Go Functional Improvement and Tourism

Go FIT eHandbook for expert

Erasmus+

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INTRODUCTION

Vacations always bring in mind a relaxing aquatic environment since in many occasions tourists prefer to spend their holidays either in a destination next to a beach or to a hotel with a swimming pool and fitness equipment. Therefore this guide (eHandbook for Experts) is focused on designing effective exercise programs in the water or in a gym. It will help the exercise expert to achieve relevant and high-quality skills and competences in designing the appropriate program for tourists and helping them to adopt a new healthy lifestyle.

CONTENTS

CHAPTER 1

Water training program

O B J E C T I V E S

After studying this chapter, you will be able to:

- Understand the importance of water exercise program.
- Understand the importance of water exercise training and its benefits
- Categorize exercises that can be performed in the water environment
- to design a water training program for people with musculoskeletal problems

This chapter discusses the peculiarities of the pool environment and the physical properties of the water and how to design a water based training program in deep and shallow. Successive chapters discuss the peculiarities of the pool environment, the physical properties of the water should be taken into account for the proper design of a water exercise program.

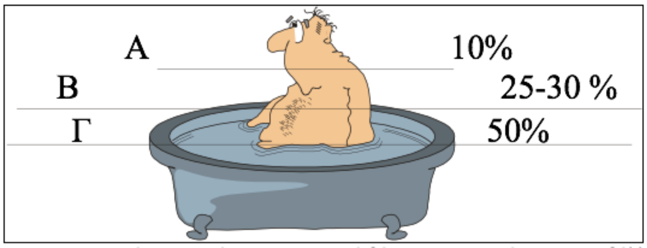
Trainers must have a basic understanding of the peculiarities of the pool environment and the principles of the aquatic environment. The principles of the aquatic environment are: buoyancy, drag, viscosity, fluid resistance, hydrostatic pressure and water temperature (1,2,3)

The use of the aquatic environment for exercise is beneficial to the trainee due to its peculiarities. For example, we rarely consider the resistance of air when we do a leg lift on land. We assume that all the resistance is provided by the effect of gravity on the leg. When this exercise is performed in water, however, the effect of gravity is opposed by the force of buoyancy (4). Therefore, most of the resistance to movement comes from the fluid resistance of the water and not the weight of the leg (1,2,3).

PRINCIPLES OF THE AQUATIC ENVIRONMENT

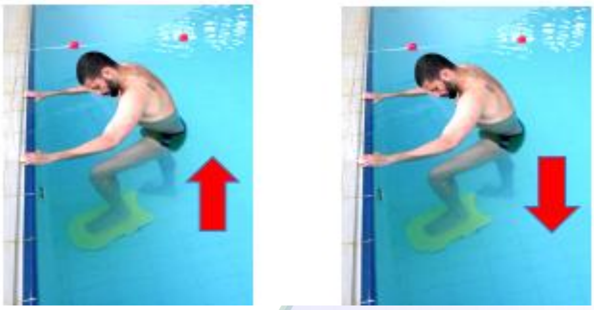
BUOYANCY

Buoyancy provides many benefits for water exercisers. It decreases the effects of gravity and reduces weight bearing or compression of joints. Many people who cannot exercise on land bearing their full weight can exercise comfortably and vigorously in the water (2,3). Buoyancy also depends on the depth of immersion because being immersed deeper displaces more water. A body immersed to the neck bears approximately 10 percent of its body weight. A body immersed to the chest bears approximately 25 to 35 percent, and a body immersed to the waist bears about 50 percent (Picture 1) (1).



Picture 1. The weight bearing vary from the depth of immersion

Just as gravity assists or resists movements on land, buoyancy can assist or resist movement in the water. Because the force of buoyancy is vertically upward, any buoyed movement toward the surface of the pool is buoyancy assisted. Any movement of a buoyant object toward the pool bottom is buoyancy resisted (Picture 2). When equipment is added, buoyancy and gravity become more involved and affect muscle use (1).



A B

Picture 2. A: any buoyed movement toward the surface of the pool is buoyancy assisted, **B:** Any movement of a buoyant object toward the pool bottom is buoyancy resisted,

RELATIVE DENSITY (SPECIFIC GRAVITY)

The relative density of an object is the property that determines whether the object will float. If this value is greater than 1, the object will sink; if it is less than 1, the object will float. If the value is exactly 1, the object will float just below the surface of the water (1). The relative density of a body depends on its composition. The specific gravities of fat, bone and lean muscle are 0.8, 1.5 to 2.0 and 1.0, respectively. People who are lean and muscular will tend to sink; those with more adipose tissue tend to float (5).

DRAG

Movement in water tends to slow down quickly. Drag, the resistance you feel to movement in the water, is a function of fluid characteristics (viscosity), frontal shape and size, and the relative velocity between the participant and the water (1). The results of drag make for a very different loading to the muscles during exercise in the water compared to land exercise. On land, your muscle load decreases when you achieve a constant speed. In the water, you have a constant muscle load provided by the water through full range of motion (5).

VISCOSITY

Viscosity refers to the friction between molecules of a liquid or gas, causing the molecules to tend to adhere to each other (cohesion) and, in water, to a submerged body (adhesion). This friction between molecules, or the water's viscosity, is what causes resistance to motion. Because water is more viscous than air, water provides more resistance to motion than air. As Galileo discovered, friction or viscosity causes an object to fall slower through water than air. He found that a combination of the surface area of an object and its speed determines the resistance to the motion caused by the fluid viscosity (drag). During exercise, additional resistance increases the intensity of the movement and thus requires greater muscular effort (1).

In water exercise, the resistance of the water increases with the speed or velocity of movement. When speed is increased, range of motion and body position can be compromised. The most effective way to train a muscle is through a full range of motion. It is also difficult to push against the water's resistance in all directions of movement when using fast, ballistic movements. Additionally, some individuals are not able to maintain movement at speeds high enough to alter or influence intensity.

Options include hand position (drag shape), lever arms (arms and legs), (Picture 3) adding impact (acceleration), using impeding or assisting arms (action/reaction), and traveling (total body inertia). There are other options and combinations of options as well. Altering intensity with these options does not compromise range of motion or safety. Individuals could work through a full range of motion against the water's resistance in all directions and promote muscle balance. Using the laws and principles of the water can help individualize intensity alterations through a variety of adjustments and is a much better option than merely adjusting speed (1,5).

Picture 3. Elbows bent (shorter resistance arm) requires less effort, elbows extended (longer resistance arm) requires more effort.

HYDROSTATIC PRESSURE

Pascal's law states that fluid pressure is exerted equally on all surfaces of an immersed body at a given depth (1). Hydrostatic pressure affects internal organs of the body as well as the skin. Hydrostatic pressure can decrease swelling and pressure, especially in the lower extremities that are immersed deeper. However, people who have respiratory disorders might have difficulty breathing when immersed in the water past the rib cage due to the hydrostatic pressure (1,5).

AQUATIC EQUIPMENT

An increasing variety of fitness equipment is available for use in aquatic training. Some of this equipment is used in land fitness and can be brought into the aquatic environment, whereas other equipment is developed specifically for use in the water (5).

Aquatic equipment falls into five general categories:

- Buoyant, Drag, Weighted, Rubberized, Flotation

Following is a partial list of the general types of equipment used in the aquatic environment:

- Foam hand bars, Foam noodles, Foam belts for around the waist, Foam kickboards, Foam wafers or boards (Picture 4)
- Plastic paddles, Fins—hand held or attached on the ankles, Plastic hand-held drag equipment, Drag parachutes (Pictures 5)
- Balls—beach balls, water polo balls, weighted balls, and so on
- Various hand-held weighted dumbbells
- Rubber tubing and bands

General types of equipment used in the aquatic environment

Foam hand bars	Plastic paddles	Balls—beach balls	Dumbbells	Rubber tubing
Foam noodles	Fins—hand held	water polo balls	Hand-held weighted dumbbells	Bands
Foam belts for around the waist	Fins attached on the ankles	weighted balls		
Foam kickboards	Plastic hand-held drag equipment			
Foam wafers or boards	Drag parachutes			

Aquatic equipment general categories:

Buoyant	Drag	Flotation	Weighted	Rubberized
Foam hand bars	Plastic paddles	Foam noodles	Dumbbells	Rubber tubing
Foam noodles	Fins—hand held	Foam belts for around the waist	Hand-held weighted dumbbells	Bands
Foam belts for around the waist	Fins attached on the ankles	Foam kickboards	weighted balls	
Foam wafers or boards	Plastic hand-held drag equipment	Balls—beach balls		
Foam kickboards	Drag parachutes			
	Foam hand bars			
	Foam kickboards			

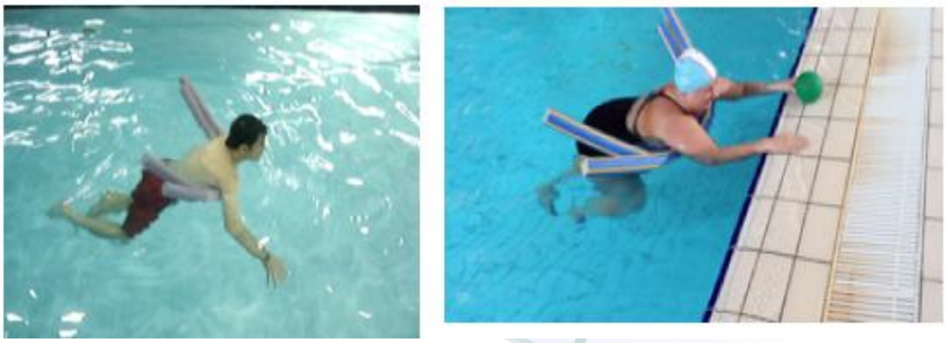
Picture 4. Buoyant equipment

Picture 5. Drag equipment

Before adding equipment to your aquatic program, you should recognize the purpose of the equipment, be aware of all safety considerations, and understand how the equipment will alter training results. It is important to consider assisted and resisted movement, agonist and antagonist muscle relationships, type of muscle contractions, and the effect each type of equipment has on single- and multiple- joint movement.

Deep and Shallow water exercises

To increase the mobility of the lower and upper body joints, the movements should be performed at a slow pace, in a wide range of motion and with control. In the deep water exercises, the participants will feel more comfortable if perform the exercises in a prone or in an upright position. Later they can perform similar exercises in a supine position (Picture 6, 7). Exercises to increase mobility can be performed also in a shallow water, for the knee, hip and shoulder joint.



Picture 6. Deep water mobility exercises in a prone or in an upright position

Picture 7. Deep water mobility exercises in a supine position

Scientific Rationale for Aquatic Training

Researchers have found that aquatic exercise is undertaken in water, usually with a temperature between 32°C and 36°C. The aim of exercise therapy for people with osteoarthritis (OA) is to improve their strength and control over the knee joint in order to improve sensorimotor control and achieve compensatory functional stability (6) This may be achieved by the following changes: increased muscle strength, improved balance and coordination of movements, and improved joint mobility (6,7).

Aquatic exercise may be more beneficial for people with OA than similar training on land, as the element of hot water is believed to reduce pain and stiffness of the musculoskeletal system and cause muscle relaxation (8). Aquatic exercise may therefore be more beneficial as initial exercise therapy for people with OA than similar training on land.

Osteoarthritis and aquatic exercise

- Heywood et al. (9) founds significantly lower loads during aquatic exercise compared to exercise on land.
- The rehabilitation program including water exercises most significantly reduced pain in patients with OA before and after total hip replacement surgery (10)
- Belz et al. (11) reported the effects of exercises in a rehabilitation pool on gait efficiency of the treated patients. The results obtained from 249 patients after a 20-week rehabilitation treatment program in water (2 times a week) clearly indicate that this particular type of kinesitherapy is effective in the treatment of degenerative lesions of the hip joint. The patients who exercised in water obtained significantly better results than the control group.

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DID YOU KNOW ?

We rarely consider the resistance of air when we do a leg lift on land. We assume that all the resistance is provided by the effect of gravity on the leg.

When this exercise is performed in water, however, the effect of gravity is opposed by the force of buoyancy (4).

Therefore, most of the resistance to movement comes from the fluid resistance of the water and not the weight of the leg (1,2,3).

In the water, can be performed all the type of exercises, in similar way like the land.

SUMMARY

Aquatic exercise may be advantageous for people with OA. When the element of hot water is included, it is thought to reduce pain sensation, reduce stiffness of the muscular-skeletal system, and to cause muscle relaxation in people with arthritis.

Rehabilitation program including water exercises most significantly influenced the reduction of pain in patients after total hip replacement surgery. Inclusion of water exercises in a rehabilitation program can reduce the use of analgesics in patients with OA.

Designing an Aquatic Training Program

It is critical that the aquatic training program is designed to achieve the following functional outcomes. The sequence is critical!

1. improving range of motion
2. increasing muscular strength
3. improving aerobic and functional ability

Range of Motion Training

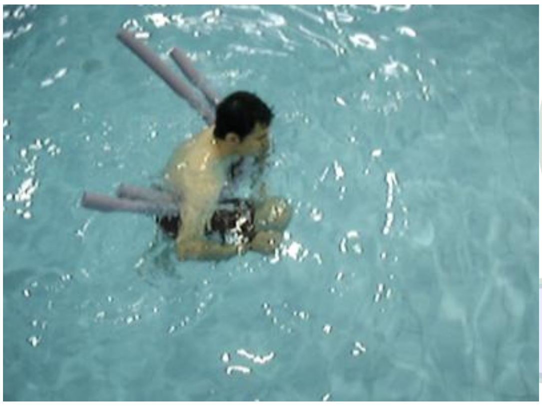
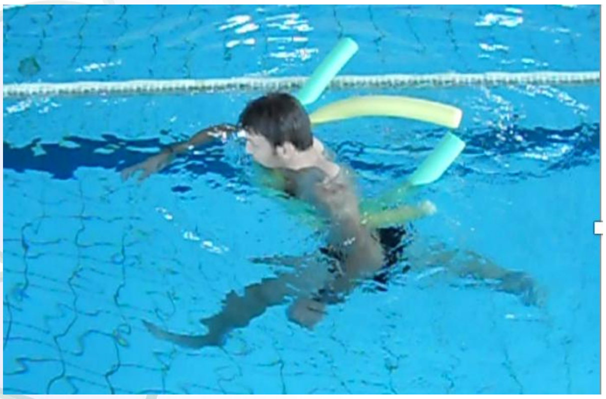
To increase the mobility of the lower and upper body joints, the movements should be performed at a slow pace, in a wide range of motion and with control. In the deep water exercises, the participants will feel more comfortable if perform the exercises in a prone or in an upright position (Picture 6). Later they can perform similar exercises in a supine position (Picture 7). Exercises to increase mobility can be performed also in a shallow water, for the knee, hip and shoulder joint.

Muscular Strength

In water exercise, the resistance of the water increases with the speed or velocity of movement. When speed is increased, range of motion and body position can be compromised. The most effective way to train a muscle is through a full range of motion. Introducing drag equipment simply increases the drag forces of the water. Drag equipment usually increases the surface area to create additional resistance for muscle action. The important concept to note regarding the drag directional force vector is that drag always opposes the direction of movement. The amount of resistance created by a piece of drag equipment is based on the frontal surface area, shape, velocity or speed of the movement, turbulence, and water density (5) (Picture 5). In an aquatic strength training program the number of the repetitions for each exercise should be more than 15. The speed of the movement should be fast, in a big range of motion, with a big lever arm

Aerobic and Functional Ability

For the aerobic training in deep water you can use flotation equipment. You can perform running, bicycling or cross country exercise (Picture 8). In order to improve balance and functional ability is better to perform exercises on sallow water (Picture 8). You can perform one leg stance exercises and use the perturbations of the water when you want to make more difficult the exercise. You can also use steps or stairs.

