The role of lifestyle medicine and exercise therapy in the treatment of chronic diseases

Abstract of PhD Thesis

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INTRODUCTION

Previously, physical activity was a natural part of people's lives but by the 21st century it had become a problem waiting to be solved. As a result of the industrial revolution and large-scale agriculture, more and more people moved to cities and more and more mechanized processes forced them to the sedentary lifestyle. With the development of medicine and pharmaceutical industry, infectious diseases were replaced by civilization diseases, such as obesity, cancer, cardiovascular and metabolic diseases, that can be cured by lifestyle changing. However, with the general increase in living standards, the rate of obesity among adults has increased to 43% worldwide, and one of the biggest challenges has become maintaining a healthy lifestyle, including regular physical activity.

Lifestyle medicine is a medical approach that aims to prioritize lifestyle-changing treatments, such as nutrition, exercise therapy, stress management, and smoking cessation programs in the modern medicine. Although it does not yet constitute an independent, medication area in Hungary, it combines the relevant disciplines and the work of professionals from different fields (medical specialists, dietitians, various exercise professionals, psychologists, etc.) in a complex system for the sake of one goal. Its principles are now included in all medical recommendations at both prevention and rehabilitation levels, and its effect in the treatment of civilization diseases has been proven by numerous scientific studies.

Among its areas, movement therapy, which is the main topic of the thesis, can be highlighted, which in this case means the treatment of people living with chronic diseases through exercise. This includes assessment, counseling, trainings and monitoring. For its success, an initial motivation of the patients is important, which the professionals must further build during professionally structured training sessions so that the effect of the therapy is permanent, sustainable and actually influences the health and quality of life of the patients. Patient education plays a major role in the therapy, which enables patients to safely and effectively continue the life-long therapy that has already been integrated into their everyday lifestyle.

To cover the topic as broadly as possible, we divided our research into three parts, which examined different parts of the process. In the first research, we examined the feasibility of incorporating a lifestyle medical assessment protocol into a medical practice program and the possibility of arterial stiffness as a risk assessment method. In the second research, we examined the effectiveness of an individualized and lifelong exercise therapy method. In the complex lifestyle program with cooperation of medical doctors and dietetians, patients of different ages, diseases and conditions participated in a 3-20-month, personalized exercise intervention, and then we published the experiences and methodology in case studies. The third research conducted on the topic seeks to answer how a lifestyle program can be developed in a larger number of elements

among the elderly. As a member of an international research group, we examined the impact of regular exercise on motivation and health status of the elderly. All three studies aimed to apply the theory to real life (which is also used in clinical trials under the term "real-world study"), which in several cases led to compromises - these are discussed in the limitations of the studies.

Lifestyle medicine

The book “Lifestyle Medicine,” first published in 1999, defines lifestyle medicine as the integration of lifestyle practices (including nutrition, physical activity, sleep medicine, behavior modification, smoking cessation, responsible alcohol consumption, mental health and stress management) into the practice of modern medicine to reduce risk factors for chronic disease and/or, if disease is already present, to supplement therapy. Lifestyle medicine integrates scientific evidence from various health-related fields to assist the clinician in not only treating disease but also in maintaining good health.

Beyond the existing approach, in recent decades the search for evidence and reasons has helped to integrate lifestyle medicine into modern medicine. To facilitate this, the American College of Lifestyle Medicine was founded in 2004 as the first professional organization, which has been conducting decisive scientific work in the field of lifestyle medicine ever since. The European organization was launched in 2016 under the name European Lifestyle Medicine Organization, two years after the establishment of the Hungarian Lifestyle Medicine Society. Since then, countless national and international organizations have started operating in the field of lifestyle medicine.

The role of exercise therapy in lifestyle medicine

The term exercise therapy refers to the preventive and rehabilitation (secondary and tertiary prevention) treatment of chronic patients, i.e. the therapeutic method of exercise guided by a specialist, which prevents or cures these diseases. Regular, training-type physical activity (PA) or exercise (i.e. any type of movement, regardless of intensity, when energy is required to operate the skeletal muscles) has a beneficial, curative effect not only in case of cardiovascular and metabolic diseases but also in numerous psychiatric, neurological, pulmonary and musculoskeletal diseases.

The effects of PA are very diverse: it depends on the types of exercise performed and their intensity, but overall it can be said that it improves the condition of blood vessels, heart performance, reduces blood sugar and cholesterol levels, speeds up metabolism, reduces bone mass loss, increases muscle strength, improves movement coordination and boost the immune system.

Exercise therapy (as part of lifestyle medicine) is now at the forefront of both Hungarian and international medical recommendations, but it usually prescribes the same general recommendation of at least 150 minutes of moderate-intensity PA (50-70% of maximum heart rate) or 75 minutes of vigorous-intensity PA (70-85% of maximum heart rate) aerobic exercise (such as walking, running, swimming, cycling, and other forms of endurance exercise) per week for all types of disease, which was also the WHO recommendation for healthy adults for decades. The latter's recommendation formulated in 2020 already recommends more, 150-300 minutes of exercise per week to achieve better results. On the other hand, according to some research, even 10-59 minutes of low-intensity physical activity (low-intensity PA, <50% of maximum heart rate) per week lowers mortality rates and 30 minutes a day may be equivalent in effect to blood sugar- and blood pressure-lowering medications.

