Bulletin of the *Transilvania* University of Braşov
Series IX: Sciences of Human Kinetics • Vol. 15(64) No. 2 – 2022
https://doi.org/10.31926/but.shk.2022.15.64.2.8

EFFECTS OF PHYSICAL EXERCISE ON METABOLIC DISEASES

O. GHERVAN [1] F. LEUCIUC[2]

Abstract: *Physical activity and diabetes have been linked, as it plays an important role in preventing the progression of peripheral neuropathy, and its impact is primarily on the development of muscle strength and the ability to replace the function of nerve fibers with impaired disabilities. It seems that any form of exercise added to a balanced lifestyle significantly improves the quality of the subject with diabetes (type 2 diabetes). The small differences between aerobic and endurance training as a benefit on type 2 diabetes does not promote a certain form of exercise. In conclusion, the effects of regular exercise are recognized as an effective way to improve the condition of the disease. The basis of exercise therapy is simply the ability of skeletal muscle contractile activity to increase insulin sensitivity and promote blood glucose absorption and stabilization. Thus, regular participation in aerobic structure, endurance, or competing exercise had generally favourable effects on glycemic control, body composition, endothelial function, physical work capacity, and self-reported well-being.*

Key words: *metabolic disease, exercise, diabetes, atherogenic dyslipidemia, hypertension*

1. Introduction

The overall incidence and prevalence of diabetes has increased significantly as the risk of micro vascular and cardiovascular adverse events increases and medical management needs to change the risk factor. Diabetes is not only a group of metabolic disorders characterized by chronic hyperglycaemia resulting from a defect in insulin secretion, insulin action or both, but also a cause of vascular disease that affects almost all types and sizes of blood vessels. It is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels [2]. The increased risk of cardiovascular disease (CVD) in diabetes includes premature atherosclerosis [3], along with diabetes-related endothelial dysfunction, which has been reported to

[1] State University of Physical Education and Sports, Chisinau, Republic of Moldova
[2] Faculty of Physical Education and Sports, Suceava, Romania

lead to vascular morphological and structural changes [1].

An in-depth analysis leads to an understanding of the effects of exercise on metabolic diseases encountered more and more often at older ages.

2. Aim of the study

The aim of this systematic analysis is to identify and evaluate the literature and current studies on the effects of exercise on metabolic diseases and beyond.

3. Methods

We used materials from the following electronic databases: PubMed, Physiotherapy Evidence Database (PEDro), Cochrane Register of Controlled Trials, Scopus and Web of Science in order to prepare this systematic review.

4. Discussions

The beneficial effects of exercise on vascularity can help reduce the risk of cardiovascular disease by improving the expression and endothelial phosphorylation of synthase oxide synthase (e NOS), acetylcholine-induced vasomotor function, and reducing pro-oxidant enzymes, with an impact on arterial diameter, cardiovascular obtained through both aerobic and isometric exercises [2]. Physical activity and diabetes have been linked, as it plays an important role in preventing the progression of peripheral neuropathy, and its impact is primarily on the development of muscle strength and the ability to replace the function of nerve fibers with impaired disabilities.

The results of these data suggested that localized effects of exercise were evident in reshaping the size, thickness, and function of the arterial wall.[3] People with diabetes have physiological limitations of exercise, including insulin resistance, decreased blood flow to the limbs and skeleton with decreased cardio respiratory status. They also have a slower oxygen uptake kinetics which indicates a low capacity to adapt to an acute change in oxygen demand at the beginning of the exercise. "After training, increase in peak oxygen consumption (Vo2peak) was greater in the aerobic group (time-by-group interaction $P = 0.045$), whereas increase in strength was greater in the resistance group (time-by-group interaction $P < 0.0001$). HbA1c was similarly reduced in both groups (−0.40% [95% CI −0.61 to −0.18] vs. −0.35% [−0.59 to −0.10], respectively). Total and truncal fat, VAT, and SAT were also similarly reduced in both groups, whereas insulin sensitivity and lean limb mass were similarly increased. β-Cell function showed no significant changes. In multivariate analyses, improvement in HbA1c after training was independently predicted by baseline HbA1c and by changes in Vo2peak and truncal fat". [4]

