



BE-NEW

Exercise for diabetes: beneficial effect of new educational and physical activity programs

ERASMUS+ SPORT PROJECT

Collaborative Partnerships

Grant Agreement n. 622371-EPP-1-2020-1-IT-SPO-SCP

IO-01 REPORT

Exercise protocols for diabetic people

September 2022 – M21





Table of contents

1. Introduction.....	3
2. BE-NEW coordinator and partners.....	6
2.1. Unibo	
2.2. Uisp	
2.3. Sus	
2.4. Radio Capodistria	
2.5. Ajspt	
2.6. Rioja	
2.7. Duth	
3. State of the art on diabetes and physical activity.....	11
3.1. Exercise and type 1 diabetes	
3.2. Exercise and type 2 diabetes	
3.3. Mix exercise training	
4. World Health Organization guidelines.....	16
4.1. Good practice statements	
5. BE-NEW exercise protocol.....	18
5.1. PHA in the gym	
5.2. Swimming protocol	
5.3. Head-out water immersion	
5.4. Walking protocol	
6. Conclusions.....	29





1. Introduction

Diabetes is a serious, chronic condition that arises when raised levels of blood glucose occur because the body cannot produce enough insulin or cannot effectively use the insulin it does actually produce. Approximately 537 million adults aged 20-79 years are currently living with diabetes, but this number is predicted to rise to 643 million by 2030 and to 783 million by 2045. At the same time, according to estimates, 240 million people are living with undiagnosed diabetes, which means that almost half of the people affected by diabetes are unaware they have the condition.

An insulin deficit, if left unchecked in the long run, can cause damage to many of the body's organs, leading to disabling and life-threatening health complications such as cardiovascular diseases (CVD), nerve damage (neuropathy), kidney damage (nephropathy), lower-limb amputation, and eye disease (mainly affecting the retina) resulting in visual loss and even blindness. However, if appropriate management of diabetes is achieved, these serious complications can either be delayed or prevented altogether.

Type 1 diabetes is one of the most common chronic diseases in childhood. While the condition can develop at any age, it occurs most frequently in children and young adults. Type 1 diabetes cannot be prevented because it is caused by an autoimmune process in which the body's immune system attacks the insulin-producing beta-cells of the pancreas. As a consequence, the body produces little to no insulin.

People with type 1 diabetes require daily insulin injections to survive. However, with daily insulin treatment, blood glucose monitoring, and the right amount of education and support, these people can live healthy lives and decrease the complications associated with diabetes.

Type 2 diabetes is the most common type of diabetes worldwide. Although type 2 diabetes may present similar symptoms to those of type 1 diabetes, they are generally much less dramatic. Considering that the condition may be completely symptomless, the exact time of the onset of type 2 diabetes is usually impossible to determine.

Although the causes of type 2 diabetes are still not completely understood, there is a strong link with overweight, and obesity, increasing age, ethnicity, and family history. As with type 1 diabetes, contributors to type 2 diabetes risk are thought to include polygenic and environmental triggers.



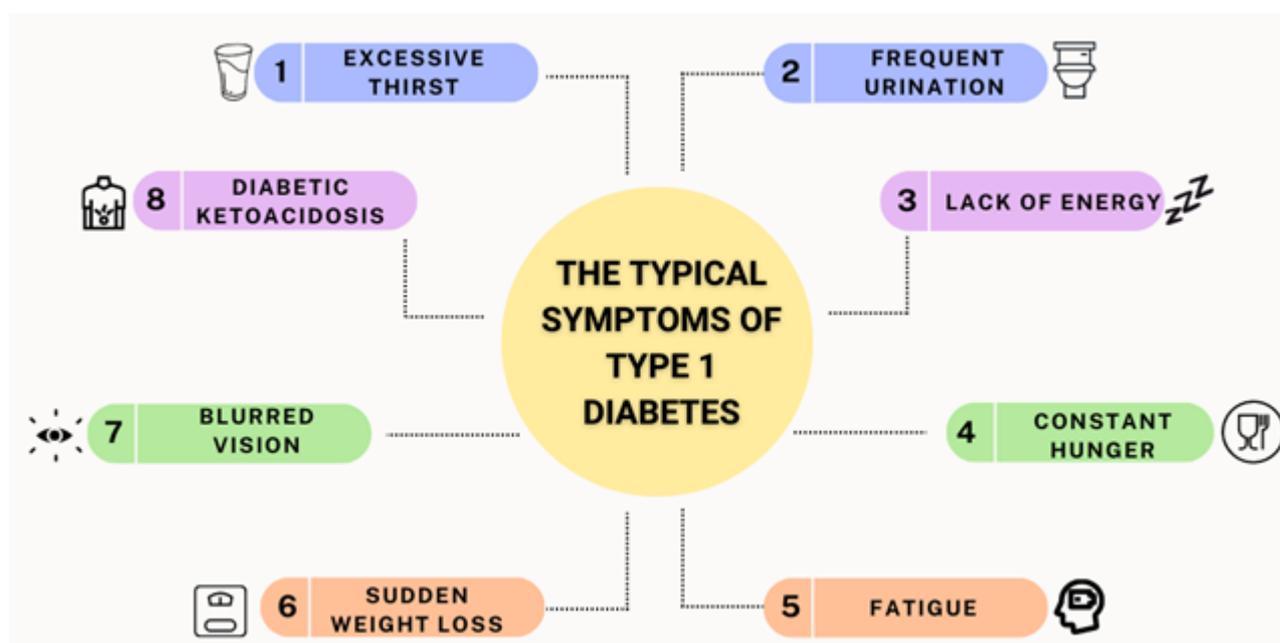


Figure 1. The typical symptoms of type 1 diabetes. Source: IDF Diabetes Atlas, 10th edition (2021).