Picture 8. Deep water aerobic exercises, running and cross country

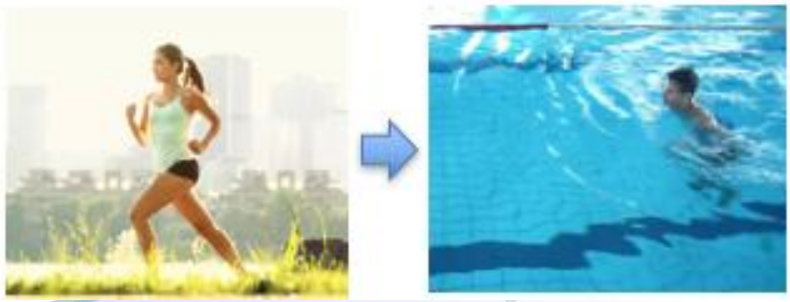

Picture 9. Shallow water aerobic exercises, running

SUMMARY

An aquatic exercise training program can be a complete exercise program. You can perform exercises and drills as a land based program (Picture 10,11,12,13,14,15,16). However you benefit from the peculiarities of the pool environment. You don't have gravity forces and this is very important for persons with cartilage problems like osteoarthritis, or for persons with spine problems.

A complete program should start with mobility exercises and mild aerobic exercises as a warm up.

The main part may include aerobic exercises such as jogging and cycling and muscle strengthening exercises for the upper and lower extremities. Muscle strength exercises should perform with or without the use of drag equipment. The motion should be fast, in a big range of motion for 15 and more repetitions. Finally, you can perform balance and functional ability exercises by choosing the appropriate depth of water, performing one leg stance exercises with the use of perturbations.

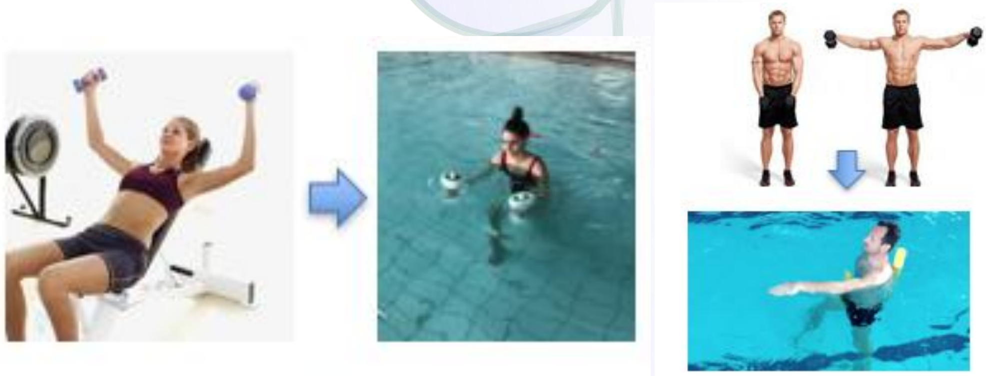


Picture 10. Running on land and in deep water

Picture 11. Bicycle on land and in deep water

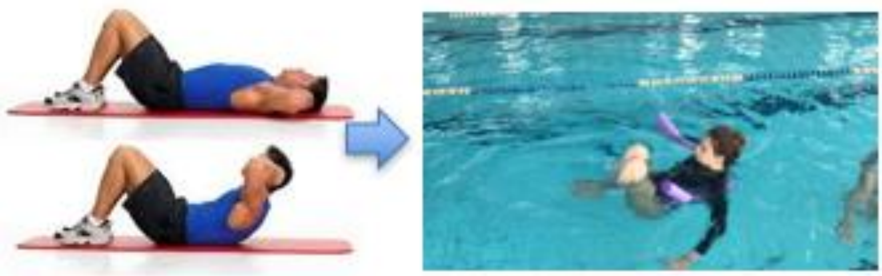
Picture 12. Elliptic movement on land and in deep water

Picture 13. Step movement on land and in deep water



Picture 14. Upper limb strength training on land and in shallow water

Picture 15. Lower limb strength training on land and in shallow water



Picture 16. Abdominal training on land and in shallow water

CHAPTER 2

Proprioception Training

O B J E C T I V E S

After studying this chapter, you will be able to:

- understand the importance of proprioception on joint stability.
- understand the importance of proprioception training in older people and in persons after injury.
- categorize exercises that can be performed to train proprioceptive ability
- use priopríoceptive exercises for injury prevention.
- design a proprioceptive training program for people with musculoskeletal problems

This chapter discusses the concept of proprioception and the important role it plays in joint stability. The mechanism by which it stimulates, receives and processes information will be analyzed. How proprioception can be reduced by immobility and after an injury but also how proprioception can be improved by performing the appropriate exercises.

Trainers must have a basic understanding of the mechanism by which proprioception stimulates. So they will be able to choose the appropriate proprioceptive exercises according to the needs, limitations and goals of their practitioners.

PROPRIOCEPTION AND EXERCISES

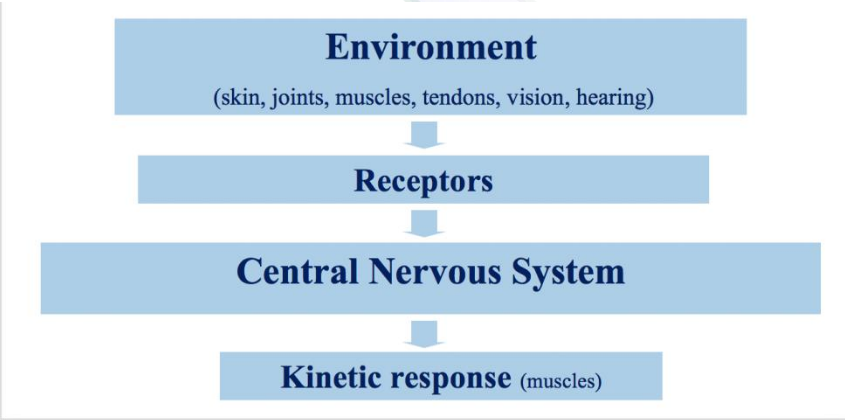
PROPRIOCEPTION

Proprioceptive signals from mechanoreceptors of the joints, muscles, tendons, and skin are essential for the intact neural control of movement. In the literature several researchers have defined the definition of proprioception:

Proprioception is defined as the neural process by which the body takes in sensory input from the surrounding environment and integrates that information to produce a motor response (1).

Proprioception refers to the conscious awareness of body and limbs and has several distinct properties: passive motion sense, active motion sense, limb position sense, and the sense of heaviness (2). However, it has long been established that proprioception has an unconscious component in which proprioceptive signals are used for there flexive control of muscle tone and the control of posture that has long been recognized (3).

The Central Nervous System (CNS) receives information about the position of the body in the space from various receptors (proprioceptors) located in muscles, ligaments, skin. According to these information, CNS activates the appropriate muscles and generates the appropriate kinetic responses



Picture 1. Receiving information from proprioceptors and producing appropriate motor responses

It is important to understand the difference between proprioception and balance. It has been hypothesized that proprioception is important for providing smooth, coordinated movement as well
as protection and dynamic stabilization of joints.

This means that proprioception is a neurologic process, whereas balance is the ability to remain in an upright position. Balance exercises are aimed at improving proprioception; train the brain to recognize the body's segment position every moment.

PROPRIOCEPTION TRAINING AFTER LIGAMENT INJURES

ANKLE

Ankle sprains are the most common injuries managed by athletic trainers (4,5). Physically active individuals participating in activities that require jumping, changing direction, and pivoting are at increased risk for ankle sprain (6,7). After an initial ankle sprain, the joint's passive (eg, joint capsule) and dynamic (eg, muscle) restraints are weakened, leaving the joint unprotected and at risk for reinjury (5). Ankle sprains and the repetitive trauma often associated with the condition can lead to long-term disability, time lost from activity, and economic burdens for patients (7). Although the cost of treatment after a single ankle sprain is low, compounding expenses for extended care to address repetitive sprains in patients with conditions such as chronic ankle instability can increase the economic burden (8). These costs, coupled with the declining physical activity levels and health-related quality-of-life deficits experienced by these individuals, highlight the importance of developing preventive strategies (8).

Proprioception is defined as the neural process by which the body takes in sensory input from the surrounding environment and integrates that information to produce a motor response (6)

Examples of proprioceptive training for the ankle joint include balancing on a single leg with the eyes closed, balancing on a wobble board or ankle disk (Picture 2), and balancing on a single leg while completing a task such as catching or throwing a ball (4,5,6,7) (Picture 3).

These types of exercises can enhance the sensorimotor system's ability to adapt to a changing environment and subsequently protect the body from injury.

Duration ranged from 5 to 30 minutes, frequencies ranged from 1 to 5 times per week, and lengths ranged from 4weeks to an entire athletic season (8,9,10,11).

In addition, the preventive exercises ranged from balancing on a stable surface with the eyes closed to balancing on a tool such as a wobble board and could be included as a warm-up, rehabilitative session, or home-based program (9,10,11,12).

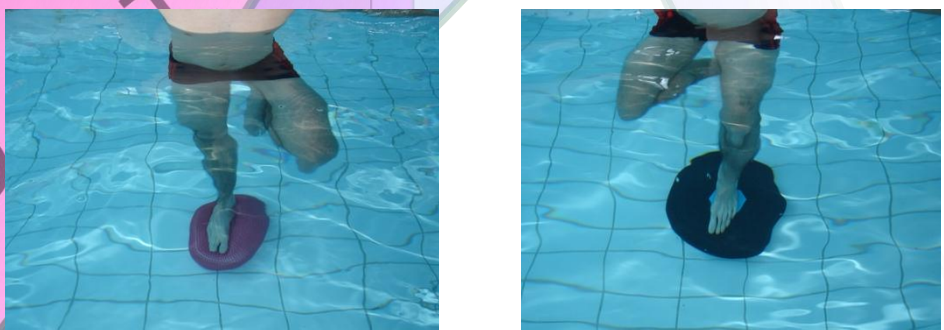
Proprioceptive training reduced a patient' s risk of sustaining a first-time or recurrent ankle sprain (7). Because the implementation details varied so greatly, trainers should consider the amount of daily time they have to dedicate to a patient and the equipment available to them. Proprioceptive training is a cost- and time-effective intervention that can benefit patients who have sustained a previous ankle sprain during physical activity and can subsequently reduce the risk of further complications.

Picture 2. Balancing on a bosu. Two legs stance

Picture 3. Balancing on a balance board. One legs stance, while trying to kick the ball

When using the pool environment for lower limb training, subjects try to stand in the water and maintain a stable upright stance over the base of support, while water movement and turbulence play an important role by overloading the postural control systems especially during one-leg stance (Picture 4). Although water-based training is a non-weightbearing condition for the joints, keeping balance is a difficult task because of the turbulence produced in the water (Picture 5).

Picture 4. One leg stance in water



A B

Picture 5. A. One leg stance on an air disk in water **B.** One leg stance on a wobble board in water

KNEE

Each year, more than 2 million anterior cruciate ligament (ACL) injuries are reported worldwide, with a greater prevalence in young female athletes (13). Multiple modifiable and nonmodifiable risk factors (eg, biological, hormonal, biomechanical, and psychosocial) can influence an individual's susceptibility to knee injury (14). It has been demonstrated that dynamic valgus is one of the most important modifiable risk factors.

Decreased neuromuscular control and high-risk movement biomechanics appear to be significantly influenced by abnormal trunk and lower extremity movement patterns (15). Trainers should implement neuromuscular and proprioceptive training exercises in an attempt to correct high-risk movements and prevent ACL injuries.

The components of neuromuscular control and proprioception are balance training, plyometric (jump) training, strength and resistance training, running-technique training (combined technique training and running exercises [eg, shuttle run, bounding run]), and stretching (16).

Examples of proprioceptive training for the knee joint include balancing on a single leg (with the knee flexed 15°) with the eyes open or closed, balancing on a wobble board, and balancing on a single leg while completing a task such as catching or throwing a ball. Jumping on a trampoline, jumping on a foam mat, jumping on a bosu. Is very important the trainer to check the landing technique avoiding dynamic valgus of the knee.

PROPRIOCEPTION TRAINING FOR OLDER PERSONS

Over 40% of women worldwide will sustain a fracture due to osteoporosis during their lifetime according to the International Osteoporosis Foundation, which may result in remarkably increased morbidity/mortality and reduced quality of life (e.g. restriction of mobility, disability, social isolation, insecurity and fear) (17). It is estimated that 90% of all hip fractures are caused by falls and that hip fracture is the sixth leading cause of death among patients aged over 65 years (17,18).

Postural control refers to control of the body's position in space for the purposes of stability and orientation (19). Falls and fractures are commonly caused by deficient postural control (5, 6). Patients with osteoporosis have an increased risk of falls, due to muscle weakness, spine kyphosis, and decreased postural control (20).

Interventions, including strength training, balance training, endurance, agility and muscular stretching, have been shown to be effective in decreasing the incidence of falls in elderly people (21,22). Interventions that aim to improve the balance and posture of osteoporotic patients reduce the risk of falling and prevent fatal events or hospitalization.

Reducing the incidence of falls is an important approach to decrease health costs and improve quality of life in older patients.

Individuals following hip fractures experience greater postural sway, possibly due to reduced muscular strength and proprioception [23]. Such physical limitations could hinder daily living and increase the risks of falls in patients following hip fracture compared to their healthy, age-matched counterparts.

Balance deficit was the major risk factor for falls. Balance training could prevent falls in elderly individuals [24]. Balance training has a positive role in increasing overall function for hip fracture patients. Moreover, balance training could significantly increase gait and lower limb strength.

Examples of proprioceptive training for older persons include balancing on a single leg with the eyes open. Older persons need support in order to perform the training safely. The older persons should have something close to him / her to help him / her balance and control the stance when he or she is going to lose it. This can be a wall or a chair.

Same exercises could performed in a swimming pool, more safely and without the risk of a fall.

Dynamic balance exercises can also be performed, asking the practitioner to walk on a line, controlling the movement of their body in space.

PROPRIOCEPTIVE TRAINING EQUIPMENT

A big variety of fitness equipment is available for use in proprioceptive training.

wobble boards

- air disks
- bosu
- trampoline
- foam mats

General types of equipment used in the proprioception training

wobble boards	**air disks**	**bosu**	**trampoline**	**foam mats**
round and allows movement in all directions	Big or small	soft inflatable surface	flat	in different sizes
square and allows movement in one direction, AP or ML	the foot contact surface has a different texture	hard surface, swing ability due to base of support	inclined	in various thick

Scientific Rationale for Balance Training

A study evaluating a balance training programme reported improved functional balance and decreased the number of falls in patients with osteoporosis after 12 months of intervention (25)

An other study demonstrated that a 12-month sensorimotor balance exercise programme could significantly increase static and dynamic postural balance, as well as reduce the number of falls, in osteoporotic women (23).

