

Relationship between patients' knowledge and medication adherence among patients with hypertension

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Objective: The purpose of this study was to investigate the relationship between knowledge on arterial hypertension (AH) and its management, and adherence to pharmaceutical treatment.

Methods: The study included 233 patients diagnosed with AH and treated with hypotensive drugs for at least 1 year. The 8-item © Morisky Medication Adherence Scale (MMAS-8) and the Hypertension Knowledge-Level Scale (HK-LS) were used.

Results: Sixty-three percent of the patients had a low level of knowledge on AH, with the smallest proportion of correct answers provided for items related to non-pharmaceutical treatment, diet, hypertension definition, and drug adherence. When compared to patients with a high level of knowledge, those with a low knowledge had lower scores in the MMAS (6.45 ± 1.45 vs 7.08 ± 1.04 ; $P=0.038$). Multiple-factor analysis showed that statistically significant independent determinants of good adherence included a high level of knowledge ($\beta=0.208$; $P=0.001$), non-pharmaceutical treatment ($\beta=0.182$; $P=0.006$), and frequent blood pressure measurements ($\beta=0.183$; $P=0.004$). The most significant factor in MMAS was knowledge in the “drug adherence” domain ($\rho=0.303$; $P<0.001$).

Conclusion: Patients' knowledge on hypertension is a significant independent determinant of good adherence. Other independent determinants include non-pharmaceutical treatment and regular blood pressure measurements.

Implication for practice: The identification of knowledge deficits as a factor contributing to lack of adherence and poor hypertension control remains a key challenge for multidisciplinary team caring for patients with hypertension.

Keywords: medication adherence, arterial hypertension, medical knowledge

Introduction

The prevalence of hypertension in the general population is ~30%–45% and increases with age. According to the World Health Organization (WHO) data, hypertension is found in 47% of the population in underdeveloped or developing countries and in 49% in developed countries.¹ The number of adults with hypertension is predicted to increase by 60% by the year 2025, to a total of 1.56 billion adults.¹

The population-wide effectiveness of hypertension treatment is still insufficient. The primary factor contributing to an unsatisfactory response to pharmaceutical treatment is poor medication adherence. The management and control of hypertension are possible with a combination of medication and strict lifestyle changes. Published studies indicate that ~60% of patients treated for hypertension discontinue treatment within 6 months.² Apart from adverse effects and inadequate blood pressure (BP) control despite treatment, the most common causes of lack of adherence are believed

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to include a lack of patient involvement in the treatment process or motivation to continue it and a lack of information on the disease and its treatment, especially detailed information on dosage.³

An important component to control hypertension is knowledge, which is relative to lower rates of ceasing interventions, following the interventions behavior, and better control on disease by patients. As a result, careful evaluation of hypertension has been considered as an inseparable part of general care of the patients.

This results from poor awareness of the consequences of nontreatment, mistrust of the physician, and negating the necessity of treatment when symptoms are not present.⁴ Other than deficits in knowledge, factors of significance for adherence are reported to include sociodemographic and clinical (comorbidities, multidrug treatment) characteristics, as well as patients' health-related beliefs.^{5,6}

Observations indicate that patients with hypertension are least knowledgeable on normal BP values and on lifestyle changes required during the treatment process.⁷ The appropriate lifestyle changes are fundamental for preventing hypertension. Clinical studies prove that appropriate lifestyle modifications can have a hypotensive effect comparable to be seen with single-agent pharmaceutical treatment.⁸ Lifestyle changes may be a safe and effective way of preventing or delaying hypertension, avoiding or delaying pharmaceutical treatment in patients with grade 1 hypertension, and reducing BP in patients who are already treated, which allow dosages of hypotensive drugs to be reduced.⁹

European Society of Cardiology (ESC) guidelines include salt restriction, moderation of alcohol consumption, high consumption of vegetables and fruits and low-fat diet, weight reduction and maintenance, and regular physical exercise as lifestyle measures that have been shown to be capable of reducing BP.¹⁰

In Poland, hypotensive drug treatment is found to be effective in 28% of male and 29% of female patients.¹¹ At the same time, as many as 39% of men and 29% of women diagnosed with hypertension do not start their treatment, which indicates poor awareness of long-term complications of hypertension.¹¹ Epidemiological studies performed in Europe and in the United States demonstrate that a higher effectiveness of hypertension treatment – as high as 63% – is achievable. The European Society of Hypertension (ESH) and the Polish Society of Hypertension consider patient education aimed at enhancing their knowledge and motivation, and covering especially non-pharmaceutical treatment, to be a primary method of managing all patients

with hypertension.¹² Such patients should be managed by a therapeutic team. Nursing assistance may prove particularly significant in the process of lifestyle modification, where long-term adherence remains very low. Published studies demonstrate that team-based care is more effective than standard treatment, especially if it involves nurses and/or pharmacists.¹³ The beneficial effect of the involvement of pharmacists and nurses has been obtained when their tasks involved patient education, behavioral and medical counseling, assessment of adherence to treatment, and, for pharmacists, interaction with physicians in the area of guideline-based therapy.^{13–15}