Table 1

Changes observed after 4 months of training in the aerobic and resistance groups

	Aerobic group	Resistance group	P value time	P value time by group intervention
HhA %	-0,40	-0,35	≤0,0001	0,759
Fasting glicemia, mg/dL	-15,2	-12,0	0,004	0,718
Total cholesterol, mg/dL	-0,8	-0,7	0,845	0,969
LDL cholesterol, mg/dL	1.8	2,3	0,537	0,933
HDL,cholesterol, mg/dL	2,9	1,3	0,034	0,413
Triglycerides, mg/dL	-27,8	-23,9	0,001	0,926
Glucose dispersal rate,mg+kg FFM	1.15	0,52	0.006	0,271
Systolic,mmHg	-6,8	-5,1	0,034	0,750
Diastolic, mmHg	-4,6	-2,0	0,041	0,407
VO_2 peak, mL+kg+min	4,0	2,1	-	0,045
HbA1c	-0,91	0,84	0,979	0,546
VAT, cm^2	-61,4	-33,5	≤0,0001	0,360
SAT, cm^2	-13,8	-19,5	≤0,0001	0,627

Muscle capillary density, oxidative capacity, lipid metabolism and insulin signalling proteins were increased through regular training. Both aerobic and endurance training promote adaptations of vascular function associated with improved insulin action and are considered risk modulators of cardiovascular-related cardiovascular events. Combining endurance exercise with endurance exercise may lead to greater improvements in adults with diabetes.

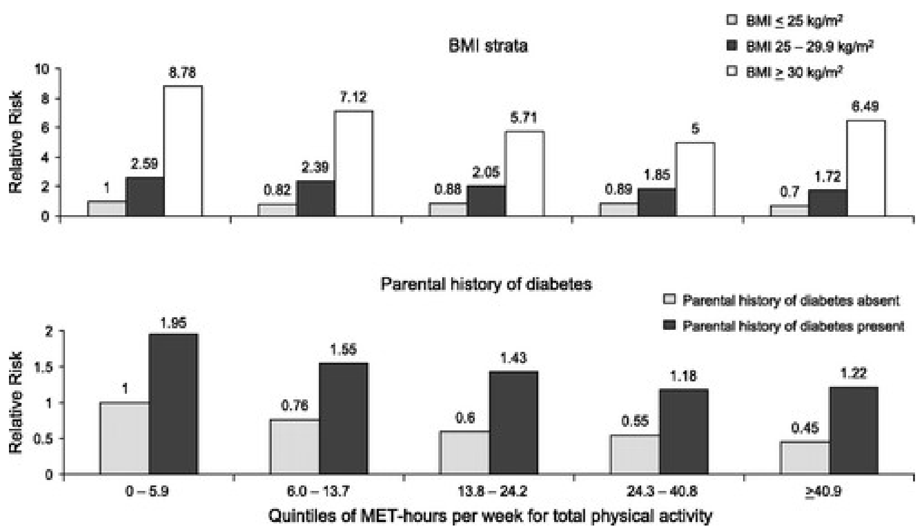

Fig. 1.*Multivariate relative risks of type 2 diabetes according to physical activity, after10 yr of follow-up* [5]

In present, the therapeutic treatment of type 2 diabetes involves some form of lifestyle change. In particular, regular exercise is recognized as an effective method of improving the condition of the disease [4], [6].

Subjects in the PRT group, compared with control subjects, significantly improved plasma glycosylated hemoglobin levels (−12.6 ± 2 vs. +1.2 ± 1%, P = 0.01) and muscle glycogen stores (+31 ± 7 vs. −23 ± 6%, P = 0.04) after adjusting for insulin use, years of diabetes, sex, and the changes in physical activity and diabetes medications described below [6].

The basis of exercise therapy simply refers to the ability of skeletal muscle contractile activity to increase insulin sensitivity and promote blood glucose absorption and stabilization [5]. Regular participation in aerobic structure, endurance, or competing exercise has been reported to have generally favourable effects on glycemic control, body composition, endothelial function, physical work capacity, and self-reported well-being [5, 8]. Progress has also been made in optimizing the program variables that define the exercise requirement, including intensity, duration, and single daily sessions vs. multiple [8].

In general, there seems to be a strong justification for including scheduled exercise in patients with type 2 diabetes.

With specific reference to type 2 diabetes, one study reported that 6 months of exercise training improved glycemic control, lipid profile, and function in patients with long-term illness; however, the magnitude of the change compared to patients with a shorter duration of the disease could not be addressed due to the absence of this specific group.

