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The Change of HbA1C Parameters and the Body Mass Index in Diabetes Treatment Cycle Depending on the Frequency of the Undertaken Physical Activity Program

Summary

Diabetes is treated as a set of metabolic diseases, which, in light of today's knowledge, significantly influences the change in the treatment strategy of this disease. Physical exercise has become an indispensable component in the treatment of type 2 diabetes. The aim of this paper is to assess changes in HbA1C level and BMI, depending on the frequency of the workout scheme (daily exercises vs. every other day) in the process of diabetes treatment.

The research was carried out on a sample of subjects aged 48-75. 82 patients, divided into two groups, took part in the research. In Group I, the workout program was applied daily, while in Group II – every other day. In both groups the session length was 35 minutes. After the analysis of differences between the groups, it was ascertained that no statistically significant differences ($p>0.05$) in the analysis of the BMI mean value can be observed between the women from both groups. Similarly, men from Group I and II did not exhibit any statistically significant differences ($p>0.05$) as far as the mean value of the BMI was concerned. While analyzing the mean value of HbA1C after completing the research, no statistically significant differences ($p>0.05$) were found between men and women from the respective groups.

Conclusions from the study were as follows: no relation between BMI and HbA1C level, and the frequency of exercises was found; patients who participated in the treatment accompanied by physical activity control and close medical supervision, obtained clinical improvement and gained mobilization to undertake physical activity after the study was complete.

Key words: physical activity, diabetes, chronic disease, lifestyle.

JEL codes: I12

Introduction

Diabetes is treated as a set of metabolic diseases, which significantly changes the strategy for its treatment in the light of today's knowledge (Atval et al. 1992; Nowak et al. 2010; Davis et al. 1999; Segel, Paramore, Cryer 2002, p. 724-733; Turner et al. 1998). In recent years, the attitude of medical personnel to the needs expressed by the patients has changed. Treatment aims are determined individually: suggested by the physician and accepted by the patient. Treatment components, however, have remained unchanged (Szybiński 2001, p. 751-758).

The literature indicates that workout plays an important part in treating type 2 diabetes. In fact, patients have not always been encouraged to work out. No benefits from physical activ-

ity were presented to them (Bassuk, Manson 2005; Berger, Hagg, Ruderman 1975; Figueroa et al. 2007, p. 437-444; Kirk et al. 2004, p. 821-832; Boule et al. 2002, p. 60-61; DeFronzo, Ferrannini 2006).

It is necessary to educate patients in terms of all aspects of diabetes treatment, which is a specific disease. When qualifying a patient for a particular workout program, one should present all indications and contraindications, as well as a clearly developed workout routine. This paper was aimed at answering the following question: Does the frequency of workout (every day versus every other day) significantly affect the improvement in metabolic control of diabetes?

The aim of the study

Aim of the study: assessment of changes in the HbA1C level and BMI, depending on the frequency of workout: (daily exercise versus every other day) in the treatment of diabetes.

Materials and methods

The study was conducted among randomly selected 82 patients aged 48-75 with type 2 diabetes. The background check revealed that they had not undergone myocardial infarction, had no history of cancer, and no neurological episodes. Health of the respondents was good. Among subjects, there were 52% women and 48% men. All participants accepted physical exercise as an important part of the treatment of diabetes. The subjects did not exhibit any contraindications to the designed workout routine. Patients were divided into two groups: the first (I) group (41 persons, 21 women and 20 men) worked out every day, while the other (II) group (41 persons, 21 women and 20 men) exercised every other day. The scope and intensity of workout was developed and approved by physiotherapists.

Groups I and II were homogeneous in terms of gender and age structure (the differences between the groups were not statistically significant, $p>0.05$). All subjects took oral hypoglycemic medication (under strict medical supervision) and followed diabetic diet, developed individually for each patient by a dietician.

The average duration of the study in both groups was 8 months. Throughout the entire period of observation and workout, the composition of groups did not change. During the first meeting with patients, a medical interview was carried out. It included background check, patient's preferences, degree of metabolic control, medical examination and symptoms. EKG, body height and weight measurements were made, BMI was calculated and HbA1C level determined. Patients promised to strictly follow the guidelines and to participate in the proposed workout program at home, while following specially designed dietary recommendations.

During the whole workout period, patients kept a self-observance diary, where they recorded their workout data (types of exercise, time, heart rate before and after exercise) and their diet.

