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## Factors associated with adherence in patients with type 2 diabetes mellitus

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### Summary

**Introduction.** Only 50 - 75% of patients surveyed adhere to therapeutic recommendations in the treatment of chronic diseases. It is estimated that half of the patients discontinue therapy after one year from the start of treatment. Failure to comply with therapeutic recommendations often leads to complications of diabetes. New methods are now being sought to help diabetics adhere to the recommendations of the therapeutic team. According to the World Health Organization, interventions to improve adherence have a greater impact on health than the development of treatment.

**The aim of the study** was to analyze the degree of adaptation to the therapeutic recommendations of patients with type 2 diabetes.

**Material and methods.** 150 patients (96 women) 65.2 ± 11.8 years of age who were treated for exacerbation of type 2 diabetes were examined with their own questionnaire regarding compliance with the therapeutic recommendations and a standardized HBI (Health Behavior Inventory) questionnaire to assess health behaviors.

**Results.** A high degree of compliance with pharmacological recommendations was presented by 30%, the average 42,7%, and low 27,3% patients. High level of adherence was presented by people aged 50-69 ( $p<0.001$ ), higher education ( $p=0.042$ ), in a relationship ( $p=0.026$ ), living in the countryside ( $p=0.029$ ). People with a high level of compliance with pharmacological recommendations more often followed behavioral recommendations regarding weight reduction (62.2% vs. 23.4% vs. 31.7%), physical activity (71.1% vs. 45.3% vs. 46.3%) and daily weight control 33.3% vs. 17.2% vs. 4.9%). In the comparative analysis of the level of adherence, depending on the selected variables, it was observed that the higher level of compliance was for people who were diagnosed with comorbidities (compliance with the recommendations 6.6 vs. 5.1 in people without additional diseases), in non-smokers than in those who smoked tobacco ( 6.9 vs. 6.1), in subjects with hemoglobin HbA1C  $\leq 7\%$  than in HbA1C patients  $> 7\%$  (7.0 vs. 6.6). The level of adherence to recommendations was the lowest in patients treated with the combination regimen (tablets+insulin;  $p=0.024$ ). High level of health behaviors was presented more often by women compared to men (108 vs. 103), older people compared to younger ones (age 60-69 HBI=109.1 vs. age up to 49 years HBI=93.3), pensioners compared to economically active people or unemployed (108.3 vs. 101.1 vs. 92.3). In multivariate analysis, the independent predictors of adherence to pharmacological therapeutic recommendations are the absence of co-morbidities and older age ( $\beta=0.212$ ,  $p=0.005$ ).

**Conclusions.** Patients with diabetes have a moderate level of adherence and the compliance with health behaviors. An independent predictor which has a positive influence on the HBI is the old age (the older the patient, the better the level of adherence). The predictor which reduced the level of adherence and the HBI was the absence of comorbidities.

**Key words:** type 2 diabetes mellitus, adherence

## **Introduction**

Type 2 diabetes is the most frequently diagnosed form of diabetes in the world. Recently there has been a significant increase in the incidence of diabetes. In the European Region 64 million people has diabetes - 33 million women and 31 million men (aged > 18 years). 23.5 million people aged 20-79 are living with undiagnosed diabetes [1]. According to the latest research from 2013, in Poland diabetes affects around 2.7 million people, which gives 8% of the Polish population. They are forecasting an increase in the number of diabetics by 80% over the next 20 years. The reasons for this phenomenon sees the insufficient prevention and aging population. It is worrying that over half a million people are not aware of their disease [2].

Adherence to treatment is defined by four notions: adherence, compliance, persistence and concordance. Adherence is the extent to which the patient achieve therapeutic recommendations. Compliance determines the percentage of medication. Persistence refers to the perseverance of therapy, specifically the time in which the drug is taken, and the concordance describes the patient-doctor collaboration in the choice of therapy and responsibility for the decisions taken. [3]

In Poland, the problem of non-adherence is serious. The CODE 2 results confirmed 20% adherence during 1/5 of year by diabetes taking statins, antihypertensive and hypoglycemic medication [4]. 31% of patients used only part of the packaging of medicines, and took 25% of all prescription drugs portion [5]. Taking into consideration the implementation of prescriptions, 20-30% of medicines is never bought and only 40% of patients fill the next prescription. In addition, the patients often buy drugs and do not take them. Therefore, there can be no assurance that the bought drugs are later regularly taken by the patient [6].