Evidence shows that type 2 diabetes can be prevented or delayed, and there is accumulating evidence that remission of type 2 diabetes may sometimes be possible. The key element of type 2 diabetes management is promoting a lifestyle that includes a healthy diet, regular physical activity, smoking cessation and maintenance of healthy body weight.

Considering this, the goal of the BE-NEW program is to improve the physiological condition of people with diabetes through participation in exercise and sports activity programs. The BE-NEW project specifically targets the objective pursued by the Erasmus+ program related to “*promote voluntary activities in sport, together with social inclusion, equal opportunities and awareness of the importance of health enhancing physical activity, through increased participation in, and equal access to sport for all*”.

A review of the scientific literature has been conducted, analysing various physical activities (gym, walking, and swimming) that could be applied in diabetic populations and, as a consequence, update the knowledge of the benefits of systematic exercise and training for these patients.



All types of diabetic or prediabetic people were enrolled in the project to achieve both social and scientific purposes.

Concerning the social purpose, one of the BE-NEW activities included raising awareness among diabetic people that regular practice of physical exercise improves the quality of life and health in general. From the scientific point of view, the project aimed to study the effects of physical exercise on all types of diabetes to deepen the knowledge of the disease.

The goal of sports training in the BE-NEW project is to achieve maximum individual efficiency in a selected physical activity discipline limited by rules. From the point of view of the diabetic individual, there are four main aims of training:

1. Improve the person's level of awareness that the regular practice of physical exercise improves their health
2. Increase the person's skill in one or more areas of physical activity
3. Increase the individual's motivation to perform physical exercise
4. Decrease the level of medications





2. BE-NEW coordinator and partners

Coordinator organisation:

2.1. University of Bologna (Italy) - UNIBO

The University of Bologna was founded in 1088 and is one of the most renowned and prestigious universities in Europe. With 86.000 enrolled students, 2800 teaching professors (full, associate, and assistant), and 3000 technical-administrative staff, it is the most populated university community in Italy.

The University of Bologna is one of the European leading universities in the management of international cooperation projects and mobility projects, and one of the first universities in Europe for participation in the Erasmus+ Programme (for number of incoming and outgoing students).

In the last 5 years, Bologna has been selected as coordinator and partner in many EU projects. Many of these Erasmus+ funded projects are financing innovative educational programmes and are closely linked to society's needs, as foreseen by the Strategic Plan of the University which fosters innovation in research, education, and more on the Third Mission of the University, namely the close links to societal needs, social responsibility, and social inclusion.

Partners:

2.2. Unione Italiana Sport Per Tutti Bologna (Italy) - UISP

Unione Italiana Sport Per Tutti (UISP) is a national association founded in 1948. UISP is formally recognized by the Italian Olympic Committee as a Sports Promotion Association, by the Italian Ministry of the Interior as a social welfare agency, and is registered in the official list of Italian social promotion organizations.

UISP offers a wide range of diverse physical activities for each population group, focusing on the sedentary population suffering from chronic degenerative diseases, and promoting collective well-





With the support of the
Erasmus+ Programme
of the European Union



being through individual well-being. UISP strives to develop not only cultural innovation but also methodological and organizational techniques for a sport for all citizens.

The Committee of Bologna counts more than 50,000 members and has distinguished itself in recent years as the vanguard in national projects to promote physical activity for health (HEPA) through the implementation of innovative projects and a program of targeted communication for all citizens. Special UISP courses, inspired by the psycho-geriatric method of memory formation for the elderly were presented at the 2009 ISCA Contention and, as a collaborative project with the City of Bologna, awarded by the World Health Organization.

2.3. Sport Union of Slovenia (Slovenia) - SUS

Sports Union of Slovenia, as the largest sports for all organization in the country, connects different sports organizations, associations, clubs, and individuals working in the field of sports recreation and sports education in Slovenia. It unites over 200 organisations and has over 60.000 members scattered all over Slovenia. Their common goal is to promote healthy lifestyles and active use of leisure time.

The purpose of SUS is to unite clubs that act in the field of sports, sport and recreation, and recreational educational activities for every individual, encourage their advanced professional training, strive for the progress of professional work, and introduce new methodologies.

SUS has been accredited by the Ministry of Education in Slovenia to deliver certified (and compulsory) nonformal training programmes in their fields of expertise and is therefore well placed to ensure the proper validation/recognition also of the current training programme in the national system.

Through non-formal education, SUS educates over 500 certified trainers in the field of sport and recreation. SUS offers additional education opportunities and training by organizing various seminars, conferences, forums, and congresses on topics in the field of sport for all and healthy lifestyles.





SUS belongs to the network of EFCS (European Federation for Company Sport), TAFISA (The Association For International Sport for All), ISCA (International Sport and Culture Association) and FARE (Football Against Racism Europe).