In both groups (I and II), single session took 35 minutes and included the following exercises: 20 minutes of gymnastics and 15 minutes of exercises with a ball. Group I did the exercises every day in the morning, while Group II every other day. The workout intensity was similar in both groups.

During the 8-month observation period, patients were examined twice by a doctor. During the examination, their BMI was determined on the basis of anthropometric formula BMI (BMI = weight / height^2). Patients' HbA1C level was determined at the laboratory of the Regional Hospital in Szczecin. The statistical analysis was based on student's t-distribution, with significance threshold at $p \leq 0.05$.

Results

The BMI analysis before the workout program in Group I (21 women and 20 men) revealed that BMI $\overline{x}$ =29 for women and $\overline{x}$ =30 for men. There was no statistically significant difference ($p>0.05$).

In Group II, the BMI before workout program also did not differentiate the genders ($p>0.05$). The index for women was $\overline{x}$ =28, while for men $\overline{x}$ =31.

The analysis of differences between the two groups (Group I and Group II) before the workout program revealed no statistically significant differences ($p>0.05$) between women in terms of the average BMI. Similarly, men from Groups I and II did not differ significantly in terms of BMI ($p>0.05$). The average BMI for men and women in both groups is illustrated in Figure 1.

HbA1C level of all patients was also analyzed before starting the workout program. It was found that women from Group I had an average value of HbA1c at 8.8% and it was insignificantly higher ($p>0.05$) than men's result (8.4%). In Group II, the average value of HbA1c in women (8.5%) was insignificantly ($p>0.05$) lower than in men (8.8%).

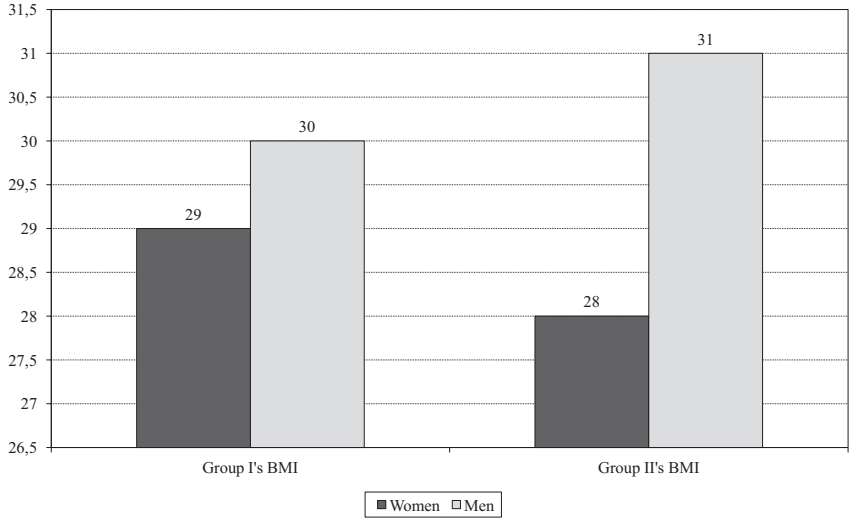
The analysis of an average value of HbA1C of women in both groups (Group I and Group II) before the workout program revealed no statistically significant differences ($p>0.05$). Similarly, men from Groups I and II did not differ significantly in terms of HbA1C level ($p>0.05$). The average HbA1C value for men and women in both groups is illustrated in Figure 2.

At the end of the study (after 8 months), HbA1C level and BMI of patients were measured. It was found (Fig. 3) that men and women from Group I had BMI $\overline{x}$ =29, while in Group II the average BMI for women ($\overline{x}$ =27) was insignificantly lower ($p<0.05$) than the average value for men ($\overline{x}$ = 30).

The analysis of differences between the two groups (Group I and Group II) after the workout program revealed no statistically significant differences ($p>0.05$) between women in terms of the average BMI. Similarly, men from Groups I and II did not differ significantly in terms of BMI ($p>0.05$).