One recent review confirmed that a home-based exercise programme was able to reduce the rate of falls and risk of falling (26). In particular, a balance training programme was revealed to effectively prevent falls and improve quality of life in elderly people (25).

Altered balance was the greatest contributor to falls in elderly people. Good postural balance could reduce the risk of fractures through improving postural stability, mobility and diminishing the risk of falls. Balance training programmes are associated with a significantly reduced frequency of falls in osteoporotic patients.

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DID YOU KNOW ?

Proprioception is a neurologic process and balance is the ability to remain in an upright position. Balance exercises are aimed at improving proprioception; train the brain to recognize the body's segment position every moment.

Proprioception can be reduced by immobility and after an injury but also can be improved by performing the appropriate exercises.

Examples of proprioceptive training include balancing on a single leg with the eyes open or closed, balancing on a wobble board and balancing on a single leg while completing a task such as catching or throwing a ball (4,5,6,7).

These types of exercises can enhance the sensorimotor system's ability to adapt to a changing environment and subsequently protect the body from injury.

SUMMARY

In order to prevent limb injuries, peripheral and central nervous system receptors, mechanoreceptors within muscles; tendons; and ligaments have to be activated. Balance exercises seem to help this activation occur faster and more effectively (27). In other words, the goal of balance exercises should be to reduce the time between neural stimuli and muscular response. Furthermore, it is important that balance exercise programs improve proprioception not only during the rehabilitation phase, but also during the competition period. This means that balance improvement may decrease the risk of future injury.

Designing a Proprioceptive Training Program

It is critical that the proprioceptive training program is designed with progression in order to achieve the following functional outcomes.

1. improving joint stability during static stance
2. improving joint stability during dynamic stance

The content of a balance training program should be adjusted to the peculiarities of each sport - person. Balance exercises must be done in a controlled environment in which the joints are moving in a functional relationship to each other and to the same degree as in normal functional activities, including sports activities.

Improving joint stability during static stance

Start from a 2-leg stance position, and advance to a 1-leg stance position. Try to keep the body stable. Start performing the exercise with open eyes and then with closed eyes (if that is possible).

Try to increase the duration of each exercise.

Improving joint stability during dynamic stance

Start performing the drills from the more stable surface to a less stable surface. Perform drills from a single-plane balance board to a multi-plane balance board. Change the surface on which the board is placed (from soft carpet to hard tile).

Select basic drills related to the specific sport, progressing from the easier to the more difficult.

Start performing the drills with open eyes and then with closed eyes (if that is possible).

Try to increase the duration of each drill.

SUMMARY

Total duration of a proprioceptive training program should be from 15 to 20 minutes.

Each exercise should be performed for 20 seconds and then increased 5 seconds progressively until the 45 seconds.

Respectively, the rest period between each exercise should be reduced from 30 seconds to 15 seconds, gradually. The progression of the balance training program should be from less to more challenging surfaces, such as placing a board on a soft (e.g., carpet) or hard (e.g., tile) surface, or by changing the distance the coach stands from the player.

Trainer will be responsible for choosing the appropriate exercise difficulty for each trainee so that he or she performs the exercises with the correct technique and in the required duration.

CHAPTER 3

Exercise and Diabetes Mellitus

O B J E C T I V E S

After studying this chapter, you will be able to:

■understand the importance of exercise in people with diabetes melitus

■understand the importance of understand and Learning about Prediabetes

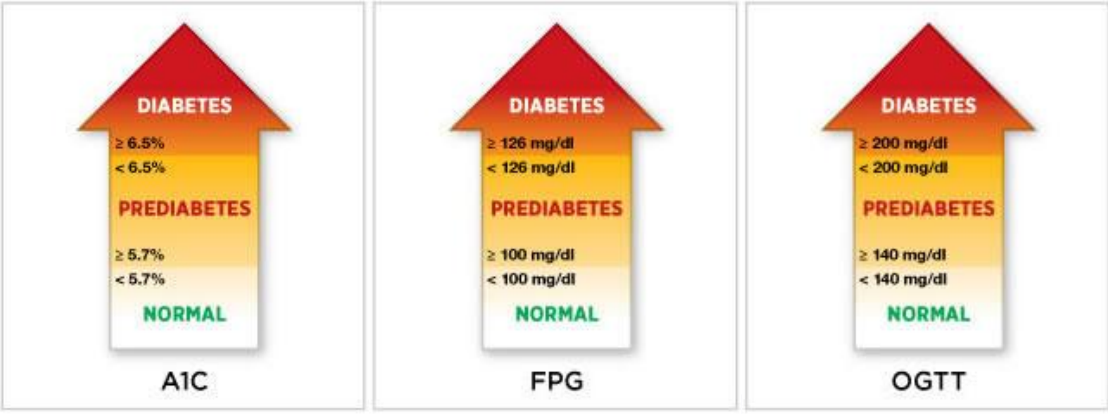
■design proper exercise programin people with diabetes melitus

Diabetes mellitus is characterized by glucose metabolism dysfunction, which causes hyperglycemia as a result of an imbalance between insulin availability and need [1]. DM can be caused by a variety of reasons, such as discontinuation of secretion or reduced insulin secretion by pancreatic cells as well as inadequate or non-functional insulin receptors. The involvement of each of the above factors in the appearance of DM helps both to categorize the disease in subcategories (eg type 1 and type 2 diabetes) and to identify the clinical symptoms of each subclass. Common symptoms of DM are three "poly (very)" (polyuria, polydipsia and polyphagia) and are closely related to hyperglycemia and glycosuria. A person suffering from DM does not have the capacity to transfer glucose into the cells for catabolism (glycolysis) and energy production. As a result of this dysfunction, on the one hand, the cells "starve" and increase the catabolism of fats and proteins to produce energy, and on the other hand, elevated levels of glucose in the vessels cause "endothelial damage", glycosylation proteins and damage to the nervous system. The diagnostic criteria for DM are presented below.

DIAGNOSING DIABETES AND LEARNING ABOUT PREDIABETES[4]

There are several ways to diagnose diabetes. Each way usually needs to be repeated on a second day to diagnose diabetes.

Testing should be carried out in a health care setting (such as a doctor's office or a lab). If blood glucose level is determinedvery high, or if classic symptoms of high blood glucose in addition to one positive test exist, a second test to diagnose diabetes may not be required.



A1C

The A1C test measures the average blood glucose for the past 2 to 3 months. The advantages of being diagnosed this way are that there is no need to fast or drink anything.

Diabetes is diagnosed at an A1C of greater than or equal to 6.5%.

Result	A1C
Normal	less than 5.7%
Prediabetes	5.7% to 6.4%
Diabetes	6.5% or higher

FASTINGPLASMAGLUCOSE (FPG)

This test checks your fasting blood glucose levels. Fasting means after not having anything to eat or drink (except water) for at least 8 hours before the test. This test is usually done first thing in the morning, before breakfast.

Diabetes is diagnosed at fasting blood glucose of greater than or equal to 126 mg/dl.

Result	A1C
Normal	less than 100 mg/dl
Prediabetes	100 mg/dl to 125 mg/dl
Diabetes	126 mg/dl or higher

ORAL GLUCOSE TOLERANCE TEST (ALSO CALLED THE OGTT)

The OGTT is a two-hour test that checks your blood glucose levels before and 2 hours after you drink a special sweet drink. It tells the doctor how your body processes glucose.

Diabetes is diagnosed at 2 hour blood glucose of greater than or equal to 200 mg/dl

Result	Oral Glucose Tolerance Test (OGTT)
Normal	less than 140 mg/dl
Prediabetes	140 mg/dl to 125 mg/dl
Diabetes	200 mg/dl or higher

Random (also called Casual) Plasma Glucose Test

This test is a blood check at any time of the day when you have severe diabetes symptoms.

Diabetes is diagnosed at blood glucose of greater than or equal to 200 mg/dl.

What is Prediabetes?

Before people develop type 2 diabetes, they almost always have "prediabetes" — blood glucose levels that are higher than normal but not yet high enough to be diagnosed as diabetes.

Doctors sometimes refer to prediabetes as impaired glucose tolerance (IGT) or impaired fasting glucose (IFG), depending on what test was used when it was detected. This condition puts one at a higher risk for developing type 2 diabetes and cardiovascular disease.

No Clear Symptoms

There are no clear symptoms of prediabetes, so, some people may have it and not know it.

Some people with prediabetes may have some of the symptoms of diabetes or even problems from diabetes already. Usually prediabetes is diagnosed during diabetes testing.

People with prediabetes, should be checked for type 2 diabetes every one to two years.

Resultsindicatingprediabetesare:

- An A1C of 5.7% – 6.4%
- Fasting blood glucose of 100 – 125 mg/dl
- An OGTT 2 hour blood glucose of 140 mg/dl – 199 mg/dl

Types(Forms) of Diabetes Mellitus

Diabetes mellitus occurs in two main types: (i) type 1 or insulin dependent diabetes mellitus (IDDM) and (ii) type 2 or Non-insulin dependent diabetes mellitus (NIDDM). Other forms of diabetes are gestational diabetes which is-associated with a 40-60% probability of having a Type 2 DM in the next 5-10 years, and diabetes of other etiologies (eg from genetic abnormalities in insulin action, disease pancreas, surgery, drug toxicity) [2].

Type 1 diabetes mellitus

Type 1 DM is less common than type 2 DM, making up approximately 5-10% of cases. The Type 1DM (formerly called "juvenile" DM) is characterized by the autoimmune destruction of pancreatic beta cells by the T lymphocytes, resulting in total insulin deficiency [2]. The disease usually affects individuals aged <30 years old and it first emerges, at the age of 5-6 years or during adolescence. Self-antibodies to β(beta) cells in the pancreas appear early in disease progression and are used as indicators to control its' development. The autoimmune destruction of β-cells does not occur abruptly. Even before the disease is diagnosed, in large groups of β-cells there is ongoing inflammation, while other cell groups are atrophic. It is estimated, therefore, that about 70% of the β-cells has been destroyed prior to the diagnosis of DM.

Patients experience symptoms such as polyuria, polydipsia and reduction of body mass, with a significant increase in blood glucose concentration. Also because of lack of insulin, ketones are increased, resulting in diabetic ketoacidosis, which may even threaten the life of the patient. Patients with DMType 1 require insulin treatment.

Type 2 diabetes mellitus

Type 2 diabetes is the most frequently occurring type of diabetes (90-95% of cases of the DM). Appears mainly in adults and the likelihood of it is increased over the age. The prevalence of DM in population> 65 years is approximately 20%. Type 2 DM is inextricably linked to obesity and particularly to central (abdominal) obesity, in both adult and obese adolescents [10]. Genetic and environmental factors are implicated in the onset of the disease. DM is often associatedwith a variety of metabolic and cardiovascular dysfunctions, such as hypertension, dyslipidemia andatherosclerosis. Together with obesity, they are syndrome X or metabolicsyndrome [11].

In contrast to the type 1 DM, type 2 DM, tissue resistance to insulins mainly responsible for hyperglycemia. In early stages of the disease, pancreaticcells are adapted to insulin resistance, by increasing their size andfunction. Thus, initially, an increase in insulin secretion is observed in the patient.In later stages, changes in metabolic pathways, calcium homeostasis,free radicals, etc., trigger apoptosis mechanisms with a negative impactin the total mass and function of β-cells. In the diagnosis of DM 2,in most patients a decrease by 25-30% in the mass of β-cells [12] andby 10% of α-cells is evident [13]. At more advanced stages of the disease, the destruction ofβ-cells may be large and the patient may experience a decrease in insulin secretion,and exogenous administration of the hormone is required [2].

After diagnosing the disease, most people manage to control it, with combination of medication and lifestyle changes. Lifestylemodification for people suffering from DM 2, should aim to lose at least **7% of body mass** and participating in systematic exercise for **150 min / week**. With over time, the adoption of a careful diet and participation in exercise programs can lead to a reduction in body mass, reduction in insulin resistance and more efficient control of the development of the disease [14]. With the medication, when this is considered necessary, a reduction in glucose levels is achieved by **increasing insulin secretion**, or **by lowering insulin resistance in the liver or peripheral tissues** or by **altering the absorption of carbohydrates in gastrointestinal tract**etc. With these practices, ie, lifestyle change and medication, no exogenous insulin administration is required for patients' survival. However, during the development phase of the disease, a number of patients may experience a lack of insulin secretion, resulting in the need for exogenous administration.

How does exercise affect the transfer of glucose to the cell?

Physical exercise, has long been recognized as an important component of diabetes care (67) and now is considered an important component in the prevention or delay of type 2 diabetes (33, 102). However, only 39% of adults with diabetes are physically active (defined as engaging in moderate or vigorous activity for at least 30 min, three times per week) compared to 58% of other adults (79). It is important that exercise professionals be equipped to assist people with diabetes and those at risk for diabetes in adopting and maintaining more physically active lifestyles.

Initial studies in animals [18] have shown that exercise increases glycogen uptake with two mechanisms: (i) the insulin-dependent mechanism, thereby increasing the **insulin sensitivity**, and (ii) the non-insulin-dependent mechanism, associated with the **cellular contraction** [19, 20]. Subsequent studies, in experimental animals and in humans, have shown that the effect of insulin and the contraction of the cell on glucose transport is cumulative [21, 22]. During cell contraction, the release of calcium from the sarcoplasmic reticulum and the increase in the AMP / ATP ratio activate kinase pathways (such as, calmodulin dependent protein kinase II, AMP-dependent protein kinase, PI3K, AS160), which lead to an increase in glucose transport in the cell [9, 23]. This increased transfer continues after the end of the exercise and is affected by availability to glycogen. Rats, who underwent prolonged exercise (with muscle gonorrhea), had increased glucose transport one hour after the end of exercise. Increased GLUT4 activity was found at 18 h after the end of exercise and remained high up to 48 h, when glycogen replenishment was not the case dueto non-carbohydrate feed intake[24]. Despite the important studies that have examined the insulin- dependent and non-insulin-dependent transport mechanisms of GLUT4 on the cell surface during exercise and recovery, the precise mechanism is yet to be determined [25].

Acute effects of exercise on glucose homeostasis in normoglycemic people

The amount of glucose in the circulation, is estimated at about 4g per 70kg person and is important for the normal operation of different systems. At the commencementof exercise, the glucose release from the liver (glycogenolysis process) increases about 2-4 times, so the body can cope with the demands of working muscles for increased glucose uptake. When exercise intensity is <80% of VO_{2max}, the blood glucose levels are maintained to the desired level, because increased consumption from the muscles is compensated by an increase (3-5 times) of glucose production (with glucogenolysis) by the liver. Mechanisms of gluconeogenesis, i.e. glucose production from non-carbohydrate sources (such as lactate, pyruvate, glycerol, alanine and other amino acids), are employed to support glucose production. It is estimated that the gluconeogenesis provides 6-11% of glucose production at 40 min exercise. At moderate exercise on a bicycle, glucose consumption was estimated at 3 mg / kg body mass per minute [26]. Glucose uptake by muscle in 40 min cycling was elevated 7 times, from resting levels, when exercise intensity was low, and 10-20 times when the intensity was moderate / intense. In case the increased consumption was not counterbalanced by glucose production by the liver, symptoms of hypoglycemia would occur in about 30 minutes of exercise [27]. In normoglygaemic-people, the occurrence of hypoglycaemia in exercise is uncommon, except inprolonged exercise and depletion of glycogen.

