Acta Salus Vitae, Vol 11, No 1 (2023)
ISSN 1805-8787 actasalus@palestra.cz

VERIFICATION OF THE EFFECT OF AN EXERCISE PROGRAMME USING WALKING AND DIET ADJUSTMENT IN HYPERTENSION

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Abstract

One of the leading risk factors for cardiovascular disease is hypokinesis. Therefore, an exercise regimen is emphasized for the prevention and control of hypertension, while at the same time aiming to reduce overall cardiovascular risk in addition to achieving normal blood pressure values.

The study aimed to verify the effect of an exercise programme using walking and dietary modification on the reduction of blood pressure values in hypertension, while the effect of the intervention on weight reduction and change in body composition was also studied.

The research method in our work was a case study. The proband was a physically inactive overweight woman, age 55 years, treated hypertensive, whose blood pressure at entry to the program reached the values of mild hypertension even with treatment. Baseline data were resting blood pressure values measured for 7 days in the morning and evening, a two-day record of physical activity, a seven-day record of diet, diagnosis and analysis of body composition with the InBody device, and calculation of the WHR index. The proband developed a physical activity intervention program using walking for 12 weeks, a minimum of 5 times per week, at moderate intensity, with a gradual increase in daily walking time from 30 to 60 min/day. As an adjunct to the exercise intervention, she was recommended a dietary modification. At the end of the follow-up period, blood pressure values were measured in the same way, a diagnostic and body composition analysis was performed with the InBody device, and the WHR index was calculated. The intervention program was also evaluated in relation to overweight and body composition as important factors in hypertension.

After 12 weeks of the intervention programme, the mean reduction in systolic blood pressure was 6,29 mmHg in the morning and 4,86 mmHg in the evening. The average reduction in diastolic blood pressure was 4,57 mmHg in the morning and 3,14 mmHg in the evening. There was also a decrease in heart rate by an average of 4,07 beats per minute. At the same time, the intervention program led to a reduction in the proband's body weight (by 7,2 kg), a decrease in BMI (from 27,8 to 25,5 kg/m2), a decrease in body fat percentage (by 3,9 %) and a decrease in WHR index (from 0,91 to 0,88).

These results confirmed that regular physical activity and dietary modification play an important role in the treatment of high blood pressure and verified the effectiveness of expert recommendations in hypertension. They also confirmed the positive effect of these recommendations on weight reduction and body composition. In summary, this work verified the beneficial effects of walking supported by dietary modification on the following risk factors for cardiovascular disease - high blood pressure, overweight, body fat, and central obesity.

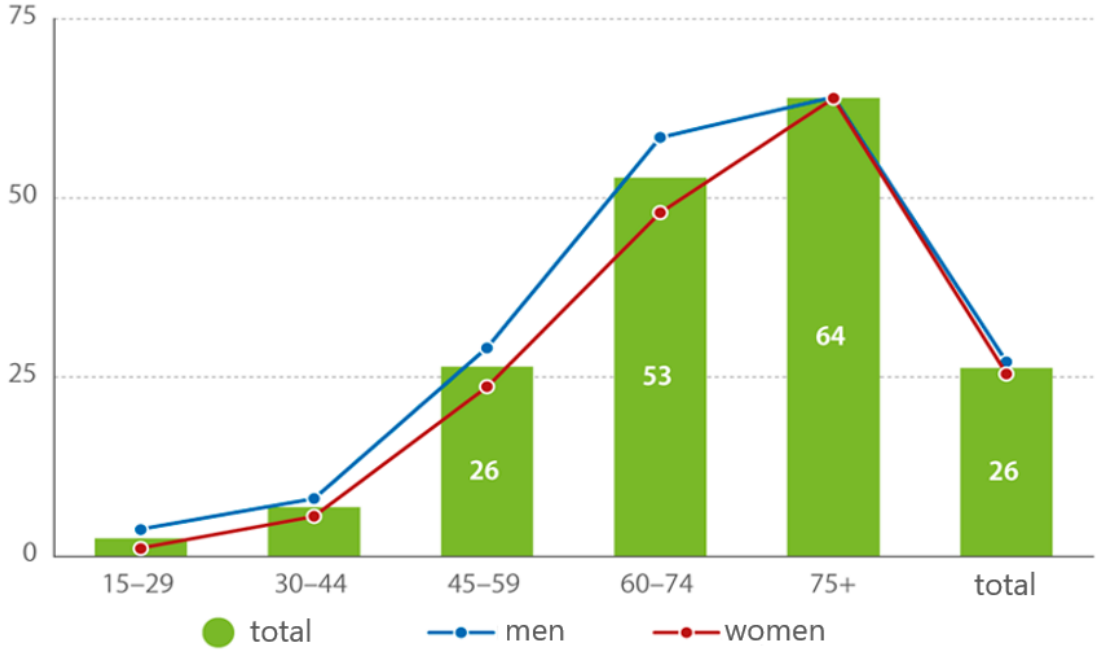
Keywords: *hypertension, blood pressure, walking, exercise intervention*

1. INTRODUCTION

Cardiovascular diseases are among the most common diseases and causes of death in developed countries today. Among the most common of these is hypertension, which is also one of the major risk factor for other cardiovascular diseases.

The prevalence of hypertension in the population of the Czech Republic is assessed in the European Health Interview Survey (EHIS), which is compulsorily conducted in EU countries once every six years. In the Czech Republic, it is conducted by the Institute of Health Information and Statistics of the Czech Republic (IHIS CR) together with the Czech Statistical Office (CSU), most recently in 2019. The EHIS results show, among other things, that hypertension is the most common chronic disease in the Czech Republic. As can be seen in Figure 1, hypertension affects more than a quarter of the population, its prevalence increases significantly with age and is more common in men (27% in men and 25% in women), with the exception of the over-75 group, in which women and men are equally represented (Pištorová, 2021).