Figure 1

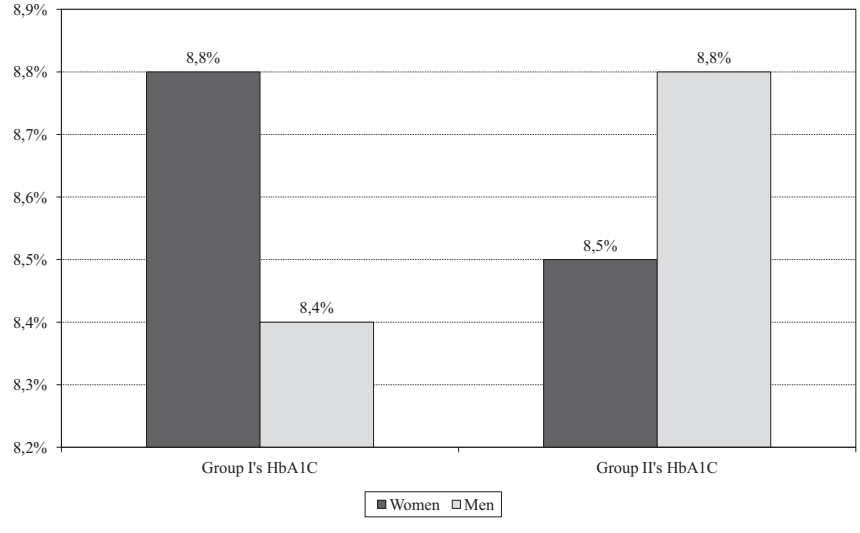
Average BMI for men and women surveyed from Group I and II before the beginning of the study



Source: author's own study.

Figure 2

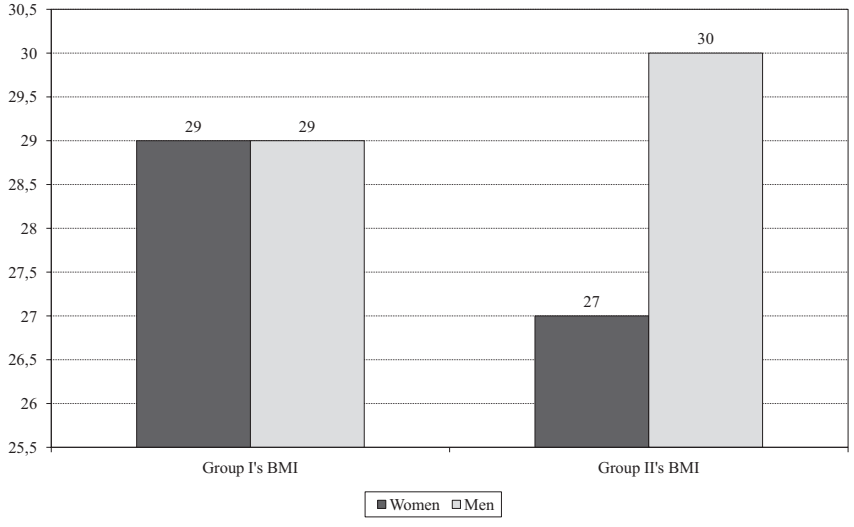
Average HbA1C levels for subjects from Group I and II before the beginning of the study



Source: as in Figure 1.

Figure 3

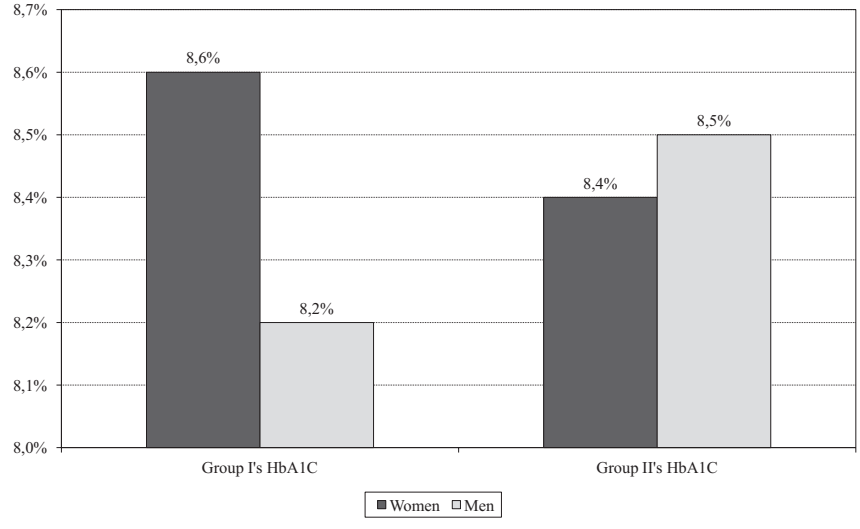
Average BMI of men and women from Group I and II after the study



Source: as in Figure 1.