The papers on the level of knowledge of Polish patients prove the insufficient knowledge on arterial hypertension (AH) and its complications.¹⁶ The connection between sociodemographic variables and the level of knowledge on hypertension is widely discussed in the literature.^{17,18} However, there are small number of papers focusing on the association between the level of knowledge and the adherence to drug recommendations. Information on relationship between patients' knowledge on hypertension and adherence may be helpful in the prevention of complication, treatment planning, and better patient health control.

The purpose of the study was to investigate the relationship between knowledge on hypertension and on its management, and adherence to pharmaceutical treatment in hypertension.

The investigation included the following questions:

1. What is the knowledge level of Polish patients with hypertension treated with at least one hypotensive drug?
2. How does adherence differ depending on knowledge regarding hypertension?
3. Does a correlation exist between knowledge and adherence, and what other variables affect adherence?

Materials and methods

Participants

The study was performed in the Kosmonautów health center in Wrocław. Data were collected from January 2015 through November 2015. Eligible patients were consecutively selected by the physicians, who informed them of the study objectives and recruited all patients who agreed to participate. All the study participants gave informed consent. The survey included 233 patients (124 females) aged between 32 and 90 years (mean age 63±15 years) diagnosed with hypertension at least 1 year before (which is in line with the ESH guidelines),¹⁰ treated for hypertension with at least one hypotensive agent, and who had been patients of the health center for at least 6 months.

The inclusion criteria were as follows: 1) clinically confirmed hypertension diagnosis, 2) the patient's written informed consent, and 3) age ≥ 18 years. The exclusion criteria were as follows: 1) moderate to severe dementia (defined as mini-mental score ≤ 15),¹⁹ 2) lack of consent, and 3) patients with severe concomitant diseases, which could affect adherence to therapeutic guidelines, were excluded from the study due to their complex treatment schemes and the possibility of adverse effects and reactions occurring as a result of the use of multiple medications. Patients were selected by a panel consisting of a physician and a nurse – specialist in the field of cardiac nursing. The sample group was homogeneous and could be subjected to statistical analysis.

Patients were divided into two groups based on their knowledge level. The patients' knowledge was assessed using the Polish version of the Hypertension Knowledge-Level Scale (HK-LS). According to the asymmetrical answer distribution (Figure 1), the group was divided into two subgroups depending on the score:

1. ≤ 17 points – low level of knowledge on hypertension (n=147);
2. between 18 and 22 points – high level of knowledge on hypertension (n=86).

Ethical consideration

The study was approved by the Bioethics Committee (approval no KB 136/2015); all patients recruited to the study provided their informed and voluntary written consent to participate in the study.

Instruments

Two validated instruments were used: the 8-item © Morisky Medication Adherence Scale (MMAS-8) and the HK-LS.

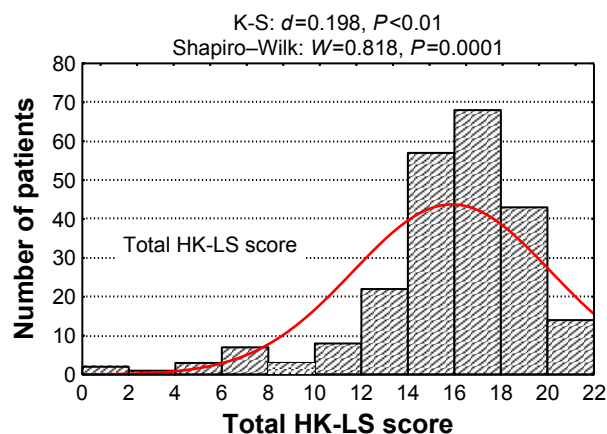


Figure 1 Histogram of hypertension knowledge scores obtained by 233 patients. **Abbreviations:** HK-LS, Hypertension Knowledge-Level Scale; K-S, Kolmogorov-Smirnov test.

Furthermore, the patients were interviewed and their medical records were analyzed to gather detailed information. The instruments were distributed by a cardiac nurse during patients' follow-up appointments for continuing hypotensive treatment.

Adherence

Self-reported medication adherence was assessed using the MMAS-8, previously translated and validated. Self-reported MMAS-8 is simple to administer and is feasible and economical in clinical practice. The MMAS-8 was designed to facilitate the identification of barriers to and behaviors associated with adherence to chronic medication.^{20,21} The tool has been confirmed as reliable and significantly associated with BP control in individuals with hypertension, as well as with antihypertensive medication pharmacy fill rates. MMAS-8 scores may range from 0 to 8, with scores of <6 , 6–8, and 8 reflecting low, medium, and high adherence, respectively.²² The questionnaire has very good psychometric properties (Cronbach's $\alpha = 0.81$).