Figure 1: Percentage of people with hypertension in the Czech Republic in 2019

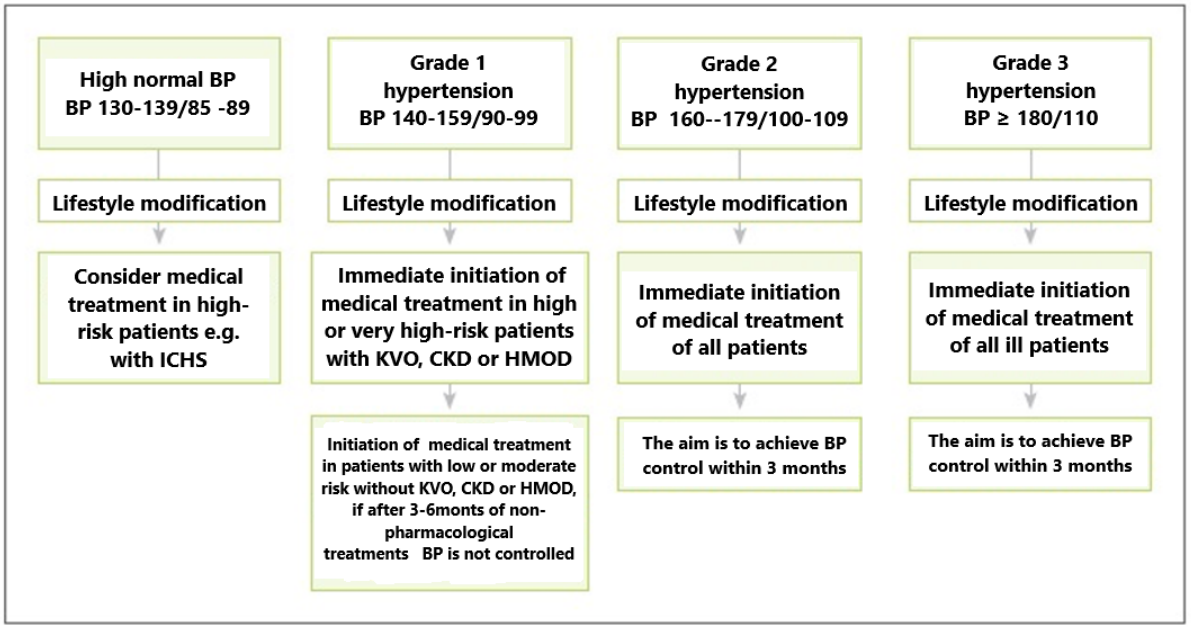


source: Pištorová, 2021

As far as the development of hypertension in the Czech Republic is concerned, blood pressure values in our population have decreased significantly over the last 30 years. In addition to improvements in the pharmacological treatment of hypertension, this is also due to improvements in dietary habits in terms of reduced consumption of salt and saturated fat. In fact, blood pressure has fallen even in people who have not been treated pharmacologically (Widimsky, 2019).

The principles of initiating antihypertensive treatment are summarized in Figure 2. Lifestyle modification is recommended for all patients with high blood pressure and also for those with high normal blood pressure. In grade 2 and 3 hypertension, pharmacological treatment is initiated immediately. In grade 1 hypertension and in high normal blood pressure, pharmacological treatment is indicated depending on the level of risk determined by the SCORE tables and the presence of cardiovascular disease and organ damage (Cífková, 2018).

Fig. 2: Initiation of antihypertensive treatment



Initiation of antihypertensive treatment (lifestyle modification and medical therapy) at different BP values measured in the office

CKD - chronic kidney disease HMOD - hypertension-mediated organ damage;
ICHS - ischaemic heart disease; CVD - cardiovascular disease; BP - blood pressure

source: Cífková, 2018

Non-pharmacological treatment of hypertension consists of regimen measures including physical activity, adherence to nutritional measures (including limitation of salt intake and alcohol consumption), weight reduction, smoking prohibition and avoidance of blood pressure-raising drugs (Koudelka and Sovová, 2018). Last but not least, efforts to limit the influence of stress are important, as it can significantly increase blood pressure (Psalmanová, 2017). Sleep hygiene also plays a role in the treatment of hypertension (Novák and Plačková, 2012).

Physical activity recommendations are mainly focused on aerobic physical activities. It has been shown in many studies that people who perform some regular physical activity have a significantly lower risk of cardiovascular disease (24% for men and 27% for women) than people who do not perform any activity (Mikeš and Tuka, 2020). In hypertensives, physical activity reduces the risk of cardiovascular complications both directly, by lowering resting and exercise blood pressure values, and indirectly by affecting other risk factors for cardiovascular disease, through weight reduction, increased glucose tolerance, improved lipid profile, reduced stress, or reduced probability of smoking (Štejfa, 2007).

The simple fact that physical activity has a positive effect on mood and leads to psychological relaxation cannot be overlooked, so in people in whom psychology plays a role in the development of hypertension (stress, suppressed anger, conflict avoidance, etc.), it may have a secondary effect on lowering blood pressure by affecting emotional state.

The major health organisations that deal with the relationship between physical activity and cardiovascular disease, including hypertension, such as the American College of Sports Medicine (ACSM), the European Society of

Cardiology (ESC) and the Czech Society of Cardiology, follow the Guidelines for Physical Activity in the Population, published by the US Department of Health and Human Services in 2018. The American College of Sports Medicine (ACSM) recommends aerobic exercise for people with hypertension at a frequency of 5-7 times per week (with the possibility of supplementing with weight training with a lower load 2-3 times per week). The frequency of physical activity is recommended for most days of the week, because in addition to the effect of aerobic exercise on the drop in blood pressure with long-term exercise, there is also an immediate effect, persisting up to 24 hours. Its intensity should be moderate (i.e. 40-60% of VO2max or Borg scale level 11-14) and its duration 30-60 min, either continuous or intermittent, with each exercise lasting at least 10 min. Regarding the type of aerobic exercise, prolonged rhythmic physical activities using large muscle groups such as walking, cycling, swimming are recommended. At the same time, the progression of the exercise program should be gradual in hypertonic patients, especially in terms of intensity (Zaleski, 2019).

The European Society of Cardiology (ESC) recommendations on non-pharmacological treatment and prevention of cardiovascular diseases from 2021 are comparable. The Czech Society of Cardiology has also adopted them for its recommended practices. These recommendations include moderate-intensity aerobic physical activity for 150-300 minutes per week, or intense aerobic physical activity for 75-150 minutes, or a combination of both, spread throughout the week, such as walking, jogging, cycling, etc. Activity spread over smaller (at least 10-minute) periods also helps to reduce sitting time. If some individuals are unable to follow these recommendations due to age, other illnesses or other limitations, they should be as physically active as their abilities and conditions allow. For people with low levels of physical fitness, a gradual increase in the level of physical activity is recommended. Intensity should be assessed in relative terms (e.g., using the Borg scale), as persons with low physical fitness must exert more effort to perform the same physical activity than more fit persons (Visseren et al., 2021; Vrablík et al., 2022).

The U.S.Federal Guidelines (Physical Activity Guidelines Advisory Committee Report, 2008) suggest that an exercise volume of 500–1,000 MET·min/week (MET equivalent of PA × number of minutes) is optimal and can be achieved, for example, with 150 min/week of walking at 6.4 km/h (intensity of 5 METs) or 75 min of jogging at 9.6 km/h (10 METs). It seems to me more flexible to express recommendations of exercise in MET.min /week than in minutes/week.

It is important to include activities in the exercise programme that do not interfere too much with the daily routine, at least initially, and that the patient will enjoy or at least not be averse to, because such activities will be easier to maintain in the long term. From this perspective, walking, which is also accessible and safe, seems ideal.

Isometric physical activities such as lifting and carrying loads, mowing the grass, digging in the garden, etc. are not suitable for hypertensive patients (Widimský, 2019). Hypertonic people should avoid strength sports (lifting heavier loads, weightlifting, wrestling, bodybuilding), as the contraction of large muscle groups increases resistance in the vasculature and thus blood pressure; competitive sports are also not suitable because of the psychological upset (Hošková, 2012).

In patients with controlled hypertension and with high normal blood pressure, the recommended physical activity can be

started without stress testing; in patients with stage 2 hypertension or in patients who have already suffered organ damage (heart, retina, kidneys), stress testing is advisable. If a patient with hypertension has any serious associated disease, it is advisable to consult the treating physician regarding physical activity. Absolute contraindications to physical activity in hypertensive patients are acutely decompensated hypertension (BP > 180/110 mmHg), fresh myocardial infarction, complete conduction disorder, acute heart failure, unstable angina and, of course, any other acute illnesses (Mikeš and Tuka, 2020).

