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TRAINING PROGRAM AND CARDIORESPIRATORY PARAMETERS IN OBESE PATIENTS WITH TYPE 2 DIABETES MELLITUS

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A b s t r a c t

We evaluated the effect of a 12-week training programme of walking on cardiorespiratory parameters in patients with type 2 diabetes mellitus and obesity (DM). Eleven DM patients (duration of diabetes, 6,9±5 years), treated with a diet or oral antidiabetics, were included in this study. The anaerobic threshold and cardiorespiratory parameters were determined by symptom-limited spiroergometry before and after 12 weeks of the training programme. The patients walked daily for 30–60 min with the intensity at the anaerobic threshold level. This training programme was found to contribute to an improvement in DM patients' fitness and in their transport system parameters.

K e y w o r d s

Diabetes mellitus type 2, Spiroergometry, Exercise therapy, Cardiorespiratory parameters

INTRODUCTION

The importance of regular physical exercise, as part of therapy in diabetes of both types, has sufficiently been demonstrated by its favourable influence on both metabolic conditions and important parameters of the cardiovascular system (*1, 2*). A number of studies have also shown that regular physical exercise can decrease risks of the development of both type 2 diabetes and cardiovascular diseases (*3, 4*). Our study was aimed at evaluating the influence of walking, at an intensity of the anaerobic threshold level, on parameters of the transport system in DM patients.

MATERIAL AND METHODS

A group of 11 patients with type 2 diabetes mellitus (6 men and 5 women) treated at the Diabetes Centre of the Second Department of Internal Medicine, St. Anne's Teaching Hospital in Brno, were included in the study. Their average age was 56.6±8 years, mean body mass index (BMI) was 30.5±2, and the average duration of diabetes was 6.9±5 years. All patients were treated either by a diet and/or with oral antidiabetics. None of the patients manifested a severe degree of specific diabetic complications or contraindications for the selected physical activity due to other diseases.

Six patients had hypertension controlled by Ca antagonists and/or ACE inhibitors. A long-term metabolic compensation was a condition for participation in the study. Patients who had any form of ischaemic heart disease were not included.

After general examination (patient history, physical examination, ECG at rest and basic laboratory tests), all patients were subjected to initial bicycle spiroergometry (Cardiovit CS 10 Schiller, gas analyser Medgraphics) to assess their functional fitness, to diagnose ischaemic heart disease, if present, and to determine the limit of a safe intensity of exercise. We chose a protocol with an intensified workload up to the symptom-limited maximum (basic load of 40 W, intensification at 20 W, 2-minute duration of each workload step). In each patient, the value of heart rate at the anaerobic threshold (AT) level determined the intensity of walking. AT levels were expressed as values of oxygen uptake (VO_{2AT}), oxygen uptake per kg body weight (VO_{2AT}/kg), heart rate (HR_{AT}) and metabolic equivalent (MET_{AT}).

Subsequently, all patients were subjected to 12 weeks of walking training undertaken daily for 30 to 60 min. After 12 weeks, the patients were examined by spiroergometry.

The experimental protocol, which respected the Declaration of Helsinki, was approved by the local Ethics Committee. A written informed consent was obtained from each patient prior to their participation.

The data obtained were processed by a Microsoft Excel 97 program. Statistical analysis was carried out by the Wilcoxon test for paired values and the results were considered significant at $P < 0.05$.

RESULTS

The results of the transport system parameters evaluated are given in *Table 1*.

After the training period, the values of HR_{AT}, VO_{2AT}, VO_{2AT}/kg, MET_{AT} and the value of pulse oxygen (PO_{2max}) were significantly increased. We did not find any changes in the values of maximum load (W_{max}), maximum HR (HR_{max}), maximum oxygen uptake (VO_{2max}, VO_{2max}/kg and MET_{max}).

DISCUSSION

Diabetes mellitus of type 2 is accompanied by obesity in more than 80 % of the diabetics. In most of the patients, insulin resistance (IR) has already developed by the time type 2 diabetes is diagnosed. Insulin resistance leads to an acceleration of atherogenesis. Suppression of insulin resistance and, therefore, promotion of sensitivity to insulin, appears to be the main therapeutic objective in patients with type 2 diabetes in order to reduce the risk of cardiovascular complications.

A number of studies have shown that DM patients have a low level of physical fitness in comparison with healthy individuals matched by age, and that this low aerobic capacity is associated with a number of cardiovascular risk factors. That is why regular physical exercise is accentuated in DM patients (*5–7*). A number of authors have been dealing with the question of which type of physical exercise, and at what intensity, duration and frequency, should be used to treat DM patients. It has been found that walking is a most physiological exercise and, therefore, it was used in our study. However, the studies on walking in the treatment of DM patients have reported different results in relation to important metabolic and cardiovascular parameters (*6–10*).