Moreover, previous work has documented differences in physiological characteristics based on the duration of type 2 diabetes. For example, Park et al. [8] Reported that, compared to patients with a shorter duration of the disease, those with a long history of diabetes (> 6 years) had a significantly lower quality of the leg muscles, an indicator of the integrity of the contractile apparatus. And Feyter et al. [8] also found more indices of physical work capacity to be significantly lower in patients with long-term type 2 diabetes compared to newly diagnosed patients. These findings suggest that diabetes duration is associated with differences in physiological and functional status and that there may be a divergent response to exercise training. Reported that, compared to patients with a shorter duration of the disease, those with a long history of diabetes (> 6 years) had a significantly lower quality of the leg muscles, an indicator of the integrity of the contractile apparatus. And Feyter et al.[8] Also found more indices of physical work capacity to be significantly lower in patients with long-term type 2 diabetes compared to newly diagnosed patients. These findings suggest that diabetes duration is associated with differences in physiological and functional status and that there may be a divergent response to exercise training.

In their study S Damian Skrypnik and colleagues showed significant changes in the content of calcium, iron, magnesium, zinc and copper in serum, hair and urine, as a result of 2 different ways of short-term physical training in women with abdominal obesity. The main differences between the types of exercises analyzed were the higher serum and urine concentration of Fe and the lower concentration of urine Ca after strength training compared to resistance training. These are the first such discoveries ever reported [11].

Also in this study, a decrease in serum iron concentration was observed, both after endurance and strength training, although without an increase in iron loss in urine and without differences in changes in Fe parameters between groups. Athletic exercises have been shown to increase iron absorption in the bone marrow and improve erythropoiesis.

The study by Bertinato et al. [8], showed a link between low serum magnesium levels and excess body mass, insulin resistance and diabetes in women - but not in men. The study confirmed an association between magnesium metabolism and anthropometric parameters - decreased body mass, BMI and total body fat negatively correlated with hair loss Mg, although only in group B. It also showed that strength-resistance training. Obese patients affect Mg homeostasis, as opposed to endurance training alone. In group B, a move of magnesium from the tissues to the blood resulted from an increase in serum Mg, while a decrease in Mg content was more pronounced in older patients with no concomitant changes in magnesium after training. Mg is crucial for energy metabolism, cardio respiratory function, muscle action and high exercise performance.[9] The study is consistent with these findings in obese women who have undergone strength-endurance training: a positive correlation was found in group B between Mg hair and exercise at maximum working speed and exercise at maximum oxygen uptake after training. [10]. Studies have shown changes in serum zinc levels following exercise: increased endurance training and decreased strength. The decrease in serum Zn is accompanied by an increase in zinc after strength training. Moreover, in group A, the decrease in hip circumference was positively correlated with the increase in Zn concentration in urine. In addition, in group A - as opposed to group B - Zn hair loss was observed. Thus, increased body mass appears to be a factor that is at least partially responsible for the response of Zn metabolism to endurance exercise. Low zinc content in obesity is a risk factor for hypercholesterolemia, diabetes and increased inflammation [11]. Thus, the prevention of zinc disorders in patients with excess body mass following training is crucial.

Studies in both animals and humans have shown that copper deficiency induces a number of components of the metabolic syndrome, such as insulin resistance, atherogenic dyslipidemia, [10] hypertension, high cholesterol and triglycerides, and altered lipoprotein composition. A very interesting recent study by Tarantino and co-workers on 100 obese patients with a low prevalence of comorbidities showed a negative prediction of intima-media thickness of copper serum levels. An increase in serum Cu concentration was observed after strength-endurance training and a decrease in Cu content after pure endurance training. Moreover, in group A after training, the Cu content was positively correlated with the body fat content. These findings suggest that there is a link between adipose tissue and Cu homeostasis.

5. Conclusions

It seems that any form of exercise added to a balanced lifestyle significantly improves the quality of the subject with diabetes (type 2 diabetes). The small differences between aerobic and endurance training as a benefit on type 2 diabetes does not promote a certain form of exercise. In conclusion, all forms of movement promote adaptations of vascular functions associated with improved insulin action and are considered risk modulators of cardiovascular events related to exercise. However, combining endurance exercise with endurance exercise can provide greater improvements in adults with diabetes.

In conclusion, the effects of regular exercise are recognized as an effective way to improve the condition of the disease. At the heart of exercise therapy is simply the ability of skeletal muscle contractile activity to increase insulin sensitivity and promote blood glucose absorption and stabilization. Thus, regular participation in aerobic structure, endurance, or competing exercise had generally favourable effects on glycemic control, body composition, endothelial function, physical work capacity, and self-reported well-being. Therefore, training programs for patients with type 2 diabetes should be carefully monitored and prescribed by specialists to avoid overloading the subjects but also to attract them to physically and physically sustainable programs.