Dietary measures also play an important role in hypertension. Firstly, because of its direct effect on blood pressure, and secondly, because of its influence on the risk of cardiovascular complications of hypertension, as dietary intake also affects other risk factors for atherosclerosis. In addition to lowering blood pressure, it helps to reduce overall body weight, normalize blood lipid and blood sugar levels and reduce susceptibility to thrombosis (Cífková, 2005).

Important in hypertension is the reduction of dietary sodium intake, i.e. salt (sodium chloride) restriction. The recommended daily intake of salt is 5 g (this corresponds to about 2 g of sodium); in hypertensives, salt consumption per day should not exceed 4 g. It is not enough to limit the use of table salt, it is also necessary to significantly reduce or eliminate foods containing salt, such as sausages and many other processed foods (Kužela and Patlejchová, 2003). In hypertensive patients, the consumption of fats, or saturated fatty acids that increase blood cholesterol levels, which is the main component of sclerotic plaques, should also be significantly reduced (Sovova, 2008). It is desirable to limit red meat, which contains a lot of fat with saturated fatty acids. On the other hand, the consumption of good quality oils with a high content of unsaturated fatty acids is recommended, as well as the consumption of fish, as it contains the so-called omega-3 fatty acids, which have an anti-sclerotic effect. In addition to the anti-sclerotic effect, restriction of fat consumption also leads to a reduction in total energy intake and consequently to a reduction in body weight, which is another important dietary measure in obese or overweight patients (Kužela and Patlejchová, 2003).

Alcohol restriction is essential for people with hypertension, as immoderate alcohol consumption increases systolic and diastolic blood pressure - expert recommendations limit alcohol consumption to 14 units per week for men and 8 units per week for women, where one unit is defined as 250 ml of beer or 125 ml of wine (Widimský, 2019).

Consumption of a larger amount of dietary fibre, which is antisclerotic, is advisable. Water-soluble fibre (pectins, beta-glucans) lowers cholesterol levels both by preventing the reabsorption of cholesterol in the small intestine and, once broken down in the large intestine, is partially absorbed and then reduces cholesterol production in the liver. Water-insoluble fibre (cellulose, hemicelluloses, lignin) reduces the reabsorption of bile acids in the small intestine, and the newly formed acids are then formed from cholesterol, resulting in a reduction in blood cholesterol levels. It also plays a role in weight loss as it reduces the feeling of hunger. The daily intake of dietary fibre should be 25-30 grams and the ratio of soluble to insoluble fibre should be 1:3. In our population, the daily fibre intake is only 10-15 grams (Suchánek, 2013).

In the context of the diet for high blood pressure, the so-called DASH diet (Dietary Approaches to Stop Hypertension) is sometimes referred to, in which mainly fruits, vegetables and fish are represented

and animal fats and cholesterol are limited. Studies have shown the effect of this diet on lowering blood pressure values and reducing cardiovascular complications and overall mortality (Widimsky, 2019).

Overview of available studies focused on the effect of physical activity

Lee et al. (2021) conducted a large meta-analysis to evaluate the effect of walking on blood pressure and heart rate. They included a total of 73 studies with hypertensive and normotensive participants of both sexes aged 16 to 84 years that evaluated the effects of an intervention program using walking on blood pressure values and on heart rate. Walking was of moderate intensity, most commonly brisk walking in the countryside or in the city, and in a few studies treadmill, Nordic walking or stepper walking, and the intervention programme lasted on average 15 weeks (most commonly 12 to 15 weeks). The frequency and duration of walking was 20-40 minutes 3-5 times per week, with an average of 153 minutes per week (most commonly 150 to 180 minutes). In the results of this meta-analysis, then, the decrease in systolic blood pressure values averaged 4.11 mmHg (73 studies included), the decrease in diastolic blood pressure values averaged 1.79 mmHg (69 studies included), and heart rate decreased by an average of 2.76 beats per minute (26 studies included). In the conclusion of this paper, the authors summarize that walking can reduce both systolic and diastolic blood pressure, regardless of age, gender, or baseline blood pressure.

Oja et al. (2018) reached almost identical results in their paper. Their meta-analysis included 37 studies lasting at least 8 weeks, with a total of 2001 adult inactive healthy participants, and the intervention exercise program consisted of normal walking for thirty studies, and the other was treadmill walking or Nordic walking. In the results, the decrease in systolic blood pressure values was 4.05 mmHg and the decrease in diastolic blood pressure values was 1.76 mmHg.

Another meta-analysis by de Barcelos et al. (2022) also confirmed that aerobic physical activity reduces systolic and diastolic blood pressure in adults with hypertension. Twenty-four studies lasting at least six weeks were selected, with 12 studies including an intervention exercise program with progression in intensity, frequency and/or duration and 12 studies an intervention exercise program without progression. The total number of participants in the studies was 1207, and these were men and women aged 37-73.5 years with hypertension; in 11 studies, participants were treated with antihypertensive. The most common aerobic physical activity in the studies was stationary bicycle riding, walking and running, the length of the intervention program ranged from 6 to 37 weeks and individual exercise sessions lasted 20-60 minutes with a frequency of 3-4 per week. After aerobic training with progression, there was a decrease in systolic blood pressure values by an average of 10.67 mmHg and diastolic blood pressure values by an average of 5.49 mmHg. After aerobic training without progression, there was a decrease in systolic blood pressure values by an average of 10.17 mmHg and diastolic blood pressure values by an average of 6.51 mmHg. In their conclusions, the authors of this paper summarize that aerobic physical activity can reduce systolic and diastolic blood pressure in adults with hypertension. While there is almost no difference in blood pressure reduction with and without exercise progression, it is apparent when examining individual studies that greater reductions may occur with progression in intensity and even more so in duration. The authors also mention in their conclusions the association of older age and greater blood pressure reduction.

For example, Fu et al. (2022) reached similar results to a previous meta-analysis,

including 14 studies with a total of 1027 hypertensive patients aged 35 years or older and duration of aerobic training ranging from 4 to 20 weeks (most commonly 12 weeks). The aerobic physical activity here was most commonly walking, running, cross-country skiing, and stationary biking. The duration of exercise ranged from 20 to 60 minutes and its frequency was 3 times per week. As a result of aerobic training, the values of systolic blood pressure decreased by an average of 9.91 mmHg and diastolic blood pressure by an average of 4.32 mmHg.

In their study, Blumenthal et al. (2000) investigated the effect of exercise on high blood pressure in addition to the effect of weight loss. The six-month study involved 133 adults with high normal blood pressure and with grade 1 to 2 hypertension, sedentary lifestyle and overweight. The authors focused on assessing the effects on high blood pressure of aerobic physical activity alone and aerobic physical activity combined with a weight loss intervention program consisting of dietary modification and change in eating behaviour. Both the exercising group and the exercising while losing weight group showed a reduction in blood pressure at the end of the study, however, the combined program group showed a greater reduction, with a 7 mmHg reduction in systolic blood pressure and a 5 mmHg reduction in diastolic blood pressure for the aerobic physical activity combined with the weight loss intervention program. For aerobic physical exercise alone, there was a reduction in systolic pressure of 4 mmHg and diastolic pressure also by 4 mmHg.