Knowledge

The HK-LS assessed respondents' knowledge in defining hypertension, lifestyle, medical treatment, drug compliance, diet, and complication of hypertension. Each item was a full sentence that was either correct or incorrect. And each item was prepared as part of a standard answer (correct, incorrect, or do not know). To assess the content validity of the scale to identify whether items were or were not representative of the knowledge level of hypertension, the opinions of experts were requested through an assessment form. The expert opinions were evaluated and in the Polish language version provided all the questions.

The scale included 22 items divided into six subdimensions. The expressions are incorrect in nine items. Each correct answer is worth 1 point. Incorrect statements are encoded inversely to the other items. The maximum score is 22 for the entire scale. The minimum score is zero for the entire scale and for all subdimensions.²³ The questionnaire has adequate psychometric properties (Cronbach's $\alpha = 0.81$).

Possible determinants of adherence

Variables that may affect the aspects of adherence studied include ESC hypertension grade, disease duration, type of treatment and of hypotensive drugs administered, presence of comorbidities, self-control and keeping a self-control journal, and sociodemographic factors (age, sex, living situation, and education).

Statistical analysis

The level of knowledge was evaluated by the HK-LS questionnaire. The maximum score was 22 points. The distribution of scores obtained is shown on the histogram in Figure 1. The distribution is highly asymmetrical, with a left skew, that is, a small proportion of low scorers. Therefore, at a further stage, the following classification criteria were used: ≤ 17 points – low level of knowledge on hypertension, points between 18 and 22 – high level of knowledge on hypertension.

For quantitative variables, the normality of empirical distributions was verified using the Shapiro–Wilk test. Subsequently, mean values and standard deviations were calculated, and mean values were compared between the two patient groups in one-way analysis of variance. If the null hypothesis of no differences between groups was rejected, post hoc tests were performed (multiple comparisons: least significant difference).

Qualitative and ordinal variables were grouped in contingency tables, with numbers (n_i) and fractions calculated. The independence of qualitative characteristics was verified using Pearson's chi-squared test. The strength of correlations was determined by calculating Spearman's rank correlation coefficients (ρ) and significance levels (P).

The correlation of the independent variables of adherence was tested in multiple linear regression analysis using the

forward stepwise method, after testing the applicability of the least squares method and performing analyses of outliers. For independent variables (knowledge and age), standardized coefficients and regression coefficients b were calculated. The statistical significance of variables in the model was verified using Student's t -test. The quality of the proposed multiple linear regression model was evaluated using standard error of the estimate (SE_e). Calculations were performed using the STATISTICA Version 10 software suite.

Results

Patient characteristics

In the group of 233 patients studied, 63% showed a low level of knowledge on hypertension. In the sociodemographic analysis, the only factor for which differences were found was the patients' living situation. The majority of patients with a low level of knowledge on hypertension were living alone (83.7% vs 15.1%; $P=0.045$) (Table 1).

Analysis of the patients' clinical characteristics showed that the low knowledge level group had a higher rate of ischemic heart disease (31.3% vs 15.1%; $P=0.01$). A total of 56.5% patients with a low knowledge level and 27.9% patients with high knowledge level group had elevated BP (systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg). Thirty-five percent of patients with a low knowledge level and fifty-eight percent of patients with high knowledge level

Table 1 Respondents' sociodemographic characteristics in relation to their knowledge level

Nominal (qualitative) variables	Hypertension knowledge level				P-value	1 - β
	Low N=147		High N=86			
	n	%	n	%		
Sex					0.638	0.071
Female	76	51.7	48	55.8		
Male	71	48.3	38	44.2		
Education						
Primary	36	24.5	27	31.4	0.254	0.171
High school	62	42.2	37	43.0	0.905	0.037
College/university	49	33.3	22	25.6	0.721	0.186
Professional activity					0.727	0.252
Active	48	32.6	36	41.9		
Nonactive	99	67.4	50	58.1		
Living situation						
Living alone	123	83.7	13	15.1	<0.001	1.000
Living with family/partner	22	14.9	72	83.7	<0.001	1.000
Residential care institution	3	1.4	1	1.2	0.898	0.010
Age					0.945	0.054
M \pm SD	62.9 \pm 15.2		63.3 \pm 14.8			
Me (Q ₁ ; Q ₃)	64 (55; 75)		63.5 (54; 74)			
Min–Max	22–90		20–90			

Abbreviations: Me, mean; SD, standard deviation; M, median; Q₁, lower quartile; Q₃, upper quartile; P, confidence level; 1 - β , test power; Min, minimum; Max, maximum.

had their BP controlled at least daily/weekly. Patients with low knowledge level had less often stated that they owned a BP meter than patients with high knowledge level (58.5% vs 77.1%) (Table 2).