The treatment of diabetes is based on the glycemic control and the prevention of early and late complications. The Polish Diabetes Association recommends using of complex therapy of diabetes. In addition to pharmacological treatment, an important part of treatment methods are non-pharmacological (behavioral), ie. proper diet and exercises. Normalization of blood glucose level can be achieved only when patients adhere to treatment recommendations. Data in the literature indicate that only 50% of patients respects these therapeutic regimen [7].

The level of adaptation to treatment recommendations in patients with type 2 diabetes depends on many factors. Researchers agree with the existence of the relationship between

patient adherence and behavior, socio-demographic factors, health care system, medical staff attitude and course of the disease. Patient education is central to achieving a high level of adherence. Diabetologic education still needs to invest and develop standards. The authors also point to the mental health of the patient. Depression, anxiety and lack of acceptance of the disease often negatively affect the level of alignment in type 2 diabetes. Problems with adherence of patients should be identified individually, in order to adopt effective measures to eliminate the cause of non-adherence. Currently, new methods are being sought to facilitate diabetics adherence to the therapeutic team. It is worth emphasizing that, according to the World Health Organization, interventions aimed at improving adherence are more important and have greater impact on health than the development of treatment.

In most literature raises the question of the impact of socio-demographic factors - age and gender - on the level of adherence. Review of the literature provides ambiguous results. Some researchers say that older age correlated with better fulfillment of recommendations. Older patients, because they are mostly retired or pensioned, have more amount of time for regular life, physical activity and fulfill diet obligations [8]. On the other hand, these patients due to comorbidities have difficulties to meet the therapeutic requirements [9]. The literature also put forward the issue of non-adherence in youthful age. These patients often revolt and do not accept their disease [10]. Many studies have shown a connection between sex and the ability to change lifestyle in order to reduce the risk of the disease [11,12,13,14]. In the study Fitzgerald et al., on the group of 1202 diabetics, it was observed that men are more likely to adhere to treatment recommendations in order to maintain health, while women only see the negative impact of the disease on their lives. It depends on the sex-filled type of recommendations. Women more often measure blood glucose level and adhere to dietary recommendations, and men coped better with planning regular physical activity [15].

Authors of this study have tried to identify factors associated with adherence of patients with diabetes mellitus type 2. Therefore, the aim of the study was to investigate the effect of selected variables on the degree of adjustment to the therapeutic recommendations in patients with type 2 diabetes.

## **Material and methods**

For the study, 150 patients with diabetes who met the inclusion criteria (clinically confirmed type 2 diabetes, age > 18 years, consent, Mini-Mental State Examination score (MMSE > 24)

were enrolled. We used a standardized questionnaire to assess the level of health behaviors and a own survey to assess the level of adherence. Socio-clinical data were obtained from patient medical records.

In its own survey addressed issues related mainly to the method of treatment, the results of laboratory tests, vital signs, presence of comorbidities, early and late complications of diabetes, self-care and adherence to pharmacological treatment. Questions relating to the adherence was 12 and covered both intentional and unintentional non-adherence pharmacology. The survey highlighted the problems of forgetting, intentional skipping doses of medication, discontinuation of medication taking due to poor or well-being. In the survey put forward the problem of difficulty in filling a prescription and too high prices of drugs. Depending total score in own survey patients were divided into 3 groups: group I (> 8 points) low adherence, group II (8-10 points), the medium adherence, group III (11-12 points) high adherence.