The aim of the study by Moreau et al. (2001) was to assess the effect of walking on blood pressure values in 24 postmenopausal women aged 53-55 years with high normal blood pressure or grade 1 hypertension. After a 12-week intervention program using walking, systolic blood pressure values decreased by an average of 6 mmHg, while no significant decrease was observed in diastolic blood pressure. Reductions occurred in both untreated women and women taking antihypertensives.

2. AIM OF THE WORK AND RESEARCH QUESTIONS

The aim of the study was to test the effect of an exercise programme using walking and dietary modification in hypertension.
Research questions:

- Will the proband (she) with hypertension have a reduction in systolic blood pressure when regular walking is included according to the conditions set by the exercise intervention programme, and if so, how?
- Will the proband (she) with hypertension have a reduction in diastolic blood pressure with the inclusion of regular walking under the conditions of the exercise intervention programme, and if so, how?
- Will the proband's (her) adherence to recommendations for hypertension, such as the inclusion of regular physical activity and dietary modification, result in a reduction in excess weight and a change in body composition?

3. METHODOLOGY

The research method used in this study was a case study. The study was conducted between June and October 2022.

Baseline:
The proband was a postmenopausal woman aged 55 years. Her height was 177 cm and she stated a body weight of 87 kg at the initial interview. She had been diagnosed with hypertension about 20 years ago and had been treated pharmacologically since the beginning, taking an ACE inhibitor drug in the morning. She did not particularly follow the recommended regimen for

hypertension, had little exercise and was overweight. None of her family members had been treated for hypertension.

In the last year or so, the proband had observed, despite adherence to the prescribed medication, that when her blood pressure was measured in the morning with a home tonometer before taking her medication, her blood pressure was sometimes higher than before. She was told by her physician that she needed to follow the regimen, and this led her to request admission to the intervention program that was the subject of this study. She realised that she should, above all, incorporate exercise into her regime and that she could also improve her diet, in addition, she was beginning to perceive ageing in herself. Therefore, she would like to use the programme to help her initiate and implement a change that would be beneficial to her overall health.

The proband had a sedentary job that included working with clients, which was sometimes stressful. She commuted to work partly by car and partly by public transport, 3 times a week, the walk from the tram to work was about 400 m, after work, she usually went shopping or immediately home. The rest of the days she worked from home. She lived alone, in an apartment, and used the elevator. With friends, she went for a walk or to sit together occasionally, sometimes on an undemanding trip and about once or twice a year she went on a wellness stay or a not very demanding sightseeing holiday. She did not have a sporting attitude and did not engage in any regular physical activity. She had no physical limitations and felt healthy.

As for eating habits, the proband ate 3-4 times a day before the intervention, she prepared her own food, about 1-2 times a week she bought lunch or dinner in a restaurant or fast food or durable food to heat in the microwave. She liked sweet pastries, but tried not to eat too many. She would like to increase her fluid and fibre intake because of her diverticulosis of the colon, but she has not been very good at getting used to it. Her daily fluid intake was 1.5-2 litres (water, unsweetened tea), she did not consume alcohol, coffee only rarely. She did not smoke.

The proband was provided with a physical intervention programme supported by dietary modification, after which its effect on her blood pressure was evaluated. This programme was subsequently evaluated in relation to overweight and body composition as important factors in hypertension.

Diagnostic methods

Blood pressure measurement

Before and after the intervention program, the proband measured her blood pressure and resting heart rate at home with an Omron automatic digital oscillometric device for 7 days in the morning and evening.

Diagnosis and analysis of human body composition

Before and after the intervention program, the proband underwent a diagnostic and body composition analysis with the InBody device. This device works on the principle of bioimpedance, or the DSM-BIA method (direct segmental multi-frequency bioelectrical impedance analysis). The InBody measures many body parameters - the most important are total body weight, body fat, skeletal muscle, body water and minerals. It also diagnoses overweight and obesity by calculating BMI (Body Mass Index). It also determines the BMR (Basal Metabolic Rate).

WHR index

Waistline and hipline circumferences were measured before and after the intervention program. From the measurements, the WHR index was calculated, which indicates the distribution of fat in the body.

It assesses the type of fat distribution according to the WHR index:

	Rather peripheral	Balanced	Rather central	Central risk
Women	< 0,75	0,75-0,80	0,80-0,85	> 0,85
Men	< 0,85	0,85-0,90	0,90-0,95	> 0,95

(Komárek, 2007)

Recording of physical activity

At the first meeting, the proband was asked to observe and record her usual physical activity for 2 days. She was instructed to record all activity covering the entire 24 hours, indicating the type of physical activity and the exact duration of that activity. Based on the physical activity record, the proband's daily activity factor was determined, and the record also served, in addition to the information provided by the proband at the initial interview, to provide a more accurate picture of the proband's usual exercise habits and therefore her fitness.

The proband was provided with an indicative list of types of physical activities for her reference and use. Then, an activity factor was assigned to each type of physical activity in the proband's record, and a daily activity factor for a particular day was calculated, taking into account the duration of each activity.

Activity factors for specific physical activities:

1.1 BM sleep
1.2 BM lying awake (passive rest, TV, reading, etc.)
1.5 BM sitting and standing activity (reading, hygiene, dressing, cooking, eating, riding in transport)
3.0 BM moderate physical activity (housework, routine cleaning, laundry, walking 3-4 km/h, shopping, cycling up to 10 km/h)
5.0 BM low-intensity physical activity with little sweating (heavy cleaning, yard work, cycling up to 16 km/h, swimming breaststroke or 20 m/min mark)
8.0 BM physical activity with moderate intensity and moderate sweating (walking 7-8 km/h, heavier yard work, cycling up to 20 km/h, table tennis, volleyball)
10.0 BM physical activity with high intensity and high perspiration (running 15 km/h, swimming crawl, football, hockey, basketball)

(Seliger, 1974)

Dietary record

At the first meeting, the proband was asked to observe and record her usual diet for 7 days. She was instructed to record her diet in the Calorie Chart application, which is generally used to track energy intake and expenditure by recording foods consumed and physical activity. For the purposes of this thesis, the app was used to record a typical weekly diet before starting the intervention programme. The app depicts the caloric value of foods and the macronutrient and fibre content.

Intervention methods and procedures

Movement intervention

Based on the recommendations of the Czech Society of Cardiology, the European Society of Cardiology (ESC) and the American College of Sports Medicine

(ACSM), a physical activity programme was designed for the proband, and the assessment was set so that it would not be difficult for the proband and would not burden her in her daily life.

The duration of the intervention program, including baseline and outcome measures, was determined to be a total of 14 weeks, and walking was selected as the aerobic physical activity that the proband believed she would enjoy and be able to perform fully. Baseline measurements were taken in the initial week, followed by the actual exercise programme for 12 weeks, and exit measurements were taken in the final week.