Characteristics of adherence and knowledge

Most respondents had moderate adherence scores, but in group with low knowledge level, they have lower adherence than in group in high knowledge level MMAS (6.45±1.45 vs 7.08±1.04; $P=0.038$). However, the low knowledge level group included significantly more low-adherence patients than the group with a high level of knowledge (19.7% vs 8.1%; $P=0.023$) (Table 2).

The number (proportion) of correct answers to each HK-LS item are shown in Table 3. Patients with a low knowledge level answered correctly significantly less frequently than those with a high knowledge level ($P<0.01$), the only exception being item 6, with a similar proportion of correct answers in the two groups ($P>0.05$) (Table 3).

The analysis of questionnaire answers showed that in the low knowledge level group, the largest proportion of wrong answers was provided for items on non-pharmaceutical hypertension treatment, and the lowest scores were obtained in the “diet” domain (0.49±0.64 vs 1.33±0.73; $P<0.001$), then in the “definition” (1.70±0.65 vs 1.92±0.28; $P=0.012$) and “drug adherence” (2.19±1.14 vs 3.40±0.69; $P<0.001$) domains. The highest scores were obtained in the “complications”

Table 2 Respondents' clinical characteristics in relation to knowledge level

Nominal (qualitative) variables	Hypertension knowledge level				P-value	I - β
	Low N=147		High N=86			
	n	%	n	%		
BP \geq 140 mmHg or \geq 90 mmHg	83	56.5	26	27.9	0.032	0.989
ESC hypertension grade						
Normal BP	16	10.9	11	12.8	0.662	0.049
Prehypertension	26	17.7	16	18.6	0.863	0.036
Grade 1 hypertension	70	47.6	35	40.7	0.308	0.141
Grade 2 hypertension	35	23.8	24	27.9	0.488	0.083
Comorbidities						
Diabetes mellitus	60	40.8	31	36.1	0.561	0.083
COPD	50	34.0	29	33.7	0.922	0.036
Ischemic heart disease	46	31.3	13	15.1	0.010	0.752
Kidney failure	34	23.1	26	30.2	0.298	0.184
Medication						
ACE inhibitors	72	49.0	42	48.8	0.909	0.036
Beta-adrenolytics	25	17.0	18	20.9	0.569	0.088
Angiotensin II receptor antagonists	10	6.8	5	5.8	0.984	0.029
Thiazide diuretics	29	19.7	18	20.9	0.959	0.039
Calcium channel blockers	49	33.3	25	29.1	0.597	0.075
Treatment type						
Single-agent treatment	93	63.2	56	65.1	0.959	0.043
Combination treatment	54	36.7	30	34.9		
Other hypertension treatment forms	54	36.7	38	44.2	0.325	0.168
Low-sodium/DASH diet	41	27.9	26	30.2	0.817	0.049
Weight reduction	28	19.0	20	23.3	0.549	0.096
Moderate physical activity	36	24.5	23	26.7	0.821	0.048
Keeping a self-control diary	54	36.7	52	64.2	0.048	0.979
Blood pressure control daily/weekly	52	35.4	48	57.8	0.044	0.894
Own blood pressure meter	86	58.5	64	77.1	0.052	0.795
Adherence score (MMAS-8)						
Low	29	19.7	7	8.1	0.019	0.596
Moderate	80	54.4	46	53.5	0.894	0.038
High	38	25.9	33	38.4	0.047	0.458
Time from hypertension diagnosis M \pm SD	11.2 \pm 8.3		12.3 \pm 9.2		0.349	0.070
MMAS-8 (score) M \pm SD	6.45 \pm 1.45		7.08 \pm 1.04		0.001	0.966

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Abbreviations: M, median; SD, standard deviation; MMAS-8, 8-item Morisky Medication Adherence Scale; COPD, chronic obstructive pulmonary disease; BP, blood pressure; ESC, European Cardiovascular Society; ACE, angiotensin-converting enzyme; I - β , test power.

