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ORIGINAL ARTICLE

Education, cardiovascular risk factors, and blood pressure control in hypertensive outpatients

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Abstract

Background: The lack of knowledge of hypertension and other cardiovascular risk factors continues to be a major challenge for blood pressure (BP) control and effective prevention of cardiovascular disease.

Aim: This prospective, single-centre, open-label, randomised study was designed to evaluate the impact of education on cardiovascular risk control and target BP values in hypertensive outpatients.

Methods: We studied 201 consecutive hypertensive outpatients during the first outpatient visit. Of them, 101 subjects were included in the active education group (Group E1) and were offered extra workshops additional to the standard visits. The next 100 patients (control group) received standard information and medical service during each ambulatory visit (Group E0). The follow-up period was 12 months. In both groups, cardiometabolic comorbidities, global cardiovascular risk, and the range of BP control were analysed.

Results: We observed significant systolic BP (SBP) reduction during the follow-up period in the studied population, as assessed by three different BP control methods: home BP measurement (HBPM; –4.0 mmHg; $p < 0.001$), office BP measurement (OBPM; –9.6 mmHg; $p < 0.001$), and ambulatory BP monitoring (ABPM; –4.8 mmHg; $p < 0.001$). Similar results were noted in terms of diastolic BP (DBP) reduction in OBPM (–11.3 mmHg; $p = 0.001$) and ABPM (–2.7 mmHg; $p = 0.001$). We found no correlation between education intensity and the achieved BP reduction. We observed a decrease in the percentage of obese patients in Group E1 (84.3% vs. 76.0%; $p < 0.001$).

Conclusions: A significant BP reduction and cardiovascular risk factor control was observed in the studied group, irrespective of the intensity of education.

Key words: education, hypertension, lifestyle modification, nonpharmacological treatment, risk factors

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INTRODUCTION

Cardiovascular disease (CVD) has been invariably the leading cause of death worldwide [1, 2]. In Europe, CVD accounts for about 42% of female and 38% of male deaths in the 75-year-old population [1]. It is believed that hypertension (HTN) is directly or indirectly responsible for about 12.8% of the total number of deaths annually, which is 7.6 million worldwide [1]. On the basis of the NATPOL and PolSenior studies in Poland, almost 10.5 million people over 18 years of age suffer from HTN [3–5]. In most European countries, blood pressure (BP) control is not satisfactory, and recommended BP targets are achieved only in 9% of patients in the United Kingdom, 15% in Spain, 27% in France, and 29% in Germany [6–9]. In Poland, currently almost 26% of HTN-treated patients achieve the recommended BP values. This result, although significantly improving over the last 20 years, is still far from expected [3, 4]. The most effective method of prevention, developmental delay, and treatment of HTN is lifestyle modification, which is an essential element of therapy and should be implemented in all patients [1, 2].

METHODS

The aim of the study was to evaluate the influence of education on hypertensive treatment effectiveness. The proposed

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method of education was based on a proprietary programme considering the effects of antihypertensive treatment and cardiovascular (CV) risk factor management in outpatients.

The study included consecutive HTN-diagnosed patients, who attended the outpatient clinic for the first time. The reasons for referring the patient to the high-profile outpatient clinic were the following: the lack of success in achieving target BP values during previous treatment, the loss of previously obtained optimal BP control, suspected secondary HTN, or other reasons for which the attending physician recognised the need for further treatment in a profiled department. The inclusion criteria comprised age ≥ 18 years, no history of attending the clinic before, and a referral from a family doctor/other specialist or previous diagnosis and treatment of HTN. The following were considered as exclusion criteria: pregnancy, current breastfeeding, diagnosed malignant or severe HTN requiring hospitalisation, HTN with a predetermined, potentially removable cause, end-stage kidney disease, the prognosis of concomitant disease with a life expectancy below one year, declared lack of possibility of regular check-ups at the clinic, psychophysical disability of a significant degree, and the lack of patient consent for participation in the study.

Study design

This was a single-centre, open-label, and prospective study. The first 101 patients who reported for the initial visit to the outpatient clinic were included in the training group involved in active education (Group E1). The subsequent 100 people were included in the standard education group (Group E0), i.e. they were not offered additional training, but only received standard information during each ambulatory visit. The order of patient inclusion in either group was random and was based on the order of patient arrival to the clinic, without any influence of the researchers involved. This method of patient inclusion was chosen due to practical and organisational reasons.