The proband was recommended to walk a minimum of 5 times a week, with a moderate intensity assessed subjectively ranging from grade 10 to 14 on the Borg RPE scale, for 12 weeks, with a gradual increase in daily walking time every 4 weeks - as follows. Week 1 to 4 30 min/day (i.e. minimum 150 min/week), Week 5 to 8 45 min/day (i.e. minimum 225 min/week), Week 9 to 12 60 min/day (i.e. minimum 300 min/week). The walking time could be spread over several parts of the day, but one such part had to last at least 10 minutes.

Each day during the exercise programme, the proband recorded in a table the amount of walking time undertaken according to the conditions set out in the intervention programme, which was over and above her normal walking time. Contact was maintained with the proband throughout, the proband was motivated and the records were continuously checked.

Table 3 gives an overview of the duration of the physical activity by week. Of the 12 weeks, the proband met the prescribed duration in 10 weeks, in some of which she exceeded it, and in two weeks the duration of physical activity was less than recommended - in week 3 the total duration was 120 min/week (compared to the recommended 150 min/week) and in week 9 the total duration was 270 min/week (compared to the recommend 300 min/week).

Table 1: Duration of physical activity during the intervention programme

1. week	PA	2. week	PA	3. week	PA	4. week	PA
Date	min	date	min	date	min	date	min
10.7.	30	17.7.	30	24.7.	32	31.7.	31
11.7.	30	18.7.	34	25.7.	30	1.8.	30
12.7.	34	19.7.	28	26.7.	0	2.8.	32
13.7.	30	20.7.	39	27.7.	28	3.8.	30
14.7.	0	21.7.	40	28.7.	30	4.8.	0
15.7.	30	22.7.	0	29.7.	0	5.8.	30
16.7.	30	23.7.	0	30.7.	0	6.8.	16
total:	184	total:	171	total:	120	total:	169

5.week	PA
Date	min
7.8.	0
8.8.	0
9.8.	45
10.8.	47
11.8.	45
12.8.	46
13.8.	45
total:	228

6. week	PA
date	min
14.8.	0
15.8.	46
16.8.	46
17.8.	46
18.8.	45
19.8.	46
20.8.	0
total:	229

7. week	PA
date	min
21.8.	45
22.8.	45
23.8.	45
24.8.	0
25.8.	45
26.8.	45
27.8.	0
total:	225

8 week	PA
date	min
28.8.	46
29.8.	47
30.8.	45
31.8.	45
1.9.	0
2.9.	47
3.9.	0
total:	230

9 week	PA
Date	min
4.9.	60
5.9.	60
6.9.	60
7.9.	0
8.9.	60
9.9.	0
10.9.	30
total:	270

10. week	PA
date	min
11.9.	60
12.9.	60
13.9.	60
14.9.	60
15.9.	0
16.9.	40
17.9.	45
total:	325

11. week	PA
date	min
18.9.	60
19.9.	60
20.9.	60
21.9.	60
22.9.	0
23.9.	60
24.9.	0
total:	300

12. week	PA
date	min
25.9.	60
26.9.	0
27.9.	62
28.9.	62
29.9.	60
30.9.	60
1.10.	0
total:	304

Source: own

Nutrition intervention

To complement the exercise intervention, the proband was advised to change her diet for the duration of the intervention programme, ideally permanently.

Prior to the start of the intervention program, the proband tracked and recorded her usual diet in the Calorie Chart app for 7 days. Based on this record, the proband's average daily intake of kcal, protein, carbohydrate, fat, and fibre was determined. The average daily intake was 1826 kcal, B 86.7g, S 168.1g, T 86.5g, fibre 8.5g.

Since the intake came out lower than the output but the proband still did not lose weight, a possible variation of 15-20% was added to the intake. After this correction,

the value of daily energy intake was 2100-2191 kcal, which compared to the daily energy expenditure was already consistent with the proband not losing weight.

The dietary record also showed that the proband was not consuming enough fibre, her diet lacked fish and she was consuming a lot of processed foods, which are unsuitable for hypertension due to their high salt content.

A sample diet was prepared for the proband to give her an idea of how she could change her diet and also make it more varied. In this diet, the energy intake was reduced by 15 % to 1870 kcal/day and the macronutrients were changed as follows: 83 g protein, 51 g fat, 262 g carbohydrate. The diet was designed to meet the recommendations for people with hypertension and the choice of foods took into account the fact that the proband omits some foods from her diet due to diverticulosis of the colon. The proband was divided into four portions and was advised to always take her time, to consume the food calmly and to chew the food thoroughly.

In addition to the presentation of a sample menu, the proband was introduced to the general principles of healthy eating and the recommendations for hypertension that she should follow in her diet were emphasized:

- reduce the salt content of the diet to 2-3 g/day (also found in seasoning mixes) or, in the case of salt with reduced sodium content, to 5 g/day;
- season the diet with herbs and salt-free spices rather than salt;
- omit salty foods, various flavourings and processed foods with hidden salt, especially sausages or some cheeses;
- leave out semi-finished foods, instant foods and fast food;
- get enough fibre in the diet by eating fruit and especially vegetables;
- drinking at least 2 litres a day, unsweetened and non-carbonated drinks, mineral water is not suitable due to its sodium content;
- limit sweet as much as possible, can be replaced by a reasonable amount of fruit;
- limit fat consumption;
- use lean meat (chicken, turkey, rabbit, veal) and consume fish 2-3 times a week;
- use vegetable fats and good quality vegetable oils as fats;
- do not fry or add fat to food;
- process food by boiling, stewing, steaming, grilling, foil baking, hot air oven.

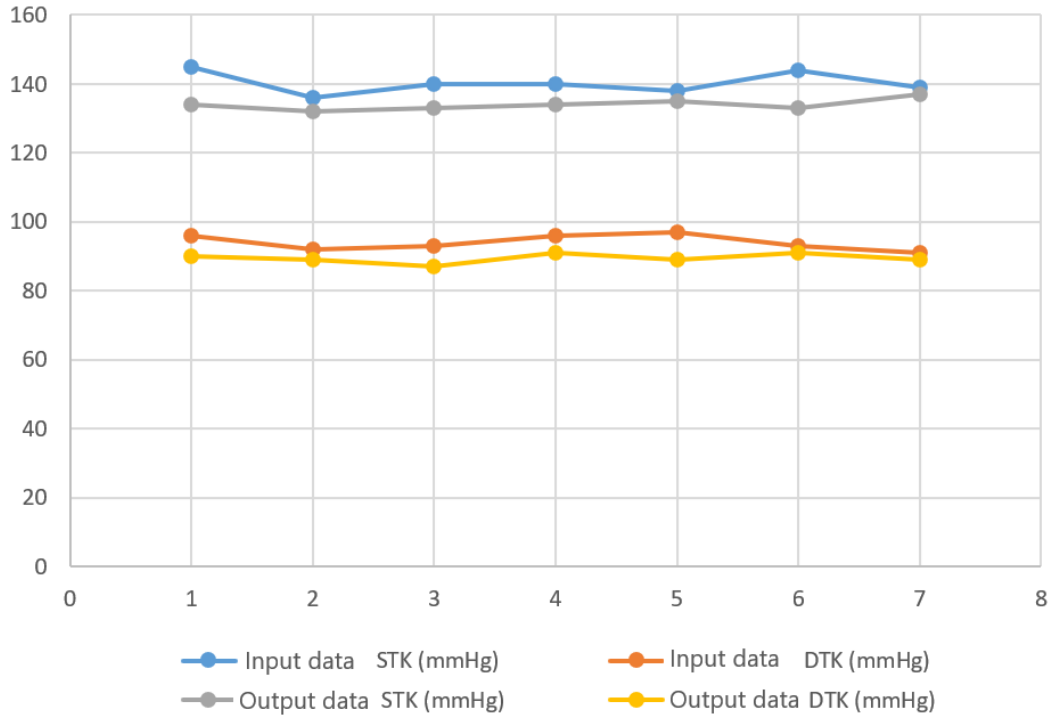
Results and discussion

Resulting comparison of input and output data

Blood pressure measurements

Table 2 compares the values of morning systolic and diastolic blood pressure measured before and after the end of the exercise intervention programme and these measurements are shown graphically in Figure 3.

