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Aerobic exercise as a protective factor in older adults with type 2 diabetes mellitus

Ejercicio aeróbico como factor protector en adultos mayores con diabetes mellitus tipo 2

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Abstract:

Diabetes mellitus type 2 (DM2) is considered a chronic degenerative disease, which is one of the most prevalent disorders in the older adult population, representing up to 14% of the world's population. DM2 is associated with chronic complications such as neuropathy, heart failure, nephropathy, retinopathy, among others. Several studies have shown that the constant performance of aerobic exercise in older adults with DM2 favours glycaemic control, the decrease of insulin resistance, as well as the improvement of pancreatic β-cell function. Likewise, aerobic exercise applied to daily life increases cognitive capacity, and produces a sense of well-being in the older adult. In this sense, aerobic exercise in older adult patients with DM2 gives them a physical and psychological improvement, which translates into a better quality of life. Therefore, the aim of this article is to present the results obtained from the review of several documents where it is observed that aerobic exercise is a protective factor in older adults with DM2.

Keywords:

Aerobic exercise, diabetes mellitus type 2, older adult, protective factor

Resumen:

La diabetes mellitus tipo 2 (DM2) es considerada como una enfermedad crónico degenerativa, que forma parte de los trastornos más prevalentes en la población adulta mayor, representando hasta el 14% de la población mundial. La DM2 está asociada con complicaciones crónicas como: neuropatía, insuficiencia cardíaca, nefropatía, retinopatía, entre otras. Diversos estudios han demostrado que la realización constante de ejercicio aeróbico en las personas adultas mayores con DM2 favorece el control glucémico, la disminución de la resistencia a la insulina, así como la mejora de la función de las células β pancreáticas. Asimismo, el ejercicio aeróbico aplicado a la vida diaria incrementa la capacidad cognitiva, y produce una sensación de bienestar en el adulto mayor. En este sentido, el ejercicio aeróbico en pacientes adultos mayores con DM2 les otorga una mejoría física y psicológica, lo que se traduce en una mejor calidad de vida. Por lo tanto, el objetivo de este artículo es presentar los resultados arrojados a partir de la revisión de diversos documentos en donde se observa que el ejercicio aeróbico es un factor protector en los adultos mayores con DM2.

Palabras Clave:

Adulto mayor, ejercicio aeróbico, diabetes mellitus tipo 2, factor protector

INTRODUCTION

The disease of diabetes mellitus type 2 (DM2) is a group of metabolic disorders, mainly characterized by hyperglycemia, due to a decrease in the efficiency of insulin production/action.[1]

According to the World Health Organization (WHO) and the American Diabetes Association (ADA), type 2 diabetes mellitus is a chronic metabolic pathology characterized mainly by high blood glucose levels, in addition to the fact that insulin does not work properly, due to a defect in the secretion or effectiveness of this hormone. During the progression of the disease, severe damage can occur in organs such as: the heart, blood vessels, eyes, kidneys, nerves, etc.[2-3]

In the development of type 2 diabetes mellitus disease, organs such as: pancreas (β-cells and α-cells), kidneys, liver, skeletal muscle, brain, adipose tissue and small intestine, play an important role. Diabetes is caused by a combination of two factors: 1) insulin secretion by β-cells in a deficient manner and 2) the inability of insulin-sensitive tissues to respond to insulin, because insulin release and activity are essentially used for glucose control. [4-6]

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Insulin keeps blood glucose levels under control through stimulation of glucose uptake in the hormone's target tissues, such as skeletal muscle, adipose tissue, and inhibition of glucose production from the liver; glucose plays the main role in regulating insulin secretion from the β-cells of the pancreas, as a stimulus-response, likewise the cells have the capacity to detect circulating glucose levels, to subsequently secrete the appropriate amount of insulin to help keep blood glucose levels under control, so that any defect in one of the processes can cause a metabolic imbalance, which contributes to the development of type 2 diabetes mellitus.[4-6]