The planned follow-up period was 12 months from the day of the first outpatient visit. During that time the patients were scheduled for three mandatory visits, with the possibility of additional appointments depending on individual indications, the doctor's approval, and the patient's wishes. During each visit, a physical examination, detailed analysis of available medical documentation, and the planning of individual diagnostics and therapy were performed. As a part of the physical examination, body mass and waist circumference were measured, and two-fold BP measurements were taken in both upper limbs according to the oscillometric method. The same automatic sphygmomanometer (Omron M6 Comfort, Kyoto, Japan; recommended on the dableducational.org list) was used for all BP measurements. The second visit (V2) took place on average three months after the initial one, and the additional trainings in the active education group were organised between the first and the second visit. The third visit (V3) was scheduled around nine months after V2, i.e. 12 months since the moment of inclusion in the study. At subsequent visits, all patients underwent the following: standard 12-lead electrocardiography, echocardiography, hourly ambulatory blood pressure monitoring (ABPM), and routine laboratory tests recommended by the Polish Society of Hypertension (PSH) [10]. Additional tests were performed when necessary. For a more complete and objective picture of the effects of the procedure, the results of antihypertensive treatment were assessed throughout the observation by all available methods of measurement: home BP monitoring (HBPM), office BP monitoring (OBPM), and hourly ABPM. The latter was performed before V2 and V3 using the DelMar Reynolds Tracker NIBP 2 (Hertford, United Kingdom) for objective evaluation of the effectiveness of the therapy and its possible optimisation during the ambulatory visit. According to the current recommendations of the PSH and the European Society of Hypertension (ESH), systolic BP (SBP) of 130 mmHg and diastolic BP (DBP) of 80 mmHg were assumed as target HBPM values. The target OBPM values were 140 mmHg systolic and 90 mmHg diastolic. In patients over 80 years of age, values below 150 and 80 mmHg were assumed to be the target ones in the office measurements. In 24-h ABPM, average values of < 130 mmHg SBP and < 80 mmHg DBP were assumed as the target ones. This is in line with the current guidelines, whereby the recommended values are < 135 mmHg/ /< 80 mmHg during daytime and < 120 mmHg /< 70 mmHg during the night (systolic and diastolic, respectively) [10, 11].

The reduction of modifiable risk factors was considered as an integral element of the treatment, therefore all participants were offered lifestyle modification advice. Based on information obtained from the physical examination during the first outpatient visit (V1), additional examinations, and the available documentation, the total CV risk was assessed for each patient in accordance with the current PSH recommendations. Afterwards, the patients were divided into small subgroups with average, high, or very high risk of CVD [10]. At each subsequent visit, a similar assessment was made, which was then presented to the patients in oral and written form. During V2 and V3, the patients' compliance with non-pharmacological recommendations was evaluated (with particular emphasis on the reduction of modifiable risk factors) and the prescribed medication was verified. At every visit, the patients were encouraged to modify their lifestyle; their achievements were accentuated and further efforts were encouraged. Patients from Group E1 were able to take part in two additional 120-min training sessions held in groups of three to eight people, as a part of the original training programme, during which the patients were educated on the treatment of HTN and prevention of CVD based on current recommendations of scientific societies. In addition, Group E1 members with obesity, overweight, or lipid disorders were directed to a nutritional clinic for a supplementary training on the principles of proper nutrition, and smokers were referred

Table 1. Training programme description in the active education study group

Workshop 1	
Trainer	Doctor
Duration	120 min
No. of participants	3–8
Description	The training was an accessible lecture with active participation of patients and practical exercises, reinforced by educational materials (brochures). The concepts of hypertension and cardiovascular risk were introduced and the situation of each individual participant was discussed. The possibilities of risk factor control were indicated and the benefits of nonpharmacological treatment were emphasised. Each patient was asked to record their own conclusions and lifestyle changes and to complete a questionnaire on the knowledge about their own health, risk factors, pro-health behaviours, treatment methods, and adherence to recommendations. Time for questions and discussion was allowed.
Workshop 2	
Trainer	Doctor
Duration	120 min
No. of participants	3–8
Description	The topics discussed previously were recapitulated, with an emphasis on the achievements in the field of lifestyle changes. Patients exchanged experiences and encouraged each other to make further efforts. The need for active participation of the patient in the treatment process through independent control of BP and body weight was highlighted. The principles of correct BP measurement were discussed in detail. Participants were asked to bring their own BP measuring devices, which were checked for the reliability of measurements and compliance with the recommendations of the dableducational.org list. The patients performed BP measurements on each other, and verified their correctness under the supervision of a doctor. The principles of pharmacotherapy were presented, with particular emphasis on the benefits and consequences of non-compliance. Time for questions and discussion was allocated.
Nutritional Clinic	
Trainer	Dietitian
Duration	30–60 min
No. of participants	1
Description	The patient was interviewed on medical history and eating habits, and was provided with advice on the appropriate quantity, quality, and distribution of meals. The follow-up meeting was planned in 2–3 weeks; the patient presented the changes and the current menu and further modifications and/or recommendations were made.
HPC	
Trainer	Nurse
Duration	30–60 min
No. of participants	1
Description	Addiction and motivation tests were conducted and advice on smoking cessation was provided, based on the experience of the HPC and the Oncology Centre in Warsaw.

BP — blood pressure; HPC — Health Promotion Centre

to an anti-smoking clinic (Table 1). Each patient had the opportunity to arrange an individual appointment at a convenient time. Diagnostic and therapeutic procedures as well as the thematic scope of the trainings were based strictly on the current guidelines [10, 11]. The study was approved by the Ethics and Surveillance Committee for Research on People and Animals at the Central Clinical Hospital the Ministry of Interior and Administration (No. 21/2013).

