Chapter

Effects of Physical Exercise on the Quality of Life of Type 2 Diabetes Patients

Pablo Tomas-Carus, Nilton Leite and Armando Raimundo

Abstract

Diabetes is one of the most important chronic diseases that impact human health, and the total number of diabetes patients worldwide may rise to about 370 million in 2030 (170 million in 2000). Type 2 diabetes patients account for 90% of all diabetes worldwide. Previous literature reported that type 2 diabetes patients have lower quality of life (QoL) than those healthy persons and that a sedentary lifestyle is a modifiable risk factor for type 2 diabetes and an independent predictor of poor quality of life. When the physical activity is planned, structured, and repetitive bodily movement performed to improve or maintain one or more components of physical fitness, it is a denominated physical exercise. Physical exercise has been effective by altering the body composition, glycemic control, blood pressure, insulin resistance, and mental and physical components of QoL. In this chapter, we also focus our attention on mental disorders. Depression and anxiety are the most common in those patients, which can lead to unfavorable influences on metabolic control and micro- and macrovascular complications compared to those with diabetes alone.

Keywords: type 2 diabetes, quality of life, physical exercise, anxiety, depression

1. Type 2 diabetes and quality of life

Since type 2 diabetes (T2D) is a chronic disease, patients will live with it for the rest of their lives, and the treatment is performed through a healthy diet plan, physical activity, and medication [1]. When not treated properly, patients may suffer various complications over time, affecting the overall health and quality of life, failing with the goals for the treatment of the disease [2, 3]. Quality of life is an individual's perception of overall well-being that comprises of a physical, mental, and social component [4]. The term health-related quality of life (HRQoL), which does not approach the concept of satisfaction or happiness and satisfaction life, that is, related with some specifics of life, is frequently employed [5]. Many psychometric tools were developed to determine the impact of diabetes and other chronic diseases and also the effect of some intervention on quality of life. For those patient, the most used are the Diabetes Quality of Life Measure (DQOL), the Diabetes-Specific Quality of Life Scale (DSQOLS), the Diabetes Quality of Life Clinical Trial Questionnaire-Revised, the Appraisal of Diabetes Scale, the ATT-39, and the revised ATT19; the Questionnaire on Stress in Patients with Diabetes-Revised, the

Type 2 Diabetes Symptom Checklist, the Problem Areas in Diabetes Scale (PAID-1), and the revised (PAID-2); and the Audit of Diabetes-Dependent Quality of Life (ADDQoL), SF36, and the EuroQol-5D [4, 6].

The daily routine of medication to control the disease, fear of injections of insulin, episodes of hypoglycemia, as well as severe dietary restriction are factors that alter the psychological state of this population [7]. Cognitive behavioral therapy and pharmacological treatment are used to manage mental health, but data of some studies indicate that 19–34% and 14–43% of depressed and anxiety disorder patients, respectively, do not respond to treatments. On the other hand, the treatment is scarce accessible and costly [8].

Physical exercise is recognized as an effective non-pharmacological therapeutic strategy to improve insulin action and glycemic control and reduce risk factors for cardiovascular disease [9]. Furthermore, it seems to be an efficient tool to promote brain health in normal and pathological conditions, protecting against cognitive impairment and/or degenerative diseases [10]. The mechanisms underlying the psychologic benefits of exercise are sustained on six theories: (i) sympathetic arousal, based on the rest physiologic adaptations by repeated exercise, mainly lower sympathetic and arousal activity, where the participant experiences a sensation of mental well-being; (ii) cognitive appraisal, where the exercise can help relief of the daily psychological hardship; (iii) affect regulation, characterized by a prolonged improvement on general mood state; (iv) thermogenic regulation, exercise increases body temperature, and this induces a relaxing state and improvement of symptoms of anxiety; (v) synthesis of catecholamines, exercise induces catecholamines production, and it is involved on regulation mood and protect mental dysfunctions; and (vi) endorphin synthesis, exercise induces endorphin production on brain (psychoactive agent of euphoria) that can act such a drug addiction [11].