Insulin action comprises four insulin receptor substrates (IRS), IRS-2 is distributed in β-cells and hepatocytes, on the other hand, IRS-1 is found in endothelial and vascular smooth muscle cells, IRS-3 is present in adipose tissue, while IRS-4 in kidney and brain.[7,8]

Among the main actions of insulin is the regulation of carbon energy deposition; insulin increases glucose uptake in adipocytes by regulating the intracellular localization of GLUT4. The GLUT proteins facilitate basic transport processes, and are present in various cells and tissues of the human body, they can transport glucose, galactose, water and analgesics. Physical exercise is the most potent stimulus for increasing GLUT4 in skeletal muscle, having an effect on insulin action, glucose disposal and increased muscle glycogen storage.[9,10]

Diabetes can be diagnosed according to the criteria: a) glycosylated hemoglobin A1C >6.5% (48 mmol/mol, b) fasting plasma glucose (absence of caloric intake for at least 8 hours) >126 mg/dL (7. 0 mmol/L), c) 2-hour plasma glucose (glucose load containing the equivalent of 75 g.) >200 mg/dL (11.1 mmol/L) and d) in users with normal symptoms of hyperglycemia, random plasma glucose >200 mg/dL (11.1 mmol/L).[11]

The American Diabetes Association classified the disease of diabetes as follows: 1) type 1 diabetes mellitus: absolute insulin deficiency due to autoimmune destruction of β-cells, 2) type 2 diabetes mellitus: progressive loss of insulin production of β-cells, 3) gestational diabetes mellitus: appears during pregnancy, when there is insufficient insulin production, 4) other types such as: a) monogenic diabetes: neonatal diabetes, b) diabetes due to pancreatitis and c) diabetes induced by drugs, chemicals that are used in the treatment of HIV AIDS.[12]

The disease of diabetes mellitus type 2, presents particular pathophysiological characteristics derived from environmental factors (obesity, unhealthy diet, sedentary lifestyle included) and genetic factors, these play an important role for the development of the disease, to mention a few, diabetes genes are related to obesity, insulin hormone resistance, and β-cells (cells that are responsible for insulin production).[13,14]

Older adults with diabetes are part of a heterogeneous population with respect to comorbidities and complications associated with the disease, in addition to this, there are other challenges faced by the older adult, an example of which is the geriatric frailty syndrome, which is associated with a decrease in muscle mass, causing a reduction in the response to external factors, generating a greater risk of falls, loss of functional capacity, greater dependence, institutionalization, and even death; physical exercise is the best way to intervene in prevention and treatment.[15-18]

Now, a physically active lifestyle is important for quality of life, also in health it has an important role in the prevention and treatment of various chronic diseases, such as diabetes mellitus type 2, by improving aspects such as: a) metabolism, b) physical fitness, c) cardiovascular health, d) decreases or delays the onset of comorbidities related to diabetes disease such as neuropathy, heart failure, nephropathy, depression and cognitive impairment. Among the benefits of physical activity in type 2 diabetes mellitus are: clinical changes such as a better organic response to insulin, decrease in glycosylated hemoglobin parameters, regulation of body weight, among others, particularly the performance of physical exercise and improved nutrition are two alternatives that favor an effective treatment, and that allows glucose control.[19-22] The aim of this article is to present the results obtained from the review of several documents where aerobic exercise is observed as a protective factor in older adults with type 2 diabetes mellitus.