Statistical analysis

Descriptive statistics for continuous variables are presented as mean and standard deviation, and for categorical variables as numbers and percentages. Normality of distribution of continuous variables was checked using the Shapiro-Wilk test. Comparison of baseline characteristics in the study groups was done using the Student t test or Mann-Whitney U test for continuous variables and χ^2 or Fisher exact test for

categorical variables. Assessment of the effect of education on BP values and the probability of achieving target BP values was done using the mixed linear and logistic models. Each model considered the fixed effects of the study group, time, and the interaction of time and group, as well as random effect of patients (to account for the fact that several measurements were taken from one patient). The effects of interaction turned out to be non-significant, and so they were not included in the final models. The results from the mixed linear model are presented as coefficients and from the mixed logistic model as odds ratios (ORs), both with 95% confidence intervals (CIs) and respective p-values. In all analyses the significance level was set at 0.05. All analyses were done using R 3.4 software (Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Out of 583 screened patients, 201 eligible subjects aged 55.7 ± 17.5 years were included in the study; 12 of them were over 80 years old and women accounted for 56.7% of the study group. In the entire study group, the mean number of CV risk factors was 2.7 ± 1.0, and the estimated total CV risk was very high in 61.5% and high in 28.57% of study subjects, respectively. The groups did not differ significantly in terms of demographic and medical data, and there were only slight differences in the initial BP values and baseline medications (Tables 2 and 3). Among the eligible patients, 174 (86.6%) registered for V2 and 122 (60.7%) registered for V3 (**Suppl. Table 1 — see journal website**). During the 12-month observation, two people from Group E1 and three people from Group E0 required hospitalisation due to newly diagnosed CV events. Acute coronary syndrome occurred in three patients, one patient had a transient ischaemic attack, and one suffered from ischaemic stroke.

The influence of various forms of education on the effects of hypertension treatment

In the whole study group, a significant decrease in SBP assessed by HBPM was observed between V2 and V3 (–4 mmHg; $p < 0.001$), as well as a significant gradual decrease in SBP assessed by OBPM. There was also a significant reduction in DBP assessed by OBPM (–11.3 mmHg; $p = 0.001$). In all study subjects a significant gradual decrease in ABPM values was found between V2 and V3 (Table 4). There was no significant correlation between the intensity of education and the level of SBP and/or DBP reduction in the study population, regardless of the method of BP measurement (Tables 4–7). There was a significant increase in the number of subjects who achieved the target BP in HBPM (both SBP and DBP) in subsequent visits (SBP before V1, V2, and V3: 15.2%, 39.1%, and 62.7%, respectively; DBP before V1, V2, and V3: 26.1%, 50.3% and 63%, respectively; the simultaneous target values of SBP and DBP before V2 and V3: 25.4% and 42.4%, respectively). A similar trend was observed in OBPM (SBP before V1, V2, and V3: 36.5%, 73.4% and 80.2%, respectively, DBP before V1, V2, and V3: 51%, 77.5%, and 87.6%, respectively; simultaneous target SBP and DBP values before V1, V2, and V3: 31%, 63%, and 75.2%, respectively) and in measurements using the ABPM method (Tables 4–6). However, there was no significant effect of the intensity of education on the chance of achieving BP targets.

The influence of various forms of education on the reduction of modifiable CV risk factors

During the 12-month follow-up, 15 out of 47 patients who declared active cigarette smoking at baseline decided to stop. It was noted that the greatest number of patients, i.e. 13 (86.7%), decided to quit their unhealthy habits and addictions between V1 and V2, and this percentage was significantly higher in the group of patients who visited the health promotion office ($p < 0.001$). Out of the 47 patients referred to the health promotion clinic, 30 (63.6%) did not report for the visit. During subsequent visits, a significant reduction in waist circumference was found in all the subgroups studied. There was also a significant decrease in the percentage of obese people between V1 and V2 (84.1% vs. 83.7%; $p < 0.001$, respectively) in the whole group. At the same time, an increase in the incidence of abdominal obesity between V1 and V2 was noted in Group E0 (82.0% vs. 85.2%, $p < 0.001$), as well as in the subgroups of patients from Group E1: patients from the active education group who did not attend any additional workshop (91.4% vs. 95.0%; $p = 0.05$) and those who completed one additional training session (80.0% vs. 85.7%; $p = 0.03$). However, in the subgroup of patients who attended two additional meetings, there was a clear reduction in the prevalence of obesity between V1 and V2 (84.3% vs. 76.0%, $p < 0.001$). In the entire study group, there was a decrease in the number of people with lipid disorders on subsequent visits, but the observed trend was not statistically significant. (Table 8).

Factors affecting the lack of efficacy of hypertension treatment

During V1, a suspicion of resistant HTN was reported in 24.5% of patients in both groups. The criteria for the diagnosis of true resistant HTN during V3 were present only in 5.1% of the patients from Group E0 and 3.2% of the patients from Group E1. In the whole study group, during V1, secondary HTN was found in 4% of study subjects, and during V3 it was diagnosed in 9.0% of patients. At the end of the study, as many as 71.4% of patients working in health care who were included in the study were treated unsuccessfully. The risk factors for ineffective treatment used in the multifactor logistic regression model were higher SBP values during V1 (OR associated with a 1-mmHg increase: 0.97; 95% CI 0.95–0.99; $p = 0.01$) and higher triglyceride levels during V3 (OR for a 1-mg/dL increase: 0.99; 95% CI 0.98–1.00; $p = 0.02$).

