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## **Physical exercise as a key element in the behavioral treatment of type 2 diabetes - the extent to which patients follow recommendations**

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## **Abstract**

### **Introduction and purpose**

Diabetes is a set of metabolic disorders whose common, characteristic feature is the occurrence of hyperglycemia. Elevated glycemia levels result from impaired insulin secretion and/or defects in its action. In type 2 diabetes, we have modified risk factors such as improper diet, reduced physical activity, and obesity. In the context of these reversible factors, intervention in patients' lifestyle, with particular emphasis on physical activity, seems advisable.

To investigate the implementation of recommendations for the treatment of type 2 diabetes, relating to physical activity as a component of behavioral treatment of diabetes.

**Materials and methods.** Author's survey covering patients' knowledge about their disease, needs and expectations regarding education. The questionnaire examines the physical activity of patients newly diagnosed and already treated for type 2 diabetes.

**Results.** The most frequently undertaken exercise was of medium intensity in the form of walking or "Nordic walking". This was also more likely to be intensified. Patients choosing this type of activity practiced it much more often and more regularly than other types of activity. Running and cycling were other activities undertaken by the patients, although in the younger group of patients.

Patients who enjoyed physical exercise were more likely and willing to do it and it was more regular.

**Conclusions.** Patients were reluctant to undertake physical exercise and usually did not treat it as an integral part of treatment. Usually, it was not a very intense effort. They also rarely intensified it when the diagnosis was made. Most of the respondents did not understand the role of exercise in the treatment process and its impact on sugar levels.

**Keywords:** type 2 diabetes; behavioral treatment; physical exercise; diabetes education.

## **Introduction**

The aim of the study is to present, based on a survey, patients with diabetes, their attitude to physical activity. The study considered the inclusion of activity after receiving the diagnosis, the intensification of physical activity during treatment, the type of activity most frequently undertaken, and patients' motivation during activity. An important aspect of the study is also the role of diabetes education in making decisions about including exercise as part of the treatment or prevention of type 2 diabetes.

Diabetes is a set of metabolic disorders whose common characteristic is the occurrence of hyperglycemia [1]. Increased glycemia levels are the result of impaired insulin secretion and/or defects in its action [2,3,4].

Long-term and too high glycemia levels cause the risk of numerous complications [5]. Currently, both doctors and patients are aware that type 2 diabetes causes premature mortality in the general population, mainly due to its late cardiovascular complications. It was found that in 2012, diabetes was the 8th cause of death in the world [6]. It is also the cause of numerous complications leading to disability of patients, the main ones being retinopathies, nephropathy and diabetic foot syndrome leading to limb amputation [7,8].

Over the last 50 years, the prevalence of type 2 diabetes has increased by 150-300% [5]. Currently, type 2 diabetes is a worldwide problem and is increasingly occurring in rapidly developing countries. It is considered the epidemic of our times. The increase in the incidence of this type of diabetes is associated with easy access to highly processed food, as well as an increasingly common, sedentary lifestyle and constantly decreasing physical activity of adults, children and adolescents. Overweight, obesity, lack of physical activity, improper diet, age and family genetic predisposition are considered risk factors for the development of type 2 diabetes [1,4,9].

The report of the Institute of Health Protection for Poland gives the number of people with diabetes at over 3 million, which constitutes approximately 8% of the population of our country. By 2040, it is estimated that the number of patients in Poland will increase, to 11% of over 4 million patients.

The recommendations of the Polish Diabetes Association, as well as the recommendations of the American ADA and the European EASD societies, in addition to the schemes and

recommendations regarding the pharmacological treatment of the disease, provide guidelines for the behavioral treatment of patients with type 2 diabetes, including physical activity as one of the components of this treatment. Numerous studies show that the degree of involvement in treatment in the form of changes: lifestyle, diet, and physical exercise at least 2-3 times a week helps to achieve appropriate glycemia levels and thus reduces the risk of acute and chronic complications of the disease [10, 11,12,13].

