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# Relationship and influences of behavioral and psychological factors on metabolic control of patients with type 2 diabetes mellitus

## Povezanost i uticaj bihejvioralnih i psiholoških faktora na metaboličku kontrolu obolelih od dijabetesa melitusa tipa 2

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**Abstract**

**Background/Aim.** Achieving good metabolic control, which plays a key role in reducing or preventing macrovascular and microvascular complications of diabetes mellitus (DM), requires continuous patient involvement in the self-management of DM. This continued engagement, which makes type 2 DM (T2DM) one of the most physically and emotionally demanding diseases, can become, at certain periods of life, extremely severe and lead to emotional distress (symptoms of depression and DM-related distress) and deterioration of metabolic control. The aim of this study was to examine the association and influence of behavioral and psychological factors on the metabolic control of patients with T2DM. **Methods**. The research was conducted as a descriptive-analytic cross-sectional study. The method of random sampling included 324 subjects with T2DM in the research. The values of biochemical parameters of metabolic control were measured by standard laboratory methods. Blood pressure was measured two times, and the arithmetic mean was calculated. Anthropometric measurement was performed, and body mass index (BMI) was calculated. Attitudes toward medication adherence, adherence to dietary recommendations, level of physical activity, presence of depressive symptoms, and level of DM-related distress were examined using standardized questionnaires. **Results.** The target values of metabolic control parameters were reached by 21.6% of respondents. Multivariate analysis as predictors of poor metabolic control identified obesity, non-adherence toward dietary recommendations, insulin therapy, low level of physical activity, and clinically significant DM-related distress. **Conclusion.** Routine application of the questionnaire used in this study in the initial stages or critical moments of the disease can assess patients' attitudes and knowledge about behavioral determinants of DM self-management and timely detect psychological conditions that affect them. It would be realistic to expect that such a comprehensive holistic approach would contribute to a lower incidence of complications and better metabolic control of T2DM.

**Key words:**
**depression; diabetes mellitus, type 2; obesity; prognosis; risk assessment; psychology; surveys and questionnaires; therapeutics.**

**Apstrakt**

**Uvod/Cilj.** Postizanje dobre metaboličke kontrole, koja ima ključnu ulogu u redukciji ili prevenciji makrovaskularnih i mikrovaskularnih komplikacija dijabetesa melitusa (DM), zahteva kontinuiranu angažovanost bolesnika u upravljanju njihovom bolešću. Ta kontinuirana angažovanost, koja čini DM tipa 2 (T2DM) jednom od najzahtevnijih bolesti, kako fizički tako i emocionalno, u određenim periodima života može postati preteška i dovesti do emocionalnog distresa (simptomi depresije i distres povezan sa DM) i pogoršavanja metaboličke kontrole. Cilj rada bio je da se ispitaju povezanost i uticaj bihejvioralnih i psiholoških faktora na metaboličku kontrolu bolesnika sa T2DM. **Metode.** Istraživanje je sprovedeno kao deskriptivno-analitička studija preseka metodom slučajnog uzorka. U istraživanje su bila uključena 324 bolesnika sa T2DM. Vrednosti biohemijskih parametara metaboličke kontrole merene su standardnim laboratorijskim metodama. Krvni pritisak je meren u dva vremena i računata je aritmetička sredina. Vršena su antropometrijska merenja i računat je indeks telesne mase. Standardizovanim upitnicima ispitivani su stavovi bolesnika prema medikamentoj adherentnosti, adherentnost prema dijetetskim preporukama, nivo fizičke

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aktivnosti, prisustvo simptoma depresije i nivo distresa povezanog sa DM. **Rezultati.** Ciljne vrednosti parametara metaboličke kontrole dostiglo je 21.6% ispitanika. Kao prediktori loše metaboličke kontrole, multivarijantnom analizom identifikovani su gojaznost, neadherentnost prema dijetetskim preporukama, terapija insulinom, nizak nivo fizičke aktivnosti i klinički značajan distres povezan sa DM. **Zaključak.** Rutinska primena upitnika korišćenih u ovoj studiji u inicijalnom stadijumu ili kritičnim fazama pogoršanja bolesti, omogućila bi procenu stavova bolesnika i znanja o bihejvioralnim determinantama upravljanja DM i blagovremeno otkrivanje psiholoških problema povezanih sa njima. Realno bi bilo očekivati da takav sveobuhvatni, holistički pristup može doprineti boljoj metaboličkoj kontroli bolesnika sa T2DM i nižoj incidenciji komplikacija.