Table 2. Baseline demographic and medical characteristics of the whole study group, the standard education group (E0) and the active education group (E1)

	Study group	Group E0	Group E1	p
Age [years]	55.7 ± 17.5	56.1 ± 18.8	55.4 ± 16.2	0.61
Sex (female/male)	114 (56.7)/87 (43.3)	61 (61.0)/39 (39.0)	53 (52.5)/48 (47.5)	0.25
Place of residence:				
City over 500,000 inhabitants	154.0 (76.6)	74 (74.0)	80 (79.2)	0.44
City 5000–500,000 inhabitants	17.0 (8.5)	11 (11.0)	6 (5.9)	
City below 5000 inhabitants or village	30.0 (14.9)	15 (15.0)	15 (14.9)	
Level of education:				
Elementary	11.0 (6.8)	5 (6.1)	6 (7.5)	0.49
Secondary	87.0 (53.7)	41 (50.0)	46 (57.5)	
Higher	64.0 (39.5)	36 (43.9)	28 (35.0)	
Active smoking at V1	47.0 (23.4)	19 (19.0)	28 (27.7)	0.18
BMI [kg/m^2]	29.3 ± 5.8	28.8 ± 5.4	29.9 ± 6.1	0.25
Waist circumference [cm]	97.4 ± 13.7	96.31 ± 13.0	98.5 (14.2)	0.26
Total cholesterol [mg/dL]	193.8 ± 39.4	196.0 ± 43.4	191.4 ± 34.6	0.84
Total cholesterol > 190 mg/dL	86 (48.6)	42 (45.7)	44 (51.8)	0.45
LDL cholesterol [mg/dL]	110.5 ± 34.7	114.1 ± 37.7	106.5 ± 30.9	0.12
LDL cholesterol < 115 mg/dL	73 (41.2)	41 (44.6)	32 (37.7)	0.36
HDL cholesterol [mg/dL]	58.3 ± 17.2	56.4 16.0	60.4 ± 18.4	0.19
HDL cholesterol < 40/46 mg/dL (men/women)	25 (14.12)	15 (16.3)	10 (11.76)	0.51
Triglycerides [mg/dL]	126.1 ± 74.7	126.8 ± 80.5	125.5 ± 68.5	0.92
Triglycerides > 150 mg/dL	43.0 (24.3)	20 (21.7)	23 (27.1)	0.48
Glucose [mg/dL]	103.0 ± 34.3	99.5 ± 27.9	106.7 ± 39.9	0.30
Glucose > 100 mg/dL	60 (33.9)	27 (29.7)	33 (38.4)	0.26
LVEDD [mm]	49.8 ± 4.4	49.6 4.3	5.01 (0.46)	0.51
LVEF [%]	65.5 ± 2.9	65.6 ± 3.3	65.4 ± 2.4	0.36
Ischaemic heart disease	7 (3.5)	3 (3.0)	4 (4.0)	> 0.99
History of myocardial infarction	3 (1.5)	1 (1.0)	2 (2.0)	> 0.99
History of CABG	1 (0.5)	1 (1.0)	0 (0.0)	0.49
Peripheral artery disease	13 (6.5)	5 (5.0)	8 (7.92)	0.56
History of TIA	4 (1.99)	2 (2.0)	2 (1.98)	> 0.99
History of stroke	12 (5.97)	4 (4.0)	8 (7.9)	0.37
Type 2 diabetes mellitus	31 (15.4)	12 (12.0)	19 (18.8)	0.24
Chronic kidney disease	23 (11.4)	12 (12.0)	11 (10.9)	0.82
GFR [mL/min/1.73 m^2]	88.7 ± 24.5	88.0 ± 25.5	89.5 ± 23.5	0.69
Serum creatinine [mg/dL]	0.87 ± 0.3	0.87 ± 0.2	0.87 ± 0.3	0.83
No. of CV risk factors	2.74 ± 1.0	2.69 ± 1.0	2.78 ± 1.0	0.76
Total CV risk:				
Low	1 (0.6)	1 (1.2)	0 (0.0)	0.72
Moderate	17 (9.3)	8 (9.2)	9 (9.5)	
High	52 (28.6)	27 (31.0)	25 (26.3)	
Very high	112 (61.5)	51 (58.6)	61 (64.2)	

Data are shown as mean and standard deviation or number (percentage). BMI — body mass index; CABG — coronary artery bypass grafting; CV — cardiovascular; GFR — glomerular filtration rate; HDL — high-density lipoprotein; LDL — low-density lipoprotein; LVEDD — left ventricular end-diastolic diameter; LVEF — left ventricular ejection fraction; TIA — transient ischaemic attack; V1 — visit 1

Table 3. Baseline blood pressure values and medical pharmacotherapy in the whole study group, the standard education group (E0) and the active education group (E1)