Therefore, it is interesting to determine whether, because of being diagnosed with type 2 diabetes, there is a change in the introduction or intensification of physical activity by patients.

### **Epidemiology**

The incidence of type 2 diabetes has increased dramatically by 150-300% in the last half-century [14]. This means that it has now become a global problem and affects 5-7% of the world's population. The number of cases varies depending on the level of socio-economic development of individual regions of the world. Type 2 diabetes accounted for 85-95% of the total number of diabetic patients in developed countries. At the same time, estimates of the incidence in the years 1995-2025 predict a 3-fold increase in the number of patients with type 2 diabetes. These forecasts mainly concern the increase in the number of patients aged 45-64, and the expected increase in the group over 65 was 2.5-fold.

Risk factors for developing type 2 diabetes.

Referring to the classification of diabetes according to the Recommendations of the Polish Diabetes Association and the definition of diabetes given there, we can talk about a group of potential risk factors for this type of diabetes. These factors are very common in prediabetes. The above recommendations include, among others, risk factors such as [1,9]:

1. Overweight or obesity BMI  $\geq 25$  kg/m<sup>2</sup> /or waist circumference  $>80$  cm for women and  $>94$  cm for men.
2. Little physical activity.
3. Pre-existing pre-diabetes.

### **Physical effort**

In the Clinical Recommendations of the Polish Diabetes Association, next to diet, another element of behavioral therapy is physical exercise.

The importance of physical activity for the effectiveness of type 2 diabetes treatment appears in many studies from around the world. Numerous studies show evidence of the effectiveness of muscle exercise in the prevention of diabetes, glucose intolerance and prediabetes. Many studies prove the positive impact of physical activity combined with a rational diet in normalizing glucose tolerance in prediabetics even in 52% and in people with diabetes in 23%

of patients [14,15]. Studies have shown that systematic, although moderate, physical exercise is an important component of behavioral therapy and therefore should be recommended routinely [16]. Physical exercise also affects parameters such as glycemia, HbA1c, lipid profile and blood pressure. At this point, we should return to the education process, the patient's understanding of the impact of physical exercise on the disease and its control, and motivation to implement increased muscular exercise in a systematic way [17, 18, 19].

The PTD recommendations include rules for undertaking physical exercise and recommended exercise intensities depending on the individual capabilities of patients. They also determine the risk of muscular exercise for patients with diabetes. The guidelines clearly define the benefits of exercising and define the rules for its application in this group.

**The impact of effort on:**

1. Lowering the glyceimic profile.
2. Reducing tissue insulin resistance.
3. Weight reduction.
4. Beneficial effect on the lipid profile.
5. Elevating the patient's mood.

The general principles of muscular exercise recommend:

1. After completing education, introduce moderate physical exercise.
2. Muscle exercise should consider the patient's capabilities and limitations.
3. Exercises in various forms should be regular exercise in order to optimize their effect. The best regimen is to exercise for at least 2-3 days, preferably every day.
4. When undertaking exercise, remember about its hypoglycemic potential.
5. During the exercise, it is important to ensure proper hydration of the body.

[16].

The recommendations pay attention to the type and intensity of physical exercise. According to the above-mentioned, the recommended physical exercise for overweight or obese people is "Nordic walking". Patients over 65 years of age should take an intense (out of breath) walk 3-5 times a week, lasting about 150 minutes/week. Patients without contraindications, young people, not overweight or obese, should be encouraged to engage in intense physical exercise. Patients practicing sports should be trained in the impact of muscular exercise on the glyceimic effect, which may be caused by various types of exercise, e.g. aerobic, interval, resistance.

In recent years, a lot of research and observational work has appeared on the effectiveness of specific types of physical exercise in relation to the metabolic control achieved by diabetics.