Table 3 Number (proportions) of correct answers to HK-LS items in the two hypertension knowledge level subgroups

Item (correct answer)	Hypertension knowledge level				P-value	1 - β
	Low N=147		High N=86			
	n	%	n	%		
1. High diastolic or systolic blood pressure indicates increased blood pressure (yes)	127	86.4	84	97.7	0.004	0.788
2. Increased diastolic blood pressure also indicates increased blood pressure (yes)	123	83.7	81	94.2	0.023	0.580
3. Increased blood pressure is the result of aging, so treatment is unnecessary (no)	107	72.8	80	93.0	<0.001	0.971
4. If the medication for increased blood pressure can control blood pressure, there is no need to change lifestyles (no)	78	53.1	71	82.6	<0.001	0.997
5. If individuals with increased blood pressure change their lifestyles, there is no need for treatment (no)	89	60.5	78	90.7	<0.001	0.999
6. Individuals with increased blood pressure must take their medication in a manner that makes them feel good (no)	22	15.0	22	25.6	0.068	0.447
7. Drugs for increased blood pressure must be taken every day (yes)	117	79.6	81	94.2	0.005	0.842
8. Individuals with increased blood pressure must take their medication only when they feel ill (no)	105	71.4	84	97.7	<0.001	0.999
9. Individuals with increased blood pressure must take their medication throughout their life (yes)	94	63.9	80	93.0	<0.001	0.999
10. For individuals with increased blood pressure, the best cooking method is frying (no)	98	66.7	81	94.2	<0.001	0.999
11. For individuals with increased blood pressure, the best cooking method is boiling or grilling (yes)	95	64.6	69	80.2	0.018	0.668
12. Individuals with increased blood pressure can eat salty foods as long as they take their drugs regularly (no)	48	32.7	63	73.3	<0.001	1.000
13. Individuals with increased blood pressure must eat fruits and vegetables frequently (yes)	70	47.6	76	88.4	<0.001	1.000
14. The best type of meat for individuals with increased blood pressure is red meat (no)	26	17.7	50	58.1	<0.001	1.000
15. The best type of meat for individuals with increased blood pressure is white meat (yes)	46	31.3	64	74.4	<0.001	1.000
16. Individuals with increased blood pressure must not smoke (yes)	74	50.3	70	81.4	<0.001	0.998
17. Individuals with increased blood pressure can drink alcoholic beverages (no)	110	74.8	81	94.2	<0.001	0.970
18. Increased blood pressure can cause strokes, if left untreated (yes)	125	85.0	86	100.0	<0.001	0.984
19. Increased blood pressure can cause heart diseases, such as heart attack, if left untreated (yes)	125	85.0	85	98.8	<0.001	0.940
20. Increased blood pressure can cause premature death if left untreated (yes)	126	85.7	86	100.0	<0.001	0.977
21. Increased blood pressure can cause kidney failure, if left untreated (yes)	111	75.5	85	98.8	<0.001	0.999
22. Increased blood pressure can cause visual disturbances, if left untreated (yes)	108	73.5	82	95.3	<0.001	0.993
HK-LS questionnaire domains (M \pm SD)	Low N=147		High N=86		P-value	1 - β
Definition	1.70 \pm 0.65		1.92 \pm 0.28		0.012	0.948
Treatment	2.30 \pm 1.01		3.10 \pm 0.55		<0.001	1.000
Drug adherence	2.19 \pm 1.14		3.40 \pm 0.69		<0.001	1.000
Lifestyle	3.04 \pm 1.15		4.48 \pm 0.64		<0.001	1.000
Diet	0.49 \pm 0.64		1.33 \pm 0.73		<0.001	1.000
Complications	4.05 \pm 1.46		4.93 \pm 0.26		<0.001	1.000
Total score (M \pm SD)	13.8 \pm 3.7		19.1 \pm 1.1		<0.001	1.000

Abbreviations: HK-LS, Hypertension Knowledge-Level Scale; M, median; SD, standard deviation; P, significance level; 1 - β , test power.

domain (4.05 ± 1.46 vs 4.93 ± 0.26 ; $P < 0.001$). The total score in the low knowledge level group was 13.8 ± 3.7 and that in the high knowledge level group was 19.1 ± 1.1 (Figure 2).

In the group of 233 patients, 71.5% of answers were correct, whereas in the subgroups the percentages were 62.6 (low knowledge level) and 86.5 (high knowledge level). In the low knowledge level group, the lowest proportion of correct answers was given in the “diet” (24.5% vs 66.3% in the high knowledge level group) and “drug adherence” (54.8% vs 84.9%) domains. In the low knowledge level group, the highest proportion of correct answers was given in the “definition” domain (85%), whereas in the high knowledge level group, the highest proportion of items answered correctly belonged to the “complications” domain (98.6%). The significance of differences was $P < 0.001$ (Table 4) (Figure 3).