	Study group	Group E0	Group E1	p
HBPM SBP prior to V1 [mmHg]	138.3 ± 12.9	138.8 ± 13.3	137.8 ± 12.6	0.44
HBPM SBP < 130 mmHg	28 (15.2)	12 (13.0)	16 (17.4)	0.53
HBPM DBP prior to V1 [mmHg]	82.4 ± 11.0	82.8 ± 10.1	81.9 ± 12.0	0.58
HBPM DBP < 80 mmHg	48 (26.1)	22 (23.9)	26 (28.3)	0.61
OBPM SBP [mmHg]	147.4 ± 20.6	150.8 ± 20.8	143.8 ± 19.8	0.02
OBPM SBP < 140 mmHg	73 (36.5)	32 (32.0)	41 (41,0)	0.24
OBPM DBP [mmHg]	90.4 ± 13.0	89.8 ± 11.4	91.0 ± 14.5	0.73
OBPM DBP < 90 mmHg	102.0 (51.0)	52 (52.0)	50 (50.0)	0.88
Heart rate [bpm]	72.9 ± 11.8	73.5 12.4	72.3 ± 11.1	0.48
Number of tablets daily prior to V1	2.68 ± 1.9	2.5 ± 1.8	2.9 ± 2.0	0.16
Pharmacological therapy:				
β-blockers	100 (51.02)	52 (53.1)	48 (49.0)	0.66
Diuretics	92 (46.9)	42 (42.9)	50 (51.0)	0.31
ACEI	96 (49.0)	38 (38.8)	58 (59.2)	0.006
ARB	61 (31.1)	32 (32.7)	29 (29.6)	0.75
CCB	85 (43.4)	41 (41.8)	44 (44.9)	0.77
Other drugs	29 (14.8)	15 (15.3)	14 (14.3)	> 0.99
Polypills	27 (13.8)	15 (15.3)	12 (12.2)	0.67
Secondary HTN	8 (4.0)	4 (4.0)	4 (4.0)	> 0.99
Resistant HTN	48 (24.5)	24 (24.5)	24 (24.5)	> 0.99

Data are shown as mean and standard deviation or number (percentage). ACEI — angiotensin converting enzyme inhibitor; ARB — angiotensin receptor blocker; CCB — calcium channel blockers; DBP — diastolic blood pressure; HBPM — home blood pressure measurements; HTN — hypertension; OBPM — office blood pressure measurements; SBP — systolic blood pressure

DISCUSSION

According to the NATPOL 2011 registry, only 42% of patients treated for HTN achieve the target BP values [4]. Similar observations were made among over 12,000 outpatients included in the Pol-Fokus study; 47.3% of respondents presented good control of BP [12]. A clearly lower percentage was noted in the study by Żak-Gołąb et al. [13], in which only 25% of the 10,880 HTN patients treated within primary care achieved the set therapeutic goals. Also, in the WOBASZ II programme the prevalence of controlled HTN was as low as 23% [14]. At the beginning of the presented work, 31% of patients met the criteria of good BP control in OBPM, which is similar to the rate obtained in previous studies in the Polish population and confirms the difficulties in achieving target values in the studied group. At the end of the observation, a significant improvement in the effectiveness of treatment as measured by OBPM was found, which was expressed as an increase in the percentage of subjects with normal BP control to 75.2%; this rate is almost twofold higher than the one reported in the NATPOL 2011 study and threefold higher than in the WOBASZ II programme. The values obtained in HBPM and ABPM were similar; the target levels were reached by 42.4% and 67.2% of respondents, respectively. This is a better result than the one achieved in Canada, which is a leader in the category of HTN treatment effectiveness [15]. In the presented study, HTN treatment was effective in 75.2% of the participants, which is close to the target set in Canada for 2020 (78.0%) [15, 16]. Based on the Canadian models and our own experience in the conducted study, the frequency of using combined preparations was increased from 13.8% to 48.8%, and in subjects from Group E1 who attended both additional trainings this rate was as high as 63.6%. The effectiveness of combined preparations has been shown in numerous publications [17]. In the meta-analysis by Gupta et al. [18] it was demonstrated that the use of such preparations results in lowering of SBP and DBP by 4.1 and 3.1 mmHg, respectively, and improving compliance with the recommendations by 21%. In the presented study, during 12 months, the reduction of mean SBP was even greater (by 4.5 ± 11.8 mmHg, 20.2 ± 21.3 mmHg, and 3.3 ± 7.9 mmHg, as assessed by ABPM, OBPM, and HBPM, respectively). The Stanford Five City Project covered all residents of two cities in Northern California, of which about 1000 were enrolled in individual training sessions [19]. After five years, it was observed, among

Table 4. Ambulatory blood pressure monitoring values during the follow-up in the whole study group, the standard education group (E0), and the active education group (E1) with subgroups

