabolic syndrome:

- improving mobility;
- strengthening muscles;
- improving coordination and balance;

The benefits of physical exercise in DM are well known and have been much studied.

The following effects of exercise are well known in the specific case of patients with diabetes:

- increases insulin sensitivity → blood glucose will be used more efficiently [5];
- increases the use of glucose in tissues;
- lowers blood sugar;
- decreases the value of glycosylated hemoglobin [6];
- improves oxygen consumption;
- improves vascular endothelial function and decreases arterial stiffness;
- lowers blood pressure;
- increases muscle strength, muscle mass;
- improves the lipid profile (decreases triglyceride levels) [6];
- weight loss [7].

These things being known, the question is how to apply kinetic programs to patients with metabolic syndrome?

The kinetic programs applied to patients with metabolic syndrome are strictly individualized, supervised, progressive and involve team work (family doctor/diabetologist/physiotherapist)

The recovery program follows a number of principles:

1. Primum non nocere;
2. Establishing the recovery objectives, the kinetic program itself but also establishing the methods for evaluating the results;
3. The precocity of instituting the kinetic therapy treatment;
4. Individualization of treatment - the patient's particularities are taken into account: age, sex, profession, patient's temperament, disease stage, disease complications;
5. The progressiveness of the kinetic program - is mandatory and of major importance:
   - in relation to the effort tolerance and the physical deconditioning of the patient;
   - the grading of the effort is done from easy to hard, from simple to complex, from known to unknown;
   - the transition to new and combined exercises is possible only after the old and simple ones have been learned;
6. Patient awareness of the effects produced by the kinetic means used but the reason why they are applied in a certain sequence;
7. The principle of independent activity - the patient must repeat physical exercises plus psycho regulation techniques outside the sessions in the recovery room;
8. The principle of motivation - involves finding ways to determine the patient to come to the gym confidently, to want physical effort and not be afraid of it [9].

Basic rules for the application of the kinetic program in metabolic syndrome:

- careful medical examination of the patient before the start of the recovery program;
- correct positioning of the patient before starting the exercise program;
- the patient must be taught to relax before starting the exercise program;
- simple terms and a calm tone should be used to explain and demonstrate the exercises;
- sudden movements that can trigger pain will be avoided;
- the maneuvers will be performed slowly and the dosing of the effort will be done carefully so as not to cause the patient to be overworked;
- wearing comfortable clothing for light exercise and pay attention to shoes;
- the patient will be permanently encouraged, following the active participation in the exercise program.

Physical training in metabolic syndrome

The physical training has 3 phases: warming up, the training itself, cooling (returning)

Warming up period

The purpose of this period is to prepare the muscles of the lower and upper limbs, but also to prepare the cardiovascular system for effort. During this

period, the heart rate (HR) must not exceed >20 beats/minute the resting heart rate (RHR) and, in absolute terms, the HR should not exceed the limit of 110/120 beats/min.

The actual training

In this period of training, there is an endurance effort.

The intensity of the effort is dependent on:

- the patient's age;
- the functional state of the cardiovascular system;
- the patient's previous physical activity.

The cooling period

In this physical training period, exercises are different or not from those in the warm-up period. A very important idea is that the cardiovascular system gradually returns to rest.

Training follow-up

The training is followed by studying two important parameters: the training heart rate (THR) and self-perception scale of exercise intensity.

Training heart rate (THR)

Training heart rate must not exceed but not to be much lower than the predetermined heart rate. The predetermined heart rate is shown in Table 1 and is a function of the patient's age both for the THR and for the maximum heart rate.

Self-perception scale of effort intensity (BORG SCALE)

The intensity of the effort must not be perceived by the patient at more than 12-14 steps (the Borg scale has 20 steps), which means a "somewhat difficult effort". Beyond this limit, the effort takes place in anaerobiosis and has no practical use in training the patient with metabolic syndrome.

Pay close attention to monitoring patients during this effort: it is mandatory to monitor blood pressure and it would be extremely useful to monitor Holter EKG [9].

Physical training parameters

The important parameters of the patients' recuperative physical training are: intensity, duration and frequency.

Training intensity:

Generally, a physical effort of 70% of the VO2 max (wave corresponding to the aerobic threshold) is considered sufficient.