In most of them, the following types of exercise were observed: interval training [17, 18], aerobic training [19, 21, 22], resistance training or popular aerobics [23, 24]. Studies also concerned moderate exercise [25], such as yoga [26], Tai Chi or walking [27,28].

Regarding the efficiency and effectiveness of exercise in relation to the improvement of the results achieved by patients, we can find comparisons of specific types of exercise, such as: comparison of continuous and interval exercise [29,30], aerobic and resistance exercise. People with type 2 diabetes benefit best from a combination of aerobic and resistance exercise. Regular exercise, even if it was small, was important for this improvement [31,32].

The recommendations of the Polish Diabetes Association regarding physical exercise are consistent with the recommendations of other global societies. The American College of Sports Medicine in cooperation with the American Diabetes Association issued recommendations for patients with type 2 diabetes regarding physical exercise.

Recommendations regarding physical exercise also appeared in the IDF Atlas 2017. We can read WHO recommendations on this issue there.

1. Children aged 5-17 should undergo at least 60 minutes of physical activity a day.
2. Adults aged 18-64 should devote 150 minutes a week to muscular exercise. This effort must be adapted to the patient's capabilities, but at the same time it should be intense. As part of this effort, the patient can practice yoga, walks, but this effort may be related to working in the garden. The patient can also choose a more intense option and then 75 minutes a week of very intense aerobic exercise is enough.
3. In the group over 64 years of age, moderate physical exercise is recommended, adapted to the capabilities of individual patients.

Recommendations regarding physical exercise in type 2 diabetes also appeared in the IDF Atlas 2017. You can read WHO recommendations on this issue there.

1. Adults aged 18-64 should devote 150 minutes a week to muscular exercise. This effort must be adapted to the patient's capabilities, but at the same time it should be intense. As part of this effort, the patient can practice yoga, walks, but this effort may also be related to physical work, for example in the garden. The patient can also choose a more intense option and then 75 minutes a week of very intense aerobic exercise is enough.

In the group over 64 years of age, moderate physical exercise is recommended, adapted to the capabilities of individual patients (IDF 2017).

### **Purpose**

The aim of the study is to examine the degree of implementation of recommendations for behavioral treatment of diabetes in terms of physical exercise. This is an important component

of treatment, which significantly affects the occurrence of late complications, pharmacological treatment, and the prognosis of the disease.

### **Materials and methods of research**

The study used an original questionnaire.

Author's questionnaire:

An original questionnaire was used to achieve the purpose of the study. The first part includes questions about the patient's general data and his disease, such as age, gender, education, duration of the disease, and type of pharmacotherapy used. The second part of the survey includes questions about understanding the essence of the disease, its natural course, possible complications and how to treat it. The purpose of this part is also to obtain information regarding the patient's understanding of the impact of body weight, diet, and physical exercise on the course of the disease and the effectiveness of pharmacotherapy.

The third part of the survey concerns another aspect of behavioral treatment of diabetes mellitus type 2 according to PTD and concerns physical exercise. It refers to the question whether the fact of developing diabetes is a sufficient motivation to undertake regular physical exercise in any form and whether the patient understands the essence of physical activity in the course of the disease and in the process of its treatment. This part assesses the patient's general attitude towards muscular exercise and shows the interest or lack thereof in a specific type of exercise.

#### *Participants*

The research was conducted based on survey questionnaires obtained from 1,005 patients with type 2 diabetes.

The conducted research is not related to the use of drugs in humans or animals.

The characteristics of the study group, including gender, age, education and place of residence, are presented in the table below.

#### *Methods*

The assessment of compliance with behavioral treatment recommendations was made based on an author's survey covering issues related to patients' knowledge about their disease, needs and expectations regarding education, as well as their implementation in the patient's own assessment.

The proprietary questionnaire included:

- Demographic data: age, gender, place of residence, education, and marital status.
- Aspects of diabetes education, i.e.: place and duration, person conducting the training

- It included issues related to education in the field of nutrition and physical exercise, as well as those elements related to glycemic self-control skills.