**Ključne reči:**
**depresija; dijabetes melitus, tip 2; gojaznost; prognoza; rizik, procena; psihologija; ankete i upitnici; lečenje.**

## Introduction

Diabetes mellitus (DM) represents a global public health crisis of pandemic proportions due to the growing number of patients, numerous complications that lead to disability and premature mortality, and the high cost of treatment and prevention [1, 2]. Data from International Diabetes Federation indicate that 463 million people worldwide, or 9.2% of adults aged 20–79, had diabetes in 2019 [2, 3]. Globally, about 90% of the total number of people with DM suffer from type 2 DM (T2DM) [3].

According to the data of the Institute of Public Health of Serbia, 770,000 people, or 12% of adults, suffered from DM in Serbia in 2019. This rate ranks Serbia third in Europe in the prevalence of DM [2].

Metabolic control is one of the key outcomes of DM management and involves maintaining blood glucose level, arterial blood pressure (BP), and lipid status within limits as close to normal as possible [4]. The American Diabetes Association (ADA) states the values of the following parameters as indicative of proper metabolic control: glycosylated hemoglobin (HbA1c $\leq$ 7%), low-density lipoproteins (LDL) $\leq$ 2.6 mmol/L, high-density lipoproteins (HDL) $\geq$ 1.15 mmol/L, triglycerides (TG) $\leq$ 1.7 mmol/L, and BP $\leq$ 140/90 mmHg [5, 6]. Unregulated BP and dyslipidemia are associated with insulin resistance and a lower likelihood of optimal blood glucose control, which increases the risk of macrovascular and microvascular complications of DM [7]. Despite that, in data for 2019, ADA stated that only 33–49% of patients reach target values of some of the parameters of metabolic control while reaching the target values of all the parameters is rare and amounts to 14% [8].

Achieving good metabolic control, which plays a key role in reducing or preventing complications of DM, requires continuous patient involvement in self-management of DM [9], where 90–95% of decisions about their disease are made by person independently [10]. This need for continued engagement makes T2DM one of the most demanding chronic diseases, physically and emotionally [11]. Therefore, behavioral requirements of self-management (medication adherence, physical activity, body mass control, and adherence to dietary recommendations) can, in certain periods of life, become too difficult for patients and result in poor metabolic control [12]. Perception of inability to meet the behavioral requirements of self-management of DM can result in the manifestation of emotional distress (symptoms of depression and DM-related distress), which may result in worsening of metabolic control [12, 13].

Despite the importance of the problem and attitudes about the need for a holistic and multidisciplinary approach to patients with T2DM, studies that comprehensively consider metabolic control are limited. Therefore, the aim of this study was to examine the association and influence of behavioral and psychological factors on the metabolic control of patients with T2DM.

## Methods

### *Selection method, size, and construction of sample*

The research was conducted as a descriptive-analytical cross-sectional study. The research population considered 4,620 patients with T2DM from the electronic register of the Diabetes Dispensary of the Health Center in Zaječar, Serbia. Statistical software G*Power 3.0.1. was used to estimate the required sample size for multivariate logistic regression analyses. By entering the assumed moderate effect size of r = 0.2 for a study strength of 95% and the error level $\alpha$ = 0.05 and potential 10 predictors, the minimum required sample size of n = 324 subjects was obtained. To reduce selection bias, respondents were determined by random sampling method, based on scheduling examination by the Integrated Health Information System performed by their chosen physicians. Thus, differences between outpatients and inpatients were avoided, and generalization to the entire sample population was provided. Exclusion criteria for all the study participants were as follows: disease duration of less than one year, subjects only on dietary therapy, and subjects with comorbidities that interfere with understanding and self-completion of the questionnaire.