2.4. Radio Capodistria (Slovenia) – Radio Capodistria

Radio Capodistria is an integral part of RTV Slovenija, the Slovenian public broadcasting service. It broadcasts in Italian, 24 hours a day, in medium wave (AM), in stereo frequency modulation (FM) and by satellite. The programme is also available on the Internet (through online streaming) and on a specific app, where it is possible to receive many media materials related to Radio and Tv Capodistria (which is the Italian language programme of RTV Slovenija). The backbone of its work is information: it broadcasts 4 radio news programmes and 10 news bulletins a day, besides numerous periodic analysis programmes.

Radio Capodistria is based in Koper-Capodistria, a bilingual city. Founded more than 70 years ago, Radio Capodistria plays an important cross-border role for more than 100,000 listeners daily in Italy, Slovenia, and Croatia.

Because of this, Radio Capodistria is among the main media references of the Italian Minority located on Slovenia's and Croatia's coastline. Therefore, any issue related to human rights, discrimination, social inclusion and (youth) participation is prioritized in its agendas, especially in relation to ethnic minorities, disadvantaged, marginalized and vulnerable groups. Moreover, as public media, any issue related to well-being, health, and quality of life for all people, groups and communities is very relevant as well.

In addition, through being part of the public radio-television system (which has many radio, tv and web channels, in different languages) Radio Capodistria can also access information on relevant examples in other locations and media, broadcasting on the whole territory of the Republic of Slovenia.





2.5. Sport for All Suceava (Romania) - AJSPT

Association Sport for All Suceava (AJSPT Suceava) is a non-profit organisation at the regional level, and a nongovernmental organisation officially recognized by the Romanian Justice Ministry since 2002. In the same year, the organisation was officially recognised by the Ministry of Youth and Sport as a sports organisation.

The main goals of AJSPT include:

- Promoting the benefits of sport and physical education, tolerance and fair play, and healthy lifestyles
- Developing partnership activities in schools and universities
- Promoting activities in nature and ecology
- Developing programs and projects for youth in sport, culture, and social fields
- Organizing training for young leaders, sports instructors and volunteers
- Developing specific activities for social inclusion of people from disadvantaged groups: children, women, unemployed, young people, immigrants, ethnic minorities, detainees and other disadvantaged groups
- Acting to prevent violence in sports, prohibited substances and methods of influencing irregular sports results;

The organisation regularly carries out sporting activities for schools within the National School Sport Olympiad. It is also a regional organiser for the #BeActive European Week of Sport. Based on the signed partnerships, AJSPT carries out sports activities in Botosani Penitentiary, 40 km away from Suceava. The organisation provides consulting services and sports-educational activities for the Probation Service of Suceava but also for companies that carry out therapy with those convicted of justice but are at liberty.

2.6. University of La Rioja (Spain) - RIOJA

The University of La Rioja was created on May 14th, 1992, and inaugurated in the academic year 1992-1993. It is the only public University in the autonomous community of La Rioja in the north of





Spain. As such, it belongs to the G9 group of Universities in Spain. It is also a founding member of the Excellence Campus Iberus.

Over these 25 years, the University of La Rioja has consolidated its role within higher education, research, innovation, knowledge generation and transmission. It has over 20.000 graduates and postgraduates with a special note for its 600 doctors in the different areas of knowledge. It is made up of an Institute of Masters and Doctoral Studies, a Center for Foreign Languages and an Institute for the Study of Wine and Winemaking sciences (ICVV), whose coordination is shared with the Government of La Rioja and the CSIC (National Center for Research).

The University is divided into four Faculties and two professional schools which teach a total of 19 degrees within the European Higher Education Area. Additionally, it offers official Master's Studies and a number of Doctorates, as well as life-long learning courses and other initiatives related to learning in higher education.

It has a vigorous activity with over 800 agreements with companies, other universities in Spain and overseas, associations and public institutions from the region and the whole country. These agreements allow for internships, mobility, and research stays.

These activities contribute to making the University of La Rioja an international and diverse institution. It is a modern, young and very active university which features itself as a close, flexible, and up-to-date higher education institution.

2.7. Democritus University of Thrace (Greece) - DUTH

The Democritus University of Thrace (DUTH) was established in July 1973 and started operating during the academic year 1974-1975. The University is currently operating eight Schools and nineteen Departments in four cities of Thrace.

Relying on the quality of teaching and research level, DUTH has secured a place among the best Greek Universities. DUTH has participated and is currently participating as coordinator and/or project partner in several EU-funded programmes.





With the support of the
Erasmus+ Programme
of the European Union



Furthermore, the University is currently participating in several co-funded bilateral and multilateral cooperation programmes such as Interreg Greece-Bulgaria, Interreg Mediterranean, Interreg Balkan Mediterranean and ENI CBC MED as well as national ones.

DUTH takes part in the Erasmus+ program as host and home institution for hundreds of incoming and outgoing students as well as for teaching and administrative staff of DUTH and of partners institutions since 1996.



3. State of the art on diabetes and physical activity

Nowadays, even though the benefits of physical exercise as a therapeutic measure for diabetic patients are well known and accepted, it is challenging to put exercise recommendations into action for several reasons. Insufficient knowledge among diabetologists and exercise professionals and a lack of dedicated facilities are indicated as important limitations. Prescribing exercise is not generally undertaken, either by the general practitioner or by the diabetologist. This may be because there is insufficient awareness of the benefits of exercise or because there is a lack of specific knowledge about current recommendations. Thus, prescriptions, when suggested, are generic and more oriented towards ‘physical activity’ rather than ‘exercise therapy’, without appropriate indication about type, intensity, frequency, timing, progression, and precautions.