Table 1. Target heart rate by age.

Target heart rate by age (years)		
Age	**Target heart rate (beats/minute)**	**Maximum heart rate (beats/minute)**
20	100-138	200
30	95-131	190
35	93-128	185
40	90-124	180
45	88-121	175
50	85-117	170
55	83-114	165
60	80-110	160
65	78-107	155
70	75-104	150

Note: ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

The intensity of the training is practically appreciated by heart rate during the effort (THR).

- 70% of V02 max - corresponds to 80% of the maximum THR achieved in the exercise test
- the THR must be 135-140 beats/minute in-patients under 40 years and 120-130 beats/minute in patients over 40 years.

There are two particular situations:

- restant angor pectoris - in this common clinical situation, THR must be at least 10 beats/minute lower than the appearance of the angina threshold.
- patients taking with β-blockers - a common situation as well, in which the THR should not be increased above 110 beats per minute because a possible decrease in the systolic flow may occur.

In order to obtain the much-desired training effect, an effort of a lower intensity can be made (in certain clinical cases, such as physical deconditioning or left ventricular failure, it is even desirable).

In these situations, a calculation formula is applied to find out the training heart rate:

THR= (60-70% MHR- RHR) +RHR

THR - Training Heart Rate

MHR - Theoretical Maximum Heart Rate

RHR - Resting Heart Rate

However, in these situations, the clinic is sovereign.

If the patient does not tolerate the HR established by calculation - lower frequencies are used and it is found that, in a longer time, the training effect is obtained.

Training duration

The training effect is obtained starting with 5 minutes. The effect increases progressively and directly proportional to the duration of the effort - up to 30 minutes. After 30 minutes, the benefit on increasing the effort capacity is small, the muscular demand is too high and the cardio-respiratory system is overloaded. These are the reasons why training is not useful to be extended beyond 30 minutes. Only in patients who have reached a good tolerance to effort - after the actual training - recreational games can be added to a lower heart rate (HR) than that achieved during training.

Training frequency

The situation indicated is 4-5 sessions/week, separated by 1 day off. Increasing the number of workouts over this value is not beneficial, but muscle discomfort is a rule. On the day off, however, the patient should do light gymnastic exercises household activities, walking. The purpose of physical therapy is that the training effect to be maintained and the capacity for effort to increase with each session.

Training methodology

There are 2 methodological variants of training:

- Continuous training - more efficient but more tiring.
- Interval training

The methodology for performing the physical rehabilitation with the help of the continuous training method is represented graphically in Figure 1.

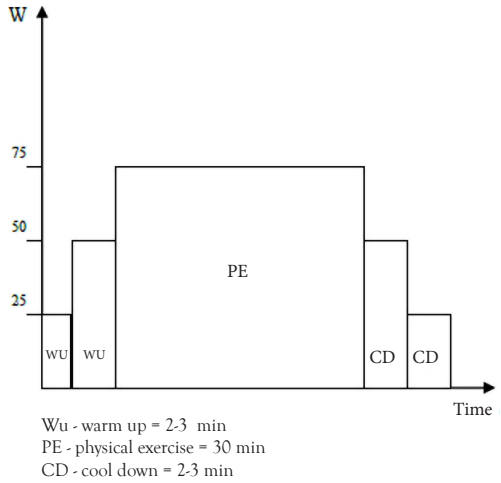

Figure 1. Continuous training.

The graph represents the training intensity expressed in watts on the ordinate, and the time expressed in minutes on the abscissa. The continuous training is carried out as follows: it starts with a warm-up period of 2-3 minutes at the intensity of 25 W and a period of 2-3 minutes at the intensity of 50 W. Then, the actual physical training period at the maximum intensity of 75 W is performed, followed by the return period, reversely, 2-3 minutes at 50 W then 2-3 minutes at 25 W.