The research was approved by the Ethics Committee of the Zaječar Health Center (decision number 1899/3 from April 6, 2017) and was conducted in accordance with the ethical standards specified in the Declaration of Helsinki (1964) and subsequent amendments to the declaration. After the approval of the Ethics Committee, the research was conducted from September 2018 to March 2019 at the Diabetes Dispensary of the Health Center in Zaječar.

### *Research implementation and methodology*

Biochemical parameters of metabolic control were measured by a fully automated high-performance chromatographic test. Data on complications and comorbidities were taken from the electronic medical records of the subjects' BP. Values were obtained by measuring with a conventional

mercury sphygmomanometer in a sitting position on two occasions, after which the mean value was calculated. Body mass and body height values of the subjects were obtained by anthropometric measurements, after which body mass index (BMI) was calculated. Following ADA guidelines, the classification of the degree of nutrition was performed: BMI < 18.5 kg/m$^2$ – malnutrition; BMI = 18.5–24.9 kg/m$^2$ – normal body mass; BMI = 25–29.9 kg/m$^2$ – overweight; BMI ≥ 30 kg/m$^2$ – obesity [14].

As research tools, standardized questionnaires were used in order to reduce information errors. After the authors obtained permission to use the questionnaires that have not been used in our area so far, they were translated according to internationally recognized methodology with cultural adaptation.

*Medication adherence*

Medication adherence was assessed by the Questionnaire on Attitudes Toward Medication Adherence. Score 1–3 classifies subjects into a group with negative attitudes toward medication adherence, while a score > 3 indicates positive attitudes [15]. Research using this questionnaire finds its high negative predictive value (76.5–82.9%), i.e., that 76.5–82.9% of respondents with negative attitudes toward medication adherence are nonadherent toward medication therapy [15]. The assessment of the reliability of the questionnaire was based on an acceptable internal consistency (Cronbach α = 0.74).

*Adherence to dietary recommendations*

Adherence to dietary recommendations was assessed by the Questionnaire on the Perception of Adherence to Dietary Recommendations (PDAQ). The questionnaire consists of 9 questions designed to cover all guidelines of dietary recommendations for patients with T2DM. The total score is obtained by summing the answers to all questions [16]. In the studies in which the questionnaire was used, the respondents were classified into the group of adherents if they ate healthy for at least 4 days a week [17]. Accordingly, in this study, the point of intersection of the scale as a whole was set at 37, with a score of 1–3 indicating non-adherence, while a score > 37 indicated adherence according to dietary recommendations. The questionnaire showed acceptable internal consistency (Cronbach α = 0.78).

*Level of physical activity*

The level of physical activity was assessed by the Physical Activity subscale of the Personal Diabetes Questionnaire (PDQ). Physical activity was assessed with two questions: 1. The level of daily physical activity, and 2. The level of program activity (exercises). The answers were coded categorically: 0 – inactivity; 1 – subthreshold activity; 2 – threshold activity; 3 –suprathreshold activity. The scores of questions 1 and 2 are summed and give the scale score as a whole (0 and 1 – unsatisfactory level of physical activity; score ≥ 2 – satisfactory level of physical activity) [18].

*Symptoms of depression*

The symptoms of depression were assessed using Patient Health Questionnaire-9 (PHQ-9), which was validated as a screening instrument for use in Primary Health Care in Serbia. The questionnaire consists of 9 questions about symptoms and signs of depression. According to achieved scores, the subjects were classified into four groups: absence of symptoms of depression (score 0–4); mild symptoms of depression (score 5–9); moderate symptoms of depression (score 10–14); moderate to severe symptoms of depression (score 15–27) [19].

*DM-related distress*

The DM-related distress was assessed by Diabetes Distress Scale. The questionnaire differentiates three groups of subjects: with little or no distress (score > 2); with moderate distress (score = 2–2.9); with high, clinically significant distress (score > 3) [20]. The questionnaire showed good internal consistency (Cronbach α = 0.93).