PA has a positive effect on many diseases, including obesity, Adiposity Based Chronic Diseases (ABCD), diabetes, hypertension and other cardiovascular diseases, neurodegenerative diseases, cancer, non-alcoholic fatty liver disease and depression.

OBJECTIVES

The aim of our research was to create a lifestyle program - with emphasis on exercise therapy - that could be used by local healthcare and health development institutions and professionals. We examined the program's components (such as assessment, intervention, monitoring) separately on local samples.

Objective I.: Incorporating a complex lifestyle medical assessment model into a medical practice program's additional preventive services.
Objective II.: Examining the effectiveness of an individualized and lifelong exercise therapy method.
Objective III.: Determining the dose-response relationships of exercise in patients with various chronic diseases.
Objective IV.: Examining the physiological, fitness and motivational effects of regular, group and supervised physical exercise among the elderly.

MATERIALS AND METHODS

Study I. - Incorporating a complex lifestyle medical assessment model into a medical practice program's additional preventive services

Participants

The study involved 299 people (70 men, 229 women, mean age 60.35±14.72 years) who volunteered to participate in the lifestyle program of the practice program of Jánoshalma. The participants were divided into four groups: those with high blood pressure and diabetes (MV+DM), those with only high blood pressure (MV), those with only diabetes (DM), and the control group (K), those without either disease. The group classification was based on the diagnosis determined by the general practitioner. Only type II diabetics participated in the study, who will be referred to as diabetics in the following.

The participants joined the program firstly to the general practitioners working in the practice community during the 13 months of the assessment period, who, after a personal and questionnaire interview, referred the participants for a lifestyle assessment and counseling. The inclusion was not limited by the presence of diseases or drug therapy. The study subjects received written and oral information about the risks of participating in the study, and then made a written statement that they were participating in the study voluntarily and could leave it at any time.

Methods

The measurements were made according to the protocol. During the analysis, height-weight, food frequency questionnaire (FFQ) and arteriograph values were compared, therefore the details of these measurements are presented. Height was measured with a SECA-213 stadiometer, while body weight was measured with a Tanita BC-545n scale. Examination of the peripheral vascular system and blood pressure measurement with an arteriograph device (TensioMedTM) were performed according to the recommended protocol. The data from the FFQ were summarized into 8 DASH food groups based on the other studies (cereals, vegetables, fruits, dairy products, meat/fish/eggs, nuts/seeds/legumes, fats/oils and sweets). In the calculation of the DASH index, the maximum score for each food group was 10 if the intake met the recommendation, while lower intakes received proportionally fewer points. The metabolic rate of the subjects was calculated using the Harris-Benedict equation.

Data management

Data were evaluated using Statistica 14 (TIBCO Software Inc., 2020). Since the mean age of the groups did not always follow a normal distribution, the Kruskal-Wallis test was used to

detect differences between the groups, and Spearman's rank correlation was used to calculate correlations. The significance level was $p<0.05$.

Study II. - Examining the practical feasibility of individualized exercise therapy in chronic patients

The same exercise therapy protocol was used in all case studies but there were differences due to the different types and severity of diseases, social background, age and other factors of the patients. In each case, the Lifestyle Medical Team was led by a treating physician and a dietitian and exercise physiologist participated in the treatments. The training sessions (guided and at home) were carried out with heart rate control, with individual safety as the primary consideration.

Case Study 1.

The patient is a 65-year-old man, with type III obesity (BW 131.0 kg; BMI 43.8 kg/m^2), high blood pressure, prediabetes, high cholesterol, and osteoarthritis in both knees at the start of the program. Based on baseline tests, his resting heart rate was average (76 bpm), and his fitness level was low (MET 5.7 ml/kg/min; VO2max 19.8 l/kg/min). Medications taken: Aspirin Protect and Astrix (aspirins), Meforal (blood sugar reducer), Bisoprolol Sandoz (beta-blocker), Coverex and Coverex-AS Komb (blood pressure reducers).

The entire lifestyle program lasted 30 weeks. The first step was a medical visit and the definition of a therapeutic plan, followed by a dietetic and exercise therapy assessment (FFQ and fitness tests) and counseling. In addition, a total of 5 dietetic consultations, 53 supervised trainings, and medical consultations were held during the program after the laboratory tests performed at weeks 16 and 31. The dietitian recommended a change in eating habits according to the DASH diet guidelines, which was further refined by discussing it with the patient based on the food diaries at subsequent consultations. The patient maintained the prescribed 1600-1800 kcal intake, of which 160g of carbohydrates, in a disciplined manner.