A recent study that analyze the effect of four meta-analyses of physical exercise on mental and physical in depression shows that in mild to moderate depression the effect of exercise may be comparable with antidepressant medication and psychotherapy, and on the other hand, for severe depression, exercise seems to be a complementary strategic to the habitual treatments [12]. Two systematic reviews with meta-analysis show that exercise was associated with significant lower depression severity in older people [13] and can decrease anxiety symptoms among healthy adults [14]. Besides that, in patients with T2D, it was found that active adults are associated with fewer symptoms of depression [15], better physical, and mental quality of life than the less active [16]. Before the prescription of physical exercise or physical activity, health professional should be aware for both physical and psychological health problems that could interfere the participant in exercise. However, strategies should incorporate a motivation program that enhance adherence.

2. Exercise benefits on patients with type 2 diabetes

The increase in the incidence of T2D has been increasing in parallel with the incidence of overweight and obesity; it suggests a possible causal relationship, particularly when obesity is of the central type [17]. There are several components of health-related physical fitness that are positively affected by regular physical activity [18]: (i) cardiorespiratory resistance, (ii) body composition, (iii) muscle strength, (iv) muscular resistance, and (v) flexibility. Although it is always recommended to practice physical activity during a significant period of time (30–60 min/session), in the last years, it has been alerted to the benefits of physical activities beyond those that are conventionally prescribed (e.g., moderate sessions of less than 20 min duration) [18].

Sedentary lifestyle, or at least reduced levels of physical activity, is often associated with the presence of diabetes. This strong and reliable association between sedentary time and diabetes was largely independent of physical activity levels, adding an additional importance to the concept of sedentary behavior being a distinct behavior in itself [19]. The same study highlights the importance of this fact, since it suggests that the deleterious effects of higher levels of sedentary comportment are not mediated by lower amounts of moderate or vigorous physical activity (MVPA). An explanation for the relation between sedentary activity and diabetes as described in literature is the increase in peripheral insulin resistance that occur in consequence of immobility [20], increasing the blood glucose levels. Recent studies comparing different times of sedentary activities in a day (e.g., in a day with 10 h of sedentary behavior could be a result of thirty 20-min bouts or in ten 60-min bouts) have shown evidence that longer periods of sedentary lifestyle have acute deleterious effects on glucose control and other cardiometabolic risk factors [21]. In line with this explanation, the authors of another study have shown that breaking up periods of prolonged sitting with 2-min bouts of light-intensity activity every 20 min in overweight and obese adults result in a 24% reduction in postprandial glucose and a 23% reduction in insulin, both improving glucose regulation [22]. Recently, the American Diabetes Association (ADA) recognized the potential health benefits of reducing and interrupting sedentary time in adults with type 2 diabetes [9]. In fact, some studies found that patients with type 2 diabetes perform less physical activity and comply with the recommendations for the practice of physical activity less than subjects without diabetes [23]. Same authors referred that about 2/3 of the patients with type 2 diabetes performed a certain frequency of physical activity; however, only 40–43% complied with the recommendations. The recommendations of the ACSM and the American Diabetes Association for adult patients with T2D point to the need to perform moderate physical activity during 150 min per week (60 min per week in 5 days) or 60 min per week (20 min in 3 days) of vigorous physical activity (which can be achieved by adding several 10-min periods), interspersed with 2 nonconsecutive days of moderate-to-vigorous strength training [24, 25]. Planned exercise training of more than 150 min/week is associated with higher hemoglobinA1c (HbA1c) declines than that of 150 min or less per week [26].