Figure 4

The average HbA1C values for subjects from Group I and II after the study



Source: as in Figure 1.

Average BMI for men and women in both groups after the workout program is illustrated in Figure 3.

The analysis of HbA1C after the workout program found that in Group I the average HbA1C level was 8.6% for women and 8.2% for men ($p<0.05$). In Group II, the average value of HbA1c in women (8.4%) was insignificantly lower than in men: 8.5% (Figure 4). The analysis of differences between the two groups (Group I vs Group II) after the workout program revealed no statistically significant differences ($p>0.05$) between men and women in both groups in terms of the average BMI ($p>0.05$).

In conclusion, the analysis of data presented in Table 1 shows a decrease in BMI in both groups (I and II), as well as a decrease in HbA1C level. The comparison of the results of the two groups revealed differences in terms of BMI ranges (1-2), while the differences of HbA1c levels ranged between 0.2% and 0.3%. The differences between the groups were observed both in terms of BMI and HbA1C. These differences, however, proved to be statistically insignificant.

Table 1

Summary of BMI and HbA1C results

Indicator	Gender	Group I		Group II	
		before the study	after the study	before the study	after the study
BMI	Women	29±2	29±2	28±1	27±3
$\overline{x}$ ±SD	Men	30±1	29±1	31±2	30±2
HbA1C	Women	8.8%±0.1	8.6%±0.2	8.5%±0.1	8.4%±0.2
$\overline{x}$ ±SD	Men	8.4%±0.2	8.2%±0.1	8.8%±0.1	8.5%±0.2

$\overline{x}$ = arithmetic mean
SD= standard deviation
Source: author's own study.

Discussion

In recent years, there has been a steady increase in the incidence of diabetes (type 1 and 2) – an incurable disease that lasts a lifetime and contributes to changes in blood vessels. This, in turn, leads to disability and increased mortality.

It is estimated that currently diabetes affects more than 180 million people around the world. More than 80% of them suffer from type 2 diabetes. Type 1 is particularly prevalent in populations of children and adolescents. In a few years, this number will increase significantly. Epidemiologists indicate that the number of people with diabetes has doubled every twenty years since 1945. This phenomenon is difficult to explain in relation to type 1 diabetes.

The increased incidence of type 2 diabetes is quite easily explained. Diagnostic methods are currently better and risk factors of the disease are well known.

We are observing negative trends in health behaviors of the population. Incidence of type 2 diabetes is closely associated with lifestyle (Ahren 2000, p. 393-410; Corpeleijn et al. 2007; Kurpas, Czech, Mroczek 2012). The development of the disease is facilitated by high-calorie diet of processed foods full of carbohydrates and animal fats, with a small amount of fiber, accompanied by low level of physical activity and aging of the population. There is also a group of people diagnosed with impaired glucose tolerance, who run a high risk of developing this condition into symptomatic diabetes.

The costs of treating diabetes have been soaring. In the US and the UK, it consumes approximately 6-7% of the total healthcare budget. It is estimated that this value may rise to 10% within a decade. It is also known that about 80% of treatment costs are associated with long-term complications caused by diabetes (Benson et al. 2003).

Basic goals of treating diabetes patients include: 'achieving and maintaining a sense of health and the quality and length of life of healthy people' (Declaration of St. Vincent) [6].

Many years of experiments and results of multicenter studies (DCCT, UKPDS) prove this potential. We should 'motivate' and educate patients and their loved ones so that the treatment targets are clear and understandable to all. Aims must be determined by the physician and accepted by the patient. For example: workout! Formerly ignored, workout has been finally given proper importance as a part of diabetes treatment, especially type 2 (insulin dependent), which is associated with obesity. Workout is especially important in the prevention and treatment of impaired glucose tolerance (Alkhateeb et al. 2007).

It has been observed that regular workout regulates the metabolism of glucose, as shown in this study. It also causes numerous positive changes in the body and is an important addition to the dietary treatment of obesity. Low physical activity is rarely the primary cause of obesity, although it facilitates its development. Systematical workout prevents excessive accumulation of body fat. It improves the overall efficiency and physical fitness. It also ensures better cardiorespiratory endurance. It contributes to the reduction of elevated blood pressure, which often accompanies obesity. Moreover, it slows down osteoporosis (Coggan et al. 1993).