EPIDEMIOLOGY OF DIABETES MELLITUS TYPE 2

The World Health Organization established that an older adult is considered to be 60 years of age or older. According to the National Institute of Statistics and Geography (INEGI), there are approximately 17,958,707 elderly people in Mexico, which represents 14% of the total population.[23-25]

The International Diabetes Federation (IDF) has established projections on the disease worldwide, according to the data, the prevalence spreads as age advances, so the most affected population are older adults. In 2019, the number of people with diabetes mellitus in an age range of 65 to 99 years was 135.6 million equivalent to 19.3% of the population, if this propensity affects, the number of older adults with diabetes mellitus will be 195.2 million in 2030 and 276.2 million in 2045, which reveals a significant growth, for older adults, as all the challenges it means for public health and economy. In Mexico, 25.8% represents about 2.3 million people with a diagnosis of diabetes mellitus type 2, in a range of 60 to 69 years, which implies that, more than a quarter of the total population suffers from it. In 2018 in Hidalgo older adults with type 2 diabetes mellitus were about 12.83%, which determines a high prevalence.[26-27]

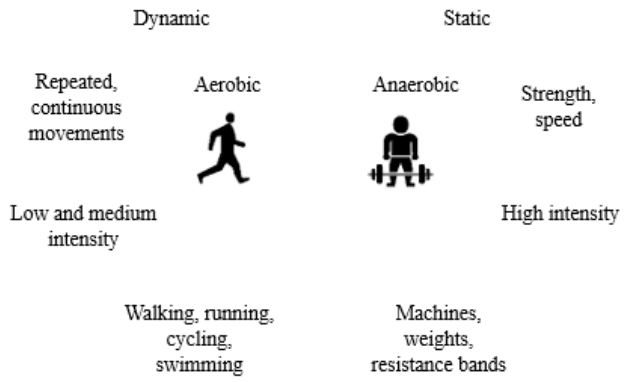
CLASSIFICATION OF PHYSICAL EXERCISE

Physical activity is defined as all those body movements produced by the contraction of skeletal muscle, and therefore energy expenditure.[28]

On the other hand, physical exercise is defined as a subset of physical activity, which includes planned, structured and repetitive body movement that favors the maintenance of the physical condition of human beings. Physical exercise is classified into: aerobic exercise and anaerobic exercise according to the different characteristics they present (Figure 1).[29-31]

Anaerobic exercise is a type of physical activity that is characterized by its intensity and short duration, it is produced by the ATP energy source of the muscles when contracting; it is established as a static exercise, which includes physical activities that require greater effort. Among the benefits there are flexibility, elasticity, resistance, and joint strengthening.[28-29]

Figure 1. Differences between aerobic and anaerobic exercise.[29-31]



Anaerobic tests are divided into: (a) anaerobic power which uses strength-speed, stair performance, vertical jump and cycloergometer test (used to quantify workload), and (b) anaerobic capacity such as maximal oxygen debt test, ergometric test (evaluates the heart's response to physical exercise), measurement of oxygen deficit during a constant load test and measurement of blood lactate. Resistance training, also known as strength training, includes weight machines or elastic bands; flexibility exercises are used to improve range of motion; and balance exercises provide gait and muscle strengthening, which prevents the risk of falls. Aerobic exercise known as dynamic includes repeated and continuous movements of different muscles, the muscle groups involved in exercise depend on aerobic metabolism, in which ATP energy is extracted from carbohydrates, fatty acids, amino acids, some of the aerobic activities are: walking, running, cycling, swimming, etc. [29-31]

EXERCISE CONSIDERATIONS FOR PEOPLE WITH TYPE 2 DIABETES MELLITUS

Maximal oxygen uptake (VO2), also known as the capacity of the cardiorespiratory system to supply oxygen and the ability of skeletal muscles to utilize oxygen, decreases by 8% to 10% over each decade of age, making it vitally important to maintain a high aerobic fitness in aging. It has been shown that people who are athletic, even at 60 years of age, can maintain a 30 to 40% higher VO2 max compared to those who are not active but are active. Maximal aerobic capacity directly impacts independence, quality of life, both in healthy older people and in those with disease.[29,32]

The American Diabetes Association established the classification and exercise recommendations for type 2 diabetes mellitus, as shown in (Table 1). It is important that, before choosing the exercise modality, the patient's disease stage should be diagnosed and characterized, in addition to considering a stress test, based on aerobic fitness, comorbidities, body composition and muscle strength, an exercise intervention should be provided, which should be individually tailored, with continuous training and supervised by the professional for compliance and thus obtain greater long-term benefits. The following components of exercise prescription should also be considered: a) setting goals, b) identifying (physical) barriers, and c) providing recommendations on type, frequency, and intensity.[33-35]