When exercise intensity is high (> 80% of VO_{2max}) there is an increase in blood glucose levels, both during exercise and recovery (for up to 1h) [8]. In particular, during high-intensity exercise, the large release of catecholamines (increase in plasma levels by 10-20 times from resting levels) causes high amounts ofglucose release from the liver (increase by about 8 times, compared to rest).

The production of glucose, therefore, exceeds consumption, resulting in increased blood glucose. During high-intensity exercise, insulin shows less reduction compared tolow intensity exercise,possibly as a response to the increased glucose levels. The glycogen / insulin ratio of the hepatic portal vein does not show any major changes.At the end of the exercise, the sharp decline incatecholaminesresults in a sharp increase in insulin levels. Hyperinsulinemia and hyperglycemia promotes muscle glycogen replenishment.

Kraniou et al. [28] examined the effect of the intensity of aerobic exercise on GLUT-4. Healthy sedentary individuals were exercised, either for 60 min at 40% of peak oxygen consumption (VO_{2peak}), or for 27 min to 83% of VO_{2peak}.

Muscle glucogenlevels of vastuslateralis quadriceps muscle was lower at the end of the highintensity of exercise, suggesting greater glycogen consumption. The expression of GLUT4 at mRNA and protein level was increased in both types of exercise, compared to rest. The expression of GLUT4 was maintained elevated at 3h after exercise, howeverwith no statistically significant differences between the two exercise intensities.

Acute effects of exercise on patients with diabetes mellitus

The acute effects of exercise on DM patients are dependent on glucose levels in rest, the type and diseaseduration, the medication type as well asthe exercise duration and intensity. Patients with DM 1, with smooth insulin regulation at rest, require more thorough exercise supervision, ashypoglycaemia is likely. Conversely, in DM 2 the risk of hypoglycemia during exercise is reduced, compared to DM 1.

Exercise, increases glucose transport in cells with non- insulin-dependent mechanisms, leading to the reduction of glucose levels in individuals with insulin deficiency or insulin resistance (DM 2). The non-insulin-glucose transport (during exercise) does not exhibit a dysfunction in diabetic patients [29]. This mechanism improves its function withphysical training and by increasing hexokinase enzyme [1, 29]. Patients with DM 2 with slightly increasedglucose levels show a decrease in glucosewith exercise, but without hypoglycemia. In particular, patients with DM 2, posing glucose levels of 200 mg / dlandnormal insulin levels after 45 minutes of exercisein 60% of VO_{2max}, showed a decrease in blood glucoseby ~ 50 mg / dl [30]. When the exercise was heldshortly after meals,postprandial hyperglycemia and hyperinsulinemia was decreased [31]. This reveals a significant positive effect of exercise on the diabetic patients, as postprandialhyperglycemia is an independent risk factor of developing cardiovascular disease.

Hypoglycemia is the "fear" of insulin-dependent patients during exerciseand recovery, especially when it comes to prolonged aerobic exercise. As the insulin is exogenously administered, no reduction in its' baseline levelsis observed in the beginning of exercise, as this is the case with a normoglycemic people. Indeed, if insulin hasbeen administeredto a working muscle shortly before the beginningof the exercise, increased muscle perfusion during exercise results in rapid release ofinsulin into the circulation. As glucagon levels are not alteredsignificantly during exercise, there is no reduction in the glucagon / insulin ratio.Consequently, hepatic glucose production does not show the expected increase duringexercise. In addition, elevated insulin levels cause high glucose uptakefrom the muscle. Theabove two factors (decreased glucose releaseup to 50% and increased glucose uptake by the muscles) lead to reduction in glucosein the blood, ie the occurrence of hypoglycemia. It is therefore important to reduce the insulin dose in patients with insulin dependent diabetes, ifaerobic exercise is to be performed [3, 32]. Dose reduction is proportional to duration and intensityof exercise. In people with ketoacidosis and hyperglycemia exercise is inappropriate [3, 32, 33].

Acute adaptations of patients with DM, in high-intensity exercise are similar with those of normoglycemic individuals. The large increase in catecholamines, in this type of exercise can compensate for high levels of insulin, and lead to high glucose release from the liver and, therefore, to avoid hypoglycaemia.

CHRONIC EFFECTS OF EXERCISE

Exercise & Prevention of Diabetes Mellitus

Exercise and increased physical activity contribute to prevention of DM. Asinsulin resistance is preceded complete development od DM, systemicparticipation in training programs may be an important limiting point of the disease development [40]. Study results from Finland [41] showed that a decreasebody mass, fat intake and saturated fatty acids in combination withincreased fiber consumption and exercise can reduce the appearance by 58%of DM 2 in subjects with impaired glucose tolerance. In addition, a DM preventing program in the United States (USA Diabetes Prevention Program) [14, 42], in pre-diabetic individuals, showed that lifestyle modifications, with accompanying reduction in bodymass by at least 7%, and engaging in exercise for at least 150 min / week for3 years, resulted in a greater reduction in the incidence of DM 2 compared to the applicationof pharmacotherapy without any change in lifestyle. Low levels of physical activityand capacity are independent risk factors in theappearance of the DM [43].

Chronic effects of exercise on patients with diabetes mellitus

Frequency, intensity and duration of exercise in interventional studies that examined the effects of exercise on patients with DM vary. The largest number of studiesinvolved aerobic exercise 3-5 times a week. The intensity used, ranged between50-75% of VO_{2peak} and the duration of the programs lasted from 10 weeks to one year.A smaller number of studies examined the benefits of resistance exercise. Although insome studies the exact training protocol is not clear[44], in most studies the frequency of training was 3 times / week andthe duration of the programs from 8 weeks to 6 months. The intensity ranged between 50-80% of 1 RM and the sets from 1-4, and 8-20 repetitions / set [44].

Chronic effects of exercise on patients with diabetes mellitus 1

ymptoms of hypoglycaemia (sweating, trembling, increased heart rate, confusion, etc.)increase the fear of young people with DM 1, as well as their parents for participation in exercise [47]. Probably, this is one of the reasons that researchhas shown that young people with DM 1 have lower aerobic capacity (lower VO_{2max} andshorter time of maximum fatigue) compared to non-diabeticpeople with similar somatometric features [48, 49]. Nevertheless, there are famous high-profile athletes who suffer from DM and have distinguished themselves in sports,such as rowing, swimming, cricket, basketball [33].A large number of studies have focused on the mechanisms of glycemic regulation atexercise, in individuals with DM 1 [50]. Exercise, as mentioned above, increases the insulin receptors sensitivity and the activation of GLUT-4 (translocation to cellularmembrane). In young subjects with DM 1, the insulin receptor sensitivity was increasedafter the exercise and maintained at high levels for 7-11 hours on recovery[51]. Participation of children, aged 11-14 years, in a three-month exercise program (60 min / week) showed an increase in HDL, but no decrease in glycosylatedhemoglobin [52]. While participation in a six-month program (60 min, 4 times / weeks) increased HDL, decreased LDL, triglycerides and glycosylatedhemoglobin [52]. Consequently, the above researchers suggest long-term participation of DM-1 people in exercise, at least for 3 times / week [52].In a meta-analysis [53], which examined the chronic effects of aerobic exercisein individuals with DM 1, it is reported that while systematic exercise did not changeglycosylated hemoglobin levels, the required insulin dose decreased by 6-15%.In these studies, although individuals with DM 1 experienced improvements in lipids, insulin sensitivity and endothelial function after exercise,they did not show any changes in blood pressure, as opposed to the results of studies inpatients with DM 2. The young age of the participants with DM 1 in the studies maybe the main reason forthis result. Studies, which focusedon the effects of resistance exercise,report a decrease in glycosylated hemoglobin levels in patients with DM 1 [36].

Chronic Effects of Exercise in Patients with Diabetes Mellitus 2

In patients with DM 2, beyond of the positive effects of exercise on insulin sensitivity and glycosylated hemoglobin (by 4.2 mmol / mol or 0.6%),improvements are observed in other body systems and functions, such as endothelial cellsfunction, lipid profile, etc.

Endothelial Function and Exercise in Patients with Diabetes Mellitus 2

Aerobic exercise program of six months' duration (4-6 times a week, 40-45 min, 70-75% of maximum heart rate) in subjects with glucose intolerance (IFG),improved endothelial function [54]. Conversely, minimal changes in endothelialfunction were presented in pre-diabetic subjects and 1st grade relatives of patients with DM2, who participated in an aerobic exercise program (lasting 10 weeks, frequency3 times / week, 45 min / workout, intensity 70% VO_{2max}) [55]. Also, a combined exercise and healthy diet program(a 30% reduction in daily calorie intake) which lasted for 12 weeks inoverweight and obese subjects with DM 2, improved glycemic and lipid-profile but did not result in major changes in endothelial function [56]. It mustbe noted that in the last two studies, the endothelial function of the participants was not pathological. Cohen et al. [57] applied a 14-month resistance exercise to obese people withDM 2 (2 months under supervision, 12 months with guidance). Inthe onset of the program the intensity was set to 50-60% of the 1 RM and then progressively increasedat 75-85% of 1 RM (3 sets, 8 reps). The exercise did not improve endothelial function in the first 2 months of training. Important improvements, however,observed at 14 months. The study showed that significant improvements in endothelial dysfunction do notappear immediately, but after systematic and chronic exercise.

Comparisons of the combined effect of endurance and resistance exercise on the endothelial function were performed by Kwon et al. [58], in women with DM 2. Participants performed either brisk walking (12 months, 5 times / week, 60 min / day, intensity 4-6 METs) or a resistance exercise with elastic straps(3 times / week, 3 sets, 10-15 repeats, 60 min / day). The study results showed that, after systemic aerobic systemic exercise, the respiratory threshold appeared ingreater VO_{2max}relative intensity and a decreased glycosylated hemoglobinwas observed. Although improvement in endothelial function was observed with both types of exercise,the improvement was greater after the aerobic exercise program, compared to theresistance exercise most possibly due to the higher frequency of aerobic exercise.

Lipidemic profile and exercise in people with diabetes mellitus.

Increased physical activity improves the lipid profile. More specifically, a literature review[59] presented 51 research results (with 4,700 participants) examining theeffects of aerobic exercise on the lipid profile. The duration of the intervention wasover 12 weeks, and HDL cholesterol increased by 4.6%, whileplasma triglycerides and total cholesterol decreased by 3.7% and 1%, respectively.Furthermore, patients with DM 2 with increased physical activity showed reduced adipocytes concentrationcompared to their sedentary peers[60]. Participation of patients with DM 2 in resistance exercise programs(3 times / week, 60 min duration, intensity 60-80% RM, 2-3 sets of 8 exercises)resulted in reduction of apolipoprotein-B, improved glycemic control and better insulin sensitivity [61]. The study of Kadoglou et al. [60] showed that aerobic exercise led to greater changes in the lipid profile and systolic arterialpressure, compared to resistance exercise.

Exercise Load and Effects on Diabetes Mellitus

Attempting to answer the question, “what is the requiredexercise load, which brings positive results to DM”, Segerstrom et al. [62] examined high (72% of the heart rate reserve) and low (65% of the heart rate reserve) intensity combined aerobic and resistance exercise in women. Improvement in insulin sensitivity and reduction in glucose hemoglobin was evident in participantsin high intensity exercise.High intensity was responsible for 30% of insulin sensitivity improvement,while the total amount of exercise (about 200 min / week) was responsible for 25% forreduction in glycosylated hemoglobin.

What is the optimalload of exercise to benefit the patient?

People with glucose tolerance (IGT) are offered a minimum exercise programat **150 min / week with moderate-intensity exercise** (minimum weekly consumption-900 kcal / week, 60-90 minutes at 60% of VO_{2peak}). For exercise to be effective,prevention of diabetes mellitus should also be followed by a healthy nutritional programby limiting calorie intake [3, 63]. A recent study by Dube et al. [64] suggests that the improvement in insulin sensitivity was positively related to the weekly energyconsumption (kcal) spent during exercise. However, improvement inglycemic control was observed even when the energy expenditure during exercise wasabout 400 kcal / week, without changes in eating habits.

A study that examined the effect of exercise intensity on insulin sensitivityin the elderly, reports that high intensity exercise (75% of VO_{2peak})produce positive results compared to low intensity exercise (50% of VO_{2peak}) [65]. Theload in both exercise programs was about 1000 kcal / week and the durationof the programs were 12 weeks.Despite the positive effects of exercise on DM, a study by Ford and others. Showthat only 23% of elderly people with DM 2 were exercising more than 60 min /week [66]. Possibly the fear and the lack of information may influence the participationof DM patients in exercise programs.

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CHAPTER 4

SELF- MYOFASCIAL RELEASE WITH FOAM ROLLERS DURING HEALTH TOURISM

O B J E C T I V E S

After studying this chapter, you will be able to:

■understand the importance of myofascial release exercises.

■understand the importance of myofascial release exercisesin all people.

■categorize exercises that can be performed to train myofascial release

■design myofascial release training program for exercising people

This chapter discusses the concept of myofascial release and the important role it plays in muscularskeletal function. The mechanism by which it stimulates, receives and processes information will be analyzed.

Trainers must have a basic understanding of the mechanism by which myofascial release exercisesstimulates. So they will be able to choose the appropriate exercises according to the needs, limitations and goals of their practitioners.

EXERCISE PROGRAM FOR TOURISTS WITH OR WITHOUT MUSCULOSKELETAL DISORDERS

When designing a program for an unknown team of persons (like tourists are) it must be taken into account that the program should be adequate and effective for different target groups, of different ages, musculoskeletal condition, athletic level etc. At the same time an exercise program for tourists has to combine effectiveness with relaxation and fun since they are on holidays and they have the need to escape from their usual routines and entertain themselves in all circumstances, even during an exercise session. An exercise program that appears suitable to accomplish all previous goals is self-myofascial release (SMR) with foam rollers (FRs) (or other SMR tools) since it is effective, relaxing and entertaining and it is also expected to be something new at least for the majority of the tourists.

SMR: its aims and its effectiveness

SMR is a self-massage technique that derives from the concept of myofascial release. Myofascial release is awhole-body, soft tissue therapy technique which through the application of pressure by the hands of a manual therapist in the myofascial tissues facilitates a stretch into the restricted fascias and elongates and soften the tight connective tissues (Barnes, 1997; Paolini, 2009; Weerapong et al., 2005). By extension, SMR works under the same principles as myofascial release (MacDonald et al., 2013) and has similar goals but in this case the pressure in the tissues is exerted by the individuals themselves using specialized devices like FRs, roller massagers and various types of small balls. Both techniques aim to treat myofascial restrictions that are due to connective tissue tightening.

Connective tissue tightening comes as a result of overuse and overactivity of the myofascial tissues (due to poor posture, repetitive movements, imbalanced training etc) (Behara& Jacobson, 2017; Clark &Lucett, 2011). This overactivity gives rise to recurrent microtrauma which in its turn creates inflammation. Inflammation initiates a protective mechanism, increasing muscle tension and causing muscle spasm. As a result of the spasm, adhesions begin to form in the soft tissue (Clark &Lucett, 2011). Adhesions (which are also known as “knots”, “hot spots”, “trigger points”, “tender points”) are defined as “dense, hypersensitive areas found within a palpable taut band of muscle tissue” (Aboodarda et al., 2015; Kantelborn, 2006; Penney, 2013). These adhesions can be active or latent but in all cases, form a weak, inelastic (unable to stretch) matrix that decreases normal elasticity of the soft tissue (Clark &Lucett, 2011; Paolini, 2009). The clinical signs and symptoms of these trigger points are restricted range of motion, pain and muscle weakness due to pain (Cagnie et al., 2013).