Exercise is normally suggested in the management of type 1 and 2 diabetes mellitus and can improve glucose uptake by increasing insulin sensitivity and lowering body adiposity. Both alone and when combined with diet and drug therapy, exercise can result in improvements in glycaemic control in type 2 diabetes. In addition, exercise can also help to prevent the onset of type 2 diabetes, in particular in those at higher risk, and has an important role in reducing the significant worldwide problem of this type of pathology.

Recent studies have improved our understanding of the acute and long-term physiological benefits of exercise, although the precise duration, intensity, and type of exercise have yet to be fully elucidated. However, in type 1 diabetes, the expected improvements in glycaemic control with exercise have not been clearly established. Instead, significant physical and psychological benefits of exercise can be achieved while careful education, screening, and planning allow the metabolic, microvascular, and macrovascular risks to be predicted and diminished.

At present, there are no recommendations for screening, exercise protocols, or treatment regimens, and the personal experience of many with diabetes, including elite athletes, has included frustration and a lack of support on issues of insulin dosage, nutrition, and the potential limits on performance and safety.

The prescription of exercise for diabetic control should be considered for a variety of associated and independent health benefits. The full scope of these benefits can be seen in a number of reviews and

include weight loss, weight loss maintenance, lipid profiles, blood pressure, psychological profile, and the constellation of symptoms that make up the metabolic syndrome.

Once a patient has been screened and the risk factors and exercise capacity determined, regular exercise may then be considered. The typical patient with type 2 diabetes is sedentary, overweight, and middle-aged or older. In this group of patients, exercise may well be beneficial but needs to be carefully implemented.

Guidelines issued jointly by the American Diabetes Association (ADA) and the American College of Sports Medicine (ACSM) include the following suggestions:

- A gentle warm-up period of 5–10 minutes
- A period of stretching
- An active cool-down period of 5–10 minutes to allow gradual adjustment of heart rate and blood pressure

The intensity, duration, and frequency of exercise necessary for good health have been adjusted from the 60–80% of maximal oxygen consumption outlined in the ACSM guidelines in 1976.

Instead, the target of an adult should be to achieve 30 minutes of continuous moderate activity, equivalent to brisk walking on five or six days a week, with the flexibility of shorter bouts of more intense activity increasingly being considered important. Vigorous activity is widely implicated in health benefits and can be safely undertaken in diabetics, provided that cardiovascular and hypertensive problems are taken into consideration.

As no studies have accurately defined the most suitable exercise program for people with diabetes, it is inappropriate to be too prescriptive and instead, we should concentrate on adherence and compliance.

When ACSM guidelines are used, there is a dropout rate of 40–70% after 12–18 months despite an active intervention programme. However, the recent guidelines have gained wider acceptance and much greater success has been reported in the Malmo intervention studies for relatively informal exercise programmes with mixed high and low-intensity exercise.

Exercise prescription must also consider patients' readiness to exercise, attitudes, and belief systems, while positively encouraging decisions to exercise. Support can be provided through a team of doctors, nurses, physiotherapists, lifestyle counsellors, and exercise consultants and even through health policy decision-making at the government and local levels.

3.1. Exercise and type 1 diabetes

All levels of physical activity, including leisure activities, recreational sports, and competitive professional performance, can be performed by people with type 1 diabetes who do not have complications and are in good blood glucose control.

General guidelines

Exercise and type 1 diabetes

All levels of physical activity including:

- Leisure activities
- Recreational sports
- Competitive professional performance

Can be performed by people with type 1 diabetes who do not have complications and are in good blood glucose control.

Food intake:

- Consume added carbohydrates as needed to avoid hypoglycaemia.
- Carbohydrate-based foods should be readily available during and after physical activity.

Metabolic control before physical activity:

- Avoid physical activity if fasting glucose levels are >250 mg/dl and ketosis is present and use caution if glucose levels are >300 mg/dl and no ketosis is present.
- Ingest added carbohydrates if glucose levels are <100 mg/dl.

Challenge:

Develop strategies that allow individuals with type 1 diabetes to participate in activities that are consistent with their lifestyle and culture in a safe and enjoyable manner.

Blood glucose monitoring before and after physical activity:

- Identify when changes in insulin or food intake are necessary.
- Learn the glycaemic response to different physical activity conditions.

Figure 2. General guidelines on exercise and type 1 diabetes.

General guidelines that may prove helpful in regulating the glycaemic response to physical activity can be summarized as follows:

- Metabolic control before physical activity
 - Avoid physical activity if fasting glucose levels are >250 mg/dl and ketosis is present and use caution if glucose levels are >300 mg/dl and no ketosis is present.
 - Ingest added carbohydrates if glucose levels are <100 mg/dl.
- Blood glucose monitoring before and after physical activity
 - Identify when changes in insulin or food intake are necessary.
 - Learn the glycaemic response to different physical activity conditions.
- Food intake
 - Consume added carbohydrates as needed to avoid hypoglycaemia.
 - Carbohydrate-based foods should be readily available during and after physical activity.

The challenge is to develop strategies that allow individuals with type 1 diabetes to participate in activities that are consistent with their lifestyle and culture in a safe and enjoyable manner.