The methodology for performing the physical rehabilitation with the help of the interval training method is graphically represented in Figure 2. The graph represents the training intensity expressed in watts on the ordinate, and the time expressed in minutes on the abscissa. The interval training (which is much more commonly used in current practice) is carried out as follows: it starts with a warm-up period of 4 minutes at an intensity of 25 W, followed by the actual physical training periods

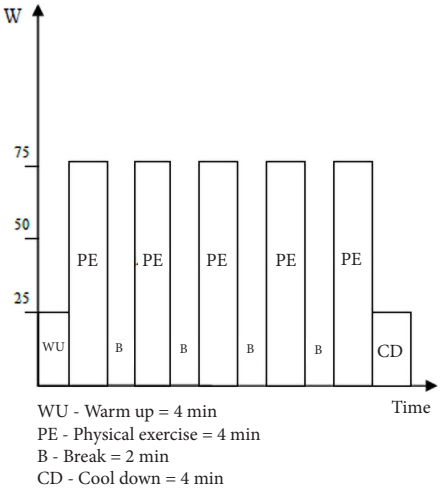

Figure 2. Interval training.

lasting 4 minutes at an intensity of 75 W. The physical training periods are interspersed with periods of 2-minute break. The return period is not neglected with time equal to the heating period (4 minutes), also at the intensity of 25 W.

Types of physical exertion

In the physical rehabilitation of patients with metabolic syndrome, the isotonic type of effort is indicated, applied mainly during the warm-up and recovery period.

Isometric effort has the potential danger of precipitation of heart rhythm disorders and the phenomena of left ventricular failure.

The isotonic effort during the actual training can be obtained with the help of:

Figure 3. Physical rehabilitation with an ergometric bicycle.

- ergometric bicycle (Figure 3)
- treadmill (Figure 4)
- rowing machine
- arm cycle ergometer

The isometric effort is represented by the physical exercises performed with lifting weights.

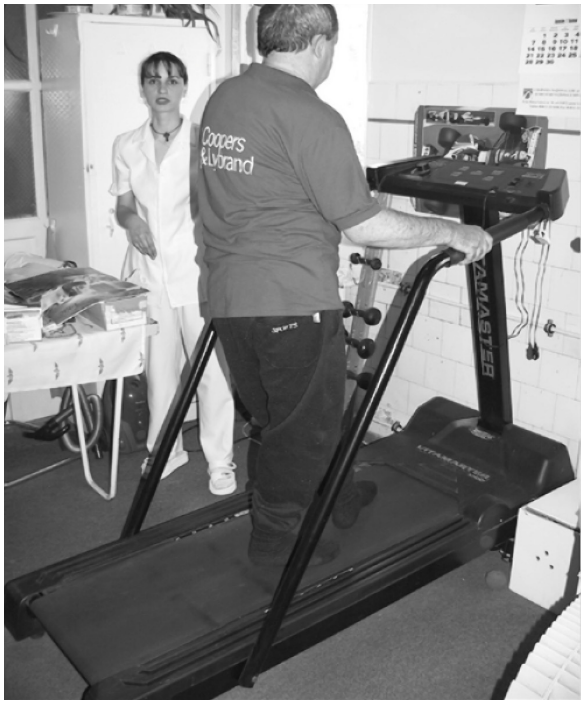

Figure 4. Physical rehabilitation on a treadmill.

Other ways to exercise

Gymnastic exercises

They are widely used in phase I of rehabilitation as well as in phase II, in the period of "heating" and "cooling" (Figure 5). Physical exercises can also

Figure 5. Gym exercises.

be used for the actual training, although the heart rate does not usually exceed 120 beats per minute (corresponding to 60% of the TMHR (theoretical maximum heart rate) but still the training effect is obtained - especially in individuals over 50 years. In this case, the exercises are longer and less vigorous.

At the end of the exercises, complex stretching programs are recommended to improve muscle properties.

Classification of gymnastic exercises types:

- breathing exercises
- exercises for muscle strength and endurance
- exercises for the development of joint mobility and muscle suppleness
- relaxation exercises
- isometric exercises.

Fast walking and jogging

They are useful in increasing the effort capacity of patients. Walking and jogging are used only in the third phase of recovery because the demand on the cardiovascular system is relatively high and the possibilities of supervising the patient during them are reduced. During the run, the heart rate is monitored, the patient controlling himself in order not to exceed the training frequency, or the remote control is used - telemetry method.

Walking and jogging are less indicated in elderly subjects because they can precipitate dyspnea attacks, require intense muscles and are difficult to drive for patients with osteomuscular and joint problems, as is often the case in elderly subjects.