Figure 3: Comparison of morning systolic and diastolic blood pressure



source: own

Table 2: Morning systolic (SBP) and diastolic (DBP) blood pressure values

	Input measure		Output measure	
	SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
1. day	145	96	134	90
2. day	136	92	132	89
3. day	140	93	133	87
4. day	140	96	134	91
5. day	138	97	135	89
6. day	144	93	133	91
7. day	139	91	137	89

source: own

Table 3 compares the values of evening systolic and diastolic blood pressure measured before and after the end of the exercise intervention programme and these measurements are shown graphically in Figure 4.

Table 3: Evening systolic (SBP) and diastolic (DBP) blood pressure values

	Input measure		Output measure	
	SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
1. day	133	88	127	85
2. day	133	91	130	88
3. day	137	92	135	87
4. day	128	89	125	86
5. day	132	88	123	86
6. day	130	89	120	84
7. day	131	90	130	89

source: own

Figure 4: Comparison of evening systolic and diastolic blood pressure

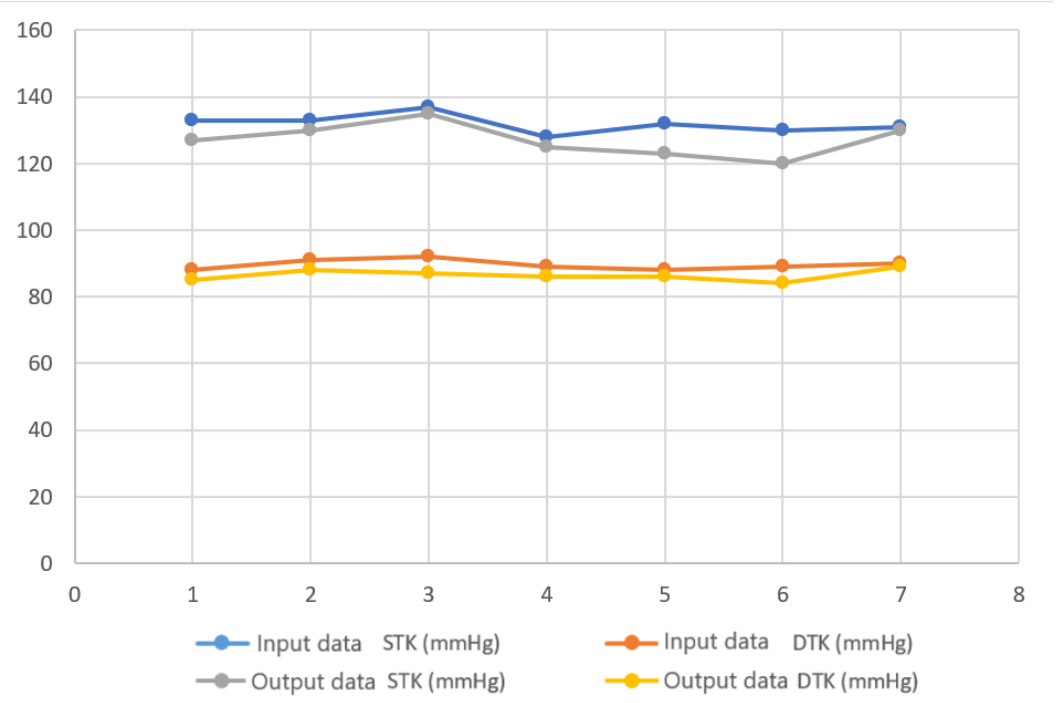


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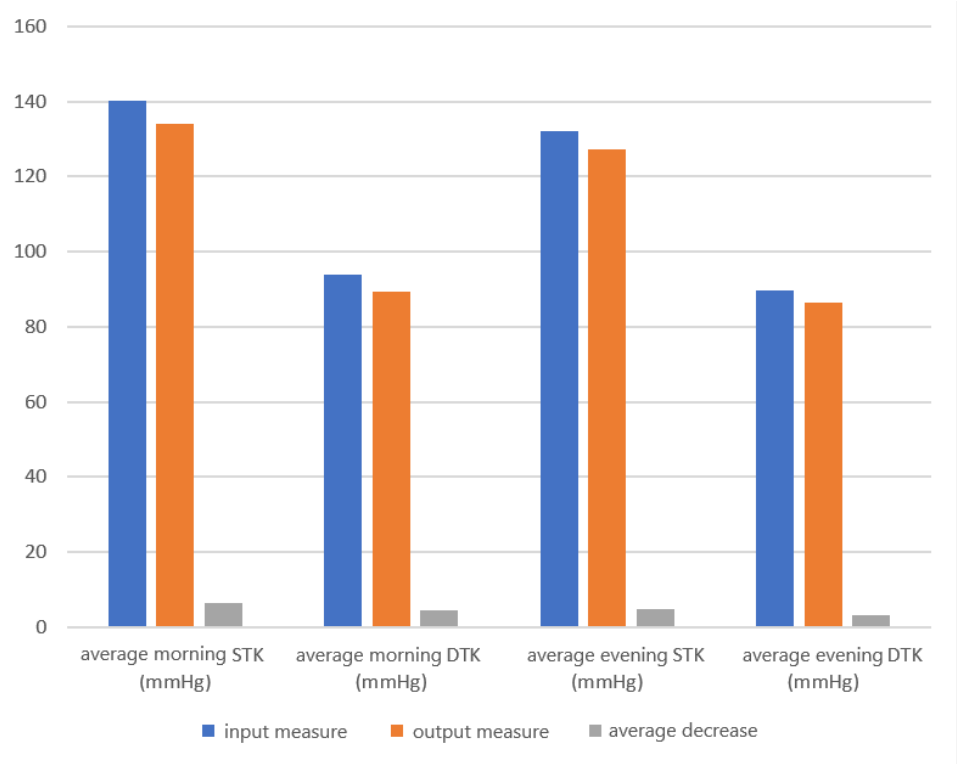
Table 4 records the average of the input and output blood pressure measurements and these measurements are compared graphically in Figure 5.