*Statistical analysis*

Statistical data processing was performed using the statistical program IBM SPSS 21.0. Data processing included methods of descriptive and inferential statistics. Numerical features are presented through mean values (arithmetic mean), measure variability (range of values and standard deviation), and attributive features using frequencies and percentages. A binary logistic regression model was used to examine the correlation and prediction of the dependent variable defined as dichotomous. The odds ratio (OR) was used in the interpretation of the model together with a 95% confidence interval (CI). As a measure of the model's adaptation to real data, the Hosmer-Lemeshow test was used to test the differences between the observed and expected values. The sensitivity and specificity of the model and the total percentage of correctly classified respondents based on the model were used in the interpretation of the results. All tests were two-sided with a significance level of $p < 0.05$.

**Results**

*Demographic and clinical characteristics*

The mean age of subjects in the research sample was 63.8 ± 9.3 years. The largest number of respondents belonged to the age group 45–65 years (n = 155; 47.8%). The demographic characteristics of respondents stratified by gender are shown in Table 1.

Most of the subjects in the sample (n = 207; 63.9%) had DM 1–10 years, and the average duration of the disease in the sample as a whole was 11.0 ± 8.3 years. The average BMI of subjects in the sample was 31.3 ± 5.7 kg/m$^2$ indicating obesity. Only 38 (11.1%) respondents in our study sample were without complications or comorbidities. The clinical characteristics of respondents stratified by gender are shown in Table 2.

**Table 1**

**Demographic characteristics of patients with type 2 diabetes mellitus stratified by gender**

| Characteristic | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Number of respondents | 141 | 43.5 | 183 | 56.5 | 324 | 100.0 |
| Age categories (years) | | | | | | |
| 30–45 | 11 | 7.8 | 6 | 3.3 | 17 | 5.2 |
| 46–65 | 69 | 48.9 | 86 | 47.0 | 155 | 47.8 |
| > 65 | 61 | 43.3 | 91 | 49.7 | 152 | 46.9 |
| Average age (years), mean ± SD | 62.6 ± 9 | | 64.7 ± 9.2 | | 63.8 ± 9.3 | |
| Marital status | | | | | | |
| live alone | 111 | 78.7 | 115 | 62.8 | 226 | 69.8 |
| community life | 30 | 21.3 | 68 | 37.2 | 98 | 30.2 |
| Education | | | | | | |
| elementary/lower | 29 | 20.6 | 93 | 50.8 | 122 | 37.7 |
| high school | 86 | 61.0 | 73 | 39.9 | 159 | 49.1 |
| college/university | 26 | 18.4 | 17 | 9.3 | 43 | 13.3 |
| Financial status | | | | | | |
| poor | 45 | 31.9 | 100 | 54.6 | 145 | 44.8 |
| satisfactory | 74 | 52.5 | 68 | 37.2 | 142 | 43.8 |
| good | 22 | 15.6 | 15 | 8.2 | 37 | 11.4 |

**SD – standard deviation.**

**Table 2**

**Clinical characteristics of patients with type 2 diabetes mellitus (DM) stratified by gender**

| | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Number of respondents | 141 | 43.5 | 183 | 56.5 | 324 | 100.0 |
| Duration of DM (years) | | | | | | |
| 1–10 | 90 | 63.8 | 117 | 63.9 | 207 | 63.9 |
| 11–20 | 34 | 24.1 | 42 | 23.0 | 76 | 23.5 |
| > 20 | 17 | 12.1 | 24 | 13.1 | 41 | 12.7 |
| Average duration (years), mean ± SD | 10.7 ± 8.1 | | 11.1 ± 8.5 | | 11.0 ± 8.3 | |
| The presence of other diseases (n = 286) | | | | | | |
| only comorbidities | 52 | 44.1 | 75 | 44.6 | 127 | 44.4 |
| comorbidities and complication | 57 | 48.3 | 85 | 50.6 | 142 | 49.6 |
| only complication | 9 | 7.6 | 8 | 4.7 | 17 | 5.9 |
| BMI (kg/m$^2$), mean ± SD | 29.9 ± 4.7 | | 32.3 ± 6.2 | | 31.3 ± 5.7 | |
| Therapeutic modality | | | | | | |
| tablets | 78 | 55.3 | 100 | 54.5 | 178 | 54.9 |
| insulin | 29 | 20.6 | 43 | 23.4 | 72 | 22.2 |
| tablets + insulin | 34 | 24.1 | 40 | 22.1 | 74 | 22.8 |
| Dose regimens | | | | | | |
| 1 dose | 14 | 9.9 | 21 | 11.5 | 35 | 10.8 |
| 2 doses | 65 | 46.1 | 86 | 47.0 | 151 | 46.7 |
| ≥ 3 doses | 62 | 43.9 | 76 | 41.5 | 138 | 42.5 |
| Is insulin an additional burden (n = 146)? | | | | | | |
| yes | 33 | 52.4 | 69 | 83.1 | 102 | 69.4 |
| no | 30 | 47.6 | 15 | 16.9 | 45 | 30.6 |
| How does insulin therapy burden you (n = 102)? | | | | | | |
| fear of hypoglycemia | 6 | 18.2 | 24 | 34.8 | 30 | 29.4 |
| limiting the activity of everyday life | 19 | 57.6 | 25 | 36.2 | 44 | 43.1 |
| frequent checking of blood glucose levels | 8 | 24.2 | 20 | 29.0 | 28 | 27.5 |