Single-factor analysis – correlation on adherence of the characteristics studied (MMAS-8 score)

Subsequently, Spearman's rank analysis was performed to evaluate the correlation of selected variables on adherence (MMAS-8 score). Table 5 shows correlation coefficients from the analysis. Correlation analysis showed that variables

Table 4 Proportions of correct answers in HK-LS domains for the two subgroups

Domain	Total (%)	Group 1 (%) N=147	Group 2 (%) N=86	I vs 2 P-value	1 - β
Definition	89.1	85.0	95.9	0.012	0.676
Treatment	65.9	57.5	77.6	<0.001	0.857
Drug adherence	65.9	54.8	84.9	<0.001	0.998
Lifestyle	70.7	60.8	87.7	<0.001	0.995
Diet	39.9	24.5	66.3	<0.001	1.000
Complications	87.5	81.0	98.6	<0.001	0.988
Total	71.5	62.6	86.6	<0.001	

Abbreviations: HK-LS, Hypertension Knowledge-Level Scale; 1 - β , test power.

having a significant positive effect on adherence included regular BP measurement ($\rho=0.171$, $P=0.009$); keeping a self-control diary ($\rho=0.017$, $P=0.007$); adherence with non-pharmaceutical hypertension treatment ($\rho=0.182$; $P=0.006$); and a high level of knowledge on hypertension (HK-LS) ($\rho=0.173$; $P=0.008$) (Table 5).

Statistically significant independent determinants of good adherence include a high level of knowledge on hypertension ($\beta=0.208$; $P=0.001$), non-pharmaceutical hypertension treatment ($\beta=0.171$; $P=0.006$); and regular BP measurements ($\beta=0.183$; $P=0.004$). The model is significant: $F(4,228)=8.99$; $P < 0.001$, but only explains 36.9% of the variation in adherence scores.

$$\text{Adherence} = 1.72 + 0.25 \times \text{non-pharmaceutical hypertension} + 0.28 \times \text{high level of knowledge on hypertension} + 0.08 \times \text{regular BP measurements}$$

The fraction of correct answers (%)

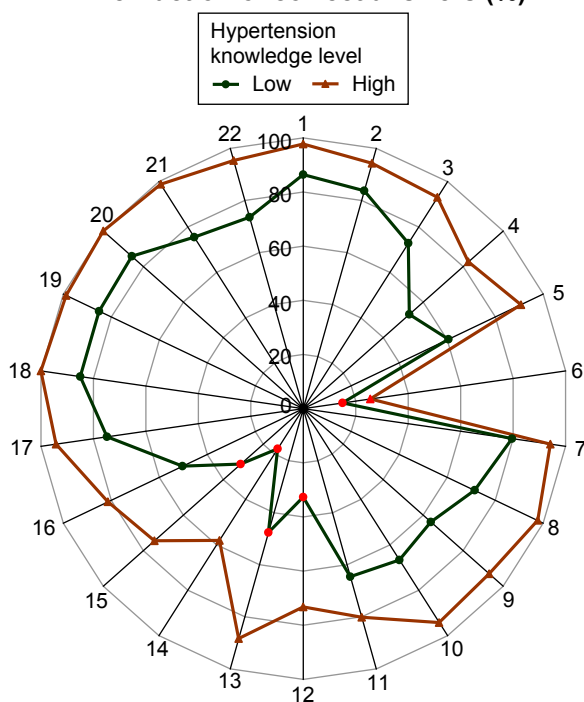


Figure 2 Comparison of correct answer proportions for each HK-LS item in the two groups differentiated by their level of knowledge on hypertension (items with <50% correct answers are marked in red).
Abbreviation: HK-LS, Hypertension Knowledge-Level Scale.

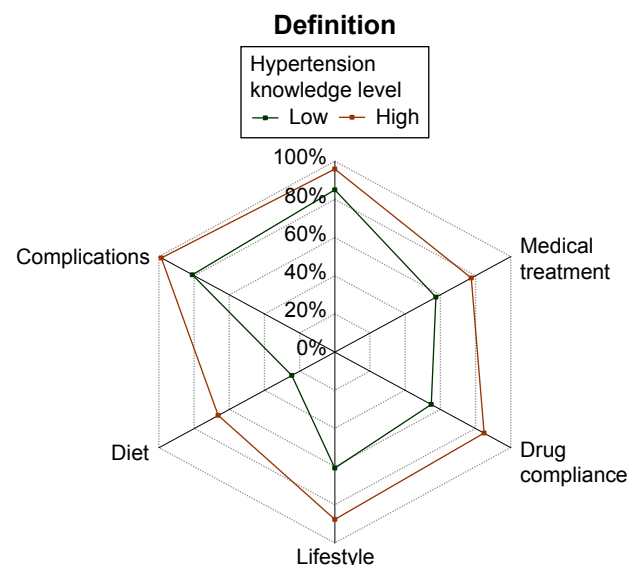


Figure 3 Comparison of correct answer percentages in the 6 HK-LS domains between the two groups differentiated by their level of knowledge on hypertension.
Abbreviation: HK-LS, Hypertension Knowledge-Level Scale.