	Study group	Study subgroups				Effect of Group E1 vs. E0	Effect of additional workshops (Group E11/12 vs. E10)
		E0	E10	E11	E12	Regression coefficient with 95% CI and respective p-value	
ABPM SBP (24-h) prior to V2	128.3 ± 12.1	128.6 ± 13.0	131.4 ± 12.0	124.1 ± 7.2	127.7 ± 11.5	–0.116 [(–3.229) – (2.98)]	–1.573 [(–4.76) – (1.60)]
ABPM SBP (24-h) prior to V3	123.5 ± 10.4	122.8 ± 10.2	127.3 ± 11.1	117.9 ± 11.3	124.4 ± 10.2	p = 0.94	p = 0.33
Effect of V3 vs. V2		–4.68 [(–6.81) – (–2.57)], p < 0.001					
ABPM DBP (24-h) prior to V2	73.5 ± 8.9	72.9 ± 7.9	75.4 ± 13.2	72.8 ± 6.8	73.6 ± 8.9	0.69 [(–1.74) – (3.12)]	0.23 [(–2.27) – (2.73)]
ABPM DBP (24-h) prior to V3	70.8 ± 8.5	70.7 ± 8.8	68.2 ± 8.8	70.6 ± 5.9	71.7 8.5	p = 0.58	p = 0.86
Effect of V3 vs. V2		–2.56 [(–3.99) – (–1.14)], p = 0.001					
ABPM SBP (day) prior to V2	131.1 ± 12.1	131.6 ± 13.1	133.7 ± 12.4	126.8 ± 7.9	130.7 ± 11.2	–0.23 [(–3.29) – (2.81)]	–1.51 [(–4.64) – (1.61)]
ABPM SBP (day) prior to V3	126.5 ± 10.6	125.9 ± 10.6	130.2 ± 10.9	121.1 ± 11.5	127.3 ± 10.3	p = 0.88	p = 0.35
Effect of V3 vs. V2		–4.58 [(–6.84) – (–2.33)], p < 0.001					
ABPM DBP (day) prior to V2	75.7 ± 9.3	75.2 ± 8.2	77.3 ± 13.6	75.1 ± 8.4	76.1 ± 9.3	0.551 [(–1.10) – (3.10)]	0.17 [(–2.45) – (2.78)]
ABPM DBP (day) prior to V3	73.1 ± 9.0	73.2 ± 9.6	70.6 ± 9.0	72.6 ± 6.5	73.6 ± 8.6	p = 0.67	p = 0.90
Effect of V3 vs. V2		–2.72 [(–4.23) – (–1.20)], p = 0.001					
ABPM SBP (night) prior to V2	118.4 ± 14.7	118.4 ± 15.5	122.5 ± 11.8	112.2 ± 10.7	118.2 ± 14.9	–0.05 [(–4.04) – (3.92)]	–1.61 [(–5.71) – (2.48)]
ABPM SBP (night) prior to V3	113.3 ± 12.4	112.7 ± 12.7	114.9 ± 12.8	105.7 ± 15.1	115.0 ± 11.3	p = 0.98	p = 0.44
Effect of V3 vs. V2		–4.60 [(–6.73) – (–2.48)], p < 0.001					
ABPM DBP (night) prior to V2	65.5 ± 9.5	64.9 ± 8.4	69.0 ± 13.6	64.4 ± 6.9	65.6 ± 9.7	0.99 [(–1.64) – (3.61)]	0.023 [(–2.70) – (2.74)]
ABPM DBP (night) prior to V3	63.0 ± 8.6	62.8 ± 8.9	60.4 ± 9.6	63.4 ± 8.3	63.9 ± 8.0	p = 0.46	p = 0.99
Effect of V3 vs. V2		–2.35 [(–3.74) – (–0.98)], p = 0.001					

Data are shown as mean and standard deviation. ABPM — ambulatory blood pressure monitoring; CI — confidence interval; E10 — patients from active education group who did not attend any additional workshops; E11 — patients from active education group who attended 1 additional workshop; E12 — patients from active education group who attended 2 additional workshops; V1 — visit 1; V2 — visit 2; V3 — visit 3; other abbreviations — see Table 3

Table 5. Home blood pressure measurement values during the follow-up in the whole study group, the standard education group (E0), and the active education group (E1) with subgroups

	Study group	Study groups				Effect of Group E1 vs. E0	Effect of additional workshops (Group E11/12 vs. E10)
		E0	E10	E11	E12	Regression coefficient with 95% CI and respective p-value	
HBPM SBP prior to V2	129.5 ± 9.4	129.8 ± 9.8	134.7 ± 7.8	128.9 ± 9.2	127.4 ± 8.5	0.09 [(–2.56) – (2.73)]	–2.01 [(–4.72) – (0.69)]
HBPM SBP prior to V3	125.5 ± 9.4	124.4 ± 8.3	130.0 ± 10.5	120.7 ± 11.7	126.5 ± 9.7	p = 0.95	p = 0.146
Effect of V3 vs. V2		–3.55 [(–4.97) – (–2.16)], p < 0.001					
HBPM DBP prior to V2	76.0 ± 8.0	76.2 ± 8.1	80.0 ± 10.3	76.8 ± 9.1	74.1 ± 6.2	–0.59 [(–3.23) – (2.05)]	–0.38 [(–3.10) – (2.34)]
HBPM DBP prior to V3	73.8 ± 10.1	74.0 ± 7.4	67.5 ± 23.1	73.6 ± 3.8	75.2 ± 7.8	p = 0.66	p = 0.79
Effect of V3 vs. V2		–1.40 [(–2.79) – (–0.05)], p = 0.04					