Table 1

Results of spiroergometric examination of patients with type 2 diabetes before and after the walking training programme

Number of patients (n=11)	Before training (x±SD)	After training (x±SD)	Statistical significance
W_{max} (W)	123 ± 35	127 ± 33	*P*>0.05 NS
HR_{AT} (pulse/min)	102 ± 16	108 ± 14	*P*<0.05 *
HR_{max} (pulse/min)	141 ± 21	145 ± 21	*P*>0.05 NS
VO_{2AT} (ml/min)	1079 ± 291	1147 ± 300	*P*<0.05 *
VO_{2max} (ml/min)	1868 ± 528	1956 ± 509	*P*>0.05 NS
VO_{2AT}/kg (ml/min/kg)	12.4 ± 1.8	13.0 ± 1.6	*P*<0.05 *
VO_{2max}/kg (ml/min/kg)	21.3 ± 3.5	22.3 ± 3.1	*P*>0.05 NS
PO_{2max} (ml/pulse)	12.9 ± 3.0	13.9 ± 3.2	*P*<0.05 *
MET_{AT}	3.5 ± 0.5	3.7 ± 0.45	*P*<0.05 *
MET_{max}	6.1 ± 1.0	6.4 ± 0.9	*P*>0.05 NS

W_{max}, maximum workload; HR_{AT}, heart rate at the level of anaerobic threshold (AT); HR_{max}, maximum heart rate; VO_{2AT}, oxygen uptake at the level of AT; VO_{2max}, maximum oxygen uptake; VO_{2AT}/kg, oxygen uptake at the level of ANP per kg body weight; VO_{2max}/kg, maximum oxygen uptake per kg body weight; PO_{2max}, maximum pulse oxygen; MET_{AT}, metabolic equivalent at the level of AT; MET_{max}, maximum metabolic equivalent; *, statistically significant; NS, statistically non-significant.

Levine et al. (11) studied exercise therapy in cardiac patients and found that a low intensity training programme is safer than a high intensity one in terms of a risk of sudden heart events. Their study also included cardiac patients with diabetes.

Home exercise at an intensity corresponding to 60–70 % of the maximum heart rate has been reported to result in a substantial improvement of functional capacity and to have a high degree of safety and compliance of patients. This implies that a low intensity training (particularly walking) can also contribute to a significant decrease in cardiovascular mortality.

Studies with a trial design similar to that used in our study have given different results of the influence of training on cardiorespiratory parameters in DM patients. *Brandenburg et al. (10)* evaluated the influence of a 3-month training

programme in a group of women (average age, 43±7 years: body mass index /BMI/, 31.8±6.5) on VO_{2max}. In this study, the training was performed three times a week for 50 min on a bicycle ergometer at an intensity of 70–80 % HR_{max}. The authors found a significant increase in VO_{2max}, but they did not observe any significant increase in HR_{max} or any change in BMI or body weight. Similarly to these authors, we did not record any significant increase in VO_{2max}, in our study. We observed no significant increase in HR_{max}, and BMI.

Walker et al. (8) investigated the influence of a 12-week training programme (60 min of uninterrupted walking five times a week at an intensity degree chosen by the participants) on VO_{2max}, and body composition and on risk factors for cardiovascular disease. A significant increase in VO_{2max} was found at the end of the programme.

From our results we can conclude that a 12-week walking programme at an AT brought about a significant increase in the values of heart rate, oxygen uptake and metabolic equivalent at the level of anaerobic threshold and maximum pulse oxygen in patients with type 2 diabetes. We consider these changes to be a significant improvement of the working capacity and economy of the transport system and, therefore, of their physical fitness. The training programme described was well tolerated by the patients, appeared to be safe and applicable in everyday life, supposing the patients were sufficiently motivated. The improvement of values at the level of anaerobic threshold can serve as a basis for a more intensive training programme.

A c k n o w l e d g e m e n t s

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PROGRAM POHYBOVÉ LÉČBY A KARDIORESPIRAČNÍ PARAMETRY U OBÉZNÍCH PACIENTŮ S DIABETES MELLITUS 2. TYPU

S o u h r n

Byl hodnocen vliv 12-týdenního programu pohybové léčby chůzí na kardiorespirační parametry u pacientů s diabetem 2. typu a obezitou. Do studie bylo zahrnuto 11 pacientů (doba trvání diabetu 6,9±5 let), léčených dietou nebo orálními antidiabetiky. Symptomy limitovaná spiroergometrie byla použita před 12-týdenním programem pohybové léčby a po něm pro stanovení kardiorespiračních parametrů a anaerobního prahu. Program pohybové léčby sestával z chůze 30–60 minut denně na úrovni anaerobního prahu. Tento program přispěl ke zlepšení zdatnosti a některých parametrů transportního systému u obézních pacientů s diabetes mellitus 2. typu.

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