Initially, the patient participated in 60-minute workouts led by an exercise physiologist once a week, later twice a week, but in addition, he also exercised regularly and a lot at home every day. The supervised trainings consisted mainly of aerobic (walking, rowing, cycling) and strengthening (cable machines, elastic bands, own body weight) exercises. The patient wore his heart rate monitor watch every day and recorded each workout and physical activity (a total of 1628 sessions) with it. The patient recorded every physical activity-related event (cycling or walking) with his watch, which is why the number of sessions was high. He monitored only two data on the watch: the daily physical activity should reach a predetermined 100% (the level of which can be specified in three difficulty categories on the POLAR watch he wore) and the heart

rate during the trainings ("Do as much as possible at medium intensity!", which was determined at 50-70% of the heart rate after the preliminary test). His home workouts consisted mainly of cycling, walking, and swimming 2-3 times a week, and were analyzed and discussed with the exercise physiologist at each in-person meeting.

Case Study 2.

A 40-year-old male patient (BW 91.0 kg; BMI 29.7 kg/m^2) suffered from non-ST-elevation acute myocardial infarction (NSTEMI), which was accompanied by elevated Troponin I (7.4510 µg/l), CRP (8.6 mg/l) and Creatine kinase (627 U/l) levels. During the acute care, coronary angioplasty was not performed and conservative therapy was recommended by his treating physicians. After 3 weeks of therapy at the Balatonfüred State Heart Hospital, chest pain still occurred frequently, which is why he started lifestyle treatment under the supervision of a professional team. In addition, his diseases included high cholesterol (6.1 mmol/l) and fasting blood sugar (8.0 mmol/l) and restless legs syndrome. The maximum load capacity was 7.0 MET in a cycling exercise test (Bruce protocol), which was performed by a cardiologist. Medications taken at the start of therapy: Aspirin protect and Zyllt (aspirins), Atoris (cholesterol reducer), Concor (beta-blocker), Coverex AS and Amlodipine (blood pressure reducers), Adexor (angina pectoris treatment medication), Pantoprazole (proton pump inhibitor), Fontin (antidepressant), Erimexol (dopamine agonist).

After acute rehabilitation, the patient started cycling at home, 2-3 times a day in 15-30 minute sessions. In the 12-month lifestyle program, he participated in supervised training once a week, where he performed aerobic exercises (walking, cycling, rowing, stair climbing) initially at low (45-55% HR), later at medium (50-70% HR) intensity. He also performed strengthening exercises with rubber bands and low weights, with a medium number of repetitions (10-15 repetitions), and later he went to play badminton with his family. Each of his training sessions (an average of 231 minutes per week over 8.85 sessions per week) was recorded with a heart rate monitor, however, due to a change in type (from a previous Safako type watch to a POLAR A300), detailed heart rate values were only analyzed from the 24th week.

The dietitian recommended a cardioprotective diet, which consisted of whole grains, vegetables, fruits, vegetable oils, low-fat dairy products, and meats. Sugar and salt intake was reduced to a minimum.

Case Study 3.

A 39-year-old female patient had prediabetes, overweight (BW 92.8 kg; BMI 34.6 kg/m^2), asthma, endometriosis and dysmenorrhea, back and knee pain, occasionally recurring bulimia, and anxiety disorder before therapy. Due to her slightly abnormal laboratory values (fasting blood sugar 6.1 mmol/l; insulin 36.5 mIU/L; HOMA 9.9), her diabetologist recommended lifestyle therapy instead of prescribing a blood sugar-lowering drug (Merckformin) for a one-month trial period, with a follow-up of two more months. Medications taken at the start of therapy: Ventolin inhaler (asthma medication, occasional use), Escitalopram Actavis (antidepressant).

The patient participated in a supervised training every week, where she performed aerobic exercise (walking, cycling, rowing). Since both her resting (85-105 bpm) and exercise heart rates were consistently higher than average, she trained regularly in the zone above moderate intensity, between 70-85% HR. She also performed muscle-strengthening exercises with rubber bands and cable machines every time, with moderate weights, for 10-15 repetitions. She participated in a total of 15 supervised trainings over 3 months. She also attended a yoga class once a week (she had done this before), occasionally went swimming, and regularly walked, the duration of which was on average between 40-60 minutes. At the beginning of the program, she also attended a dietetitian consultation, but did not follow or only partially followed the recommendations.

Case Study 4.

A 44-year-old male patient (BW 95.0 kg; BMI 29.3 kg/m^2) had symptoms (constant thirst, frequent urination, drastic weight loss, vision deterioration) for one and a half months, when a high blood sugar level (21.8 mmol/l) was measured during a screening test, and then the diabetologist diagnosed him with type 2 diabetes. His other diseases were overweight, high cholesterol and high blood pressure. Pre-program lab values: fasting blood sugar 18.7 mmol/l; HbA1c 14.8%; total cholesterol 6.2 mmol/l, HDL 0.99 mmol/l; LDL 4.22 mmol/l; triglyceride 4.59 mmol/l. After a dietitian consultation, he switched to a low-carbohydrate diet and calorie restriction, which he was only able to maintain partially during the program. Medications taken at the beginning of therapy: Jardiance, Merckformin XR (blood sugar reducers), Fenoswiss and Rosuvastatin (cholesterol reducers), Ozempic (blood sugar lowering injection), Coverex AS (blood pressure reducer). After a previous completely inactive lifestyle, he participated in supervised training 2-3 times a week during the 20 months of the program, where he performed both aerobic (walking, running, rowing) and strengthening exercises. Initially, moderate intensity (50-70% HR) training was later supplemented with high intensity interval and circuit training. Later the weight training played a greater role, since the patient had previously gone to the gym, and this was his most preferred form of exercise.