Table 1. *Exercise considerations and recommendations for type 2 diabetes mellitus disease*.[32]

	Aerobic	Endurance	Flexibility	Balance
Type	Rhythmic activity High intensity training	Resistance equipment, free weights	Stretching: static, dynamic, yoga	Balance
Intensity	Moderate or vigorous	Moderate	Stretch to the point of tightness	Slight to moderate.
Duration	150 minutes a week	8 to 10 exercises, 1 to 3 sets of 10 to 15 repetitions	Stretching 10 to 30 seconds with 2 to 4 repetitions	Any duration
Frequency	3 to 7 days a week	Minimum of 2 non-consecutive days	2 to 3 days a week	2 to 3 days a week

The capacity of older adults to perform aerobic exercise is lower than for other age groups, so it is necessary to take into account

the intensity of the activity, through the heart rate; the proposed training should consist of recreational and leisure activities (walking, cycling, walks, etc.), in addition to occupational activities (games, planned exercises, daily activities, etc.).[36]

According to studies, it has been determined that at least 150 minutes of aerobic physical activity should be performed during the week, either of moderate or vigorous intensity, complementing it with muscle strengthening exercises, for a good state of health. The recommendations also mention that 75 minutes of aerobic exercise with a vigorous intensity, accompanied by muscle strengthening for at least two days, can be performed.[37,38.]

EXERCISE IN PEOPLE WITH TYPE 2 DIAB0ETES MELLITUS

Repeated exercises, determined as physical training, have been associated with unclear effects, giving them little relevance, when in fact it has been proven through studies that aerobic, resistance and combined exercise therapy have beneficial effects on glucose control, even on some risk factors (arterial hypertension, triglyceride and low-density lipoprotein parameters) in patients with type 2 diabetes mellitus. In the study by Motahari-Tabari et al., the effect of aerobic exercise on glucose levels (p= 0.05) and insulin resistance (p= 0.02) occurred after 8 weeks.[39-41]

Francesconi, et al. determined that people with diabetes benefit from exercise, since endurance training allows for an adequate glucose uptake and metabolism in muscle cells of 50% and 70%, resulting in a decrease in insulin resistance. Similarly, benefits are obtained by applying aerobic and resistance training, by improving insulin sensitivity, blood glucose uptake and increased muscle mass. [38,42-43]

Maiorana, et al. conducted a study to evaluate the effect of aerobic exercise accompanied by resistance exercise on vascular function in people with type 2 diabetes mellitus, including 16 participants aged 52 years and older, randomly assigned to a training period of 8 weeks or no training, the results were significantly lower in cardiorespiratory frequency and glycosylated hemoglobin ($p<0.05$).[44]

In the study by Jiang et al, a Fatmax physical training (name given to the implemented exercise modality) was carried out, which was directed to older adults from 60 to 69 years old with diabetes mellitus type 2, they chose the modality of aerobic exercise of low to moderate intensity with a duration of 16 weeks, with the objective of investigating the effects of supervised intense physical training for fat oxidation in body composition, lipid profile, glycemic control and physical capacity, for which it was statistically significant in: body mass index ($p<0.05$), glycosylated hemoglobin ($p<0.01$), high density lipoprotein parameter in women ($p<0.01$), ($p<0.05$) for men, and in maximal oxygen consumption ($p<0.05$) compared to the control group. Hwang et al. demonstrated that aerobic exercise applied to all the extremities of the human body (upper and lower), improved tolerance for high intensity exercise, which resulted favorably in the ability to walk, and in turn in the performance in their daily life, in addition to their independence to perform their activities and meet their basic needs.[39,45]