Given all these, the primary goals of SMR are to: a) inhibit the overactivity of the myofascial tissues and b) soften the shortened and release the hypertoned myofascial tissues (Clark &Lucett, 2011). This is achieved through the breaking of the myofascial adhesions using pressure (Weerapong et al., 2005). The reduction of myofascial adhesions then leads to alleviation of muscular tension (Kalichman& Ben David, 2017), pain reduction (Barnes, 1997; Kalichman& Ben David, 2017), correction of muscle imbalances (Bushell et al., 2015), reduction of functional limitations of the musculoskeletal system (Boguszewski et al., 2017), functional improvement (Barnes, 1997) and restoration of tissues elasticity previously inhibited by the presence of the adhesions (Penney et al., 2013).

There are also many scientific researches that have documented statistically significant increases in flexibility (either acutely or chronically) after treatments with FRs or Roller Massagers in various muscle groups of the lower limbs like the hip flexors (Bradbury-Squires et al., 2015; Cheatman et al., 2017; Mac Donald et al., 2013; Marcovic, 2015), the hamstrings (Boguszewski et al., 2017; Junker &Stöggl, 2015; Marcovic, 2015; Mohr et al., 2014; Sullivan et al., 2013) and the ankle prantarflexors (gastrocnemius and soleus) (Daskalaki, Malliou, Beneka, Gioftsidou, Bebetsos, 2018; García-Gutiérrez et al., 2017; Halperin et al., 2014; Kelly & Beardsley, 2016). As it is pointed out in a recent meta-analysis these effects in most of the researches remain statistically significant up to 10 minutes (Cheatman et al., 2017), but in the more recent research by Daskalaki et al. (2018), that examined the effect of a treatment with a FR in the flexibility of the ankle plantarflexors, the increases in ankle ROM were more pronounced in relation to previous researches and remained statistical significant for 20 minutes. In any case the beneficial effect of SMR in the increase of flexibility is well documented.

Key points for the effective use of FRs and SMR devices

For an effective use of FRs and other self-massage tools there are 7 key points that the athletic coach, fitness instructor or physiotherapist should take into account in order to guide an effective session of SMR. Specifically, the questions that must be answered when designing a program are the following:

1) Who is the target population and what is the purpose of the SMR session?
2) What type of SMR device to use?
3) What is the best technique of rolling?
4) How much pressure to exert?
5) For how long (duration of sets, rest)?
6) Whatpacetouse?
7) WhentoperformSMR?

Who is the target population and what is the purpose of the SMR session?

A SMR session must be designed and organized according to the “principle of individuality”. For example, it must be taken into account each person’s age, experience in relation to SMR, musculoskeletal condition, special necessities, identity (if he/she is professional or recreational athlete) and the exact purpose of the FR application (i.e. warm up/cool down after training, increase of flexibility, alleviation of muscular pain, relaxation etc). All these points are explained briefly hereupon.

What type of SMR device to use?

Regarding FRs there are many different types of different sizes, material, density and diameter. According to their characteristics they exert more or less pressure to the tissues. Those made of softer, less rigid materials offer less penetration into the soft tissue because of their increased compressibility and have an effect on more superficial layers of the fascia, whereas tools that are harder and more rigid access deeper layers of the fascia and exert increased pressure. Also, a larger diameter roller will not penetrate as deeply into the soft tissue as a smaller diameter roller. So, the progression would be to select first a large diameter roller, made of a softer material and to progress to one with a smaller diameter, made of a more rigid material (Clark &Lucett, 2011).

Examples of different types of FRs that have been used in previous researches and have documented increases in flexibility are Smooth Rollers, the Grid Roller and Rumble Rollers. Smooth rollers are less aggressive and suitable for beginners. They contact larger areas and exert less pressure at the tissues (Behara& Jacobson, 2017). The Grid roller “has grooves throughout the surface of the roller, creating a grid. Across the roller’s surface there are zones of different firmness and multiple densities so, when rolling, one can utilize these different zones to alter the pressure” (Foamroller.net). It exerts a medium pressure so it is suitable for users of an intermediate level. The rumble roller is even more aggressive and it is suitable for experienced users. It contains nodules that are semiflexible but firm and have an asymmetrical shape and several of the nodules contact the body simultaneously. So, theoretically, they exert more pressure because they do not contact a large surface area like a smooth roller (Behara& Jacobson, 2017).

WHAT TYPE OF ROLLER TO USE?

Smooth Roller

The Grid Roller

Rumble Rollers

Selection of FR according to:

Material and density (softer and less rigid materials offer less penetration into the soft tissues and exert less pressure)
Surface (smooth VS nodules)
Diameter (larger diameter FRs offer less pressure in comparison with smaller diameter rollers).

Other devices for SMR

Other devices that can be used for SMR are roller massagers and different kinds of balls (medicine, tennis, golf or lacrosse balls). The difference between FRs and Roller Massagers is that while in FRs the pressure exerted depends on body-weight in RMsit depends on the strength of the upper limbs and for this reason is less in comparison with FRs. Roller Massagers are also an effective solution for persons with wrist problems that cannot support their body weight in their palms in order to apply FR i.e when treating the calves. Roller

Massagers are also convenient and travel-friendly, they can be transported more easily in the work-place, they offer variety in the application of SMR and also they are easier to use when one limb is injured and immobilized giving in this way the opportunity to focus the application on the free, uninjured limb enhancing in this way the possibility to provoke a cross-transfer effect in the flexibility of the injured limb.

On the other hand, while FRs are best used in treating large muscle groups, balls (medicine, tennis, golf, lacrosse balls) are more suitable for treating muscle or fascia on a smaller surface area (Robertson, 2008) and can concentrate more easily on a hot spot. Like FRs, balls that can be used for SMR come in various materials and different diameters (Clark &Lucett, 2011). As it is proposed by Clark &Lucett (2011) progression should be made by beginning with a large diameter ball (e.g., medicine ball) to a smaller diameter, firmer ball (e.g., tennis ball, softball, baseball, golf ball).

Techniques of rolling

As for the technique of rolling, two of the most common myofascial techniques include either exerting pressure while rolling back and forth (Bushell et al., 2015) in a slow and melting pace in order to provoke tonus decrease (Schleip, 2003) or sustaining the pressure (Barnes, 1997) in painful areas also known as "trigger points", "hot spots" or "knots" (Kantelborn, 2006; Penney et al., 2013) since the compression of trigger points is believed to release them leading finally in an increase of flexibility (Junker &Stöggl, 2015; Penney et al., 2013).

How much pressure to exert

The pressure that will be exerted depends on a combination of the type of roller, the body-weight of the subject, the modification of the exercise and the instructions given. Previous instructions in scientific researches include: a) "as much force through the roller as possible" (Kelly & Beardsley, 2016), b) "pressure equivalent to a pain level of 7 out of 10" (Halperin et al., 2014) c) "an amount of pressure that provokes a sustainable and not intolerable amount of pain/discomfort" (Daskalaki et al., 2018). All these instructions were effective in provoking an increase in flexibility. In a recent research (Grabow et al., 2017) that compared the impact of different intensities of rolling forces (50-90% of maximum discomfort) in the flexibility of quadriceps during a treatment with a Roller Massager it was found that rolling forces do not substancially amplify ROM so it is suggested to roll a below a level of significant pain or discomfort.

Duration of SMR

According to the theory, recommended durations of SMR and FR start from 30–60 seconds (Kaltenborn, 2006) and last as long as five minutes (Paolini, 2009) per muscle or until a release is felt (Couture et al., 2015; Paolini, 2009), while it is also discussed that greater durations could probably lead to greater gains in flexibility (Bradbury-squires et al., 2015; Monteiro et al., 2017; Murray et al., 2016; Škarabot et al., 2015).
The above-mentioned guidelines concerning durations are recommended only in case that the goal is the enhancement of flexibility and could be applied to the recreationally active population. In case FRs are used by athletes these durations are adequate for cool down but concerning warm up they would definitely need revision in order to not influence in a negative way the performance of the athlete.

Pace

A slow and melting pace is advised in order to induce parasympathetic state and for muscle tonus decrease (Schleip, 2003). So, the user should roll the device slowly over the muscle treated, if the goal is to break myofascial adhesions, alleviate muscular pain and/or to enhance flexibility.

What muscles to treat?

SMR could be used either locally targeting one group of muscles or globally for a whole body treatment. However, it is advisable not to treat only isolated muscles but muscle chains.

When to perform SMR?

SMR can be performed anytime during the day (for healthy subjects). When exercising it can be performed as a complementary method during warm up or as recovery and cool down. For the increase of flexibility it has been proven more effective the combination of FR with static stretching and it has been recommended that FR is executed before static stretching(Mohr et al., 2014).

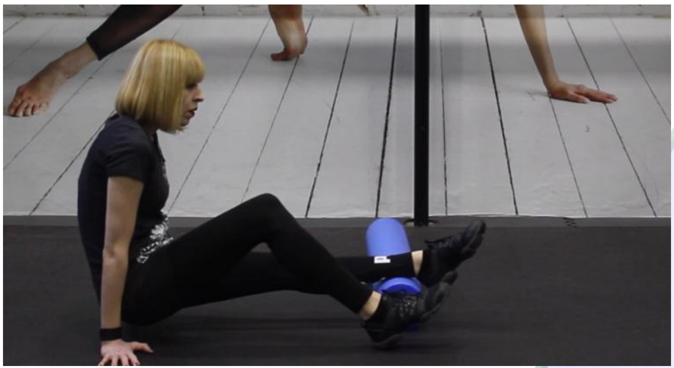
Contradictions

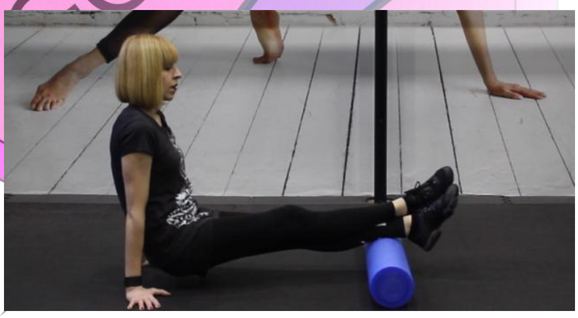
As it is proposed by Clark &Lucett (2011), anyone using SMR techniques should follow the same precautionary measures as those established for massage or myofascial release. As it is further advised by the same researchers, SMR should be cautioned or avoided by people with: healing fractures, febrile state, osteoporosis, phlebitis, acute rheumatoid arthritis, advanced diabetes, congestive heart failure, kidney failure or any organ failure (such as the liver and pancreas), contagious skin conditions, cancer (under certain circumstances such treatments should not be applied). For example, sometimes massage, pressure, or tension can damage tissue that is fragile from chemotherapy or radiation treatments.

EXERCISES FOR THE LOWER LIMBS

ANKLE PLANTARFLEXORS (GASTROCNEMIUS AND SOLEUS)

Rolling area: From the achilles tendon till the polpiteal fossa.
Progression:
1.One leg on the ground and the other on the FR
2. Two legs on the FR
3. One leg on the FR and the other crossed on top of it.





GLUTEUS MEDIUS AND PIRIFORMIS

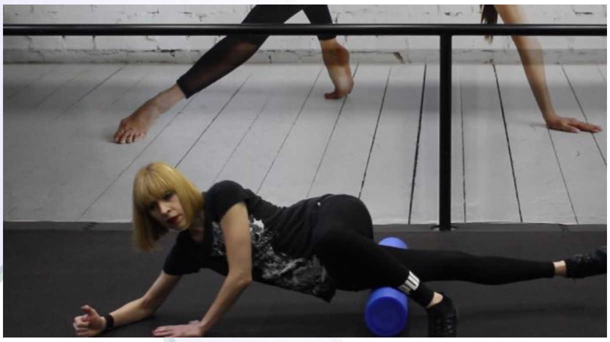
Rolling area
From ischial tuberosity till the top of the pelvis.

Progression
1. Both legs on the ground.
2. One leg on the FR and the other crossed on top of it.

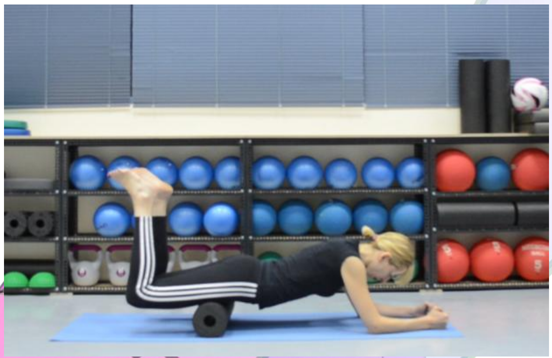
ILIOTIBIAL BAND

Rolling motion: From the greater trochanter till just before the knee joint.
Progression
1. One leg on the FR (slightly raised off the ground) and the other on the ground and crossed in front of the treated leg).
2. One leg on the FR and the other on top of it.

I.T.



QUADRICEPS/HIP FLEXORS



Rolling area: Just above the patella till the anterior superior iliac spine
Progression:
1. One leg on the ground and the other on the FR
2. Two legs on the FR
3. One leg on the FR and the other crossed on top of it.

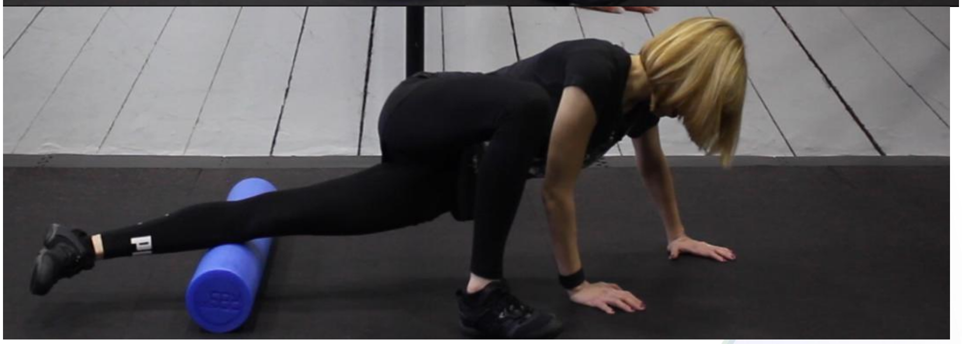
ADDUCTORS

Rolling area: From the inner side of the mid-thigh till just above the knee.
Progression:
1. Support the body weight on the palms.
2. Support the body weight on the elbows.


AMILA


AMILA

PERONEAL MUSCLES



Rolling area: From the outside lower part of the leg till just before the knee.

Progression

1. One limb on the FR and the other on the floor crossed in front of the treated leg.
2. One limb on the FR and the other above it.

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CHAPTER 5

Core training

O B J E C T I V E S

After studying this chapter, you will be able to:

Understand the importance of the core musculature.

- Understand the difference between the stabilization system and the movement system.
- Discuss the importance of core training.
- Design a core training program for clients with different level of training.
- Propose various core training exercises.