Case Study 5.

A 49-year-old male patient (BW 94.0 kg, BMI 26.6 kg/m^2) started lifestyle therapy to treat his insulin resistance. He was a basketball player until his young adulthood and regularly participated in other sports, but he had been completely inactive for the past 8 years. He successfully mastered and incorporated what he learned during the dietetic consultation into his diet. Initial results of the glucose tolerance test: HbA1c 6.3 mmol/l; 0' glucose 6.1 mmol/l; 60' glucose 14.3 mmol/l; 120' glucose 11.0 mmol/l; 0' insulin 30.2 mIU/l; 60' insulin 277.0 mIU/l; 120' insulin 302.0 mIU/l; HOMA 8.1. In addition to his illnesses, due to scoliosis and increased dorsal kyphosis, he was initially unable to raise his arms above his head at all, so it was necessary to involve a manual therapist and a masseur as part of the exercise therapy. Only after this could he begin exercises to improve posture and generally train the upper body. Medications taken at the beginning of therapy: Galvus, Rybelsus, Merckformin (blood sugar reducers), Forxiga (SGLT2 inhibitor).

The patient participated in a weekly supervised training, where he mainly performed aerobic exercises (walking, stair climbing, rowing) at a moderate intensity (HR 50-70%). In addition, his training included bodyweight, TRX and balance exercises. His training time increased (non-linearly) to 187 minutes by the last week of the program (60 minutes of moderate intensity), and he completed a total of 44 workouts and physical activities over the 4 months (on average 3.14 times per week).

Study III. - Examining the fitness and motivational effects of physical activity in a European senior program

In the first cycle of the study (2018-2020), 418 participants (113 men, 305 women; mean age 70.63±6.75 years) were studied in 5 European countries (Bulgaria 76, Hungary 55, Italy 121, Portugal 86, Spain 80). Half of the participants participated in regular training and sports championships (study group), while the other half did not participate in these programs, but only participated in the assessments (control group). The study is implemented through the Erasmus+ Sport project "Olympics4All - In Common Sports" (ICS) (project number: 590543-EPP-1-2017-1-PT-SPO-SCP). In the second cycle of the study (between 2021-2023) ("In Common Sport+" (ICS+), project number: 622503-EPP-1-2020-1-PT-SPO-SCP), the previous program continued, but the control group was dropped and only the participants in the exercise program were studied. The COVID-19 pandemic lasted between the two cycles, as a result of which some participants were unable or unwilling to return to the group trainings, so new participants were also included at the beginning and during the program, 80% of the Hungarian team continued the exercise program in the second cycle. In the following, only the data of the study group from the first cycle

and the entire group from the second cycle will be published, so only those participants who participated in a supervised exercise program. Slovenia joined the second cycle (ICS+) as a new partner country, which further increased the total number of participants. In the second cycle, 483 participants (115 men, 358 women; mean age 71.40±5.3 years) were examined (Bulgaria 65, Hungary 55, Italy 86, Portugal 75, Spain 72, Slovenia 130). The inclusion criterion was age 60 years or older and exclusion criteria were disease or medical condition that contraindicated exercise. Previous sports history did not influence inclusion. The subjects received written and verbal information about the risks of participating in the study, and then made a written statement that they were participating voluntarily in the study and could withdraw at any time.

Before the first assessment, representatives of the organizations participating in the research together learned about and practiced the details of the assessment protocol implementation in a personal meeting in Portugal. However, since the examiners were replaced at several partner organizations during the 6 years of the programs, there were later minor differences in the implementation of the tests. The assessments in Hungary took place at the training locations, indoors, throughout the program. In the first cycle, the assessments and trainings were implemented in two locations (a gym in Száhalombatta and Budapest), while in the second cycle, the surveys and trainings were implemented in three locations (a community center in Érd in addition to the previous ones).

The surveys were conducted in the same period in each country. In the first cycle (2018-2020), according to the study plan, a total of 6 assessments would have taken place every six months, however, due to the COVID-19 epidemic, the last two assessments could not be conducted, and trainings were also suspended for this period. Thus, in the evaluation, we took into account the data from the first and fourth assessments results (Rikli & Jones Senior Fitness Test Protocol) but for the questionaires (EQ-5D-5L, PMQOA, Mini Mental Test) the third instead of the fourth, according to the protocol. The participating countries started the second cycle (ICS+) in 2021 when post-epidemic restrictions were lifted. The majority of previous participants remained in the program, but new ones were also included. In this cycle, we conducted the assessments annually.