Table 4: Resulting blood pressure reduction

	Input measure	Output measure	Average decrease
average morning SBP (mmHg)	140,29	134,00	6,29
average morning DBP (mmHg)	94,00	89,43	4,57
average evening SBP (mmHg)	132,00	127,14	4,86
average evening DBP (mmHg)	89,57	86,43	3,14

source: own

Figure 5: Comparison of blood pressure values before and after the intervention programme



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Heart rate (pulse, beats per minute) was also recorded during blood pressure measurement. Table 5 compares the average heart rate values from morning and evening measurements before and after the interventional exercise programme.

Table 5: Resulting heart rate reduction

	Input measure	Output measure	Average decrease
average morning heart rate/min	69,43	65,57	3,86
average evening heart rate/min	70,14	65,86	4,28
average heart rate/min	69,79	65,72	4,07

source: own

WHR index

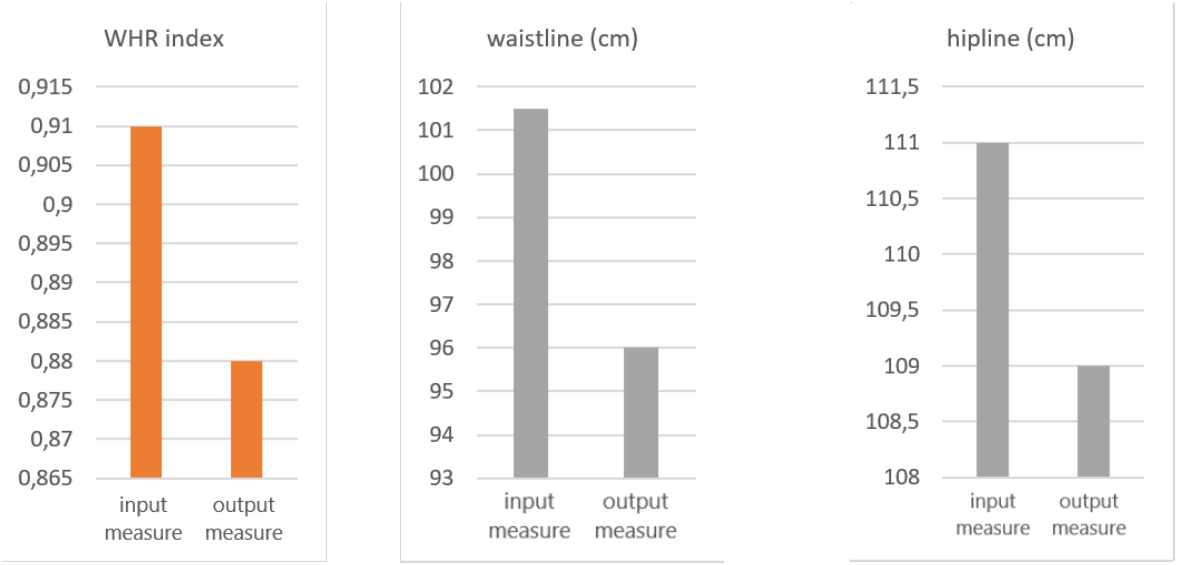
Table 6 compares the waistline, hipline and the WHR index calculated from them before and after the exercise intervention programme. These measurements are shown graphically in Figure 6. The waistline decreased by 5.5 cm, the hipline decreased by 2 cm and the WHR index value decreased and became closer to the cardiovascular disease risk threshold of 0.85 for women. However, this decrease in the WHR index was not yet sufficient to bring it below this threshold, so there is still a higher risk of cardiovascular disease.

Table 6: WHR index - comparison of results

	Input measure	Output measure
waistline (cm)	101,5	96,0
hipline (cm)	111,0	109,0
WHR index	0,91	0,88
assessing the level of risk	central risk	central risk

source: own

Figure 6: Resulting comparison of WHR index before and after the intervention programme



source: own

Body weight, BMI and body fat percentage

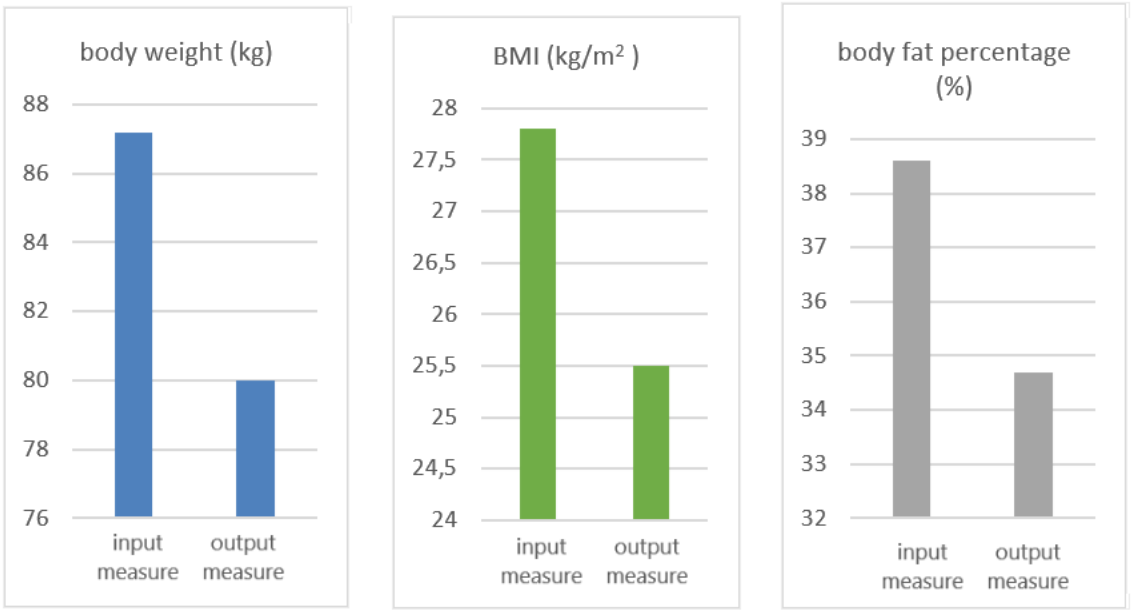
Table 7 compares body weight, BMI and body fat percentage before and after the exercise intervention programme. These measurements are shown graphically in Figure 7. Body weight decreased by 7.2 kg, BMI decreased to 25.5 kg/m2 and body fat percentage decreased by 3.9 %. Although BMI is still in the overweight range (25.0-29.9 kg/m2), it is much closer to the normal weight range (18.5-24.9 kg/m2).

Table 7: Body weight, BMI and body fat percentage - resulting differences

	input measure	output measure	resulting difference
body weight (kg)	87,2	80,0	-7,2 kg
BMI (kg/m2)	27,8	25,5	-2,3
body fat percentage (%)	38,6	34,7	-3,9 %

source: own

Figure 7: Body weight, BMI and body fat percentage - final comparison



Answer to the first research question:
The research in this paper confirmed the positive effect of regular walking on systolic blood pressure. Prior to the intervention programme, the average systolic blood pressure measured in the morning was 140.29 mmHg and in the evening was 132 mmHg. After the programme, the average systolic blood pressure measured in the morning hours dropped to 134 mmHg and in the evening hours to 127.14 mmHg. Thus, the study showed a decrease in systolic blood pressure when regular walking was included according to the conditions set by the intervention programme - the average reduction was 6.29 mmHg for morning values and 4.86 mmHg for evening values).