**SD – standard deviation; BMI – body mass index; DM – diabetes mellitus.**

*Medication adherence*

Slightly more than half of the respondents (n = 169; 55.2) had positive attitudes toward medication adherence, while 155 (47.8%) had negative attitudes. The results of the univariate analysis showed that female gender ($p = 0.001$), respondents < 65 years of age ($p = 0.009$), elementary or lower level of education ($p < 0.001$), poor financial status ($p = 0.009$), obesity ($p < 0.001$), insulin therapy with load ($p < 0.001$), and ≥ 3 therapeutic doses daily ($p < 0.001$) were statistically significantly related to negative attitudes toward therapeutic adherence.

*Adherence to dietary recommendations*

By dichotomizing the total value of the PDQ score (cut-off = 37), almost two-thirds of the respondents (n = 211; 65.1%) rated themselves as non-adherent toward dietary recommendations. Non-adherence was more common in persons < 65 years compared to the group > 65 years (71.5% vs. 57.9%, respectively) and in obese persons compared to those with normal body mass (74.7% vs. 36.4%, respectively). The duration of diabetes ($p = 0.772$) was not statistically associated with adherence to dietary recommendations.

*Physical activity*

The results obtained using the subscale of Physical activity in PDQ indicate that more than half of respondents (n = 211; 65.1%) had unsatisfactory levels of physical activity. The results of the univariate analysis showed that the female gender ($p = 0.027$), elementary or lower level of education ($p = 0.001$), obesity ($p < 0.001$), and the presence of complications ($p < 0.001$) were statistically significantly related to the unsatisfactory level of physical activity.

*Symptoms of depression*

In our study population, every second respondent had mild to moderate depression (n = 154; 50.6%), every tenth (n = 33; 10.2) had moderate to severe depression, and two-fifths had no symptoms of depression. The results of the univariate analysis showed that the female gender ($p < 0.001$), elementary or lower level of education ($p = 0.003$), insulin therapy with load ($p = 0.001$), and the presence of complications ($p = 0.002$) were statistically significantly related to symptoms of depression.

*DM-related distress*

By dichotomizing the value of total scores and scored associated subscales into categories of clinically significant distress (score ≥ 3) and no distress or moderate distress without clinical significance (score < 3), we obtained the results that clinically significant distress was present in 114 (35.2%) respondents. The results of the univariate analysis showed that the female gender ($p = 0.006$), higher levels of education ($p = 0.029$), insulin therapy with load ($p < 0.001$), three and more therapeutic doses daily ($p = 0.031$), and the presence of complication ($p = 0.005$) were statistically significantly related to clinically significant distress.

*Relationship and predictive influence of examined variables on the metabolic control of subjects with T2DM*

Slightly less than a quarter of respondents in the research sample met all three goals of good metabolic control (n = 70; 21.6%). Data on the values of metabolic control parameters of the subjects in our study sample are shown in Table 3.