3.2. Exercise and type 2 diabetes

A standard recommendation for diabetic patients, as for nondiabetic individuals, is that physical activity includes a proper warm-up and cool-down period.

- A warm-up should consist of 5–10 min of aerobic activity (walking, cycling, etc.) at a low-intensity level.
- The warm-up session is to prepare the skeletal muscles, heart, and lungs for a progressive increase in exercise intensity.
- After a short warm-up, muscles should be gently stretched for another 5–10 min.
- Primarily, the muscles used during the active physical activity session should be stretched, but warming up all muscle groups is optimal.
- The active warm-up can either take place before or after stretching.
- After the activity session, a cool-down should be structured similarly to the warmup. The cool-down should last about 5–10 min and gradually bring the heart rate down to its pre-exercise level.



There are several considerations that are particularly important and specific for the individual with diabetes. Aerobic physical activity should be recommended, but taking precautionary measures for physical activity involving the feet is essential for many patients with type 2 diabetes.

Proper hydration is also essential, as dehydration can affect blood glucose levels and heart function adversely. Physical activity in heat requires special attention to maintaining hydration. Adequate hydration prior to physical activity is recommended (e.g., 0.5 L of fluid consumed 2 h before physical activity). During physical activity, fluids should be taken early and frequently in an amount sufficient to compensate for losses in sweat reflected in body weight loss, or the maximal amount of fluid tolerated. Precautions should be taken when exercising in extremely hot or cold environments.

High-resistance exercise using weights may be acceptable for young individuals with diabetes, but not for older individuals or those with long-standing diabetes. Moderate weight training programs that utilize light weights and high repetitions can be used for maintaining or enhancing upper body strength in nearly all patients with diabetes.

Several long-term studies have demonstrated a consistent beneficial effect of regular physical activity training on carbohydrate metabolism and insulin sensitivity, which can be maintained for at least 5 years. These studies used physical activity regimens at an intensity of 50–80% Vo_{2max} three to four times a week for 30– 60 min a session. Data on the effects of resistance exercise are not available for type 2 diabetes although early results in normal individuals and patients with type 1 disease suggest a beneficial effect.

It now appears that long-term programs of regular physical activity are indeed feasible for patients with impaired glucose tolerance or uncomplicated type 2 diabetes with acceptable adherence rates. Those studies with the best adherence have used an initial period of supervision, followed by relatively informal home physical activity programs with regular, frequent follow-up assessments. A number of such programs have demonstrated sustained relative improvements in Vo_{2max} over many years with little in the way of significant complications.





3.3. Mix Exercises Training

Regarding diabetes mellitus and physical exercise, the most widely studied field is the one that encompasses activities that involve walking, cycling, and swimming. Currently, the available scientific evidence calls for the performance of mixed exercises that combine aerobic activity with resistance exercises as the non-pharmacological treatment of choice for patients with type 2 diabetes mellitus. The analysis of the means of fasting insulin levels, insulin resistance, fasting blood glucose, glycated haemoglobin, and body mass index shows the effectiveness of structured programs of aerobic exercises and resistance in reducing insulin resistance.



4. World Health Organization guidelines on diabetes and physical activity

The World Health Organization recommends that all adults and older adults with type 2 diabetes should undertake regular physical activity:

- Adults and older adults with type 2 diabetes should do at least 150–300 minutes of moderate-intensity aerobic physical activity
 - or at least 75–150 minutes of vigorous-intensity aerobic physical activity
 - or an equivalent combination of moderate and vigorous intensity activity throughout the week for substantial health benefits
- Adults and older adults with type 2 diabetes should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional benefits

WHO RECOMMENDATIONS ON TYPE 2 DIABETES AND PHYSICAL ACTIVITY



All adults and older adults with type 2 diabetes should undertake regular physical activity

WEEKLY:

- 150–300 minutes of moderate-intensity aerobic physical activity
- Or 75–150 minutes of vigorous-intensity aerobic physical activity
- Or an equivalent combination of moderate and vigorous intensity activity



TWICE A WEEK OR MORE:

- Muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups

THREE TIMES OR MORE:

- Varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity

WHEN NOT CONTRAINDICATED:

- Increase moderate-intensity aerobic physical activity to > 300 minutes
- Or > 150 minutes of vigorous-intensity aerobic physical activity



Figure 3. Recommendations on type 2 diabetes and physical activity. Source: World Health Organization, Physical activity and sedentary behaviour (2022).



As part of their weekly physical activity, older adults with type 2 diabetes should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity on 3 or more days a week, to enhance functional capacity and prevent falls.

When not contraindicated, both adults as older adults with type 2 diabetes may increase moderate-intensity aerobic physical activity to more than 300 minutes; or do more than 150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for additional health benefits.

4.1. Good practice statements

When not able to meet the above recommendations, adults with type 2 diabetes should aim to engage in physical activity according to their abilities: start by doing small amounts of physical activity and gradually increase the frequency, intensity, and duration over time.

They may wish to consult with a physical activity specialist or health care professional for advice on the types and amounts of activity appropriate for their individual needs, abilities, functional limitations/complications, medications, and overall treatment plan. Generally, pre-exercise medical clearance is unnecessary for individuals without contraindications prior to beginning light- or moderate-intensity physical activity not exceeding the demands of brisk walking or everyday living.