It also included research questions:

- The degree of compliance with educational recommendations regarding diet, physical exercise, and self-control.

### *Procedure*

To select a representative study group, the estimated minimum sample size was set at approximately 1,000 surveys. A total of 1,600 surveys were distributed, which were successively collected and verified for completeness after completion. Ultimately, 1,112 surveys were returned (return rate of 70%). After initial verification, some of the surveys were rejected due to lack of completeness. The final analysis involved 1,005 correctly and fully completed sets of questionnaires.

- Before completing the questionnaires, patients were instructed on how to complete them, and after completing them, they passed them on to the attending physician or nurse.

- Survey research using the author's questionnaire did not contain sensitive data. Therefore, the collected data did not enable the identification of individual patients. Furthermore, this was not an interventional study. Standardized surveys were used in accordance with their intended purpose.

- Therefore, the study did not require the consent of the Bioethics Committee.

### *Statistical analysis*

The obtained results of empirical research were subjected to statistical analysis. The values of the analyzed parameters measured on a nominal scale were characterized by frequency and percentage, while those measured on a ratio scale were characterized by the arithmetic mean and standard deviation.

Multi-way tables and the  $\chi^2$  independence test were used to assess the existence of relationships between the analyzed unmeasurable parameters. However, non-parametric tests were used to assess the existence of differences in measurable parameters due to the lack of compliance with the normal distribution, assessed based on the Shapiro-Wilk W test. The Mann-Whitney U test was used to compare two independent groups, and the Kruskal-Wallis H test and post-hoc multiple comparisons were used for more than two groups.

An inference error of 5% and the associated significance level of  $p < 0.05$  were assumed, indicating the existence of statistically significant relationships or differences. The obtained results are presented in tables and figures. Statistical analyzes were performed based on Statistica v. 10.0 computer software (StatSoft, Poland)