A binary logistic model was analyzed in order to determine the correlation and prediction of good metabolic control defined by achieving the target values of all three metabolic parameters. The first step was the application of univariate analysis with a dichotomized dependent variable metabolic control (good – met all three goals and bad – not met all three goals). Some socio-demographic and clinical characteristics of respondents, behavioral determinants of DM self-management, and psychological characteristics of the respondents (symptoms of depression and DM-related distress) were applied as dependent variables in the model. Detailed data are shown in Table 4.

The results of the univariate analysis showed that the metabolic control of subjects could be associated with several variables between which there may be an independent relationship. Multivariate logistic regression analysis showed which of these variables can be independent predictors as opposed to others that affect metabolic control as cofactors. The results are shown in Table 5.

**Table 3**

**Metabolic control parameters of patients with type 2 diabetes mellitus (n = 324, 100%)**

| Parameters | Value |
|---|---|
| Blood pressure, n (%) | |
| normal blood pressure | 195 (60.2) |
| arterial hypertension | 129 (39.8) |
| $Hb_{A1C}$ (%), mean values ± SD | 7.5 ± 1.5 |
| Regulation of blood glucose, n (%) | |
| good | 126 (38.9) |
| bad | 198 (61.1) |
| HDL(mmol/L), mean ± SD | 1.3 ± 0.3 |
| LDL (mmol/L), mean ± SD | 3.2 ± 1.1 |
| Triglycerides (mmol/L), mean ± SD | 2.2 ± 1.5 |
| Lipid status, n (%) | |
| normolipidemia | 113 (34.9) |
| dyslipidemia | 211 (65.1) |

**$Hb_{A1C}$ – glycosylated hemoglobin; SD – standard deviation; HDL – high-density lipoproteins; LDL – low-density lipoproteins.**

**Table 4**

**Metabolic control in relation to demographic and clinical characteristics, behavioral determinants of diabetes mellitus (DM) management, and psychological characteristics of respondents (univariate analysis)**

| Parameter | Metabolic control | | | | *p* |
|---|---|---|---|---|---|
| | good | | bad | | |
| | n | % | n | % | |
| Number of respondents | 70 | 21.6 | 254 | 75.4 | |
| Gender | 40 | 28.4 | 101 | 71.6 | $\chi^2 = 6.743$ |
| male | 30 | 16.4 | 153 | 83.6 | $p = 0.009$ |
| female | | | | | |
| Age categories (years) | | | | | |
| 30–65 | 31 | 18.0 | 141 | 82.0 | $\chi^2 = 2.777$ |
| > 65 | 39 | 25.7 | 113 | 74.3 | $p = 0.008$ |
| Body mass level | | | | | |
| normal | 22 | 50.0 | 22 | 50.0 | $\chi^2 = 32.986$ |
| overweight | 28 | 26.4 | 78 | 73.6 | $p < 0.001$ |
| obesity | 20 | 11.5 | 154 | 88.5 | |
| Duration of DM (years) | | | | | |
| 1–20 | 46 | 22.2 | 161 | 77.8 | $\chi^2 = 0.129$ |
| > 20 | 24 | 20.5 | 93 | 79.5 | $p = 0.720$ |
| Insulin therapy | | | | | |
| no | 54 | 30.3 | 124 | 69.7 | $\chi^2 = 19.424$ |
| yes, no load | 8 | 17.4 | 38 | 82.6 | $p < 0.001$ |
| yes, with load | 8 | 8.0 | 92 | 92.0 | |
| Number of therapeutic doses | | | | | |
| 1 | 55 | 29.3 | 133 | 70.7 | $\chi^2 = 15.477$ |
| 2 or more | 15 | 11.0 | 121 | 89.0 | $p < 0.001$ |
| Complications | | | | | |
| no | 40 | 24.2 | 125 | 75.8 | $\chi^2 = 1.381$ |
| yes | 30 | 18.9 | 129 | 81.1 | $p = 0.240$ |
| Dietary adherence | | | | | |
| yes | 48 | 42.5 | 65 | 57.5 | $\chi^2 = 44.643$ |
| no | 22 | 10.4 | 189 | 89.6 | $p < 0.001$ |
| Depression | | | | | |
| no depression/minimal | 36 | 28.3 | 91 | 71.7 | $\chi^2 = 5.605$ |
| yes | 34 | 17.3 | 163 | 82.7 | $p = 0.018$ |
| DM related distress | | | | | |
| no/moderate without clinical significance | 58 | 27.6 | 152 | 72.4 | $\chi^2 = 12.746$ |
| clinically significant | 12 | 10.5 | 102 | 89.5 | $p < 0.001$ |
| Level of physical activity | | | | | |
| satisfactory | 51 | 35.7 | 92 | 64.3 | $\chi^2 = 29.874$ |
| unsatisfactory | 19 | 10.5 | 162 | 89.5 | $p < 0.001$ |
| Medication adherence | | | | | |
| adherent | 70 | 41.4 | 99 | 58.6 | $\chi^2 = 81.849$ |
| non-adherent | 0 | 0.0 | 155 | 100.0 | $p < 0.001$ |