Good practice statements

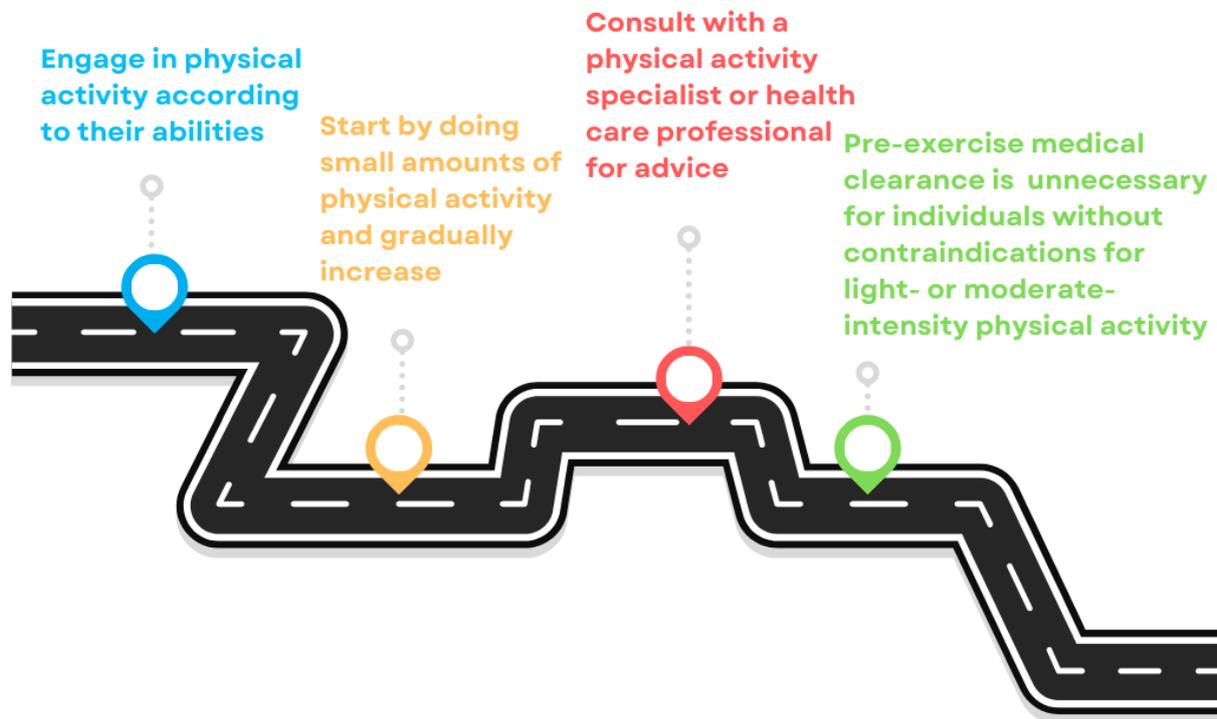


Figure 4. Good practice statements. Source: World Health Organization, Physical activity and sedentary behaviour (2022).

5. BE-NEW exercise protocols

As previously written, the BE-NEW project specifically targets the objective pursued by the Erasmus+ program related to “*promote voluntary activities in sport, together with social inclusion, equal opportunities and awareness of the importance of health enhancing physical activity, through increased participation in, and equal access to sport for all*”. As a consequence, the general objective of the BE-NEW program is to improve the physiological condition of people with diabetes through continuous exercise of sports activity.

Given the objectives of the BE-NEW project, we started the preparation phase studying the literature regarding the various types of physical activities to develop specific training protocols.

The training programs have been planned during the preparation of the proposal and the rationale behind these was:

- compare three very different aerobic activities to elucidate which one provides the best health improvement
- allow the subjects of the project to choose the activity they prefer

5.1. PHA in the gym

The subject should execute this program two times per week. Each peripheral heart action training (PHA) session starts with a 5 minute warm-up and concludes with a cool-down. The conditioning phase of each session involves circuit weight training and consists of eight resistance exercise stations, as strictly ordered:

- 1) Pectoral machine
- 2) Leg extension
- 3) Lat machine
- 4) Leg curl
- 5) Shoulder press
- 6) Calf machine

- 7) Abdominal exercise
- 8) Lower back muscles exercise

Subjects perform 10-15 repetitions of each exercise (starting from the pectoral machine), and then move to the next station (leg extension) without rest but with active pauses (e.g., subjects perform an exercise of the lower limbs as soon as they have finished one on the upper limbs, and vice versa), until the completion of the circuit training (calf machine).

Such circuit training will be performed two-four times, separated by 1 minute of rest. Subjects will wear a heart rate monitor and maintain an intensity of around 40–60% of 1-RM, which corresponds approximately to 60–80% of the maximal heart rate calculated during the pre-test.

The resistance training program should have a progression with the following characteristics:

- 2 cycles for the first four weeks, 3 cycles for weeks five to eight, 4 cycles for week nine and thereafter
- 10-13 repetitions per exercise with loads 40-50% for the first two weeks
- 13-15 repetitions per exercise with loads 40-50% for weeks 3 and 4
- 10-13 repetitions per exercise with loads 50-55% for weeks 5 and 6
- 13-15 repetitions per exercise with loads 50-55% for weeks 7 and 8
- 10-13 repetitions per exercise with loads 55-60% for weeks 9 and 10
- 13-15 repetitions per exercise with loads 55-60% for weeks 11 and 12

After the first 5 to 6 six months of training, higher loads, 70-80% of 1RM with the execution of 6-7 repetitions per exercise could also be used at one training session ONLY if these loads are tolerable by the subjects, if not they will maintain 13-15 repetitions per exercise with loads 55-60% of 1-RM.