Healthy Behavior Inventory (HBI) by Zygfryd Juczyński consists of 24 questions. It is used to assess compliance of non-pharmacological and determine the level of health behavior: preventive behavior, healthy eating habits, positive mental attitudes and health practices. Respondents answer questions about the frequency of the task in selecting the appropriate value on a scale from 1 to 5 (1 - almost never, 2 - rarely, 3 - sometimes, 4 - often, 5 - almost always). The range of points obtained by the patient is in the range 24 - 120 points. The more points get the patient, the greater the intensity of compliance with health behaviors. The resulting points are converted into stens.

## **Results**

### ***Sociodemographic and clinical characteristics of patients, depending on the level of adherence***

The study involved 150 patients (96 women and 54 men) aged  $65.2 \pm 11.8$  years. All patients were informed about the purpose and conduct of the study and signed written consent for the conduct. Table 1 presents socio-demographic characteristics of the patients. The high degree of adherence presented the 45 patients, medium 64, and low 41. Patient's level of adherence varied depending on age. Of the study group, the largest group with low adherence were elderly people aged 70-79 years (41.5%), whereas a higher degree of adherence

concerned younger people aged 50-69 years. Among people with a high level of compliance, most people had higher education (33.3%) and secondary education level (20%) while in the group with low and medium level of adherence with the most were people with secondary education level (39% and 35.9%) and professional education level (29.3% and 37.5%). The test groups were varied according to marital status, patients being in relationships were more often than not in the group with a high level of adherence (84.4% vs 58.5% in the group with low adherence). The analysis showed that in the group with higher levels of adherence were more people living in rural areas (tab. 1).

Table 1. Socio-demographic characteristics of patients according to the groups of adherence

Characteristic	Level of adherence N=150						Test p-value
	Low N=41		Medium N=64		High N=45		
	n	%	n	%	n	%	
Female	28	68.3	44	68.8	24	53.3	0.204
Age (years):							<b>&lt;0.001</b>
< 49	9	22.0%	3	4.7%	3	6.7%	
50 to 59	4	9.8%	9	14.1%	17	37.8%	
60 to 69	10	24.4%	20	31.3%	18	40.0%	
70 to 79	17	41.5%	23	35.9%	6	13.3%	
80>	1	2.4%	9	14.1%	1	2.2%	
Education:							<b>0.042</b>
Primary	4	9.8%	11	17.2%	4	8.9%	
Professional	12	29.3%	24	37.5%	17	37.8%	
Secondary school	16	39.0%	23	35.9%	9	20.0%	
College and above	9	22.0%	6	9.4%	15	33.3%	
Marital status: in a relationship	24	58.5%	43	67.2%	38	84.4%	<b>0.026</b>
Living in the countryside	4	9.8%	8	12.5%	13	28.9%	<b>0.029</b>
Professional Status:							0.205
Retired / pensioned	29	70.7%	55	85.9%	thirty	66.7%	
Working	8	19.5%	8	12.5%	11	24.4%	
Unemployed	2	4.9%	0	0.0%	1	2.2%	
Retired and working	2	4.9%	1	1.6%	3	6.7%	
Professional activity	31	75.6%	56	87.5%	33	73.3%	0.136

Analysis of clinical parameters showed that a high level of pharmacology adherence was associated with better adherence of non-pharmacological treatment of diabetes. People with high levels of pharmacological adherence often complied with recommendations on weight reduction (62.2% vs. 23.4% vs. 31.7%), physical activity (71.1% vs. 45.3% vs. 46.3%) and daily weight control (33.3% vs. 17.2% vs. 4.9%); (tab. 2). In the group of people different level of compliance differed also a way to diagnose diabetes. Patients with high level of adherence were more often than not diagnosed during family doctor's appointment (reported

with distressing symptoms). However, people with low adherence were predominantly those who had been diagnosed with diabetes accidentally during hospitalization.