Data are shown as mean and standard deviation. Abbreviations — see Tables 3 and 4

Table 6. Office blood pressure measurement values during the follow-up in the whole study group, the standard education group (E0), and the active education group (E1) with subgroups

	Study group	Study subgroups				Effect of Group E1 vs. E0	Effect of additional workshops (Group E11/12 vs. E10)
		E0	E10	E11	E12	Regression coefficient with 95% CI and respective p-value	
OBPM SBP at V1	147.3 ± 20.6	150.8 ± 20.8	145.9 ± 22.3	145.6 ± 19.2	142.0 ± 18.4	–2.674 [(–6.83) – (1.49)]	–2.994 [(–7.37) – (1.39)]
OBPM SBP at V2	132.7 ± 17.1	133.3 ± 17.4	136.7 ± 15.1	140.7 ± 23.7	128.0 ± 14.2	p = 0.21	p = 0.18
OBPM SBP at V3	127.7 ± 13.5	126.6 ± 13.4	131.6 ± 15.7	126.0 ± 10.1	128.4 ± 13.7		
V2 vs. V1		–14.90 [(–17.65) – (–12.14)], p < 0.001					
V3 vs. V1		–19.85 [(–22.97) – (–16.72)], p < 0.001					
OBPM DBP at V1	90.4 ± 13.0	89.8 ± 11.4	93.9 ± 17.4	93.6 ± 12.9	88.2 ± 12.3	1.44 [(–1.47) – (4.35)]	–0.82 [(–3.91) – (2.26)]
OBPM DBP at V2	82.3 ± 11.6	81.9 ± 11.4	86.3 ± 8.9	90.3 ± 15.4	79.0 ± 10.4	p = 0.34	p = 0.60
OBPM DBP at V3	79.1 ± 9.4	78.1 ± 8.8	79.8 ± 13.5	83.2 ± 9.9	79.6 ± 8.9		
V2 vs. V1		–7.99 [(–9.67) – (–6.31)], p < 0.001					
V3 vs. V1		–10.94 [(–12.86) – (–9.03)], p < 0.001					

Data are shown as mean and standard deviation. Abbreviations — see Tables 3 and 4.

Table 7. Patients from the whole study group, the standard education group (E0), and the active education group (E1) with subgroups who achieved the target systolic and diastolic blood pressure values in three measurement methods at the end of follow-up

	Study group	Study subgroup				Effect of Group E1 vs. E0	Effect of additional workshops (Group E11/12 vs. E10)
		E0	E10	E11	E12	Odds ratio with 95% CI and respective p-value	
HBPM prior to V3	50 (42.4)	25 (44.6)	3 (27.3)	4 (57.1)	18 (40.9)	0.84 (0.40–1.74); p = 0.64	1.06 (0.50–2.21); p = 0.88
OBPM at V3	91 (75.2)	45 (76.3)	7 (63.6)	6 (85.7)	33 (75)	0.894 (0.388–2.046); p = 0.79	1.13 (0.49–2.66); p = 0.78
ABPM (24-h) prior to V3	80 (67.2)	38 (65.5)	8 (72.7)	6 (85.7)	28 (65.1)	1.163 (0.540–2.515); p = 0.67	1.06 (0.49–2.34); p = 0.88
ABPM (day) prior to V3	90 (75.6)	45 (77.6)	8 (72.7)	6 (85.7)	31 (72.1)	0.812 (0.346–1.880); p = 0.63	0.86 (0.37–2.02); p = 0.72
ABPM (night) prior to V3	72 (60.5)	38 (65.5)	6 (54.5)	4 (57.1)	24 (55.8)	0.663 (0.31–1.9); p = 0.28	0.723 (0.34–1.52); p = 0.39
Criteria met for all three methods	25 (20.7)	12 (20.3)	1 (9.1)	2 (28.6)	10 (22.7)	1.039 (0.43–2.53); p = 0.93	1.349 (0.55–3.28); p = 0.51

Data are shown as number and percentage. Abbreviations — see Table 3 and 4

Table 8. Characteristics of the whole study group, the standard education group (E0), and the active education group (E1) at the end of the follow-up