A study by Moreau et al. (2001), assessed the effect of walking on blood pressure values in postmenopausal women aged 53-55 years with high normal blood pressure or grade 1 hypertension, which corresponds to the selection of our proband, and the intervention programme lasted 12 weeks as in our study, systolic blood pressure values decreased by an average of 6 mmHg, with reductions occurring in both untreated women and women taking antihypertensives. Comparable reductions in values were achieved in our study.

Blumenthal et al. (2000), who in their study investigated the effect of aerobic physical activity combined with dietary modification aimed at weight loss, reported a decrease in systolic blood pressure of 7

mmHg. In our research, there was a reduction of 6.29 mmHg in morning values and 4.86 mmHg in evening values. We obtained a similar result for morning measurements, while the decrease was lower for evening measurements; however, it should be noted that the intervention programme in this study lasted twice as long (6 months) as in our research.

Lee et al. (2021) or Oja et al. (2018) reported in their meta-analyses a reduction in systolic blood pressure due to walking of 4 mmHg (more precisely, Lee and Oja by 4.11 and 4.05, respectively). In comparison, our proband had better results.

Fu et al. (2022) or de Barcelos et al (2022) in their meta-analyses reported a reduction in systolic blood pressure due to aerobic exercise by 10 mmHg (more precisely Fu by 9.91 and de Barcelos by 10.67 for training with progression and 10.17 for training without progression). Compared to the reductions in these two meta-analyses, our proband showed a lower reduction.

Answer to the second research question:

The research in this paper confirmed the positive effect of regular walking on diastolic blood pressure. Before the start of the exercise intervention programme, the average diastolic blood pressure measured in the morning was 94 mmHg and in the evening 89.57 mmHg. After the exercise intervention programme, the average diastolic blood pressure measured in the morning hours decreased to 89.43 mmHg and in the evening hours to 86.43 mmHg. Thus, the study showed a reduction in diastolic blood pressure when regular walking was included according to the conditions set by the exercise intervention programme - the average reduction was 4.57 mmHg for morning values and 3.14 mmHg for evening values.

In the study by Moreau et al. (2001), which assessed the effect of walking on blood pressure values in postmenopausal women aged 53-55 years with high normal blood pressure or grade 1 hypertension, which corresponds to the selection of our proband, and the intervention program lasted 12 weeks as in our study, no significant decrease was observed in diastolic blood pressure values. In contrast, in our study, there was a decrease in diastolic blood pressure, with a decrease of 4.57 mmHg for morning values and 3.14 mmHg for evening values.

Blumenthal et al. (2000), in their study investigating the effect of aerobic physical activity combined with dietary modification aimed at weight loss, reported a 5 mmHg decrease in diastolic blood pressure. In our study, a similar result was obtained for the morning measurement, and the decrease was lower for the evening measurement; however, it should be noted that the intervention programme in this study lasted twice as long (6 months) as in our research.

Lee et al. (2021) or Oja et al. (2018) reported in their meta-analyses a decrease in diastolic blood pressure due to walking of 1.8 mmHg (more precisely, Lee and Oja by 1.79 and 1.76, respectively). In comparison, our proband achieved better results.

Fu et al. (2022) in their meta-analysis reported a decrease in diastolic blood pressure due to aerobic physical activity by 4.32 mmHg. Comparable results to this reduction were achieved in our study.

De Barcelos et al. (2022) in their meta-analysis report a decrease in diastolic blood pressure due to aerobic exercise activity of 6 mmHg (more precisely, 5.49 for training with progression and 6.51 for training without progression). Compared to this result, the decrease in values was lower in our research.

It is also worth mentioning that in addition to the decrease in systolic and diastolic blood pressure, the proband also experienced a reduction in heart rate after completing the intervention programme. Lee et al. (2021) in their large meta-analysis evaluated the effect of walking on blood pressure in addition to its effect on heart rate, and the latter decreased by an average of 2.76 beats per minute in the results. Compared to this result, the decrease in our research was greater, with an average of 4.07 beats per minute.

Answer to the third research question: In addition to physical activity and adherence to nutritional measures, basic regimen measures in hypertension include weight reduction in overweight and obesity, which is logically closely related to the previous two measures. Abdominal (central) obesity, in which adipose tissue is deposited viscerally, is particularly risky.

The research in this paper confirmed the positive effect of recommendations for hypertension, such as the inclusion of regular physical activity and dietary modification, on reducing overweight and body composition. Prior to the intervention programme, the proband's body weight was in the overweight category and regular physical activity along with dietary modification resulted in weight reduction, reduction in body fat percentage and reduction in WHR index.

The proband's body weight decreased by 7.2 kg after the intervention programme (from 87.2 to 80 kg) and her BMI decreased from 27.8 to 25.5 kg/m2, her body fat percentage decreased by 3.9% (from 38.6 to 34.7%) and her WHR index decreased from 0.91 to 0.88 - see Tables 1 and 2. Although the BMI remained in the overweight range (25.0-29.9 kg/m2), it was much closer to the normal weight range (18.5-24.9 kg/m2). The decrease in WHR index was not sufficient to overcome the threshold for cardiovascular disease risk of 0.85 in women but nevertheless approached this threshold.
A study by Blumenthal et al. (2000), evaluated the effect of aerobic physical activity and dietary modification on blood pressure in addition to the effect on body weight and body composition (in a group of 55 sedentary overweight men and women over a 6-month period). Participants showed an average weight loss of 7.8 kg, a decrease in BMI of 2.7 kg/m2 and a reduction in body fat percentage of 3.2%. In our research, similar results were achieved in half the duration of the intervention programme.

CONCLUSION

The aim of this study was to test the effect of an exercise programme using walking and dietary modification on hypertension. The findings in this case study confirmed that moderate-intensity walking performed beyond normal daily activities, 5 times per week, for 12 weeks, with a progression of duration from 30 to 60 minutes per day, supported by dietary modification, leads to lower blood pressure in hypertensive patients and also has an effect on other risk factors for cardiovascular disease (overweight, body fat, central obesity). These findings are consistent with the literature on the effect of aerobic physical activity and diet on blood pressure and other risk factors for cardiovascular disease in patients with hypertension.

During the intervention programme, the proband showed a high rate of adherence to the recommended measures, which is essential for her future, as regimen measures in hypertension bring long-term positive results only if they are followed consistently. The proband felt very good about the results achieved and her attitude towards physical activity improved significantly. She continues to be motivated in this respect so that walking beyond the usual part of her daily

routine is likely to remain. The proband has also welcomed the modification of her nutritional regime; she has become accustomed to the changes and is likely to continue to follow the recommended nutritional measures in this area. With exercise and diet, she can keep her blood pressure within normal limits, and her weight can be reduced to normal - her motivation to do so was more than evident even after the intervention programme.

Hypertension is now a major problem worldwide. It is linked to lifestyles that are generally unhealthy in today's world. Therefore, the role of physicians and other professionals, including wellness specialists, is important to motivate patients to change their lifestyles. Walking as an aerobic physical activity is a good choice for the prevention, control and treatment of high blood pressure as it is affordable, safe and ultimately reduces the cost of pharmacological treatment.

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