Table 2. Clinical characteristics of patients according to the groups of adherence

Characteristic	Level of adherence N=150						Test p-value
	Low N 41 =		Medium N=64		High N=45		
	n	%	n	%	n	%	
Non-pharmacological methods used*:							
Weight loss	13	31.7%	15	23.4%	28	62.2%	<b>&lt;0.001</b>
Physical activity (30 min per day)	19	46.3%	29	45.3%	32	71.1%	<b>0.017</b>
Reducing fatty foods	28	68.3%	52	81.3%	40	88.9%	0.055
Daily weight control	2	4.9%	11	17.2%	15	33.3%	<b>0.003</b>
Way to diagnose diabetes:							
Preventive examination of blood sugar levels	14	34.1%	13	20.3%	8	17.8%	<b>0.008</b>
Accidentally during the stay in the hospital	16	39.0%	24	37.5%	10	22.2%	
By family doctor after reporting the worrying symptoms	5	12.2%	24	37.5%	16	35.6%	
By occupational physician	3	7.3%	3	4.7%	10	22.2%	
Referral to a surgeon because of diabetic foot	0	0.0%	0	0.0%	1	2.2%	
HbA1c> 7%	25	61.0%	43	67.2%	20	44.4%	<b>0.05</b>
Method of treatment of diabetes*:							
Oral antidiabetic agents	39	95.1%	52	81.3%	35	77.8%	0.066
Insulin	18	43.9%	26	40.6%	18	40.0%	0.925
Non-pharmacological methods	35	85.4%	57	89.1%	42	93.3%	0.487

\* the proportions do not add up to 100 because some patients used more than one method

We compared the level of adherence depending on the selected variables. Higher adherence concerned persons with comorbidities (level of adherence 6.6 vs. 5.1 in patients without additional diseases), non-smokers of tobacco than in smokers (6.9 vs. 6.1) and patients with hemoglobin HbA1C  $\leq 7\%$  than in HbA1c > 7% (7.0 vs. 6.6). The level of adherence was higher in patients treated with insulin than in patients treated with tablets (7.3 vs. 6.8), and the lowest was in patients treated with insulin and tablets (6.3). Surprising result of the study is the level of adherence depending on the amount of medication. The highest adherence was in people taking large amounts of medication daily at 7.2 people taking 16-20 tablets vs. 5.6 in those taking less than 5 tablets per day.

Among the respondents, patients who admitted to treatment discontinuation were lower score in the questionnaire assessing the level of compliance (5.0) of those who claimed that the treatment does not interrupt (7.0); (tab. 3).

Table 3. Comparison analysis according to selected clinical variables

Variable	The level of adherence	P-value
Comorbidities: Yes (n=145) No (n=5)	6.8 ± 1.3 5.1 ± 2.0	<b>0,004</b>
Nicotine addiction: No (n=124) Yes (n=26)	6.9 ± 1.2 6.1 ± 1.7	<b>0.012</b>
Time from DM diagnosis: ≤5 years (n=31) 6 - 10 years (n=35) 11 - 20 years (n=57) >20 years (n=27)	6.2 ± 2.0 7.1 ± 0.8 6.7 ± 1.2 7.0 ± 1.2	0,055
Glycated hemoglobin: HbA1C ≤ 7% (n=62) HbA1C > 7% (n=88)	7.0 ± 1.1 6.6 ± 1.5	<b>0.043</b>
Method of treatment of diabetes: The tablets (n=86) Insulin (n=20) Tablets + insulin (n=44)	6.8 ± 1.3 7.3 ± 0.9 6.3 ± 1.5	<b>0,024</b>
Number of medications daily: To 5 (n=12) 6 - 10 (n=69) 11 - 15 (n=51) 16 - 20 (n=14) Over 20 (n=4)	5.6 ± 2.2 7.0 ± 1.0 6.5 ± 1.5 7.2 ± 0.9 6.6 ± 0.9	<b>0.003</b>
Discontinuation of medication No (n=130) Yes (n=20)	7.0 ± 1.1 5.0 ± 1.8	<b>&lt;0.001</b>

A similar comparative analysis was performed for the result of the general questionnaire HBI. Women received more points than men, thereby more closely presented health behavior (108 vs. 103). Older people have a higher index of health-related behaviors than younger people in the group (age 60-69 HBI=109.1 vs. age to 49 years HBI=93.3). Retired were characterized by a higher level of adherence compared to working patients or unemployed (108.3 vs. 101.1 vs. 92.3) and inactive people have a higher level of health behavior than working people (107.8 vs. 102.1); (tab. 4).