A recent study has characterized many individual impairments in key cardiac and vascular measures that are associated with CRF impairment in T2D, such as insulin resistance, endothelial dysfunction, decreased myocardial perfusion with exercise, abnormally increased pulmonary capillary wedge pressure (PCWP), decreased limb blood flow, and skeletal muscle mitochondrial dysfunction [27]. Some researchers highlight that being the reasons for which these abnormalities arise, caused by several factors, makes it unlikely that a single therapeutic approach will resolve the entire problem.

An important and recent article which evidences the benefits of physical exercise as therapy for the treatment of 26 different pathologies stresses that increased physical exercise produces a significant improvement in glucose control in people with type 2 diabetes, yielding an average improvement in hemoglobinA1c of between −0.4 and −0.6% [28]. Indeed, as mentioned in a recently published meta-analysis, a simple walk on a regular basis can provide substantial benefits with little or no impairment to the patient, promoting a reduction of HbA1c [29]. Another meta-analysis, even more recent, highlights that our body's response to HbA1c reduction is more effective when we perform more than 150/min of moderate-to-vigorous physical activity per week [26]. Several meta-analyses indicate that strength training, aerobic training, or a combination of both can induce reductions in the order of 0.4–0.6% in the amount of HbA1c [28]. It seems that there is no evidence that resistance exercise could differ from aerobic exercise in influencing glucose control, cardiovascular risk markers, or safety [30]. Same authors referred that the use of one type or another of physical exercise for T2D patients may be less important than doing some form of physical activity. Recently, in view of the fact that there is no great difference in results when comparing the effects of a strength program with an aerobic program [30], the adoption of a mixed program has been mentioned as preferential for these patients [31]. In another meta-analyses, with a total of 37 studies with 2208 patients with T2DM, it is also suggested that a mixed program is also preferable to be applied. In this study, both supervised aerobic and supervised resistance exercises showed a significant reduction in HbA1c compared to no exercise (0.30% lower and 0.30% lower, respectively). Nevertheless, when compared supervised aerobic and supervised resistance exercises with combined exercise, there was a greater reduction in the latter type of exercise program (a reduction of 0.17% higher than supervised aerobic and a reduction of 0.23% higher than supervised resistance exercises) [32].

Likewise, strength training has been suggested as beneficial for these patients, using moderate loads (50–74%) to vigorous ones (75–85%), so that as long as there are no contraindications, it is recommended to practice with a frequency of three sessions per week, involving the large muscle groups, progressing until achieving three series of 8–10 RM [33].

Diabetes patient usually has physiologic exercise limitations and decreased cardiorespiratory fitness (CRF). More exactly, when compared with people with and without diabetes, the first ones can present 20% lower maximal oxygen uptake (VO_2 max) [27]. This can be a problem for those patients once a reduced VO_2 max is linked to increased cardiovascular mortality [34]. As suggested recently, practitioners should take into consideration in the preparation of exercise programs that the addition of vigorous exercise may be essential to produce substantial changes in cardiovascular function, as it seems that vigorous, but not low-moderate exercise decreases cardiovascular disease [35]. In terms of type of training, it is suggested that interval training may be more successful than continuous training, as well as there is an evidence that suggests that high-intensity exercise improves glycemic control more than low-intensity exercise [28]. In a 4-month RCT with T2D patients, a group of participants of interval walking (n = 12) were compared to a group of continuous walking (n = 12) and to a non-exercise control group (n = 8). Both exercise groups performed 60-min, 5 days/week respective protocols. Values of VO_2 max, body fat, and glycemic control recorded improvements in interval walking group only, compared to continuous walking and control [36].

To determine which variable influences more the reduction of HbA1c, of the intensity and of the quantity of the exercise, a meta-analysis was performed [37]. They found a relation between relatively high-intensity physical training and a reduction in HbA1c ($r = -0.91$, $P = 0.002$), while no significant association between quantity of physical activity and a reduction in HbA1c ($r = -0.46$, $P = 0.26$) was found.