Table 5 Single- and multiple-factor regression analysis results for the variables studied against MMAS scores

Nominal (qualitative) variables	Single-factor analysis		Multiple-factor analysis	
	ρ/F (95% CI)	P-value	b	P-value
Age, years	0.019 (−0.106 to 0.146)	0.772	–	–
Female sex	0.028 (−0.028 to 0.155)	0.671	–	–
Education	0.107 (−0.016 to 0.232)	0.104	–	–
Professional activity – active	−0.012 (−0.137 to 0.116)	0.861	–	–
Living situation – living alone	−0.080 (−0.206 to 0.050)	0.222	–	–
ESC hypertension grade	0.082 (−0.041 to 0.208)	0.212	–	–
Duration of hypertension in years	−0.013 (−0.138 to 0.115)	0.848	–	–
Regular BP measurements	0.171 (0.049 to 0.294)	0.009	0.183 (0.051 to 0.296)	0.004
Diary of self-control	0.177 (0.055 to 0.300)	0.007	0.115 (−0.008 to 0.240)	0.089
Concurrent non-pharmaceutical treatment	0.182 (0.060 to 0.305)	0.006	0.171 (0.049 to 0.294)	0.006
Ischemic heart disease	−0.184 (−0.065 to 0.3070)	0.005	−0.199 (−0.068 to 0.2980)	0.001
High level of knowledge on hypertension (HK-LS)	0.173 (0.051 to 0.296)	0.008	0.208 (0.087 to 0.330)	0.001

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Abbreviations: MMAS, Morisky Medication Adherence Scale; ESC, European Society of Cardiology; BP, blood pressure; HK-LS, Hypertension Knowledge-Level Scale.

Spearman's rank analysis of the correlation of knowledge on specific HK-LS domains on medication adherence showed a statistically significant correlation between knowledge in the “drug adherence” domain and adherence measured by the MMAS questionnaire, especially in the low knowledge level group ($\rho=0.303$; $P<0.001$). In the entire study group, a significant correlation between knowledge and adherence was observed. Higher knowledge levels were correlated with

better adherence, that is, higher MMAS-8 scores ($\rho=0.179$; $P=0.007$) (Table 6).

Discussion

Poorly controlled or untreated hypertension causes gradual irreversible organ damage, leading to life-threatening complications or even death. Hypertension treatment involves continued drug administration, as well as lifestyle modifications and adherence with a complex set of therapeutic recommendations: reduced salt and animal fat intake, weight reduction, and regular exercise. Poor knowledge on adherence to the treatment plan negatively affects patient awareness and behaviors and poses a significant problem in hypertension control. Knowledge and education are considered crucial for proper hypertension control.²⁴ In the present study, as many as 63% of patients showed a low level of knowledge on the definition, treatment, and complications of hypertension. Other published studies confirm the poor knowledge on hypertension among patients²⁵ and a lack of appropriate education promoting the understanding of hypertension.^{26,27}

In the patients with hypertension group of the study, knowledge was poorest with regard to diet and adherence and best with regard to complications. In a study by Eshah and Al-Daken,²⁸ the lowest knowledge levels were found in the “diet” domain, as in the present study, and in the “definition” domain, in contrast to this study. Furthermore, contrary to this study, other authors reported highest knowledge levels in the “lifestyle” and “drug adherence” domains.²⁹ According to other authors, being hypertensive increases the patient's level of knowledge regarding the illness^{30,31} and motivation to learn

Table 6 Spearman's rank correlation coefficients (ρ) and significance values (P) for correlations between HK-LS domains and MMAS-8 scores

Subdimension	Total	Low knowledge level	High knowledge level
	N=233	N=147	N=86
Definition	$\rho=0.110$ $P=0.094$	$\rho=0.062$ $P=0.451$	$\rho=0.181$ $P=0.095$
Medical treatment	$\rho=0.079$ $P=0.230$	$\rho=0.028$ $P=0.732$	$\rho=0.024$ $P=0.826$
Drug adherence	$\rho=0.242$ $P<0.001$	$\rho=0.303$ $P<0.001$	$\rho=0.029$ $P=0.789$
Lifestyle	$\rho=0.065$ $P=0.320$	$\rho=-0.022$ $P=0.788$	$\rho=-0.021$ $P=0.845$
Diet	$\rho=0.058$ $P=0.378$	$\rho=-0.024$ $P=0.771$	$\rho=0.013$ $P=0.901$
Complications	$\rho=0.068$ $P=0.301$	$\rho=0.061$ $P=0.458$	$\rho=-0.140$ $P=0.197$
Total score	$\rho=0.179$ $P=0.007$	$\rho=0.151$ $P=0.068$	$\rho=0.028$ $P=0.799$

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Abbreviations: HK-LS, Hypertension Knowledge-Level Scale; MMAS-8, 8-item Morisky Medication Adherence Scale.

more. In the present study, all patients had been diagnosed with hypertension at least 1 year before, and more than half of them still showed an unsatisfactory level of knowledge on the definition, treatment, and complications of hypertension. In the low knowledge level group, only 62% of questionnaire items were answered correctly, with the lowest correct answer percentage in the “diet” domain – 24.5.