Table 4. Comparison analysis according to selected clinical variables of HBI

Variable	HBI (Score)	P-value
Sex: Women (n=96) Men (n=54)	108.1 ± 9.4 103.8 ± 12.6	<b>0,018</b>
Age (years): <49 (n=15) 50 to 59 (n=30) 60 to 69 (n=48) 70 to 79 (n=46) >80 (n=11)	93.3 ± 12.5 105.3 ± 10.6 109.1 ± 9.3 108.4 ± 8.3 109.4 ± 12.1	<b>&lt;0.001</b>
Education: Primary (n=19) Professional (n=53) Secondary school (n=48) College and above (n=30)	107.2 ± 10.5 105.1 ± 11.9 106.0 ± 10.5 109.8 ± 9.1	0.284
Marital status: In relationship (105) Free (n=45)	107.1 ± 10.8 105.3 ± 10.9	0,354
Place of residence: Village City	105.7 ± 11.5 106.8 ± 10.7	0.647
Professional Status: Retired / pensioned (n=114) Working (n=27) Unemployed (n=3)	108.3 ± 9.5 101.1 ± 13.4 92.3 ± 16.5	<b>0.001</b>
Professional activity: No (n=117) Yes (n=33)	107.8 ± 10.0 102.1 ± 12.4	<b>0,007</b>

***The level of the health-related behaviors (HBI) depending on the level of adherence***

In order to assess the impact of health behaviors adherence pharmacological comparative analysis of the level of health behaviors depending on the level of adherence. Statistical analysis revealed significant differences in the domain proper health habits, behavior preventive health practices, and the total score of the questionnaire HBI depending on the degree of adherence (tab. 5). Patients with a high degree of adherence obtained the highest scores in each domain HBI. The most common result of this group fluctuated within the range 7-10 stens, therefore it can be assumed that the behavior of the health of patients with a high level of adherence were high (Tab. 5).

Table 5. Analysis of health behaviours depending on the adherence levels

Characteristic	Level of adherence N=150						Test <i>p</i>
	Low N 41 =		Medium N=64		High N=45		
"Raw" HBI score <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	101.3 ± 11.9 [104 93; 110] 76 - 119		107.4 ± 10.6 111 [104; 114] 77 - 120		110.2 ± 8.2 112 [108; 116] 78 - 120		<b>&lt;0.001</b>
Healthy eating habits (HBI): <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	24.6 ± 3.9 26 [22; 28] 16 - 30		26.5 ± 3.8 28 [26; 29] 8 - 30		27.5 ± 3.3 28 [27; 30] 13 - 30		<b>&lt;0.001</b>
Preventive behavior: <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	25.6 ± 4.0 26 [24; 29] 16 - 30		27.9 ± 3.0 29 [27; 30] 16 - 30		28.8 ± 2.5 30 [28; 30] 15 - 30		<b>&lt;0.001</b>
Positive mental attitudes: <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	26.4 ± 3.8 28 [24; 30] 15 - 30		27.0 ± 3.4 28 [26; 30] 17 - 30		27.8 ± 2.5 28 [26; 30] 22 - 30		0.353
Health practices: <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	24.7 ± 3.1 25 [23; 27] 17 - 30		26.1 ± 3.2 27 [25; 29] 16 - 30		26.2 ± 3.2 26 [25; 29] 18 - 30		<b>0.028</b>
Sten HBI result: <i>M</i> ± SD <i>Me</i> [Q1; Q3] <i>min</i> - Max	8.2 ± 1.6 9 [7; 9] 4 - 10		8.9 ± 1.5 10 [9; 10] 4 - 10		9.4 ± 1.1 10 [9; 10] 5 - 10		<b>&lt;0.001</b>
HBI result:	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	0.247
Low (1-4 stens)	1	2.4	1	1.6	0	0.0	
Medium (5-6 stens)	6	14.6	6	9.4	1	2.2	
High (7-10 stens)	34	82.9	57	89.1	44	97.8	

### **Correlation analysis of selected variables with the level of adherence**

The predictors compounded the level of adherence were: lack of concomitant diseases ( $r=-0.233$ ,  $p=0.004$ ) and hyperglycemic episodes during the past 3 months ( $r=-0.180$ ,  $p=0.027$ ); (tab. 6). However, among the predictors relating to health behavior they were: lack of concomitant diseases in domain "Preventive behavior" ( $r=-0.194$ ;  $p=0.017$ ), and "Health practices" ( $r=-0.179$ ;  $p=0.038$ ).