Comorbidities and complications such as dyslipidemia, hypertension, and hyperinsulinemia are common in patients with T2D [32]. The use of different types of exercise can induce different benefits in the variables associated with these pathologies. Thus, supervised aerobic presented more significant improvement than no exercise in fasting plasma glucose (9.38 mg/dl lower), total cholesterol (20.24 mg/dl lower), triacylglycerol (19.34 mg/dl lower), and low-density lipoprotein cholesterol (11.88 mg/dl lower). On the other hand, supervised resistance showed a higher gain than no exercise in improving systolic blood pressure (3.90 mmHg lower) and total cholesterol (22.08 mg/dl lower) [32].

Another study compared the metabolic and hemodynamic response to high-intensity interval exercise (HIIE) and to a continuous moderate-intensity exercise (MICE). A total of 11 participants (age = 52.3 ± 3 year) underwent with the protocols suggested by the researchers. They found that capillary glycemia reduction was greater ($P < 0.05$) after HIIE than MICE as well as a reduction ($P < 0.05$) in 24 h and tendency toward reduction ($P = 0.06$) in daytime systolic ambulatory BP only after HIIE. These results recommend that HIIE is superior to MICE for reducing glycemia and ambulatory BP in T2D [38]. Recently, a HIIT protocol allows to increase protein synthesis in the skeletal muscle of older adults as well as shows an effect linked to ameliorate insulin sensitivity [39]. HIIT was also the type of program used to verify the cardiovascular benefits of exercise training and postexercise nutrition [40]. A total of 53 adults with T2D were randomized to 12 weeks of cardio- and resistance-based HIIT (4–10 × 1 min at 90% maximal heart rate) with postexercise milk, milk-protein, or placebo supplementation, thrice weekly. They evaluated carotid and femoral artery intima media thickness (IMT) and femoral flow profiles using high-resolution ultrasound. At the end of the exercise program, subjects showed a significant reduction on femoral IMT (pre 0.84 ± 0.21 mm vs. post 0.81 ± 0.16 mm, $p = 0.03$), carotid-femoral PWV (pre 10.1 ± 3.2 m/s vs. post 8.6 ± 1.8 m/s, $p < 0.01$), and resting heart rate (pre 70.4 ± 10.8 bpm vs. post 67.8 ± 8.6 bpm, $p = 0.01$) regardless of postexercise nutrition. Those improvements in vascular function could counteract the high cardiovascular mortality in individuals with T2D caused by largely owing to the progress of atherosclerosis, accelerated by arterial stiffening, reduced perfusion, and vascular inflammation [41]. A recent research did find that HIIT with or without postexercise nutrition improves endothelial function, glucose control, and cardiorespiratory fitness in people with T2D. More precisely, after 12 weeks of HIIT, the 53 adults with T2D reduced the continuous glucose monitoring (−0.5 ± 1.1 mmol/L), HbA1c (−0.2 ± 0.4%), percent body fat (−0.8 ± 1.6%), and increased lean mass (+1.1 ± 2.8 kg). Besides these variables, there were still improvements in the VO_2 peak (+2.5 ± 1.6 mL/kg/min) and %FMD (+1.4 ± 1.9%), as well as on arterial blood pressure (−6 ± 7 mmHg) [42]. Interestingly, those adaptations resulting from interventions of some duration (12 or more weeks) are also present as an acute adaptation to the exercise [43].