Physical trainers must have a basic understanding of functional anatomy to understand the principles of core training. The **core** is defined by the structures that make up the lumbo-pelvic-hip complex (LPHC), including the lumbar spine, the pelvic girdle, abdomen, and the hip joint. A strong and efficient core is necessary for maintaining proper muscle balance throughout the entire human movement system (kinetic chain) (Clark, Lucett, & Sutton, 2012)

The core musculature has been divided into the local stabilization system, global stabilization system, and the movement system (Clark, Lucett, & Sutton, 2012).To maintain core stability, neuromuscular control of the local and global stabilization systems and the movement system is required, ensuring sequential coordinated activation of all systems at the right time with the right amount of force (Clark, Lucett, & Sutton, 2012).

CORE FUNCTIONAL ANATOMY

LOCAL STABILIZATION SYSTEM

The local core stabilizers are muscles that attach directly to the vertebrae. These muscles consist primarily of type I (slow twitch) muscle fibers with a high density of muscle spindles. Core stabilizing muscles are primarily responsible for intervertebral and intersegmental stability and work to limit excessive compressive, shear, and rotational forces between spinal segments. Another way to view the function of core stabilizing muscles is that they provide support from vertebra to vertebra. These muscles also aid in proprioception and postural control because of their high density of muscle spindles (McGill 2001). The primary muscles that make up the local stabilization system include the transverse abdominis, internal obliques, multifidus, pelvic floor musculature, and diaphragm. These muscles contribute to segmental spinal stability by increasing intra-abdominal pressure (pressure within the abdominal cavity) and generating tension in the thoracolumbar fascia (connective tissue of the low back), thus increasing spinal stiffness for improved intersegmental neuromuscular control (Richardson et al, 1999, Crisco 1991; Hodges 1999; O'Sullivan PB, 2002).

GLOBAL STABILIZATION SYSTEM

The muscles of the global stabilization system attach from the pelvis to the spine. These muscles act to transfer loads between the upper extremity and lower extremity, provide stability between the pelvis and spine, and provide stabilization and eccentric control of the core during functional movements. The primary muscles that make up the global stabilization system include the quadratus lumborum, psoas major, external obliques, portions of the internal oblique, rectus abdominis, gluteus medius, and adductor complex (Comerford, 2001).

Muscles of the Core - Local Stabilization System

Transversus abdominis
Pelvic floor muscles
Diaphragm
Internal oblique
Lumbar multifidus

Muscles of the Core - Global Stabilization System Movement System

External oblique	Adductor complex
Quadratus Lumborum	Adductor magnus
Portions of internal oblique	Adductor longus
Gluteus medius	Adductor brevis
Psoas major	Gracilis
Rectus abdominis	Pectineus
External oblique	

Muscles of the Core - Movement System

Latissimus dorsi
Quadriceps
Hamstring complex
Hip flexors

MOVEMENT SYSTEM

The movement system includes muscles that attach the spine and/or pelvis to the extremities. These muscles are primarily responsible for concentric force production and eccentric deceleration during dynamic activities. The primary muscles that make up the movement system include the latissimus dorsi, hip flexors, hamstring complex, and quadriceps (Newmann, 2002.).

Core Training Parameters / Variables Exercise Selection

When a trainer design a Core training program should consider the next parameters:

Parameters of the Core Training Program

Plane of motion
Range of motion
Type of resistance
Body position
Speed of motion
Duration
Frequency
Amount of feedback

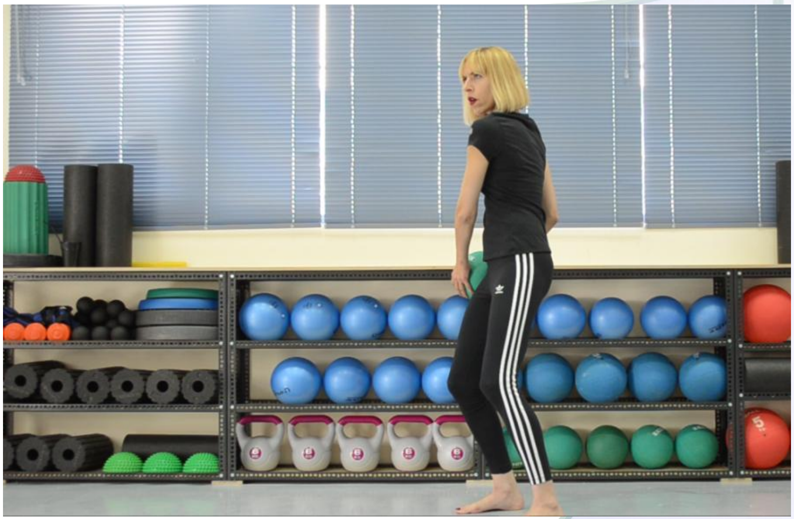
Also there are a variety of exercise selection in order a trainer to choose the proper ones.

Plane of motion: Core exercises must be safe and challenging, and stress multiple planes in a multisensory. So the exercises should be applied to the Sagittal, to the Frontal and to the Transverse and to the combination of them to experienced client.

Sagittal plane

Frontal plane

Transverse plane



Range of motion: A core training program should regularly manipulate not only the plane of motions but the range of motion also. Multiple range of motion exercise must be proposed including Full, Partial and End-range of torso motion.

Type of resistance: Modalities as tubing, stability ball, medicine ball, Bosu ball, • Power ball, Dumbbells, Kettlebells, Airex pad, etc. in relation to body position are proposed to used for the clients in order to apply different type of resistance.

Body position: Proposing different body positions a trainer will to emphasize the entire muscle action spectrum focusing not only on force production (concentric) and force reduction (eccentric) but to the dynamic stabilization (isometric) of the core muscle which is the keystone for a healthy musculoskeletal system. The proposed body position are Supine, Prone, Side-lying, Kneeling, Half-kneeling, Standing, Staggered-stance, Single-leg, Standing progression on unstable surface etc.

Finally, the Speed of motion (Stabilization, Strength and Power), the Duration, the Frequency the Amount of feedback will be considered in order to integrades the proposed Core Training program.

Exercise selection for the Core Training Program

ystematic
Progressive
Activity/Goal-specific
Integrated
Proprioceptively challenging

When designing a core training program, the personal trainer should design a systematic, progressive, functional and emphasize the entire muscle action (concentric, eccentric and isometric) comprehensive core training program.

Progressive program: the program has to be **easy** to **hard**, **simple** to **complex**, **known** to **unknown** and from **stable** to **unstable** while selecting the appropriate exercises to elicit a maximal training response.

Systematic program: the program has to focus initially to stabilization of the core muscle and continually to gain the strength and the power of the core muscle with the proper exercise selection.

When designing a core training program, the personal trainer should also create a proprioceptively enriched (controlled yet unstable training environment) with Swiss ball, BOSU, Reebok Core Board, half foam roll, Airex pad, Bodyblade etc

DID YOU KNOW ?

….The use of weight belts for apparently healthy adults engaging in a moderately intense exercise program is not recommended. Weight belts may raise an individual's heart rate and systolic blood pressure and often give individuals a false sense of security and the misconception they can lift heavier

loads. Instead, personal trainers need to educate their clients as to appropriate exercise technique and proper activation of the core musculature (the body's natural belt)…(**Clark, Lucett, & Sutton, 2012).**

SUMMARY

Performing traditional abdominal and low-back exercises without proper spinal and pelvic stabilization may cause abnormal forces throughout the LPHC, which may lead to tissue overload and cause damage (Clark, Lucett, & Sutton, 2012). However, performing the drawing-in maneuver or bracing can help stabilize the pelvis and spine during core training and other functional movements. In addition, keeping the cervical spine in a neutral position during core training improves posture, muscle balance, and stabilization (Clark, Lucett, & Sutton, 2012).

Designing a Core Training Program

It is critical that the core training program is designed to achieve the following functional outcomes. The sequence is critical!

1. Local stability (Intervertebral stability)
2. Global stability (Lumbopelvic stability)
3. Kinetic efficiency (Movement efficiency)

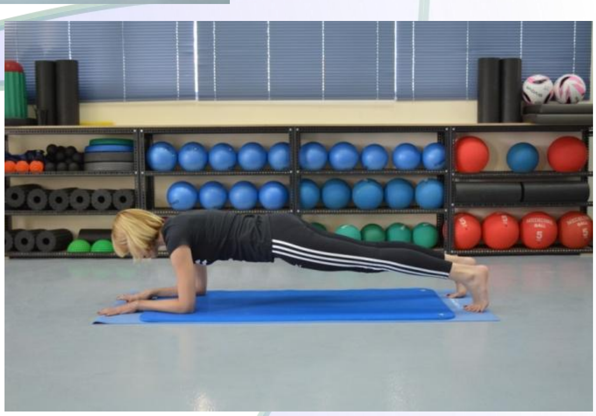
LEVELS OF CORE TRAINING

There are three levels of training for the core training: stabilization, strength, and power.

A proper core training program follows the same systematic progression.

Core-Stabilization Training

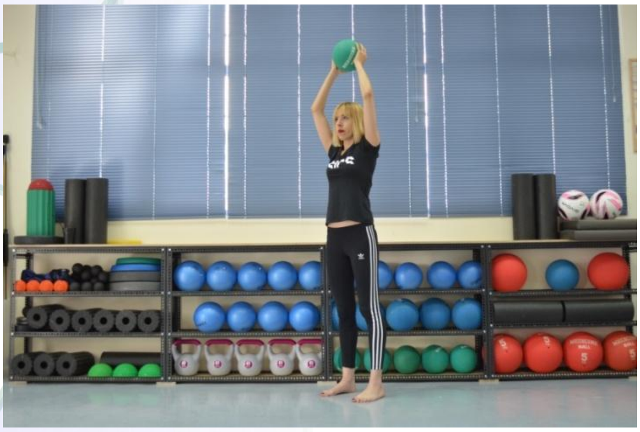
In core-stabilization training, exercises involve little motion through the spine and pelvis. These exercises are designed to improve neuromuscular efficiency and intervertebral stability, focusing on drawing-in and then bracing during the exercises with mostly isometric activation of the core muscle. Usually the participants spend 4 weeks at this level of core training.



Core Strength

In core-strength training (Phases 2, 3, and 4), the exercises involve more dynamic eccentric and concentric movements of the spine throughout a full range of motion while participants perform the activation techniques learned in core-stabilization training (drawing-in and bracing). The specificity, speed, and neural demands are also progressed in this level. Usually the participants spend 4 weeks at this level of core training. These exercises are designed to improve dynamic stabilization, concentric strength (force production), eccentric strength (force reduction), and neuromuscular efficiency of the entire kinetic chain. Exercises in this level include:



Core Power

In core-power training , exercises are designed to improve the rate of force production of the core musculature. These forms of exercise prepare an individual to dynamically stabilize and generate force at more functionally applicable speeds. Exercises in this level include:





SUMMARY

The core musculature helps protect the spine from harmful forces that occur during functional activities. A core-training program is designed to increase stabilization, strength, power, muscle endurance, and neuromuscular control in the LPHC. Core training programs must be systematic, progressive, activity or goal-specific, integrated, and proprioceptively challenging.

Core exercises must be safe and challenging, and stress multiple planes in a multisensory.

A core training program should regularly manipulate not only the plane of motions but the range of motion also. Proposing different body positions a trainer will to emphasize the entire muscle action spectrum focusing not only on force production (concentric, eccentric, isometric).

Amount of feedback will be considered in order to integrades the proposed Core Training program.

The program has to focus initially to stabilization of the core muscle and continually to gain the strength and the power of the core muscle with the proper exercise selection.

Finally when a trainer is designing a core training program should also create a proprioceptively enriched using proper equipment.

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CHAPTER 6

Exercise and Obesity

Definition

Because many assessments are used to determine threshold values for overweight and obesity, the definitions vary. Overweight can be most simply defined as weight that exceeds the threshold of a criterion standard or reference value (0). The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive fat accumulation that may impair health (0). A common current approach in the clinical setting for determining overweight and obesity is to use body mass index (BMI).

Obesity refers to the accumulation of excess adipose tissue in the body. The disease is associated with an increased likelihood of developing health problems and can lead, over time, to a reduction in life expectancy [2, 3]. Its main characteristic is the disruption of the energy balance, that is, the relationship between consumed and produced energy.

Obesity, considers to be a multifactorial disease characterized by disorders in endocrine system and metabolism, as well as disorders in the person's behavior. It is considered as a chronic and relapsing disease and a major problem of public health. Obesity is linked to appearance other chronic diseases, such as arterial hypertension, type 2 diabetes, heart disease and stroke episodes, dyslipidemia, sleep apnea syndrome, asthma and hormone-dependent cancers [2, 4-6]. The alarming growth rate of people with obesity in industrial and countries, has led to the classification of obesity by the World Health Organization (WHO) as a "rising epidemic"; and a major public health threat [3].

Obesity appears to reduce life expectancy, and this effect is most powerful in those who develop obesity earlier in life. Flegal and colleagues (using National Health and Nutrition Examination Survey [NHANES] III data reported that obesity, but not overweight, is related to excess premature death (0). They estimated 112,000 excess deaths per year because of obesity and reported that as obesity levels became more severe (class I to II to III), the mortality rate increased. In addition, several studies have found a protective effect on mortality for overweight individuals when other conditions are present such as heart failure and revascularization per percutaneous intervention (0). It is important to understand that there are limitations to this “obesity paradox” data. These include the cross-sectional nature of the observations, limited data on change in weight over the follow-up period, and assessment of variables that may affect weight including pulmonary disease, human immunodeficiency virus (HIV) infection, alcohol and drug use, smoking, and cancer (0). The obesity paradox may, in part, be explained by cardiorespiratory fitness levels in overweight and obese individuals. Higher fitness values based on estimated metabolic equivalents (METs) during an exercise test are associated with a lower all-cause mortality rate (0). Recent findings from the legendary Harvard Alumni Health Study reported a doubling of heart disease risk in those who were obese in early childhood (0). But, importantly, this risk was reduced when weight loss occurred in midlife or later. This study is important because it is one of the few to provide these data longitudinally with prospective measured BMI in both early and later life.

CLASSIFICATION OF OBESITY

o assess the individual's fat content and to classify the disease, the Body Mass Index (BMI) is used.

BMI is recommended by the National Institutes of Health to classify overweight and obesity and to estimate relative risk of associated disease (0). Body mass index indicates overweight for height but does not discriminate between fat mass and lean tissue. The BMI does, however, significantly correlate with total body fat (0). Therefore, BMI is an acceptable measure of overweight and obesity in the clinical setting. Body mass index is calculated as weight divided by height squared. In particular, is the ratio of the body mass (weight in kg) to the height squared (in m^2) [7, 8]. Obese is an adult with a BMI greater than 30 ($kg{\cdot}m^{-2}$), while overweight is an adult with a BMI of more than 25 ($kg{\cdot}m^{-2}$) [3].

The measurement of body fat, for the evaluation of obesity, can be done (i) by direct methods, such as CT and MRI, and (ii) by indirect methods, such as underwater weighing, skinfold measurement or the measurement of bioelectric resistance (bioelectric impedance assessment, BIA). Despite the reliability of these methods in the determination of body fat; the complexity of measurements, the need for special equipment and specialized personnel and the radiation (in the case of CT) do not make them easy to use. For these reasons, the World Health Organization suggests, for epidemiological reasons, studies, the use of the Body Mass Index (BMI), as a handy tool for classification of obesity. Increased body weight and coexistence of other risk factors, such as smoking, increase the likelihood of heart metabolic disease.