It has also been shown that negative energy balance cannot be obtained if physical activity is not accompanied by dietary restrictions. A one-time intense workout suppresses appetite for a short time, due to elevated blood levels of glucose, lactate, catecholamines, and higher body temperature. With regular physical activity, the daily food consumption increases proportionally to the energy expenditure (Del Canizo-Gomez, Moreira-Andres 2004).

Numerous studies have shown that regular physical activity during 10-12 weeks reduces fat mass and leads to favorable changes in blood lipid profile. This is manifested by lower total cholesterol and LDL fraction with a simultaneous increase in HDL concertation.

These factors are very important in the treatment of diabetes, but undoubtedly the most important therapeutic effect of exercise is its effect on insulin sensitivity. The metabolic syndrome associated with obesity is accompanied by a reduction in insulin sensitivity and hyperinsulinemia. Weight reduction improves insulin sensitivity (Gary et al. 1999).

Physical exercise has a colossal impact in the prevention and treatment of insulin resistance and skeletal muscles (regardless of fat reduction). It has been found that single workout session results in greater glucose uptake by muscles and glycogen synthesis, and it improves insulin sensitivity. It results in an increased transport of glucose (stimulated by insulin) into cells, and its oxidation. This is probably a post-receptor effect. Increase in insulin sensitivity caused by physical activity is also facilitated by proliferation of capillaries in muscle tissue.

It is recommended that patients with diabetes wok out, as much as their abilities and lifestyle permits. However, physical exercise must be introduced gradually, with consideration given to patient's age, individual treatment goals, motivation, abilities, possible complications and contraindications. Treatment of type 1 and type 2 diabetes with physical exercise use slightly different approaches.

There were many attempts to develop principles of dosage regulation, carbohydrates supply and physical workout intensity for diabetes patients treated with insulin, which would provide a good metabolic control. It is difficult, however, to use these rules in practice, as they impose a rigid framework for the patient to follow. Rarely can one predict in advance when exactly the physical exercise will begin, what its intensity will be how long it will take. Therefore, it is necessary to make a preliminary assessment of metabolic control, patient's efficiency in the implementation of individual insulin therapy, their ability to self-monitor blood glucose and self-prevent hypoglycemia. Physical effort that starts suddenly and is quite intense (e.g. running, playing tennis, swimming) may paradoxically lead to an increase in blood glucose. It may also have a 'delayed effect' of insulin requirement; even many hours after the exercise, insulin sensitivity may be increased, which translates into decreased insulin requirement. Therefore, insulin dosage must be corrected. Naturally, a longer duration of workout may generally be planned. In such cases, one should reduce the dosage of insulin to about 40-60% of the normal demand. All these factors need to be taken into account while planning a workout program for a patient. Young people with diabetes should be encouraged to be physically active (Yokoyama et al. 2004).

Among workout types, dynamic oxygen trainings are preferred, such as gymnastics, walking, jog-trot, swimming, ball games, and cycling. Static efforts are contraindicated, since they stimulate the adrenergic system and significantly increase blood pressure. One should choose exercises that give pleasure, do not interfere with other activities and plans, and satisfy individual needs of physical activity. Workout must be preceded by a warm-up (5-10 minutes). Many studies have shown that to achieve greater sensitivity to insulin and more sustained reduction in blood glucose, it is advisable to work out every other day, no less than three times per week. Each session should last 30-45 minutes and its intensity should be equal to 30-40% of maximum oxygen uptake, i.e. the pulse rate should be greater than 140/min. In obesity, to reduce fat content one should exercise daily (Beeson et al. 2003; Berger et al. 1979).

The Polish Diabetes Association states that physical exercise improves health of diabetic patients. Ideally, it should be undertaken regularly and daily. However, there is a lack of documented evidence which routine (every day or every other day) helps more in the treat-

ment of diabetes. The role of regular physical exercise in the treatment of this disease needs further studies concerning frequency of workout, types and intensity of exercises.

Conclusions

By observing a 8-month period of workout carried out by patients diagnosed with diabetes, treated with oral hypoglycemic and following diabetic diets, it has been found that:

1. Adding workout program (in the form of different forms of movement) to a treatment of type 2 diabetes – with varied frequency but similar duration – led to similar results.
   1.1. There was no correlation between BMI and HbA1C, and the frequency of workout (daily or every other day), provided similar intensity, diet and treatment of diabetics.
2. Workout program resulted in a minimal but apparent tendency to support anti-diabetes treatment.
   2.1. Probably the study period was insufficient to observe clear correlations and changes.
3. After the study, patients treated with addition of physical workout and being under strict medical supervision, experienced a subjective clinical improvement of their health and felt motivated to continue exercise as part of the diabetes treatment.