To verify what type of training may be more effective for the improvement of some health indicators in patients with T2D, 41 participants were assigned to the non-exercise control group, 73 to resistance training 3 days a week, 72 to aerobic exercise in which they expended 12 kcal/kg per week, and 76 to combined aerobic and resistance training in which they expended 10 kcal/kg per week and engaged in resistance training twice a week [31]. After the 9-month program, a reduction in the waist circumference was recorded in all groups. The fat mass was reduced in the resistance training group and in the combination training group (lost in mean 1.4 kg and 1.7 kg, respectively). Only the combination training exercise group decreased hemoglobinA1c and improved maximum oxygen consumption, compared with the control group. It is important to highlight the reduction on HbA1c, once that has been associated with a 15–20% decrease in major cardiovascular disease events. On the other hand, the increase on 1 MET in fitness compared with control obtained in the aerobic and combination groups will not be less important, because of the public health significance given that each increase of 1 MET is associated with 15–20% lower cardiovascular disease mortality risk [44]. A total of 266 patients with T2D training 3.4 sessions/week, each lasting 49 min with an intensity of 50–75% of maximum pulse, for 20 weeks, showed also an increased VO_2 max (+11.8%) [37].

Another interest result was that just the combination training group lost weight, and although both the combination and resistance training groups lost fat mass compared with the control group, the aerobic group did not. The authors suggest firstly that the resistance training group did not lost weight because they increased their lean mass. The inexistence of a reduction on weight and fat mass on aerobic group may be due to an increase in energy intake, to an expenditure compensation, or to both. This was also the same conclusion from another study where it was found that the weight of the patients was not reduced at the end of the intervention [45]. The possible explanations for this was that the training period was relatively short (8–20 weeks), and also the patients overcompensated for their loss of energy by increasing consumption, or patients lost fat mass; however, their volume of muscle mass increased.

Similar results were published in 2007 study [46]. Although the various groups achieved a reduction in HbA1c compared with control, it was again the combination group, the one that registered a more significant reduction (−1 vs. −0.4% with resistance training vs. 0.5 with aerobic group). The practice of physical exercise also allows to increase fat-free mass (in particular muscle mass) and reduce visceral fat in these patients, which has a positive implication in this pathology [47]. This is the reason for the lack of significant effects on weight reduction. Even they could lose some fat mass, they also increased the muscle mass [28].

Physical exercise increases insulin sensitivity in the trained muscle and muscle contraction-induced glucose uptake in the muscle. This increase in insulin sensitivity leads to an increase in glucose uptake by insulin-sensitive tissues, with lower insulin consumption, leading to a reduction in glycemic levels. The mechanisms that underlie this adaptation include increased postreceptor insulin signaling and increased transport of glucose into the muscles by greater dispersion of the muscle capillary network and blood flow [28]. The decrease in insulin resistance in response to increased insulin sensitivity, as well as the reduction of triglyceride (TG) values as a relevant effect for these patients [47].

It is known that older adults with T2D present an increased risk for cognitive decline reported in verbal memory, information-processing speed, and executive functions [48]. The use of exercise programs has also been used in patients with T2D in order to achieve improvements at the cognitive level. Recent literature has shown benefits with either the application of aerobic exercise, resistance training, or a multicomponent exercise program. A 24-week period of square-stepping exercise (SSE) program was used to mitigate this increased risk for dementia present in this pathology [49]. SSE is a low-intensity program that is convenient to older adults for the improvement of cognitive function. Those 24-week SSE program shows promise in improving cognitive function, specifically executive control, in older adults with type 2 diabetes and sCCs. There remains some question regarding the feasibility of the SSE program in this population that has a high chronic disease burden. In an RCT with 155 community-dwelling women aged 65–75 years living in Vancouver that were randomly allocated to once weekly (n = 54) or twice weekly (n = 52) resistance training or twice weekly balance and tone training (control group) (n = 49), both resistance training groups achieved improvements on their performance on the Stroop test compared to control. They concluded that the 12 months of resistance training improve the executive cognitive function of selective attention and conflict resolution [50]. A total of 33 adults (17 women) with amnestic mild cognitive impairment ranging in age from 55 to 85 years participated in an RCT, which used aerobic exercise. After the 6-month program, the women of the aerobic exercise group presented several benefits in different variables such as a higher executive function, increased glucose disposal during the metabolic clamp, and reduced fasting plasma levels of insulin, cortisol, and brain-derived neurotrophic factor. The men who participated in the aerobic exercise group, they increased plasma levels of insulin-like growth factor I and had a favorable effect in one of the executive function tests [51]. A total of 100 older adults with T2D presenting mild cognitive impairment were randomized into a multicomponent exercise or an education control group. The exercise group exercised for 90 min/d, 2 days/week, 40 times for 6 months, and the multicomponent exercise program consisted of biweekly 90-min sessions involving aerobic exercise, muscle strength training, postural balance retraining, and dual-task training. The results of the study demonstrated the effectiveness of the program in improving the performance on mental state examination and logical memory scores and reducing whole brain cortical atrophy, compared with control group [52].