Training protocol

The members of the study group participated in 60-minute training sessions twice a week, in the first cycle for 18 months at two locations (Budapest and Százhalombatta), while in the second cycle for 20 months at three locations (Érd, Budapest and Százhalombatta). The training sessions took place indoors and, due to the coordinated work of the trainers, had a uniform theme and movement material. The training sessions included aerobic, strengthening, balance,

coordination and stretching/relaxation exercises. The training of the Hungarian study group always began with a warm-up (~10 minutes of joint movement, circles, aerobic exercises such as walking in place). The main part consisted of strengthening, balance and stretching exercises based on gymnastics, Pilates and dynamic yoga. Fitball, Pilates ball and gymnastic stick were used as equipment. The main considerations in compiling the exercise program were safety and the highest possible efficiency, which could be achieved with exercise material adapted for the elderly. Although these were group workouts, it was also a consideration to provide easier or harder variations of certain exercises, taking into account individual differences.

Data management

The survey data were recorded in Microsoft Excel spreadsheet for each country. The data were checked using the Shapiro–Wilk test and descriptive statistics (such as mean and standard deviation) were calculated. Statistical analyses were performed using SPSS for Windows Version 22.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at $p<0.05$.

RESULTS

Study I. - Incorporating a complex lifestyle medical assessment model into a medical practice program's additional preventive services

The results were given in each case in relation to the control group (K). In the patient groups (MV+DM, MV, DM), BMI values show grade I obesity (30 – 34.99 kg/m^2), while the K group, although borderline, fell into the overweight (25 – 29.99 kg/m^2) category. Compared to the K group, all three patient groups showed a significant difference. Both systolic and diastolic blood pressure values were significantly higher in the MV+DM group and the values of the MV group were lower than these. The lowest values can be observed in the DM and K groups, although the systolic BP value is already considered to be elevated blood pressure here. Looking at the data on arterial stiffness, contrary to this trend, the highest value is observed in the MV group, while the values of the MV+DM, then the DM and K groups were lower. The difference is significant for both measures in the MV group, however, while in the case of PWV, all groups fall into the "normal" category (7 – 9.7 m/s). In the case of Aix the DM and K groups fall into the normal (<30%), and the MV and MV+DM groups into the elevated (>30%) range.

No significant difference can be observed between the groups in terms of dietary habits. The DASH index shows a mean value for all (38.48 - 40.55), daily fluid intake shows only a 2.5 dl difference (1.88 - 2.17 l) between the groups. Although the number of daily meals showed a significant difference, there is no real difference between the values (3.35 - 3.89 meals/day). Correlation tests of the measured values show a significant correlation for several variables,

however, a moderately strong correlation is seen between BMI and blood pressure (SYS r=0.36; DIA r=0.29), age and AS indicators (PWV r=0.42; Aix r=0.4), and heart rate and Aix (r=-0.51). The DASH index did not show a correlation with the examined variables.

Study II. - Examining the practical feasibility of individualized exercise therapy in chronic patients

Case Study 1.

The results showed a clear improvement in the patient's health indicators. His body weight decreased by 24.1 kg (18.4% decrease compared to the initial value), his BMI decreased to 35.8 kg/m^2. All values in his laboratory findings showed a decrease in the 12th week, then a slight increase in the 31st week. The resting heart rate (from 76 bpm to 67 bpm) and blood pressure (from 137/71 mmHg to 122/66 mmHg) measured immediately before the supervised training (taking the average of the first and last week's training) also decreased significantly. Among the laboratory values, the slight increase in blood sugar and total cholesterol levels is probably due to the medication reduction determined by the treating physician in the second cycle. The patient stopped taking Meforal for prediabetes and Fenoswiss for high cholesterol, while the dose of Coverex-AS Komb for high blood pressure was halved. The patient's CV fitness showed 7.7 MET and 26.9 ml/kg/min VO2max according to the previously used YMCA protocol. According to the heart rate monitor data, there was a significant increase in the level of activity: the number of steps taken per day increased from 9133 to 16087 steps (taking the average of the days of the first and last week), while the time spent exercising increased from 13.5 hours/week to 33.95 hours/week. Of this, 798 minutes were spent at moderate intensity in the first week of the program, the most in the 14th week, 1321 minutes, and then the intensity decreased, with values between 502-843 minutes per week. These are very high numbers, which is explained by the fact that the patient recorded all the physical activities he performed (for example, cycling to the store, swimming and longer walks).

Body weight was measured under the same conditions every week of the 30-week therapy. Based on these results and the exercise time recorded by the heart rate monitor, a significant positive correlation can be observed between the degree of body weight loss and the time spent exercising at moderate intensity ($r=0.52$ $p<0.001$). In the first half of the therapeutic period (weeks 1-16), the exercise time spent at moderate intensity (50-70%) was high, and the degree of body weight loss was proportionally greater than in the later period.

Case Study 2.

During the lifestyle therapy, the patient's body weight loss was continuous: he lost 14.0 kg (15.3% of his initial body weight) over 12 months, and his BMI decreased accordingly. His CV fitness level almost doubled (from 7.0 MET to 13.4 MET) based on the modified Bruce cycling test. His resting heart rate decreased significantly based on the ECG measurement despite the modification of the medications (from 73 bpm to 66 bpm). His blood pressure averaged 97/66 mm Hg during the program, which caused the treating physician to reduce the number and dose of medications twice. By the end of the program, the number of medications taken decreased from ten to six, while the dose of two medications was halved.