**Table 5**

**Logistic regression model with poor metabolic control as dependent variable**

| Independent variables | $p^*$ | OR (95% CI) |
|---|---|---|
| Body mass level | < 0.001 | |
| normal | | 1.00 |
| overweight | 0.018 | 2.80 (1.20, 6.55) |
| obesity | < 0.001 | 5.61 (2.36, 13.35) |
| Insulin therapy | 0.001 | |
| no | | 1.00 |
| yes/no load | 0.008 | 3.68 (1.41, 9.60) |
| yes/with load | 0.004 | 3.73 (1.54, 9.04) |
| Dietary adherence | | |
| good | | 1,00 |
| bad | < 0.001 | 3.73 (1.95, 7.15) |
| Diabetes mellitus related distress | | |
| no distress/moderate with no clinical significance | | 1.00 |
| clinically significant distress | 0.040 | 2.26 (1.04, 4.93) |
| Level of physical activity | | |
| satisfactory | | 1,00 |
| unsatisfactory | 0.004 | 2.73 (1.39, 5.35) |

**The value of Hosmer-Lemeshow (C = 8.318, *p* = 0.403) indicates the agreement of the model with the data. The sensitivity of the model shown is 93.3%, the specificity is 37.1%, and the overall accurate prediction is 81.2%.**

***– the Wald test; OR – odds ratio; CI – confidence interval.**

**Discussion**

In the conducted research, all three goals of metabolic control were met by 21.6% of respondents, which is significantly better than the results of studies conducted in Japan (11.2%) [21] and Poland (8%) [22]. Females in this study had poorer metabolic control than males, which is consistent with the results of studies published by others [23]. The higher prevalence of psychological distress (symptoms of depression and DM-related distress), negative attitudes toward medication adherence, and a lower level of physical activity caused by traditional social roles of this gender group may be an explanation for this finding.

An interesting finding is that older people (> 65 years) have better metabolic control than people < 65 years. The same age distribution of metabolic control is indicated by the results of other studies [4, 21]. The finding can be interpreted as a higher life load of younger people, less tendency to change ingrained life habits, and greater sensitivity to the stigma of the disease.

Results of the conducted research indicate a negative relationship between attitudes toward medication adherence and metabolic control of the patients with T2DM. Subjects with lower Attitude Scale scores (poorer medication adherence) also show poorer metabolic control of T2DM. The published research results in the available literature are consistent with ours [24]. T2DM medication therapy is often complex since it required a higher number of drugs and higher daily doses. In our study, 37.7% of respondents had a lower level of education, and 44.8% assessed their financial situation as unsatisfactory. For this reason, the lack of knowledge about the disease, the importance of therapy, and the poor availability of drug therapy may explain the negative association between metabolic control and attitudes toward medication adherence.

In our study, complex therapeutic regimens (42.5% of respondents) showed a statistically significant association with negative attitudes toward drug adherence. That, as well as the fact that complex therapeutic regimens can create difficulties in integrating determinants in the management of DM into daily life routines [25], can be explained by this finding.