The benefits that patients with type 2 diabetes can acquire when they undergo an exercise program are numerous, as we have pointed out here. If there are several modes of exercise, it is necessary to break the barriers that impede the regular participation of these patients in these programs and to provide the practice in the programs that most motivate each one.

3. Type 2 diabetes mellitus and mental disorder

Beyond the physical and social well-being implications, patients with T2D are more likely to experience mental health problem. Among the mental disorders, depression and anxiety are the most common in those patients, which can lead to unfavorable influences on metabolic control and micro- and macrovascular complications compared to those with diabetes alone [53].

Depression is a medical condition in which the affected patient experience a feeling of sadness, lack of motivation, and change in thinking which lasts for more than 2 consecutive weeks, and it can lead to a decrease in the performance of the activities of daily living [54].

Individuals with T2D have a doubled risk to be diagnosed with depression than in the general population. The concurrent presence of both these disorders has a negative effect on the quality of life, loss of productivity, and absence at work, a higher risk for mortality and to develop the long-term micro- and macrovascular complication of diabetes compared with those patients without depression [55]. Besides that, those patients are associated with a poor glycemic control and poor adherence to healthy lifestyles [56].

Although it is well documented that patients with T2D are more likely to experience depression, the mechanisms underlying this association is poorly understood. It is pointed out that psychological factors such as the burden of life and related-events of the disease predispose the patient to depression. On the other side, there is a potential biological evidence that is emphasized in three aspects: (i) hyperglycemia, due to the high intracellular glucose level on the brain, it can activate polyol pathway that induces an oxidative stress and formation of advanced glycation end products, and both of them can lead to a neuronal damage; (ii) microvascular dysfunction, involved in an increased cerebrovascular damage, those injury can affect the frontal and subcortical regions of the brain that regulate mood state; and (iii) low-grade inflammation, with less evidence linked to depressive symptoms but is associated with chronic disease and predispose to cardiovascular complications [55]. On the other side, diabetes duration is viewed as a mediator for depressive symptoms. These symptoms tend to elevate immediately following diagnosis and decrease and increases again after several years. The duration of diabetes less than 10 years and bigger than 30 years is associated with increased depressive symptoms, while that between 10 and 30 years is remaining low [56].

It can be classified on (i) major depression, when the presence of depressive mood and anhedonia (reduced positive affect) for 2 weeks is accompanied by at last five symptoms such as depressed mood, uncontrolled weight for no apparent reason, lack of motivation, psychomotor disorder, loss of energy or increased fatigue, alteration in sleep, difficulty thinking and thoughts of dead or suicide; (ii) minor depression, which is similar to major depression, but the patient has few than five symptoms; and (iii) dysthymia, when the patient experiences an acute depressive mood for most of the day which persists for at least 2 years. However, at least two of the following symptoms should be present: changes in appetite, low self-esteem, sleep alteration, difficulty thinking, discouragement, and loss of energy or increased fatigue [57].

The nine-item patient health questionnaire is a valid and reliable screaming tool frequently used for the diagnosis of depression. It is an easy and brief self-report questionnaire and can be used in patient with T2D. It consists of nine questions based in the depressive symptoms with score of "0" (not at all) to "3" (nearly every day). It calculated a total score, and it ranges from 0 to 27. A cutoff score of 10–14, 15–19, and 20–27 indicates moderate, moderately severe, and severe depression, respectively [58].