It is indicated to use a pedometer (step counter) and few steps must be added each day so as to reach 10.000 steps/day. The progress should be noted every day. Also, the distance traveled must be doubled every 3 months.

Physical exertion in water and swimming

Swimming requires, especially in inexperienced people, a high energy consumption, which exceeds 7 METs. It also records heart rates close to the maximum or that significantly exceed the target training frequency.

On the other hand, performing simple exercises in water or walking through water can have advantages over other physical exercises, because the venous return is favored and the energy consumption does not exceed that allowed for patients with diabetes and coronary heart disease.

In addition, for patients with osteomuscular problems, moving through the water is much easier than the other types of effort used.

The heart rate of the patient in the water should also be tracked by telemetry methods.

Jumping rope

It is another type of training used by patients with metabolic syndrome.

Energy consumption is high, usually exceeding 7-8 METs, so it is indicated only for patients who have successfully completed the second phase of recovery, towards the end of it, or -more often- in the third phase of rehabilitation.

Isometric effort

It is the last type of effort used in physical training and is relatively recently introduced in rehabilitation programs. The isometric effort is achieved mainly by lifting weights or exercising with weights. The weights will be initially 1-2 kg, and 3-4 kg later.

Their use is safe, especially if applied in the second part of the second phase of recovery. The heart rate does not increase excessively during the use of weights, and the ischemic threshold is usually not reached, because the coronary flow increases by rising the peripheral resistances, secondary to the increase of the intraaortic pressure.

Contraindications and precautions in the physical training of patients with metabolic syndrome

Progressive physical exertion (measured in intensity and frequency) is an integral part of the treatment of metabolic syndrome and diabetes, having a beneficial effect on its evolution as well as on the complications that may occur.

Contraindications to physical training are:

- blood glucose value over 200 - 300 mg%;
- advanced retinopathy - which could promote retinal detachment;
- diabetic nephropathy;
- hypertension with diastolic value above 120–130 mmHg.

Regarding physical training precautions, it shoul be noted that, for type I diabetes, the hypoglycemic effect of physical exertion will be greater if

it is done 3-4 hours after the injection of crystalline insulin and 8-12 hours after the injection of semi-slow insulin [9].

Practical aspects of rehabilitating patients with metabolic syndrome

- an exercise test is performed (on a cycle ergometer or treadmill) - to determine the degree of heart damage;
- the effort in physical training must be progressive - it starts with 10 minutes and increases slowly, up to 30-40 minutes, within 8-12 weeks;
- if insulin is administered in the thigh and then a physical effort is made that mobilizes the lower limbs, it may produce too rapid reabsorption; therefore, it is recommended to administer insulin subcutaneously to the abdomen;
- for patients with insulin pumps - the basal infusion rate is reduced and pre and postprandial boluses are changed;
- the heating phase is mandatory;
- the effort phase consists of working on devices, brisk walking, cycling;
- 20 minutes before exercise, a small snack (10-20 g rapidly absorbable carbohydrates) is administered to prevent hypoglycemia;
- pay close attention to foot care due to the common complication of diabetes, i.e., diabetic foot;
- the special recommendation is made for the patient to have sugar available (glucose tablet, fruit, snacks);
- it is good that the physical training session takes place at the same time, to create a new level of vasomotor and metabolic regulation;
- family or friends to be included in the patient's physical activities (it is an opportunity to spend time together).

Dance and metabolic syndrome

Dance (classical, folk) is a pleasant and effective therapeutic resource in the recovery of patients with metabolic syndrome. Dance leads to increased muscle strength, static and dynamic balance, coordination, physical endurance, improved emotional state and alleviation of depression. Perhaps, the most important fact is that dance has positive effects on brain neuroplasticity.

Conclusion

Supervised physical training programs, strictly individualized, progressive and applied as a true lifestyle of patients with metabolic syndrome, along with diet and recommended medication - will reduce the complications of the disease, will significantly improve the quality of life of these patients, and increase their life expectancy. In addition, it is certain that physical rehabilitation will bring patients a good tone and mood.

Conflict of Interest

The author confirms that there are no conflicts of interest.

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