For a summarized version of this program, see the figure 5.



With the support of the Erasmus+ Programme of the European Union



With the support of the Erasmus+ Programme of the European Union



GYM TRAINING

Recommended frequency: at least 3 times a week
Workout phases: warm-up - training - cool-down

RECOMMENDED APPROACH



- Combination of anaerobic training with overloads and aerobic resistance training in the same session
- Circuit training consisting of 5 or 6 exercises
- Variable number of repetitions
- Total body: alternating upper and lower body exercises
- Repeat the exercises in sequence, then recover
- Recommended intensity level: medium-high
- Recommended duration: 45 - 60 minutes



USEFUL TIPS

- Keep yourself hydrated during your training session: your hydration status affects your performance
- Ask your instructor to provide you with a personalised training plan and to help you improve your motor movements
- Training should be aimed at changing your body composition: gaining muscle mass means increasing the amount of energy spent by the body at rest
- Prefer exercises that involve several muscle groups: they increase energy expenditure. Initially you can use your body weight



TALK TEST

- **LOW INTENSITY** - you can speak effortlessly
- **MEDIUM INTENSITY** - you are able to speak, but not comfortably
- **HIGH INTENSITY** - you cannot speak



Figure 5. Be-New gym training program.



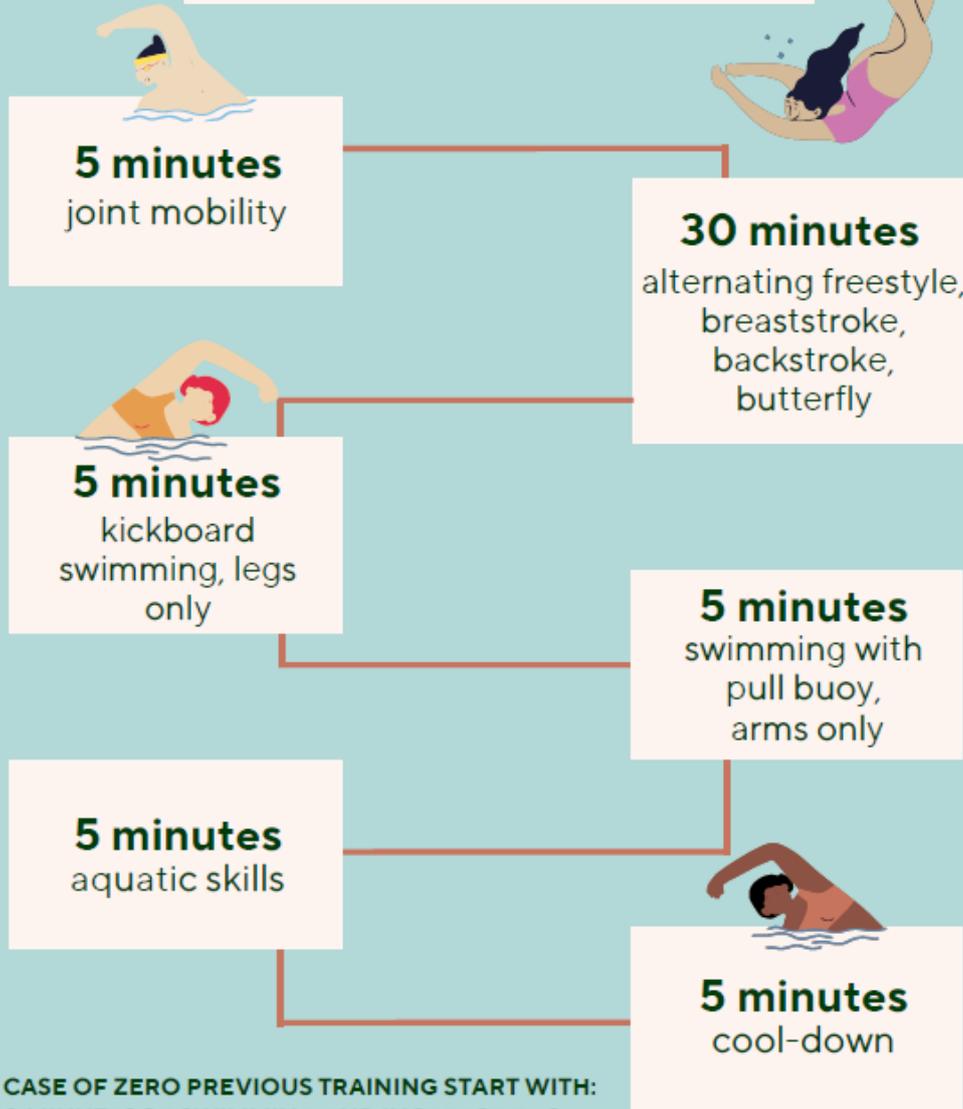
5.2. Swimming protocol

In the swimming pool, participants complete a standardized warm-up consisting of:

- 5 min of articular mobilization
- 30 minutes of easy swimming (alternating the various swimming styles – front crawl, breaststroke, backstroke, and butterfly)
- 5 min of leg-only swimming
- 5 min of arm-only swimming
- 5 min of aquatic skills
- 5 minutes of cool-down

In case the subjects will be previously untrained, the swimming training program should begin with 20 minutes of swimming and increase each week by 2 minutes until 30 minutes of swimming is reached.