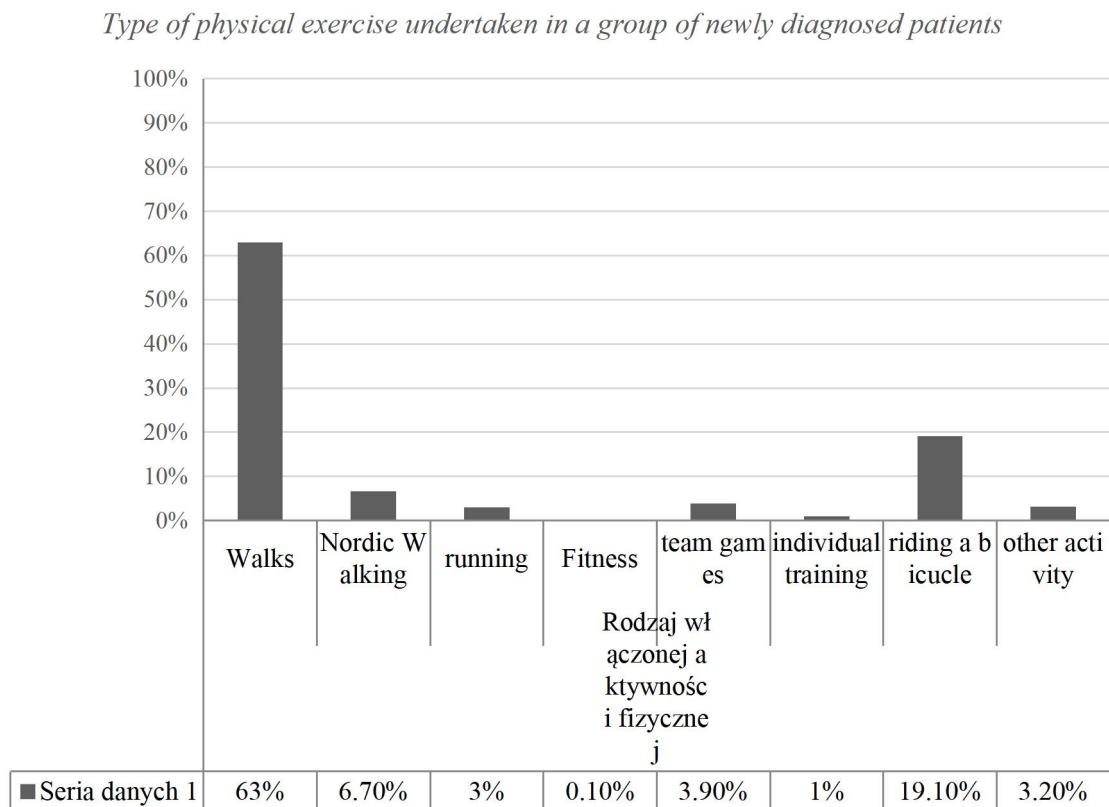


## Results

As a result of the surveys, the following results were obtained:

Diabetes education in the field of physical activity. Compliance with education recommendations T2

Dig. 1. Type of physical activity engaged in by the respondents.



In the study group, 46% of respondents declared they started physical activity after being diagnosed with diabetes. Only 16.7% declared that these activities were regular. The largest percentage of respondents declared the duration of exercise to be up to 1 hour per week (21.9%). Most surveyed patients do not see a connection between the disease, its treatment, glycemic levels achieved and physical exercise (64%).

In the group of patients who declared physical exercise, the most frequently undertaken activities are listed in the table below.

Table 1. Types of effort undertaken.

parameters		Cardinality	Percentage
Type of physical activity included	walk	734	63 %
	Nordic Walking	80	6,7 %
	Running	35	3 %
	Fitness	10	0,1%
	Team games	46	3,9 %
	Individual training	12	1 %
	Cycling	223	19,1 %
	Other activities	38	3,2 %

In the study group of patients, 46% of respondents started physical activity after the diagnosis of the disease. The most common form of sport was walking (63%), while the least popular form of sport among the respondents was fitness (0.1%).

However, if the patient decided to include physical activity in his new health habits, he declared diabetes education as a motivator for this action (62%).

### **Changes in physical activity after diagnosis of the disease**

The following tables refer to the data obtained regarding patients' physical activity. They show the impact of the diagnosis of the disease on physical activity, its implementation in everyday life, its possible intensification or the lack of response in this area.

Table 2. The importance of education for engaging in physical activity after diagnosis of diabetes is illustrated in the table below.

Questions		Did the patient increase physical activity in any form after being diagnosed with diabetes?				Statistical analysis
		Yes		No		
		Liczność	%	Liczność	%	
Training after diagnosis of the disease	Yes	279	75,6 %	517	81,3 %	$\chi^2 = 4,57$ p = 0,03
	No	90	24,4 %	119	18,7 %	
The training took place in a hospital ward	Yes	70	18,9 %	165	25,9 %	$\chi^2 = 6,33$ p = 0,01
	No	299	81,1 %	471	74,1 %	

Diabetes education in this area turned out to be statistically significant for the intensification of physical activity after the diagnosis of the disease (p=0.03). Including or increasing exercise was declared by 75.6% of patients who completed the training, while as many as 81.3% of patients, despite participating in diabetes education, did not receive instructions on including physical exercise.

Education regarding the proper principles of exertion and its intensification turned out to be important in relation to the patient's decision to undertake such activity.

Study of the relationship between the intensification of physical exercise after diagnosis of the disease and patient education.

Table 3. The relationship between the intensification of physical exercise after diagnosis of the disease and the patient's education.