Table 6. Spearman's rank correlation coefficients (rho) and their significance (P) for the analyzed predictors of adherence and health-related behaviors (HBI).

Variable	Domain HBI				HBI - sum (score)	Adherence (score)
	Healthy eating habits	Preventive behavior	Positive mental attitudes	Health practices		
No comorbidities	$r=0.034$ $p=0.664$	$r=-0.194$ $p=0.017$	$r=-0.105$ $p=0.201$	$r=-0.170$ $p=0.038$	$r=-0.131$ $p=0.110$	$r=-0.233$ $p=0.004$
Hyperglycemia in the last 3 months	$r=-0.025$ $p=0.759$	$r=-0.077$ $p=0.348$	$r=-0.078$ $p=0.342$	$r=0.050$ $p=0.547$	$r=-0.042$ $p=0.609$	$r=-0.180$ $p=0.027$
Age (years)	$r=0.218$ $p=0.007$	$r=0.204$ $p=0.012$	$r=0.184$ $p=0.024$	$r=0.378$ $p<0.001$	$r=0.310$ $p<0.001$	$r=0.011$ $p=0.892$

Multiple-factor analysis showed that statistically significant independent determinants of good adherence was lack of concomitant diseases ( $\beta=-0.805$ ,  $p=0.009$ ).

Table 7. Single- and multiple-factor regression analysis results for the variables studied against HBI scores

Predictor	Health-related behaviors (total HBI score)			
	Single-factor analysis		Multiple-factor analysis	
	$b$	$p$	$\beta$	$P$
Age (years)	<b>0.285</b>	<b>0.001</b>	<b>0.212</b>	<b>0.005</b>

The only independent predictor of the assessment of health behaviors was age. The group of patients with older age characterized better adherence to health behaviors ( $\beta=.212$ ,  $p=.005$ ); (tab.7).

## Discussion

Diabetes as a chronic disease requires self-control and patient's adherence. Often it turns out to be necessary to change the current way of life. Often, only drug therapy is insufficient to achieve proper alignment and prevent complications of diabetes. The aim of the study was to analyze the level of adherence to treatment recommendations in patients with type 2 diabetes. The study group patients varied in the level of adherence. The high level of medication adherence concerned only 30% of the patients, the most respondents pointed to medium adherence to treatment recommendations. Slightly higher score in questionnaire measured level of adherence (36.4%) was obtained in studies in polish society of patients with hypertension [17].

Other available research of the level of adherence indicate that about 20% of diabetics do not apply the prescribed hypoglycemic, antihypertensive drugs and statins for one-fifth of the year [4]. The study of Świerzyńska et al. revealed that patients with type 2 diabetes most often declared adherence to dietary and physical activity, but it was not confirmed by laboratory findings [18]. Too few patients and their families participate in diabetes education [19]. Similarly, in our study, the level of adherence to other forms of treatment was unsatisfactory. Patients in our study, the least adhered with the recommendations of daily physical activity and weight reduction.

In our study, the respondents represented a high level of behavioral adherence. The average score of the HBI was 104-110 points. In the light of the research it is the high result. In Juczyński's studies indicator of health behavior for diabetics was 92.44 and was lower than that obtained by us [16,20]. A surprising result of this study was the relationship between more drugs and a high level of adherence. The authors did not pay attention to patient's caregivers helping in preparing doses of medication. In addition, hospitalized patients received medications prepared by the staff and taken in his presence.