The patient used his own heart rate monitor during the first half of the therapy, which only measured and did not record the heart rate, therefore we can analysed the data from the second half of the program after purchasing a POLAR watch. The time spent exercising varied between 221 and 510 minutes per week (of which 145-468 minutes were spent at moderate intensity).

Case Study 3.

The exercise therapy and its consequent stress reduction brought significant improvement in the patient after 3 months. Her body weight gradually decreased by 6.8 kg to 86 kg, her BMI decreased to 32 kg/m^2. Her laboratory values improved significantly (blood sugar level from 6.1 mmol/l to 4.6 mmol/l, insulin level from 36.5 mlU/l to 6.2 mlU/l, HOMA from 9.9 to 1.27)), so she managed to reduce all his values to the normal range, thus avoiding taking blood sugar-lowering medication (on medical advice). Her fitness and work capacity improved, and her anxiety symptoms almost disappeared.

Case Study 4.

The patient's body weight gradually decreased from an initial 95.0 kg to 89.7 kg over six months, and then after stopping the Ozempic injection (the active ingredient semaglutide reduces appetite and thus body weight) it fluctuated between 91-94 kg. This was presumably because, although he followed the prescribed diet during the week, he often consumed fast food and large amounts of alcohol on weekends. This acted as a kind of reward mechanism after regular training and a regular diet. Despite this, his laboratory values decreased to normal values in a short time (blood sugar level from 18.7 mmol/l to 5.8 mmol/l, total cholesterol from 6.2 mmol/l to 3.5 mmol/l, triglyceride from 4.59 mmol/l to 1.81 mmol/l), his CV fitness and muscle strength increased significantly. He was able to stop taking Ozempic on the advice of his doctor, which was a great relief for the patient.

At the start of the program, the patient's SCORE2 value was 4.2% (this is the chance of a fatal or non-fatal CVD event occurring within 10 years), which decreased to 2.6% by the end of the program. Unlike the other case studies, this patient only participated in supervised trainings 1-3 times a week during the interaction. Accordingly, his weekly physical activity varied between 60-184 minutes, in some cases exceeding this value, he exercised for an average of 107 minutes. However, 52 minutes of this was spent at moderate intensity, while 49 minutes were spent at high intensity, with lower intensity only during warm-ups, which is also in line with the WHO recommendation.

Case Study 5.

After a few weeks of regular exercise and diet, the patient's laboratory values normalized (HbA1c from 6.3 mmol/l to 5.5 mmol/l, HOMA from 8.1 to 1.8). Although an increase was visible at the end of the program, it was small, still within the normal range. The patient's body weight decreased by 2 kg, which continued after the program. His posture improved visibly and noticeably as a result of the treatments.

Similar to patient 4, the training time did not increase linearly here either, as it was often influenced by personal events and illnesses. On average, he spent 164 minutes per week training, of which 119 minutes were at medium intensity and 5 minutes at high intensity. Most of the training at home was done on a rowing ergometer, which the patient particularly enjoyed. He followed online video rowing workouts, from which he found the ones that suited his fitness level and was able to easily measure his progress, which greatly helped his motivation.

Summary of the results of II. Study

The five patients examined differed from each other in many aspects (fitness level, diseases, family status, standard of living, motivation), but they all had in common the need for a lifestyle change. The primary motivation in almost all cases (except for patient 1) was the development of their disease, but later (as their physical condition improved) additional motivational factors emerged. The duration spent training, the intensity and the types of exercise performed were equally varied. The planning of exercise therapy was personalized in all cases, in addition to adhering to the recommendations of the literature and the principle of safety. This not only increases efficiency through motivation but is also an essential factor for incorporating exercise into everyday life in both healthy people and chronic patients.

Since the change in exercise time did not develop linearly in several cases, the averages of the durations and intensity zones in a weekly summary best illustrate the exercise dose characteristic of each case. Different measured values were emphasized in different diseases, but

the decrease in body weight and blood sugar levels were common in all patients. It is important to mention that the improvement in physiological values occurred with a reduction in the number and dosage of medications (mostly blood pressure, blood sugar, and cholesterol lowering drugs).

Study III. - Examining the fitness and motivational effects of physical activity in a European senior program

The international study took place in 6 countries over 6 years, and the full evaluation far exceeds the scope of this paper, therefore only the Hungarian results are presented below. For its evaluation, it is important to take into account that group exercise programs were suspended between February 2020 and September 2021 due to the COVID-19 epidemic. For this reason, however, we can also conclude about the "detraining-retraining" effect (change after the cessation of supervised exercise) when evaluating the results for the years 2021-2023. It should also be highlighted for the evaluation that the elderly participants (the inclusion criterion was at least 60 years old, but the average age of all participants was 70.63±6.75 years) aged 5-6 years during the program and new participants also joined the program in 2021 (21 people).

Antropometric results

At the start of the program, a small decrease in all measured anthropometric parameters was observed in the first year. During COVID-19, body weight continued to decrease, but body fat and waist-hip circumferences increased (2021 year), which may be due to changes in body composition and loss of muscle mass after stopping training. By the 2022 assessment, body weight and body fat percentage had increased further (by 4.6 and 4.7%), but we experienced an improvement in circumferences. By the end of the study (2023), body weight and waist-hip ratio had increased further, while body fat percentage showed a slight decrease.