Marcus, et al, carried out a study in which not only aerobic exercise was used, but also high strength eccentric aerobic resistance exercises were implemented, due to the fact that when only aerobic activities are performed, it can cause the loss of lean tissue, which leads to less strength and poor muscle function, affecting the lower extremities and mobility of the elderly. 05 in the aerobic exercise combined with high strength exercises, in addition, in the levels of glycosylated hemoglobin results of -0.59 (-1.5 to 0.28) were observed in comparison with the group in which only aerobic exercises were performed -0.31 (-0.60 to -0.03).[46]

It is affirmed according to Zanuso, et al, that the effect of vigorous training is a predictor for better results in the decrease of glycosylated hemoglobin, increase in VO2 and increase in insulin sensitivity, so it can be affirmed that aerobic exercises with higher intensity produce better benefits; however, if training were performed where aerobic exercise and strength are combined, better results could be induced, not only in glucose control, but also in muscle strength and in the adaptation of tolerance to physical activity. Madsen, et al., performed a high intensity intervallic training for 8 weeks, which resulted in improved glycemic control and good functioning of the β-cells of the pancreas, and also showed a decrease in abdominal fat mass in patients with diabetes.[47,48]

Nieuwoudt, et al. performed high-intensity training to improve β-cell function; the particular effects of the exercise depended on the metabolic state of the individual and the type of exercise established. In this study, physical activity was performed for 12 weeks; the results showed improvement in β-cell function, in addition to better glycemic control.[49]

There is a relationship between intensity and duration of physical activity in improving insulin sensitivity, as well as interval exercises have been beneficial in moderate and high intensity, according to each person's ability and capacity. The frequency of exercise is a predictor in the decrease of glycosylated hemoglobin, however, there are other variables within these that are important, such as supervision, volume or intensity, and the combination of more than one exercise. Aerobic exercise, resistance exercise, or both, of 150 minutes or more during the week, are associated with a decrease in glycosylated hemoglobin, and more significant improvements are expected if physical activity is combined with diet.[50-52]

Slentz, et al., conducted a clinical trial in which they performed an exercise intervention combined with healthy eating styles for prediabetic individuals, which yielded significant results ($p<0.001$) in the decrease of fasting glucose.[53]

BENEFITS OF EXERCISE IN OLDER ADULTS WITH TYPE 2 DIABETES MELLITUS

In older adults, physical exercise plays an important role in achieving healthy aging. This includes changes in mental health, such as stress coping skills and psychological well-being, which contribute to quality of life.[54-56]

Resistance training in conjunction with aerobic exercise boosts health benefits by increasing muscle mass, as well as improving glucose transport, mitochondrial oxidative capacity increases 3 to 10 times, since in type 2 diabetes mellitus there is an imbalance of this function; the absorption of fatty acids is favored, which in sum improves the action of insulin.[57,58]
Martinez, et al., analyzed the effects of an exercise intervention in older adults in hospital care, which provided significant benefits in care, as well as in quality of life and strength ($p<0.05$).[59]

Silva, et al., evaluated the effect of aquatic exercises for mental health, it was carried out in 40 participants, 20 people with depression and 20 adults without depression, the results showed a significant decrease in depression score after the application of aquatic exercises compared to scores before implementation ($p<0.01$).[60]

In one study, a 4-month strength exercise training for cognitive function and physical performance in older adults showed significant results in processing speed and executive function ($p<0.05$) and muscle strength ($p<0.05$).[61]

A study was conducted using inflammatory cytokines with interleukin, tumor necrosis factor and C-reactive protein as biomarkers, which yielded significant results ($p<0.002$), ($p<0.01$) and ($p.0.00$) respectively, which determined that interventions that integrate physical activity improve inflammatory and lipid markers.[62]

CONCLUSION

According to the literature and the evidence of what physical exercise has done over time, specifically aerobic exercise either put into practice individually, as well as the maximization of its potential by combining it with other exercises, has been of vital importance for the health of older adults, so it is advisable in an intervention to consider physical activity as a protective factor for the reduction of risks associated with complications, as well as in the control of type 2 diabetes mellitus disease.

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