Referring to anxiety, it is defined as a subjective feeling of fear, worry, and discomfort, for no reason at all or derived from anticipation of something [59]. Results from a recent meta-analysis support scientifically evidence that people with T2DM exhibit an increased likelihood of having anxiety disorder and anxiety symptoms than people without diabetes, and on the other side, it is associated with poor glycemic control and increased diabetes complications [53]. Those patients can experience physiologic sensation such as tachycardia, dizziness, sweating, headaches, and gastrointestinal disorder and also avoid places, people, and events. The diagnosis of the disease may induce anxiety because the patient has to adopt a severe lifestyle change in function of the disease treatment with a daily management of diabetes and worry of the long-term micro- and macrovascular complication [53]. It is common to diagnose anxiety using self-report symptom scales, mainly the Spielberger Trait Anxiety Questionnaire, the general health questionnaire for anxiety subscale, Hospital Anxiety and Depression Scale for anxiety (HADS), and Hopkins symptom checklist [59].

It is important to note that the idea that physical exercise has positive effects on depression and anxiety of patients with T2D in some cases is not unanimous. For instance, results from a systematic review of intervention studies [60] concluded that the evidences of physical exercise on psychological outcomes are conflicting. In this review, aerobic exercise shows to improve symptoms of anxiety. Significant difference in depression was found only in resistance training. For quality of life, among 6 studies (478 participants examined), only 2 reported significant effect of aerobic training compared to control group. Previous studies examined (361 participants), a mixed effect of resistance training on the mental domain of the SF-36 and SF-12 questionnaire was found. The authors stand out that heterogeneity of the studies was reflected on the mixed results found [60]. On the other side, a randomized controlled trial of 218 inactive patients with T2D found that no exercise was superior to resistance or combined exercise of 22 weeks, three times per week for improving mental health status [61]. Against the mixed evidence of physical exercise to improve mental health in T2D, it is necessary for future studies to confirm some findings. The literature showed that physical activity can mitigate mental disorder in active patient with T2D [15], and in this sense, an important benefit of physical activity or physical exercise for mental health on those patients could be speculated.

For these patients, it is expressly recommended to perform at least 150 min of aerobic exercise of moderate-to-vigorous intensity and at least 2 sessions of resistance exercise. The compliance with these recommendations may have a positive impact on the physical functioning and may improve or maintain their health status [62]. In addition to the specific benefits, aerobic and resistance training seems to be synergic, and available evidence recommends combining both form of trainings to confer great improvements for people with T2D. In this sense, the effects of combined physical exercise program in those patients (aerobic-resistance exercise performed 60-min, 3 days/week for 12 weeks) was examined and reported significant effects in several domains of quality of life in the exercise group (mental health, +40%). The authors emphasize the importance of combining aerobic exercise with strength training in the clinical care of people with T2D [63]. In another study, the effect of three types of treatments in people with T2DM for 24 months was evaluated: (PE) physical exercise with a combined program, n = 59; (M) medication with metformin, n = 30; (PE + M) combination of physical exercise and medication, n = 195. The "PE" group trained three times a week, the "M" used 850 mg of metformin twice a week, and in "PE + M" they combined the two treatments. The physical exercise program consisted in a combination of aerobic, resistance, flexibility, and balance trainings which is performed for 60 min. After the study period, the "PE" and "PE + M" groups improved mood states and better perceived of physical and mental domains of quality of life in comparison with the "M" group [64].

This scientific evidence presented above reinforces the preponderant role that physical exercise plays as medicine in treatment of different pathologies, especially T2D. However, faced with the growing interest in using physical exercise as a non-pharmacological treatment for psychological changes, further research is needed to determine the type and dose response in this population.

Conflict of interest

Authors have no conflict of interest to disclose.

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