Fitness tests results

All fitness tests (except the 6 min. walking test) showed improvement in 2019, but the values developed differently in the second cycle after COVID-19. The grip strength value practically decreased back to the initial baseline value in 2021, but by the end of the study there was an improvement (4.7% increase). The Chair stand test, which measures lower limb muscle strength, also showed a decrease after the "de-training", but by 2022 its average reached an "excellent" value for age (14.4% increase), and decreased minimally only by the end of the program. In the 6 min. walking test, participants achieved excellent results at the beginning of the program (2018), which showed a continuous decrease between 2019 and 2022, and then a significant increase in 2023 (22.4%). The reason for this could not be found, as the participants

performed well on all other tests, so we ruled out lack of motivation and it is unlikely that other circumstances (such as temperature, individual mood, fatigue, etc.) could have influenced performance in this level. In the Chair sit & reach and Timed up & go tests, there was some deterioration due to "de-training", but improvement was seen by 2022, followed by stagnation. However, the Back scratch test, which tests shoulder mobility, showed improvement even in 2021, and after a slight decrease in 2022, the best value was measured in 2023.

Overall, it can be said that the results of the group studied were mostly within the normal range, and even there close to the upper values. The exception was the tests measuring flexibility (Chair sit & reach and Back scratch), where the Hungarian participants achieved excellent values above the normal range.

EQ-5D-5L life quality questionaire results

All five aspects show very low scores (between 1-2), which means that participants have, on average, no or mild problems in the various areas and only minimal changes have occurred over the years. The Anxiety/Depression factor is noteworthy, which completely disappeared during the first year of the program, increased after the COVID-19 pandemic, and then gradually began to decrease, which clearly shows the positive effect of exercise on mental health.

Motivation test results

The scores of the 6 dimensions used in the evaluation of the PMQOA questionnaire also show minimal changes over the years. For the participants, the most important motivational factors for Maintaining physical activity are the Social environment and Maintaining/improving fitness and health, while the least important factor is increasing their Recognition. The PMQOA results of the 2019 survey did not prove to be reliable due to a data collection error, and are therefore omitted from the analysis below. After the COVID-19 period, the importance of the Recognition and Challenge dimensions decreased, while the Health dimension became even more important among the participants in the 2021 survey, and then these values practically stagnated until the end of the program.

Mini Mental Test results

The Mini Mental Test, which measures the presence and severity of dementia, was not relevant to the sample studied and was therefore later removed from the protocol. In the case of the Hungarian sample, the initial results were 28.95±1.51 points (out of a maximum of 30 points available), which means that the questions asked were answered incorrectly at most 1-2 times.

CONCLUSIONS

When evaluating the results of our studies, we formulated the following conclusions:

1. Regular physical activity has a significant positive effect not only on health and fitness, but also on mental health.

2. In the case of low fitness, elderly and/or patients with chronic diseases, even low-intensity, regular and supervised exercise results significant improvement.

3. The effectiveness of lifestyle therapy is improved by the cooperation of the lifestyle medical team (doctor, dietician, exercise therapist) not only at the beginning of the lifestyle program, but also during its course.

4. The assessment protocol is an important part of lifestyle treatment, because it allows the therapy to be personalized and progress to be accurately monitored. The latter is not only important information for professionals but also has a positive effect on the motivational factors of patients.

Exercise as a therapeutic method in the treatment of chronic diseases is now well known, but it is not widespread. In order for it to be effectively integrated into practice and become part of health care treatments, it is necessary to develop a professionally sound, complex program that involves all the participating organizations involved.

At the beginning of the programs, we consider it important to carry out appropriate assessments and examinations. Even for healthy individuals, but especially for elderly and/or chronically ill patients, a preliminary medical examination and opinion is necessary before starting regular exercise. This is especially important if the person has previously lived an inactive life or has not performed strenuous sports activities in recent years.

After medical “permission”, the assessments should include laboratory tests (Study II.), arteriograph measurements (Study I.), anthropometric measurements (Study I-III.) and fitness tests (Study II-III.). These are necessary so that the exercise therapy can be tailored to the individual as much as possible, and in the case of group training, to be adjusted to the average condition of the group. In the case of group exercise, individually determined, pulse-controlled training would be the most effective, but this requires much greater financial and professional expenditure, and is therefore difficult to implement. However, if these conditions can be created, it is definitely worth using this method for the greatest safety and efficiency. The assessments carried out at the beginning of the exercise program also greatly help to monitor progress, which allows for the shaping and continuous personalization of lifestyle therapy (including nutrition and exercise therapy, medication) with later control measurements.

The preparation of the professionals involved in the therapy and the definition of competencies are also important for the creation of the program. Previously, physiotherapists dealt with chronic patients from the health sector, humankinesiologists and health developers from the sports sector. In recent years, the fitness industry has also approached the chronically ill population by offering a course for trainers on conducting disease-specific training (Medical Fitness Expert – MES), which equips trainers who have previously worked with healthy people with important knowledge. This will also give patients a greater opportunity to find a professionally competent professional who can help them recover through lifestyle.