Table 1. BMI classification

Weight class	Obesity class	BMI (kg/m^2)
Underweight	–	<18.5
Normal	–	18.5–24.9
Overweight	–	25.0–29.9
Mild obesity	I	30.0–34.9
Moderate obesity	II	35.0–39.9
Severe obesity	III	≥40.0

Weight class is determined by BMI cut-off points. Obesity is defined as BMI ≥30 kg/m^2.

Adapted from: Blackburn, George & Mun, Edward. (2005).

BMI has a strong correlation with body fat percentage, as well as with total body fat (in absolute terms) [9]. For this reason, the BMI can be used for sufficient evaluation of a large number of people. The results of measurements, however, should be interpreted with caution, given that the BMI could provide with false results in the assessment of obesity to people with large muscle mass. In particular, there may be important inaccuracies with respect to determining if a given BMI is "unhealthy" or if a person with a BMI categorized as overweight (or obese) actually has an elevated body fat percentage. For instance, some studies have reported that a BMI range of 25.0 to 29.9 may be no different from a BMI <25.0 or even superior with respect to all-cause death (0). Others report that all-cause mortality is lowest for the BMI range of 20.0 to 24.9 (0). In addition, the BMI does not provide information on the fat and the type of obesity.

Types of obesity

The results of studies over the last two decades have revealed that the severity of obesity morbidity is more correlated with local body fat distribution than the total amount of fat [10]. Obesity based on fat distribution, is distinguished in "abdominal" or "central" obesity and in "peripheral obesity".

Abdominal obesity (formerly called "android" obesity) increased fat distribution in the upper body and especially in the body abdomen [11]. This type of obesity is considered to be the most common, as it is associated with elevated rates of diabetes mellitus and heart disease [12].

The second type of obesity, peripheral obesity (formerly called "Gynecological obesity" [11]), has a high fat deposition in thigh and buttocks. This type of obesity is associated with a lesser degree complications compared to central obesity [12]. A more important factor in fat distribution is distinguishing abdominal visceral fat from subcutaneous fat. Visceral fat lies deep within the body cavities and is associated with a higher risk than subcutaneous fat and waist circumference because of the metabolic characteristics, which include insulin resistance, glucose intolerance, and clustering of metabolic risk factors (0). Despres et al. [13] using CT, showed that both central / abdominal obesity is divided into two subtypes: superficial subcutaneous and deep, visceral obesity. Obese people with elevated viscera fat, showed abnormal glucose tolerance and elevated levels of triglycerides in blood, while people with similar total abdominal fat but low visceral fat had normal glycemic and lipidemic profiles [12]. Visceral fat is best measured by magnetic resonance imaging (MRI) or computed tomography (CT), which are expensive and unavailable to most clinical exercise practitioners.

Factors that promote visceral obesity are age, gender, hormone- (testosterone, DHEA, estrogen), genes, race, growth hormone levels, the function of the hypothalamic-pituitary-adrenal axis and glucocorticoids as well as eating habits (increased consumption saturated fat and fructose). Finally, the lack of physical activity and the sedentary lifestyle contributes to the development of visceral obesity. On the contrary, participation in exercise programs brought fat loss from the abdomen even when there was no significant reduction in body weight [14]. The increase muscle mass and improve the sensitivity of β-adrenergic receptors, possibly contribute to less accumulation of fat in the abdomen in people exercising systematically.

Assessment of the obesity

Easy, bloodless methods for assessing abdominal fat concentration in abdomen is (i) measuring the waist circumference and (ii) calculating the ratio of the-waist to hip circumference ratio (waist to hip ratio). According to World Health Organization [15], waist / hip >0.90 for men and >0.85 for women, are considered as high-risk individuals for cardiovascular disease diseases. Also, individuals with BMI >30 kg / m^2 and waist circumference> 102 cm for men and> 88 cm for women, are considered as people at increased risk of developing diabetes mellitus. and cardiovascular diseases [12, 15, 16]. In a large multinational study with 168,000 participants Balkau and others. [17] showed that the onset of cardiovascular diseases and diabetes mellitus, had a greater correlation with the waist circumference than with BMI. Surprisingly this correlation, (the waist circumference and the morbidity) was statistically significant even in individuals with BMI <25 kg/m^2. Other researchers [18] suggest taking BMI and body rate into account fat as a best way to assess cardiometabolic risk in people with obesity. Finally, taking into account both BMI and blood triglycerides is suggested as a good practice to assess the risk of obesity [13].

Obesity Epidemiology

Based on World Health Organization, the levels of obesity have more than doubled since 1980 [19]. In 1997, the World Health Organization officially characterized obesity as a "global epidemic" [20]. Initially, obesity problem was prevalent in countries with a high per capita income. However, during the last decades, the prevalence of obesity is increasing both in developed and developing countries. [21]. Large urban centers have an increased incidence obesity compared to semi-urban territories [3]. Obesity is not common phenomenon in sub-Saharan Africa [0].

It is estimated that obesity (BMI 30 - 35 kg·m^{-2}) reduces life expectancy by mean term, from two to four years [22]. Body mass index> 32 kg·m^{-2} for time over 16 years of age, was associated with a double rate of mortality in women [23]. At United States is estimated that obesity is responsible for more than 300,000 annual deaths [0, 24], while in Europe about 1 million of deaths are due directly or indirectly to the increased body weight [21, 25].

The prevalence of the extreme obesity category (i.e., BMI ≥ 40 kg·m^{-2}) from 1988 to 1994 (2.9%), from 1999 to 2000 (4.7%), and from 2003 to 2004 (4.8%) (0). Extreme obesity appears to be increasing in younger people and is greater among black women than in men, as well as among blacks than in non-Hispanic whites. Black women have the highest rates of extreme obesity in terms of ethnic and gender makeup (0). In the same period, the prevalence of overweight and obesity also rose in every age, gender, and ethnic category.

And throughout the United States, each state demonstrated an increase in the prevalence of obesity with a continual rise throughout the 1990s and into the early 21st century. Although obesity often begins in childhood and early adolescence, 70% of all obesity begins in adulthood. Approximately 17% to 19% of children in the United States are obese, and many will carry their obesity into adulthood (0). The risks of childhood obesity persisting into adult obesity depend on the severity of obesity, age of onset, childhood BMI value, and parental obesity (0). Weight gain tends to be more rapid in early adulthood and can be as much as 10 to 16 kg over a 15 yr period (0.75 to 1.0 kg annually) (0). This weight gain is attributed to an environment that discourages physical activity and promotes excessive food intake, including large portion sizes and high fat content.

During the last few decades, Greek population adopts a sedentary lifestyle and levels of obesity and associated cardiovascular disease tend to reach epidemic proportions. In Greece, the prevalence of obesity is currently at the highest levels among the countries of Western Europe [26, 27]. To men, the prevalence of obesity ranges around 26%, while women in 18.2% [26]. Although the increase in adult obesity is considered to be extremely severe, more alarming is the emergence of this phenomenon in childhood, with 30% of Europe's children being classified as overweight or obese [28]. Interventions in Greek people lifestyle are deemed necessary, to halt the rise in obesity in the country.

Obesity Pathophysiology

Obesity results from longstanding positive energy balance. The simplicity of this restatement of the first law of thermodynamics can blind us to the complex physiology of food intake and calorie expenditures and tempt us to tell patients only to “eat less and run more.” Such an approach is oversimplistic and ineffective. Positive energy balance has a myriad of contributors in current societies, ranging from increasing availability of lower-cost foods that some refer to as a toxic food environment to decreasing physical activity at work and in leisure. Average daily calorie intake has increased by over 200 kcal over the last several decades (0) as food costs have fallen dramatically and as more calories are consumed outside the home. At the same time, physical activity has fallen because of advances in equipment and ergonomics in the workplace.

The occurrence of obesity [29] is associated with both genetic and epigenetic factors. The contribution of genetic predisposition to obesity was estimated at 20-25% while the influence to the body fat distribution was estimated at 50% [30]. Obesity, however, develops under certain conditions, such as the adoption of a high lipid nutrition, sedentary lifestyle, etc. [31]. The significant rise in obese people rates in recent decades, indicates the important role of the environmental factors and sedentary lifestyle in obesity.

In studies that examined the food intake regulation and energy storage, the existence of a homeostatic mechanism in the human organism was supported which its main function is the conservation of energy stocks [32]. Energy deficiency stocks, trigger mechanisms leading to food intake. Increased energy expenditure due to intense physical activity, leads to an increase in calorie intake.

Short-term and long-term regulatory systems determine food intake, energy expenditure and body energy storage. The short-term food regulation prevents over-eating at each meal, while long-term focuses on the conservation of body energy reserves. Short-term (fast) feedback signals that regulate food intake are: (i) the feeling of filling of the gastrointestinal tract, (ii) the hormones of the gastric- endothelial system, which suppress food intake, such as cholecystokinin (CCK), peptide YY, glucanoid peptide (GLP-1), etc., (iii) ghrelin and (iv) of the oral cavity sensors. Long-term feedback signals that regulate food intake are not fully known. According to "glycostat- long-term regulation theory," the reduction in blood glucose concentration causes hunger feeling, whereas increased glucose levels promote the feeling of satiety. According to two more theories, "aminostatic" and "lipostatic" changes in the concentration of amino acids, ketoacids and certain fatty acids in the blood, regulate the feeling of hunger. Also, the ambient temperature affects the food intake regulation, as the food and temperature adjustment centers are located in the hypothalamus resulting in two-way interaction. Also, feedback signals from the fatty tissue regulate the energy stocks and food intake [0, 33].

Changes in the smooth function of the neuro-hormonal system have been associated with abdominal / visceral fat deposition and obesity [12]. Moreover, physiological function of the nerve center of food intake, changes in obesity.

Food intake adjustment

Adjusting food intake is a complex process [34]. Contraction and hyperactivity of the stomach are associated with the appearance of a sense of hunger and seeking for food. The individual's desire to consume a particular food is an appetite, while the desire of the person to terminate the consumption of food is associated with saturation. Although environmental factors can affect these feelings, the primary role in hunger and saturation is regulated by special cerebral centers [32]. The anterior medial hypothalamic nuclei are saturation centers and their destruction in experimental animals leads to bulimia.

Turning on POMC increases power consumption, while activating the POMC NPY and AGRP, reduces energy consumption and increases food intake. Sub-core nuclei in turn, affect hormone secretion, such as thyroid, adrenal and pancreatic hormones and regulate its nutritional individual behavior [30, 32]. Dysfunctions of the melanocortin hypothalamic system lead to obesity [32], while over-activation of this system is a major factor of anorexia [30].

The role of adipose tissue in controlling appetite and obesity

Adipose tissue is not only for lipid storage. It's metabolic active tissue, secreting a host of hormones and peptides that affect the energy balance. In the last decade, lipokines, fatty tissue cytokines, are concentrated scientific interest, as results of studies support their participation in pathogenetic mechanisms [36]. Significant lipokines are leptin, resistin, lipoprotein, quinine, bisphosphine, desoline and bispine [36-38].

Leptin, a 166 amino acid protein, was considered key to research against obesity [39, 40]. It is produced in the adipose tissue and when it crosses the cerebral block, then passes information to the brain about the body needs for food intake [33]. Genetically modified mice, homozygous for the ob gene (ob/ob) presents lack of leptin and have 3-4 times greater body weight than heterozygous mice [30]. Lack of leptin suppresses the feeling of saturation, leading to consuming food without any restriction, while reducing energy consumption. However, only a small percentage of obese people are deficient in leptin and may benefit from its exogenous administration [32, 41]. On the contrary, great number of people with obesity show elevated levels of in plasma and serum [30], leptin resistance and increased sense of seeking for food [42].

Another hormone, which appears to play an important role in the onset of food intake, is ghrelin. It is a circulating peptide hormone, synthesized in the stomach. Ghrelin's action in the hypothalamus, causes the release of growth hormone from the pituitary [43]. Chronic ghrelin consumption from rats resulted in increased food intake and obesity [44]. Ghrelin levels increase during fasting and are reduced in an hour following a meal. The fact that ghrelin levels peaks before the meal, led researchers to assume that ghrelin is involved is in the process of food intake initiation. The appetite stimulatory effects of ghrelin are exerted via stimulation of the NPY neurons of the hypothalamic nucleus. The ghrelin has been found suppressed in obese people. This reduction is probably related to changes in the sensitivity of ghrelin receptors [30].

Obesity hormonal changes

Obese subjects have fluctuations in blood hormone concentration, but also hormonal activity dysfunctions, such as desensitization of hormone receptors. More analytically, obese individuals often have reduced levels of growth hormone as well as hypothyroidism (increase in TSH and decrease in T4) [45]. Also, people with belly-obesity show increased levels of glucocorticoids (cortisol) and insulin and leptin resistance [45,46]. In obese men have been observed reduced levels of total and free testosterone [47-50], while in menopause women, decreased levels of estrogen have been associated with increased fatty tissue and visceral fat deposition [51]. Nevertheless, biphasic estrogen activity in adipose tissue (with lipogenic and lipolytic action) has been described [51].

Hyperinsulinemia, hyperleptinemia, dyslipidaemia, greater activation of the renin-angiotensin system, as well as mitochondrial dysfunction is considered that they contribute to dysfunction of the sympathetic nervous system [52-56] and affect the acute responses to exercise.

Treatment

Although all weight loss treatment should include specific diet, behavioral, and exercise prescriptions, and in some cases pharmacotherapy or weight loss surgery, the specifics of treatment must be matched to the patient's circumstances, including her BMI and related considerations. Patients at lower BMI and without comorbid conditions should be offered less intensive treatment than patients with extreme obesity (BMI ≥40) who have significant obesity-related comorbidities such as diabetes, hypertension, and obstructive sleep apnea. Treatment goals need to consider both the medical benefits of modest (10%) weight loss and the patient's expectations. The NIH has recommended a 10% weight loss within 4 to 6 mo and weight loss maintenance as an initial weight loss goal because this amount is associated with several health-related benefits. Improvements in obesity-related functional limits and medical comorbidities should be identified. Patients, on the other hand, commonly want to lose 35% of their weight to attain their dream weight, seek to lose 25% to reach a satisfactory weight, and would consider a weight loss of 17% disappointing (0). Few commonly prescribed weight loss programs achieve average weight losses that match patients' expectations. Physicians' expectations are not much lower; they consider a weight loss level of 13% disappointing. Patient expectations have been remarkably resistant to change, which may contribute to treatment dissatisfaction, treatment discontinuation, and treatment recidivism.

Exercise Therapy

Certainly exercise and physical activity are important in order for people to avoid becoming overweight or obese. But for the treatment of overweight and obesity, exercise alone has not shown long-term weight loss success (0). Exercise in conjunction with diet therapy or other treatment modalities, however, is effective in slightly accelerating weight loss (0). In the National Weight Control Registry (NWCR), over 90% of the successful subjects combined exercise with diet therapy (0). And evidence from the NWCR suggests that regular exercise of 60 to 90 min on most days of the week, expending 2,500 to 2,800 kcal per week, may be required to maintain large amounts of weight loss for the long term (0). Regardless of the timing of exercise and its effectiveness in causing or maintaining weight loss, all overweight and obese patients will likely demonstrate improvements in cardiovascular function and physical fitness as a result. Additionally, exercise can improve self-esteem, which may improve adherence to weight loss-based treatments.