When we cumulate the data obtained in terms of mineral metabolism, both aerobic and endurance training have significant effects on the metabolism of calcium, iron, magnesium, zinc and copper in women, with a predominance of favourable effects on the balance of iron, magnesium, zinc and copper from mixed resistance exercises. Further large-scale studies are needed to determine the most favourable way to improve the degradation of minerals in the human body.

The data provided by the authors of all studies included in the analysis lead to a clear conclusion; any form of movement brings innumerable medical and psycho-emotional benefits.

References

1. An, K.H., Min, K.W., Han K.A.: *The effects of aerobic training versus resistance training in non-obese type 2 diabetics.* In: J Korean Diabetes Assoc, Vol.29, 2005, p. 486–494. DOI: 10.2337/db05-1183.

2. Anderson, J.J., Wells, G., Verhoeven, A.C., Felson, D.T.: *Factors predicting response to treatment in rheumatoid arthritis: The importance of disease duration.* In: Arthritis Rheum Vol. 43, 2000, p: 22–29. DOI: 10.1002/15290131(200001)43:1<22:AID-ANR4>3.0.CO;2-9.
3. Bacchi, E., Negri, C., Zanolin, M.E., Milanese, C., Faccioli, N., Trombetta, M., Zoppini, G., Cevese, A., Bonadonna, R.C., Schena, F., Bonora, E., Lanza, M., Moghetti, P.: *Metabolic effects of aerobic training and resistance training in type 2 diabetic subjects: A randomized controlled trial (the RAED2 study).* In: Diabetes Care Vol. 35, 2012, p. 676–682. DOI: 10.2337/dc11-1655.
4. Bassuk, S.S., Manson, J.E.: *Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease*. In: J Appl Physiol (1985) Vol. 99, 2005, p. 1193–1204. DOI: 10.1152/japplphysiol.00160.2005.
5. Bertinato, J., Wu Xiao, C., Ratnayake, W.M.: *Lower serum magnesium concentration is associated with diabetes, insulin resistance, and obesity in South Asian and white Canadian women but not men.* In: Food Nutr Res, 2015, 59:25974. DOI: 10.3402/fnr.v59.25974.
6. Castaneda, C., Layne, J.E., Munoz-Orians, L., Gordon, P.L., Walsmith. J., Foldvari, M., Roubenoff, R., Tucker, K.L., Nelson, ME.: *A randomized controlled trial of resistance exercise training to improve glycemic control in older adults with type 2 diabetes.* In: Diabetes Care Vol. 25, 2002, p.2335–2341. DOI: 10.2337/diacare. 25.12.2335.
7. Danaei, G., Finucane, M.M., Lu, Y., Singh, G.M., Cowan, M.J., Paciorek, C.J., Lin, J.K., Farzadfar, F., Khang, Y.H., Stevens, G.A., Rao, M., Ali, M.K., Riley, L.M., Robinson, C.A., Ezzati, M.: *National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: Systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2.7 million participants.* In: Lancet Vol. 378, 2011, p. 31–40. DOI: 10.1016/S0140-6736(11)60679-X.
8. Granner, D.K., O'Brien, R.M.: *Molecular physiology and genetics of NIDDM. Importance of metabolic staging.* In: Diabetes Care Vol.15, 1992, p. 369–395. DOI: 10.2337/diacare.15.3.369.
9. Park, S.W., Goodpaster, B.H., Strotmeyer, E.S., de Rekeneire, N., Harris, T.B., Schwartz, A.V., Tylavsky, F.A., Newman, A.B.: *Decreased muscle strength and quality in older adults with type 2 diabetes: The health, aging, and body composition study.* In: Diabetes Vol. 55, 2006, p. 1813–1818. DOI: 10.2337/db05-1183.
10. Skrypnik, D., Bogdański, P., Mądry, E.: *Effects of endurance and endurance strength training on body composition and physical capacity in women with abdominal obesity.* In: Obes Facts, Vol.8, 2015; p.175–87. DOI: 10.1159/000431002.

11. Szulińska, M., Skrypnik, D., Ratajczak, M.: *Effects of endurance and endurance-strength exercise on renal function in abdominally obese women with renal hyperfiltration: a prospective randomized trial.* In. Biomed Environ Sci, Vol.29, 2016, p. 706–12. DOI: 10.3967/bes2016.095.
12. Zhang, Y., Xun, P., Wang, R.: *Can magnesium enhance exercise performance?* In: Nutrients, Vol.6, 2017, p. 946 DOI: 10.3390/nu9090946.