Questions		Did the patient increase physical activity in any form after being diagnosed with diabetes?				Statistical analysis
		Yes		No		
		Count	%	Count	%	
Education towards proper body weight	Yes	246	66,7 %	337	53 %	$\chi^2=17,93$ $p = 0,00002$
	No	123	33,3 %	299	47 %	
Education towards physical activity	Yes	241	65,3 %	338	53,1 %	$\chi^2 = 14,15$ $p = 0,0001$
	No	128	34,7 %	298	46,9 %	
Selecting physical exercise for the patient	Yes	167	45,3 %	125	19,7 %	$\chi^2=74,26$ $p = 0,00001$
	No	202	54,7 %	511	80,3 %	
The patient knows how often he should exercise	Yes	67	18,2 %	49	7,7 %	$\chi^2 = 24,98$ $p = 0,00001$
	No	302	81,8 %	587	92,3 %	

The patient's motivation to undertake physical exercise turned out to be statistically dependent on education on proper body weight, education on physical activity, selection of a specific type of exercise and instructions on the frequency of activity ( $p < 0.05$ ).

Patients were more likely to engage in physical activity after receiving education on proper body weight and its impact on the disease (66.7%). Training in physical activity had a similar impact on the patient (65.3%).

The patient did not undertake physical exercise most often due to lack of knowledge about its type (89.4%) and frequency (92.3%).

The relationship between the intensification of physical activity after the diagnosis of the disease and the type of exercise chosen and its frequency is shown in the table below.

Table 4 Relationship between the intensity of physical exercise and patient education.

Questions		Did the patient increase physical activity in any form after being diagnosed with diabetes?				Statistical analysis
		Yes		No		
		Count	%	Count	%	
Education towards proper body weight	Yes	246	66,7 %	337	53 %	$\chi^2=17,93$ $p = 0,00002$
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The patient knows how often he should exercise	Yes	67	18,2 %	49	7,7 %	$\chi^2 = 24,98$ $p = 0,00001$
	No	302	81,8 %	587	92,3 %	

The type of exercise chosen, and the frequency of exercise turned out to be statistically significant for undertaking physical activity. ( $p < 0.05$ )

The group of patients declaring additional physical activity was dominated by patients choosing walking as their preferred form of activity (78.6%).

Patients choosing disciplines such as running (99.4%), Nordic walking (97.8%), or cycling (86%) did not intensify their effort.

Depending on the frequency of exercise, a statistically significant improvement was noted in the groups practicing sports several times a week (57.2%).

The patient's conscious participation in the treatment process and its relation to physical activity are included in the table below.

Table 5 Physical activity and the patient's conscious participation in the treatment process.

Questions			Did the patient increase physical activity in any form after being diagnosed with diabetes?				Statistical analysis	
			YES		NO			
			Count	%	Count	%		
Type of physical exercise	Walking	Yes	290	78,6 %	444	69,8 %	$\chi^2 = 9,13$ p= 0,002	
		No	79	21,4 %	192	30,2 %		
	Nordic walking	Yes	66	17,9 %	14	2,2 %	$\chi^2 = 78,41$ p= 0,00001	
		No	303	82,1 %	622	97,8 %		
	Running	Yes	31	8,4 %	4	0,6 %	$\chi^2 = 41,96$ p = 0,00001	
		No	338	91,6 %	632	99,4 %		
	Cycling	Yes	134	36,3 %	89	14 %	$\chi^2 = 67,38$ p= 0,00001	
		No	235	63,7 %	547	86 %		
	How often does the patient does sports	once a week		54	14,6 %	46	74,6 %	$\chi^2 = 423,39$ p= 0,00001
		Several times a week		211	57,2%	72	11,3 %	
		Every 2-3 days		17	4,6 %	6	0,9 %	
		Every day		36	9,8 %	7	1,1 %	
Other forms, e.g. garden		51	13,8 %	505	79,5 %			

The study showed statistical significance between the patient's conscious participation in the treatment process and the type of exercise he initiated or intensified after the diagnosis of the disease and the frequency of undertaking this activity ( $p < 0.05$ ).