Data from the literature on the relationship between depressive symptoms and metabolic control parameters are inconsistent. Authors who are consistent with our results find a positive correlation between depressive symptoms and metabolic control parameters [26], while others do not [27]. The differences observed may be methodological in nature and depend on questionnaires for assessing the symptoms of depression used in the research.

The study finding of the negative predictive effect of overweight [odd ratio (OR) = 2.80; 95% confidence interval (CI) = 1.20–6.55)] and obesity (OR = 5.61; 95% CI = 2.36–13.35) on metabolic control is consistent with the findings of other studies [28]. In contrast, other studies have not found an association of obesity with any metabolic control parameters [4]. Obesity increases insulin resistance and glucose intolerance, as well as sympathetic activity [29], worsening all metabolic control parameters of individuals with T2DM, which explains this finding.

The study finding of the negative predictive effect of insulin therapy on metabolic control (OR = 3.68 – no load; OR = 3.73 – with load) is consistent with the findings of other studies [23]. This remarkable finding can be explained by understanding that the introduction of insulin into therapy for people with T2DM means that the disease is in a phase that is difficult to control. That leads to clinically significant distress with a negative impact on metabolic control. Furthermore, fear of hypoglycemia is present in 29.4% of our subjects on insulin therapy, leading them to take larger amounts of food and reduce physical activity in order to avoid hypoglycemia. One explanation for this finding worth considering in future research is that DM-related distress is a major barrier to initiating insulin therapy and that clinical inertia in the introduction of insulin into T2DM therapy is one of the reasons for poorer metabolic control in this group of patients [30].

The results of the multivariate logistic regression analysis conducted in this study indicate the predictive effect of an unsatisfactory level of physical activity (OR = 2.73; 95% CI = 1.39–5.35) on poor metabolic control of subjects with T2DM, which is consistent with the findings of other studies [31]. The results of the Look AHEAD study indicate this indirectly, showing that weight loss reduces the need for drugs that regulate glycemic status, BP, and lipid status [14].

In this study, clinically significant DM-related distress stands out as a significant predictor of poor metabolic control (OR = 2.26; 95% CI = 1.29–5.35). DM-related distress can affect metabolic control directly through pathophysiological processes (hypothalamic-pituitary axis activation, increased sympathetic activity, and insulin resistance) and indirectly through DM self-management, which may explain these findings [24].

*Limitations and adventages of the study*

The advantage of studies of this type is that they enable proper control of measurements and assessment of the prevalence of research determinants. However, the key disadvantage of these studies is the impossibility of gaining insight into the time sequence of the examined phenomena, i.e., it is not possible to determine the direction of causality for which longitudinal studies are necessary.

As self-completing questionnaires are used as research instruments, recall bias and giving socially desirable answers could not be completely avoided. The construction of individual questionnaires enabled bias of the central tendency, i.e., giving answers that were in the middle of the scale of offered answers.

Despite the existence of these limitations, the representativeness of the sample, random sampling methods, and the use of internationally recognized standardized research instruments give significant strength to the conducted study.

**Conclusion**

This study provides insight and understanding of a wide range of issues in the context of self-management of DM, which is crucial for achieving a much more effective approach to patients with T2DM. The available therapeutic modalities are less likely to be effective in individuals who have difficulty adhering to behavioral determinants of DM self-management because these problems are often beyond the reach and influence of the physicians dealing with the medical treatment of persons with T2DM.

The application of questionnaires used in this study in the care of patients with T2DM, at all levels of health care, in the initial stages or critical moments of the disease, provides insight into their knowledge and attitudes about behavioral determinants of DM self-management and timely detection of psychological conditions that affect them. That is the basis of the necessary multidisciplinary approach to patients with T2DM, which, by including other specialties (psychologists, nutritionists, physiotherapists), provides support to patients through education, motivation, behavior modification, and psychological support. The results of conducted research indicate that it is reasonable to expect that such a comprehensive approach contributes to better metabolic control of patients with T2DM.

The study results indicate that longitudinal research is necessary for a better understanding of the impact of the research determinants and for evaluating the effectiveness of a multidisciplinary approach in achieving better metabolic control of patients with T2DM. That is a basic recommendation for future research.

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