A national program led by competent experts could significantly improve the health indicators of the Hungarian population, while also reducing the burden on healthcare. Local initiatives are already operating across the country (such as the "Zöld recept", medical practice programs, Health Development Offices, "Mozgás receptre"), but it would be advisable for a team of health and sports professionals to develop and standardize this nationwide. An important part of the program is the involvement of sports associations, senior clubs, patient organizations and other relevant institutions, as well as the establishment of appropriate communication channels and the definition of different levels of authorization in relation to nutritional and exercise therapy. We hope that our results and the methods we have developed can contribute to the creation of this system.

LIST OF OWN PUBLICATIONS

List of own publications serving as the basis of the thesis

1. Dvorák M, Tóth M, Ács P (2021) The Role of Individualized Exercise Prescription in Obesity Management-Case Study. Int J Environ Res Public Health. 18(22):12028.

2. Dvorák M, Sztancsik I, Babai L, Tóth M, Ács P (2022) Supervised and Individualized Lifestyle Medicine Therapy of a Patient after Myocardial Infarction-Case Study. J Cardiovasc Dev Dis. 1;9(6):177.

3. Dvorák M, Varga D, Babai L, Horváth E, Tóth M (2022) Artériás érfali merevség vizsgálata egy hazai praxisközösség életmód orvosi programjában. Magyar Sporttudományi Szemle 23: 98 pp. 3-10., 8 p.

List of own publications not directly related to the thesis

1. Szablics P, Orbán K, Szabó S, Dvorák M, Ungvári M, Béres S, Molnár AH, Pintér Z, Kupai K, Pósa A, Varga C (2019) Effects of aerobic workout on the changes in the characteristics of dynamics of the center of gravity in different age categories. Physiol Int. 106(2):140-150.

2. Dvorák M (szerk.) (2020) Magyar Életmód Orvostani Társaság II. Kongresszusa – Absztraktfüzet. Budapest, Magyarország: Magyar Életmód Orvostani Társaság, 55 p.

Congress abstracts

1. **Dvorák M**, Bezerra P, Cancela Carral JM, Camoes J (2021) "In common sports" - egy európai szenior projekt eredményeinek bemutatása. Magyar Sporttudományi Szemle 22: 5 (93) pp. 13-14., 2 p.

2. **Dvorak M**, Babai L, Toth M, Varga D (2020) Extreme Duration Low Intensity Exercise Not Cause Additional Weight Loss For Patients With Metabolic Syndrome. Medicine and Science in Sports and Exercise 52: 7S pp. 330-330., 1 p.

3. Bezerra P, Clemente FM, **Dvorak M**, Camoes J (2019) Age-related Health State Over European Countries: The Context May Be The Difference. Medicine and Science in Sports and Exercise 51: 6 pp. 542-542., 1 p.

4. **Dvorák M**, Bezerra P, Clemente FM, Cancela Carral JM, Camoes J, Janicsák Z, Tóth M (2019) A fizikai aktivitás hatására létrejövő életmód és fittségi paraméterek nyomon követése öt európai ország idős lakosainál. Magyar Sporttudományi Szemle 20: 5 (82) p. 51

5. **Dvorak M**, Babai L, Toth M (2019) The usefulness of activity trackers and heart rate monitors in lifestyle medicine – a case study. In: Bunc, V.; Tsolakidis, E. (szerk.) 24th Annual Congress

of the EUROPEAN COLLEGE OF SPORT SCIENCE - BOOK OF ABSTRACTS. Köln, Németország: European College of Sport Science 847 p. p. 434.

6. **Dvorak M**, Varga D, Babai L, Szabo L, Ferenczi A, Horvath A (2019) Lifestyle medicine assessment and intervention in practice in Hungary. 2nd European Lifestyle Medicine Congress, Rome, Italy, 2019.11.8-10.

7. Varga D, **Dvorák M**, Szabo L; Babai L, Horváth E (2019) Eating habits of patients with chronic diseases in a hungarian municipality. 2nd European Lifestyle Medicine Congress, Rome, Italy, 2019.11.8-10.

8. **Dvorák M**, Cziráki P, Tóth M (2018) Differences in vertebral column morphology between blue and whte collar workers using a noninvasive method. In: Murphy, M.; Boreham, C.; De Vito, G.; Tsolakidis, E. (szerk.) 23rd Annual Congress of the EUROPEAN COLLEGE OF SPORT SCIENCE: 4th - 7th July 2018, Dublin – Ireland: BOOK OF ABSTRACTS. Dublin, Ireland: European College of Sport Science 868 p. pp. 511-512., 2 p.

9. Szablics P, Szabó S, **Dvorák M**, Orbán K, Balogh L, Molnár AH, Béres S, Pintér Z, Pósa A, Kupai K, Varga C (2013) Effects of weight loss on the dynamical marks of centre of gravity in different BMI, body fat percentage and waist hip ratio categories. 18th Annual Congress of European College of Sport Sciences (ECSS), Barcelona, Spain, 2013.06.26-29.