Nearly 20% of patients with a low knowledge level and 8% of patients with a high knowledge level had low adherence scores. The present findings corroborate those by other authors, reporting lack of adherence among patients with hypertension at 25%³¹ and 28%,⁵ with better results among patients who were more knowledgeable on the disease.³¹

In the study by Karaeren et al,³¹ knowledge on the causes of hypertension and reasons for hypotensive treatment was positively correlated with medication adherence. In the present study, the overall knowledge score and the “drug adherence” domain score were positively correlated with medication adherence. In other studies, knowledge on hypertension complications was not found to be correlated with adherence, which is surprising, as it could be assumed to be the primary motivation for changes in behavior.³¹ In the present study, knowledge was the highest in the “complications” domain in both groups, and the score in this domain was a predictor of good adherence. In this aspect, the present findings differ from other published reports, where patients were interested in short-term problems related to hypertension (symptoms and adverse effects of treatment) rather than long-term complications.^{31–33} In the current study, single- and multiple-factor analyses showed significant correlation of knowledge in the “drug adherence” domain on actual medication adherence. The authors state that many patients with hypertension do not understand that hypotensive medication should be taken throughout their life, as opposed to medication during symptom exacerbations^{31,34} and discontinuation when BP values are normal. In a study by Kjellgren et al³⁵ treatment side effects and disease symptoms were correlated with lack of adherence to treatment. In this study, the impact of adverse effects of treatment was not assessed; however, the “drug adherence” domain was a determinant of high adherence. Items comprised in the “drug adherence” domain are consistent with the correlation between non-pharmaceutical treatment for hypertension (salt restriction and exercise) and self-reported medication adherence, found in this study. Patients complying with non-pharmaceutical treatment recommendations were found to have better adherence to pharmaceutical treatment.

Blood pressure control involves such aspects as regular medication-taking, BP measurements, and keeping a diary of self-control.³³ In the present study, regular BP measurements and diary of self-control keeping were confirmed to be predictors of high medication adherence.

Medication adherence is crucial to hypertension control and cardiovascular complication prevention. Concurrent ischemic heart disease is a significant independent negative determinant of medication adherence. In a study by Zhao et al,³⁷ 38.4% of patients with ischemic heart disease failed to comply with treatment, and poor knowledge on treatment and complications was correlated with poor medication adherence. The negative correlation between ischemic heart disease and patients with hypertension knowledge could, or should, be explained by the frequent occurrence of ischemic heart disease as a complication of untreated hypertension.³⁶

It should be emphasized that no association between sociodemographic variables and the level of adherence to drug recommendations was discovered in our study. Only regular BP measurement and the concurrent non-pharmaceutical treatment as well as the high level of knowledge were statistically significant factors influencing the level of adherence to recommendations. Both in our study and in the literature the association between the lower level of BP control (or total lack of BP control) with lower level of adherence to recommendations was confirmed.^{38,39}

During hypotensive therapy, the detection of non-adherence in patients with noncontrolled AH is very important before increasing the dosage of the drugs. In such a situation, increasing the dosage of the drugs might intensify the side effects of the medication and increase the level of non-adherence to recommendation. Only effective communication and education can influence the regular BP control and the adherence to therapeutic recommendations.

Conclusion

1. Patients with hypertension knowledge on their illness are insufficient, with the lowest levels of knowledge on diet and drug adherence.
2. Patients with a high level of knowledge also show better medication adherence.
3. Knowledge on hypertension is a significant independent determinant of good adherence. Other independent determinants include salt restriction and regular BP measurements.
4. Concurrent ischemic heart disease is a significant negative determinant.

Implication for practice

The identification of knowledge deficits as a factor contributing to lack of adherence and poor hypertension control remains a key challenge for clinicians caring for patients with hypertension.

A multidisciplinary approach and the development of intervention programs focused on promoting patient knowledge and healthy behaviors are significant components of care, contributing to better adherence and control.

Study limitations

The most important limitation is the fact that this study sample was recruited from a single center. Then, the method used for assessing adherence was a self-assessment questionnaire; however, the MMAS had been used in multiple studies on medication adherence in hypertension, showing good psychometric properties. Finally, no information on patients' sources of knowledge was gathered.

Disclosure

The authors report no conflicts of interest in this work.

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