Socio-demographic variables had an impact on adherence to pharmacological and behavioral treatment. In the study higher level of adherence was connected with rural residents, people in relationship and patients aged 50-69 years. Age is an important predictor of adherence. In the literature, there is an ongoing discussion about the relationship between age and the level of adherence. Some studies showed a relationship between better adherence and younger age of patients [17,21-23]. In a study by Jankowska-Polańska et al., younger patient age correlated with better pharmacological and non-pharmacological adherence in the domain of health practices. The authors assumed that it may be related to a smaller number of co-morbidities and medication, and consequently with a better attitude to therapy [17]. On the other hand, in the study by Rolnick et al., which involved 4631 patients with type 2 diabetes, it was observed that younger patients were less likely to adhere to the pharmacological recommendations. The worst level of adherence characterized patients aged 18-49 years and the best patients aged 60-69 years old (36.9 vs. 57.2, respectively;  $p < 0.001$ ) [24]. The literature also consider effect of gender on the level of adherence. Some studies showed that women adhere better to the recommendations [25] but there are also publications, which lead to different conclusions [24,26]. These differences may have their source in the number and types of chronic diseases and the tools used to measure adherence. In our study patients who

suffered only from type 2 diabetes had significantly lower adherence compared to those with coexisted chronic diseases. On the other hand, the study of Rolnick et al. confirmed that the coexistence of hypertension, depression and hyperlipidaemia was associated with a lower adherence [24].

In type 2 diabetes, level of adherence has a significant influence on the course of the disease. According to the World Health Organization, interventions aimed at improving adherence are more important and has bigger impact on health than the development of treatment. Determine what group of patients adhere to recommendations in the lowest degree, and to find the cause of this condition are key elements of the strategy to improve the effectiveness of treatment. Level of adherence to the pharmacological recommendations also tested using the assay of glycated hemoglobin.

The patient's self-assessment of adherence was square with the level of glycated hemoglobin. Respondents characterized by better alignment of diabetes had significantly higher level of adherence than those with uncontrolled diabetes. Our results are consistent with published studies [29,30]. Study on the Malaysian population showed that respondents who declared inferior pharmacological adherence had higher percentage of glycated hemoglobin [29]. According to Zhang Y et al., depression has an influence on the level of glycated hemoglobin and glycemic control. Patients with depression had a higher HbA1c levels ( $7.9 \pm 2.0$  vs.  $7.7 \pm 2.0\%$ ,  $p=0.008$ ). These patients often reported hypoglycemia and had less time to adhere to the recommended diet, exercise, foot care and medicines. Depression among other variables (young age, low education, long disease duration, use of tobacco, high body mass index, insulin) was independently associated with failing to achieve target HbA1c. The relationship between depression and glycemic control has become irrelevant after switching to diet, exercise and medication [30]. The study of Wong MC et al. did not confirm the correlation between HbA1c and adherence [31].

Numerous studies have confirmed the impact of diabetes education on the degree of adherence [19,32,33]. The highest non-adherence occurs in people who have less understand the principles of the proposed therapy. Patient education on the principles of pharmacotherapy [34] diet [4.18], strengthening of motivation [35] have a positive influence of the level of adherence. Many patients declares adherence to dietary recommendations, but this is not reflected in body weight and BMI. Furthermore, according to the results of our research, as many as 17.3% of the respondents were smokers. This is consistent with the results of Kara et

al. (15%). This result is similar with the result of research of Łagoda et al. relating to heavy smoking of diabetes [36,37]. In contrast, an interesting result of this study is the observation that non-smokers had significantly higher level of adherence than smokers.

Often the lack of will power [35,39] or even the patient's personality [40] have become a major cause of low adherence [35,39]. According to data from the DAWN 41% of patients report psychological problems [41]. The study of Kostrzewa - Zabłocka et al. confirmed the association of mental health problems of non-adherence to the treatment [39].

## Conclusions

1. Patients with diabetes have a moderate level of adherence and the compliance with health behaviors.
2. An independent predictor which has a positive influence on the HBI is the old age (the older the patient, the better the level of adherence).
3. The predictor which reduced the level of adherence and the HBI was the absence of comorbidities

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