Patients with a high level of awareness of their own role in the treatment of the disease most often used walking as an additional physical activity (75.2%), much less often they chose running (3.8%) or cycling (22.9%). They most often engaged in intense physical activity several times a week (29.3%), while the smallest group were patients who performed additional physical activity regularly every 2-3 days or every day (2.5%).

### **Discussion:**

1. Physical activity as an aspect of behavioral therapy appeared during the training only in 30.8% of patients. The impact of exercise on the disease was discussed during education in 58% of patients. In the case of 29% of respondents, the appropriate type of exercise was individually selected for the patient, and only 11.5% of respondents learned how often they should practice sports. Importantly, only 7% of patients were offered a specific type of physical exercise during the training.

2. In the group of patients declaring physical exercise as an element of therapy, most patients see the relationship between exercise and the level of glycemia and general health (91.1%).

3. A large group of patients, 611 out of 1005 examined (67.9%), declare a lack of understanding of the impact of physical exercise on the disease. Among the surveyed patients, those who were aware of the impact of inappropriate body weight on the course and prognosis of the disease were more likely to declare physical activity.

4. It has been shown that the most effective physical exercise for a diabetic patient is exercise undertaken regularly, regardless of its type. Activity undertaken in this way is comparable in effectiveness in regulating glycemia levels and preventing late complications of diabetes to pharmacotherapy. (210)

5. In our own research, patients did not undertake physical exercise after the diagnosis of the disease, the vast majority (87.3%) admit to lack of physical activity and do not recognize the connection between physical exercise and the disease and its treatment.

6. During patient education, the effort they should undertake after diagnosis of the disease was not discussed in detail. The respondents did not receive specific instructions as to its type,

intensity, and frequency, and most importantly, as to the effectiveness of exercise in the treatment of the disease.

7. The most frequently undertaken exercise was of medium intensity in the form of walking or "Nordic walking". This was also more likely to be intensified. Patients choosing this type of activity practiced it much more often and more regularly than other types of activity. Running and cycling were other activities undertaken by the patients, although in the younger group of patients.

There was also undefined physical activity among the respondents, and here patients most often cited gardening as a form of physical activity.

5. Patients who enjoyed physical exercise were more likely and willing to do it and it was more regular.

The results of our own study do not differ from data published in other sources. In the study by T. Klupa et al., only a few of the patients undertook physical activity. Most patients declared minimal physical activity and usually consisted of walking or gardening [34]. These observations are consistent with the observations of our own study, in which most patients did not undertake physical exercise after the diagnosis of the disease, and if the patient declared such exercise, it also took the form of walking or working in the garden.

## **Conclusions.**

Failure to select appropriate physical exercise for a specific patient, lack of individualization of activity tailored to the abilities, age and preferences could result in lack of interest in this aspect of training and, ultimately, in the failure to undertake any physical activity. A detailed discussion of various forms of sport with the patient and the selection of an effective and satisfying form could probably encourage the patient to try to undertake such activity, therefore the main conclusion is to work with the patient during diabetes education on physical exercise in terms of its individualization and understanding its significant impact. physical activity on the treatment process and disease prognosis.

## **Author's contribution**

Conceptualization Mirella Czapska; methodology Alicja Wójcik; software, Wojciech Pakaszewski; check, Lidia Krawczyk and Justyna Matuszewska; formal analysis, Bartłomiej Kwiecień; investigation, Kamila Babkiewicz-Jahn and Justyna Matuszewska; resources, Alicja Wójcik; data curation, Lidia Krawczyk; writing – rough preparation, Mirella Czapska;



writing – review and editing, Kamila Babkiewicz-Jahn and Lidia Krawczyk; visualization, Justyna Matuszewska; supervision, Bartłomiej Kwiecień and Wojciech Pakaszewski; project administration Alicja Wójcik; receiving funding, Mirella Czapska

All authors have read and agreed with the published version of the manuscript.

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