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Zmiana parametrów HbA1C i wskaźnika masy ciała (BMI) w cyklu leczenia cukrzycy w zależności od częstotliwości podejmowania programu ćwiczeń fizycznych

Streszczenie

Cukrzyca traktowana jest jako zespół chorób metabolicznych, co w świetle dzisiejszej wiedzy istotnie wpływa na zmianę strategii leczenia tej choroby. Ćwiczenia fizyczne stały się nieodzownym elementem w leczeniu cukrzycy typu 2. Celem niniejszej pracy jest ocena zmian poziomu HbA1C oraz BMI w zależności od częstotliwości podejmowania programu ćwiczeń fizycznych (ćwiczenia wykonywane codziennie, ćwiczenia wykonywane co drugi dzień) w procesie leczenia cukrzycy.

Badaniom poddano osoby w wieku 48-75 lat. Ogółem badaniami objęto 82 pacjentów, których podzielono na dwie grupy. W pierwszej stosowano opracowany program ćwiczeń fizycznych codziennie, a w drugiej co drugi dzień. W obu grupach jednorazowe zajęcia trwały 35 minut. Po dokonaniu analizy różnic między badanymi grupami stwierdzono, że między kobietami z poszczególnych grup nie odnotowano istotnych statystycznie różnic ($p>0,05$) w analizie średniej wartości wskaźnika BMI. Podobnie u mężczyzn, badani z I i II grupy pod względem średniej wartości wskaźnika BMI nie różnili się istotnie statystycznie ($p>0,05$). Natomiast analizując średnią wartość wskaźnika HbA1C po zakończeniu badań stwierdzono, że ani pomiędzy kobietami z poszczególnych grup, ani pomiędzy mężczyznami nie odnotowano istotnych statystycznie różnic ($p>0,05$).

Wnioski z badań: nie wykazano zależności poziomu wskaźników BMI i HbA1C od częstotliwości ćwiczeń; pacjenci objęci zastosowanym leczeniem wraz z kontrolą ćwiczeń fizycznych i ścisłą kontrola lekarską po zakończeniu badań uzyskali subiektywną poprawę kliniczną i motywację do kontynuowania ćwiczeń fizycznych.

Słowa kluczowe: ćwiczenia fizyczne, cukrzyca, choroba przewlekła, styl życia.

Kody JEL: I12

Изменение параметров HbA1C и индекса массы тела по ходу лечения диабета в зависимости от частотности обращения к программе физической активности

Резюме

Диабет считают группой метаболических заболеваний, что в свете нынешних знаний существенно влияет на изменение стратегии лечения этой болезни. Физические упражнения стали неотъемлемым элементом в лечении диабета второго типа. Цель статьи – дать оценку изменений уровня HbA1C и ИМТ в зависимости от частотности обращения к программе физических упражнений (упражнения, выполняемые ежедневно, упражнения, выполняемые каждый второй день) в процессе лечения диабета.

Обследовали лиц в возрасте 48-75 лет. В общем обследовали 82 пациента, которых разделили на две группы. В первой применяли разработанную программу ежедневных физических упражнений, во второй же – каждый второй день. В обеих группах одноразовые упражнения продолжались 35 минут. После проведения анализа отличий между обследуемыми группами констатировали, что между женщинами из отдельных групп не отметили статистически существенных отличий ($p>0,05$) в анализе средней величины показателя ИМТ. Так же у мужчин обследуемые из I и II группы не отличались существенно статистически друг от друга по среднему значению ИМТ ($p>0,05$). Анализируя же среднее значение индекса HbA1C после завершения обследований отметили, что ни между женщинами из отдельных групп, ни между мужчинами не отметили статистически существенных отличий ($p>0,05$).

Выводы из обследований: не установлена зависимость уровня показателей ИМТ и HbA1C от частотности упражнений; пациенты, охваченные примененным лечением, наряду с контролем за физическими упражнениями и четким врачебным контролем после завершения обследований обрели субъективное клиническое улучшение и мотивировку для продолжения физических упражнений.

Ключевые слова: физические упражнения, диабет, хроническая болезнь, образ жизни.

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