SWIMMING TRAINING PROGRAMME



IN CASE OF ZERO PREVIOUS TRAINING START WITH:
20 MINUTES OF SWIMMING AND INCREASE EACH
WEEK BY 2 MINUTES UNTIL YOU REACH 30 MINUTES
OF EXERCISE

Figure 6. Be-New swimming training program.

5.3. Head-out water immersion

This alternative mode of a water-based program may be used successfully and induce positive metabolic adaptations in patients with diabetes mellitus type 2. Thus, the exercise program could consist of half sessions per week:

- Two sessions with aerobic aqua-exercise (until 60% of HR reserve)
- Two sessions focusing on water-based circuit weight training (40-60% of rate perceived exertion, values from 10 until 12-13 on the original scale of 6 to 20) for muscular endurance and neuromuscular performance (work to rest ratio, 1:1,5 for the 1st, 2nd and 1,5:1 for the 3rd, 4th month respectively).

The aquatic exercise should be conducted in a heated pool (120 cm depth) as specified below:



With the support of the Erasmus+ Programme of the European Union



With the support of the Erasmus+ Programme of the European Union



WATER SPORTS ACTIVITIES

THE TRAINING PROGRAM CONSISTS OF THE FOLLOWING WEEKLY SESSIONS:

2 sessions of aquatic aerobic exercises against water resistance

2 sessions of overload training circuits in the water

Training can be done in single or combined sessions



Duration: 45-60 minutes



Pool depth: at least 120cm

Figure 7. Be-New Head-out water training program.



5.4. Walking protocol

The walking program consists of 3 exercise sessions per week at 30% heart rate reserve (HRR). The target heart rate will be determined using the HRR equation by Karvonen et al. (1957).

Target HR = (220-age-resting HR) x 0.3 + resting HR.

The program begins with 25 minutes of walking and increases each week by 2 minutes until 40 minutes of walking is reached. A heart rate monitor will be worn at each exercise session to ensure that the target heart rate will be achieved.

Intensity levels at 30% of HR reserve are appropriate for untrained individuals. After 4 weeks, the intensity will increase progressively as individuals are getting fitter, and intensity levels of 40-60% of HR reserve are suggested.

The intensity level should increase every odd week of training by 5% until 60% is achieved.

Also, exercise duration could increase by 5 min (starting with 25 min) every even week until 40 min of exercise is achieved.

After the first six months of training, intensity at 1-2 training sessions could be >60% of HR reserve but not more than 70% (vigorous intensity level).

The walking training program should have a progression with the following characteristics:

- 25 min for the first four weeks at 30% of HHR
- + 5min and + 5% from the 4 to 8 weeks
- + 5min and + 5% from the 8 to 12 weeks
- + 5min and + 5% from the 12 to 16 weeks
- + 5% from the 16 to 20 weeks
- + 5% from the 20 to 24 weeks
- + 5% from the 24 to the end of the training program (increase until 70% of HHR ONLY if these loads are tolerable by the subjects, otherwise maintain 60% of HHR)

For a simplified version of the training program, see the figure below:

TRAINING PROGRAMME: WALKING



3 training sessions per week:

The duration of the workout should be increased by 5 minutes every week until it gets to 40 minutes of exercise, with the following progression:

- #1 Start with 25 minutes of low-intensity walking from week 1 to 4
- #2 Add 5 minutes of low-intensity walking from week 4 to 8
- #3 Perform 30 min of medium intensity walking from week 8 to 12
- #4 Add 5 minutes of medium intensity walking from week 12 to 16
- #5 Perform 35 minutes of high intensity walking from week 16 to 20
- #6 Add 5 minutes of high intensity walking from week 20 to the end of the programme

TALK TEST:

- LOW INTENSITY - you can speak effortlessly
- MEDIUM INTENSITY - you are able to speak, but not comfortably
- HIGH INTENSITY - you cannot speak



Figure 8. Be-New walking training program.



6. Conclusions

Concerning the implementation of the sport activities of the BE-NEW project, they have been divided into two segments: the mandatory physical tests and the practical part to be performed throughout the project.

The volunteer subjects received all the information about these activities, about the way they are carried out, about the locations and the availability of the staff of the partner organizations to help them in carrying out the sports programs.

As of the date of publication, the data gathered are continuously being analysed. So far, two measurements have been performed in the majority of the subjects. Taking into consideration that these are only preliminary data, it has been observed that people who practice physical activity showed an improvement in physiological parameters.

We are not able to quantify the improvements yet, since data are currently under analysis. However, people who do not practice any physical activity are getting worse in almost all parameters. It appears that inactivity causes very fast decreases in motor functions in people over 50.

Inviting and finding the group of subjects willing to participate in the exercise programs and the limited help from health care professional to recruit patients was the biggest challenge at the beginning of BE-NEW program. The second major difficulty was and still is to persuade the subjects about the long-term benefits of participating to regular exercise programs and their implementation throughout life. It is thus crucial to approach this target group delicately and with a lot of patience.

Project webpage: <https://site.unibo.it/benew/en>

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