	Study group	Group E0	Group E1	p
Sex (female/male)	68 (55.7)/54 (44.3)	36 (61)/23 (39)	32 (30.8)/31 (49.2)	0.45
Smoking cessation prior to V3	11 (9.1)	6 (10.2)	5 (8.1)	> 0.99
BMI (kg/m^2)	41 (34.5)	21 (36.8)	20 (32.3)	0.74
Δ BMI [kg/m^2]	–0.71 ± 5.5	–1.21 ± 6.4	–0.24 ± 4.67	0.35
Δ Waist circumference [cm]	–1.83 ± 5.2	–2.28 ± 5.4	–1.41 ± 5.01	0.37
Abdominal obesity [waist circumference > 102/88 cm (men/women)]	51 (43.2)	28 (49.1)	23 (37.7)	0.29
Total cholesterol > 190 mg/dL	48 (40.7)	26 (45.6)	22 (36.1)	0.39
LDL cholesterol > 115 mg/dL	36 (30.5)	19 (33.3)	17 (27.9)	0.66
HDL cholesterol < 40/46 mg/dL (men/women)	14 (11.9)	7 (12.3)	7 (11.5)	0.68
Triglycerides > 150 mg/dL	35 (28.7)	16 (27.1)	19 (30.2)	0.86
Glucose > 100 mg/dL	35 (29.7)	13 (22.8)	22 (36.1)	0.17
Number of tablets daily at V3	2.68 ± 1.9	2.5 ± 1.8	2.9 ± 2.0	0.16
Pharmacological therapy:				
β-blockers	70 (58.3)	40 (67.8)	30 (47.6)	0.002
Diuretics	84 (69.4)	39 (66.1)	45 (71.4)	0.61
ACEI	33 (27.3)	15 (25.4)	18 (28.6)	0.67
ARB	68 (56.2)	31 (52.4)	37 (58.7)	0.26
CCB	66 (54.5)	34 (57.6)	32 (50.8)	0.14
Other drugs	23 (19.0)	10 (16.7)	13 (20.6)	0.83
Polypills	59 (48.8)	24 (40.7)	35 (55.6)	0.03
Secondary HTN	11 (9.0)	5 (8.5)	6 (9.5)	0.62
Resistant HTN	14 (11.7)	8 (13.6)	7 (11.1)	0.86

Data are shown as mean and standard deviation or number (percentage). Abbreviations — see Table 2

other results, that improvement the patients' knowledge and an increase in the number of people being treated had no significant effect on body weight, physical activity, or alcohol intake. However, there was a clear reduction in SBP and DBP (by 14.7 and 11.1 mmHg, respectively) in the HTN-treated group undergoing intervention, while these values increased in the controls. In the presented work, despite the lack of educational support by the mass media, there was a noticeably greater reduction in SBP/DBP as assessed by OBPM (by 20.2/10.8 mmHg) and by ABPM (by 4.5/2.8 mmHg). In the study by Roumie et al. [20], it was found that the education of patients with HTN causes an improvement in BP control by 17.5%. The authors also stated that the improvement was observed in all patients, regardless of the form of training. Perhaps the lack of an additional effect of optional training was caused by the sufficient influence of reliable standard education, which was supported by a significant reduction in arterial BP in this group. In a program conducted in North Karelia, Finland, where a very high incidence of CV risk factors and mortality was observed in the 1970s, accompanied by limited knowledge demonstrated by patients and medical personnel, after five years of extensive health promotion, intensive education, lifestyle modification, and the monitoring of people with diagnosed HTN, there was a reduction in BP by 6.5/3.5 mmHg [21]. The detectability and effectiveness of HTN treatment also improved, and CV risk factors were reduced. These results are worse than the ones obtained after one year in our study (20.2/10.8 mmHg), even though in both studies the observed groups were characterised by extremely high CV risk. Further observation of the studied group will allow the assessment of the durability of the achieved effects. The high effectiveness of HTN treatment obtained in the presented study probably results from the procedure being based strictly on the PSH/ESH guidelines, the individualisation of recommendations, high frequency of the use of complex preparations, the improvement of patient involvement in education and lifestyle modification, and the self-control of BP and persistent motivation to achieve optimal BP values and reduce total CV risk. Few reports describe the results of HTN treatment based on non-office measurements. Many researchers emphasise that measurements made at home have a higher prognostic value than OBPM [22]. In the presented study, a significant improvement in the effectiveness of treatment in each measurement method was found, which confirms the reliability and reproducibility of the results.

The heterogeneity of the study group can be considered as a weak side of the presented work, but it can also be seen as its value; our goal was to create a study group based on the real population, and to use random selection methods, without the intervention of the researcher at the recruitment stage. The one-year observation time can be considered too short, but such a time limit clearly emphasises the achieved effects of treatment. Freedom in attending the appointments was to allow for the reflection of real treatment regimens, which are the result of the needs, possibilities, and difficulties of the patient, the doctor, and the system. Another limitation was the lack of verification of self-measurements performed by patients with the use of additional devices. This method, however, was considered a valuable source of information on the changes in PB between visits, in real life, and in the patient's own environment.

In conclusion, promoting pharmacological and non-pharmacological treatment adherence in individual patients with HTN is crucial for optimal BP and CV risk factor control. Therapeutic nonadherence, such as not following the recommended medical or health advice, including failure to comply with pharmacotherapy and recommended lifestyle modifications, is a major contributor to poor control of HTN and a key barrier to reducing the number of CVD deaths [23, 24]. Adherence rates vary substantially in different populations and, in general, are lower with respect to lifestyle changes in more behaviourally demanding regimens. Most individuals have clear expectations about what a new lifestyle would provide, and if these expectations are not met, they tend to be dissatisfied and less motivated to maintain such changes, particularly in environments that do not support healthy choices [25].

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WHAT IS NEW?

This single-centre and open-label study is a prospective and randomised comparison of the effect of an education programme on blood pressure and cardiovascular risk factor reduction in hypertensive outpatients. It provides results from real life based on the patients' adherence to the recommended lifestyle modifications and involvement in education, and medical outpatient care in an experienced hypertension clinical centre in central Poland.