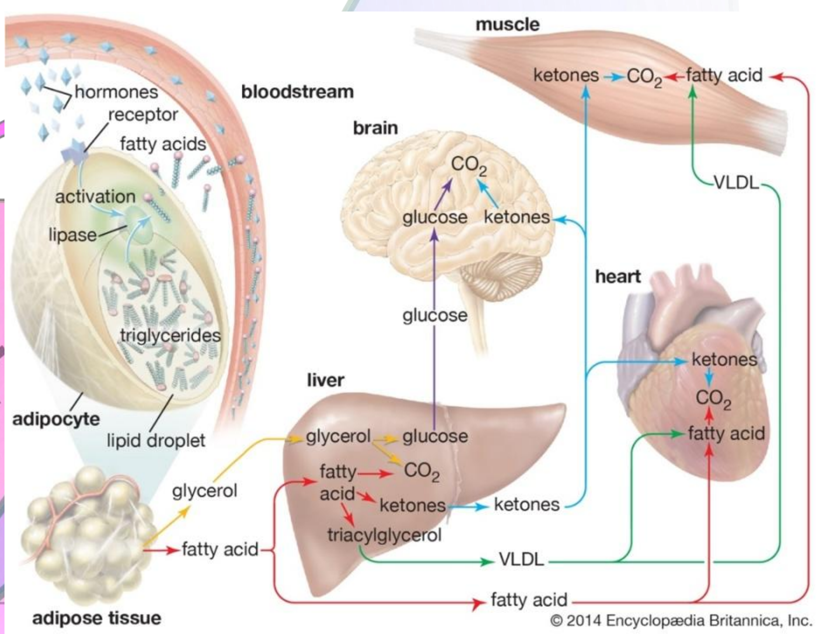
Acute effects of exercise on obese people

During rest and low intensity exercise, fats are the main source of energy for the body. In a fasting state, the body utilizes lipolysis, that is, breaks down the stored triacylglycerols (or triglycerides) of adipose tissue, to glycerol and fatty acids. Fatty acids are taken from albumin and circulated in the blood stream. They are then delivered to the muscle and other tissues where they are oxidized for energy production (ATP) (Figure 1).

Although in resting condition the rate of lipolysis of obese individuals and in particular people with central obesity is increased, the mobilization of fatty acids by adipose tissue during exercise is not at expected levels [35, 57]. The decreased sensitivity to catecholamines, but also the reduced number of β2- adrenergic receptors in the fat cells of obese individuals, potentially contribute to this abnormal response [58]. Also, people with obesity (compared to individuals with normal BMI) show (i) greater binding of catecholamines to α2- adrenergic receptors, resulting in inhibition of cAMP-forming cascade, (ii) reduced removal of the fats species from fat droplets, resulting in reduced HSL activity [58] and (iii) less increase in blood flow during exercise [59]. As a consequence of the above derangement, it is the reduced rate of release, transfer and delivery of fatty acids from the adipose tissue to the muscle cell.

The reduced rate of fat oxidation during exercise in obese people, is probably associated with the reduced antioxidant capacity [60] as vitamin C, E and β-carotene levels are lower in obese individuals [61, 62]. The reduced plasma content in antioxidants is accompanied by a lower activity of anti-oxidant erythrocyte enzymes, such as dismutase peroxide and peroxidase of glutathione [63]. The researchers assumed that reduced antioxidant activity in obese leaves their tissues exposed in free radicals, especially during exercise [60].

Figure 1. *Lipolysis during exercise*



In a recent survey, where acute effects of resistance exercise with eccentric muscular contractions were examined [64], it was found that: (i) the overweight individuals have experienced muscle injury in to a greater extent, and to a more extended time duration, compared to normal body weight individuals (ii) the post exercise increase in the basal metabolic rate was longer in overweight individuals and lasted for longer (iii) the overweight individuals respiratory ratio declined significantly for 2 days after exercise, indicating greater fat consumption and iv) changes in the lipidemic profile of overweight were greater, compared to the individuasl with normal BMI [64].

Obese individuals appear to have a decreased rate of protein synthesis after resistance exercise (acute exercise) [67]. This finding is probably related to decreased growth hormone concentration in the blood during exercise (aerobic and resistance exercise), reduced release of epinephrine, and greater release of cortisol and insulin [57].

Changes in sympathetic nervous system during exercise in obese people

At the exercise onset, people with obesity exhibit less activation sympathetic nervous system (CNS) compared with non-obese individuals [66, 67]. Also, the expected parasympathetic obviation is not observed. The results of the two systems altered function, is the lowest response to heart rate during maximal exercise (chronotropic weakness) [68].

People with obesity often have a high blood pressure increase during exercise, due to dysfunction of the baroreceptors [69, 70]. In addition, slower decline in blood pressure and reduced vasodilation [71] occurs in the first few minutes of recovery [72]. Changes in blood pressure regulating factors are observed not only in obese adults but also in healthy obese children [68]. Yet, dysfunctions also occur in blood pressure regulation reflexes during exercise, such as impaired metabolic reflex action [67, 73]. These changes are partially reversible after weight loss with hypothermic diet, (reduction by 600 kcal / day) and concurrent participation in systematic exercise [66, 74, 75]. Obese and overweight children of good physical fitness exhibit fewer hemodynamic dysfunctions during exercise, compared to sedentary peers of similar body weight [76].

Chronic adaptations to exercise in obese people

The Effects of Exercise on the Regulation of Saturation and Hunger in obese people.

The role of systematic exercise in lipokine levels and in the regulation of obesity satiety and hunger has not been adequately studied. Participation of obese women in three-month exercise program, with 1200-1600 kcal·wk^{-1} energy loss from exercise, improved insulin resistance and decreased visfatin plasma levels. A decrease in plasma visfatin levels was also observed when severely obese diabetic mellitus patients participated in an exercise program which didn't led to significant changes in their body weight [77]. On the contrary, an increase in the visfatin levels plasma was observed after high intensity exercise (7 sets of 6x35 m every 10 s, with 1 min break between sets), indicating an anorexic visfatin effect following a single training unit [78].

Rats, that fed with a high fat diet after 4 weeks training, showed improvement in leptin and insulin resistance, with no changes in adiponectin levels [79]. Bruce et al. [80] showed that aerobic exercise program of 8 weeks, improved glucose tolerance, decreased insulin resistance and increased the fatty acids oxidation in mitochondria. In addition, other studies have shown that increased fatty acid oxidation after aerobic training was mainly attributed to the increased mitochondria number, without major changes in lipolytic ability [81].

Chronic cardiovascular adaptations of exercise

Obesity is inseparably linked to co-morbidity, such as cardiovascular disease (coronary heart disease, heart failure) etc. [85]. The adhesion of lipids and inflammatory factors at the endothelium of coronary arteries, reduces their diameter, reduces blood supply and may lead to myocardial ischemia [87]. Triglycerides and inflammatory substances concentration inside peripheral vessels, causes atherosclerosis and increase of blood pressure. Obesity (mainly the central type obesity), in combination with dyslipidaemia, hypertension and diabetes mellitus consist the so called metabolic syndrome [86, 87]. The negative obesity effects can be partially reversed by a healthy diet and systematic exercise. The combination of these two factors leads to bodyweight loss and maintaining or increasing muscle mass. Specifically, low to average intensity physical activity (eg walking, jogging, biking, swimming, exercising with elliptical equipment) for at least 150 $min \cdot wk^{-1}$, results in a decrease in blood pressure, increase in high density lipoproteins (HDL or "good" cholesterol), reduction of ischemic events, improvement of lipid profile, better blood supply in the body due to improved microcirculation (by increasing the number capillaries) [88] and in general the improvement of aerobic capacity. Based on the above reasons, exercise is considered as an important parameter in prevention and treatment of obesity.

Obese people show a buildup of lipids in tissues that do not belong to adipose tissue, such as the viscera, the heart and the skeletal muscle [89]. Concentration of fat in the heart, is directly related to inflammation and increased insulin resistance [90, 91]. Aerobic exercise intervention of 12 weeks duration (60 $min \cdot d^{-1}$, at 60–70% of HRmax, 3 $d \cdot wk^{-1}$), caused a greater reduction in the pericardial and visceral fat, compared to BMI and total body weight reduction [92]. Systematic exercise participation of obese people in exercise programs caused a decrease in waist circumference and visceral fat, regardless of gender and age [93].

Chronic adaptations of exercise on the neuromuscular system

The role of resistance training in improving muscle strength (maximal strength and strength endurance), functional capacity and quality of life, was highlighted by the American College of Sport Medicine [94-99].

With the increase in muscle mass an increase in the basal metabolic rate occurs [100, 101] where the skeletal muscle at rest consumes approximately 17.6 kcal·kg^{-1} [85].

Therefore, the increase in muscle mass (muscle hypertrophy) as a result of participation in systematic resistance exercise, can lead to basal metabolism increase [100-104]. Nevertheless, it is difficult to achieve significant weight loss with resistance exercise. The beneficial effect of resistance exercise to body composition relies on modifying the adipose / muscle tissue ratio, towards muscle tissue. Maintaining increased muscle mass with resistance exercise can reduce the risk factors associated with obesity, such as dyslipidemia and insulin resistance [105, 106].

Individuals with increased body weight are likely to overload their joints and also develop osteoporosis [107-109]. However, exercise intervention which included walking along with submaximal intensity running, did not induce hip and knee joints osteoarthritis of obese people, but it also proved to be a protective disease factor [109-112]. The aforementioned studies suggest that the joints can be adapted to progressively higher charges [110, 113].

Obesity overloads the joints, not only due to the increased weight applied on them, but also biomechanical problems (e.g. gait pattern) [114]. The change in gait and running technique, contribute to the development of osteoarthritis [115, 116]. Patients with osteoarthritis usually avoid physical activity, though systematic exercise is an effective, non- pharmaceutical intervention. Participation of patients with osteoarthritis in 18-month aerobic exercise (low to moderate intensity and of moderate duration) and resistance exercise programs, significantly improved the functional capacity [117-119] and reduced the level of pain feeling compared to sedentary participants [117]. Improved muscular strength as a result of resistance exercise participation reduces possibility of falls, and prevents joint degeneration [117-119].

Abdominal muscle activity during exercise can contribute to sense of fullness of the stomach and lead to a feeling of satiety and decrease of food seeking [120-123]. In addition, by participating in sports activities, a decrease in calorie consumption is also observed, due to a decrease in access time to food during the day [124, 125].

Conclusion

Exercise and behavioral modification are cornerstones of sound weight management programs. Clinical exercise physiologists, especially those who have a strong background in behavioral or lifestyle counseling, are playing an increasing role in the primary prevention, treatment phase, and secondary prevention of overweight and obesity. Patients benefit from seeking out exercise physiologists who are providing services in weight management programs. Given the number of overweight individuals in worldwide, it is important to continue to advance clinical exercise physiologists to work with overweight patients.

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CHAPTER 7

PRIMARY AND SECONDARY PREVENTION OF CARDIOVASCULAR DISEASE

O B J E C T I V E S

After studying this chapter, you will be able to:

- Understand the importance of primary and secondary prevention of cardiovascular disease (CDV).
- Understand the peculiarities of systematic exercise training in patients with CDV.
- Use safe and effective exercise protocols for prevention / rehabilitation.
- Categorize exercises and activities that can be performed by people with or without risk factors to prevent CDV.
- Design the daily exercise prescription in secondary CVD prevention.

The intent of this chapter is to describe the guidelines for developing an exercise prescription among individuals without (primary) or with (secondary) CVD. Specifically, this chapter will focus on:

i) Modifying risk factors through systematic exercise

ii) Definitions to distinguish between terms exercise and physical activity

iii) Exercise training procedures discusses for outpatient cardiac rehabilitation programs

iv) Resistance & aerobic interval training guidelines

Qualified exercise-training staff must have a basic understanding of risk for exercise. All people (healthy and patients) should be strongly encouraged to participate in a supervised exercise training program.

ASSESSMENT AND MANAGEMNT OF CARDIOVASCULAR RISK

General

Cardiovascular disease is a major cause of disability and premature death throughout the world, and contributes substantially to the escalating costs of health care. CVD is also known as heart and blood vessels disease having an average of one death occurring at every 42 s (1). The underlying pathology is atherosclerosis, which develops over many years and is usually advanced by the time symptoms occur, generally in middle age. Acute coronary and cerebrovascular events frequently occur suddenly, and are often fatal before medical care can be given. Modification of risk factors has been shown to reduce mortality and morbidity in people with diagnosed or undiagnosed cardiovascular disease. This chapter provides guidance on reducing disability and premature deaths from coronary heart disease, cerebrovascular disease and peripheral vascular disease in people at high risk, who have or not yet experienced a cardiovascular event.

Prevalence of the Cardiovascular Diseases

Cardiovascular disease accounts for one-half of all non-communicable (NCD) deaths in the world. The statistics indicate that CVD account for 17.3 million yearly deaths, and this amount is likely to raise up to 23.6 million by the end of 2030 (2). The proportions of the deaths under the age 65 are mentioned in the Table 1. Furthermore, the contribution of CVD among the NCDs is mentioned in the **Figure 1.**

TYPES OF DISEASES	PERCENTAGES (%)
Non-Communicable Diseases	52
Communicable, Maternal, Perinatal, and Nutritional Conditions	34
Injuries and Trauma	14

Table 1: Types of diseases and its percentages [4]

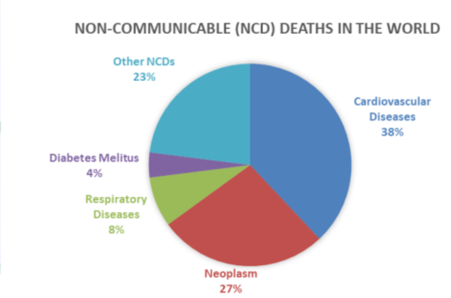


Figure 1: NCDs contributions

Primary prevention

Also, the initiative by the Centers for Disease Control intends in a simply organized ''ABCDE'' approach for guiding a consistent comprehensive approach to managing cardiovascular risk in daily clinical practice (3).

Specifically, ABCDE Approach to Assessment of Cardiovascular Risk includes:

A - Antiplatelet therapy
B - Blood pressure
C - Cholesterol & Cigarette/tobacco cessation
D - Diet and weight management & Diabetes prevention and treatment
E – Exercise / Physical activity

Primary prevention interventions are then focused on those at moderate to high risk of developing CVD events, which maximizes the benefit of interventions while reducing unnecessary treatment. Therefore, primary prevention aims to prevent disease before it ever occurs. This is done by preventing exposures to hazards that cause disease altering unhealthy or unsafe behaviours that can lead to disease, and increasing resistance to disease should exposure occur.

Secondary prevention

According to the definition, secondary prevention aims to reduce the impact of a disease that has already occurred. This is done by detecting and treating disease as soon as possible to halt or slow its progress, encouraging personal strategies to prevent recurrence, and implementing programs to return people to their original health and function to prevent long-term problems.

In the recent years major attention has been given to effective approaches to enhancing quality of life and reducing disability, morbidity, and mortality in patients with CV diseases. Specifically, scientific evidence including data from recent studies in cardiovascular patients, demonstrates that a comprehensive risk factor intervention can extend overall survival, improve quality of life, decrease need for an interventional procedure such as angioplasty and bypass grafting, and reduce the incidence of subsequent myocardial infarction (4). The AHA regarding insufficient application of secondary prevention strategies in cardiovascular patients. The AHA Panel concluded that "only approximately 1/3 of patients with CV disease" receive risk-factor intervention over the long term. The guide to comprehensive risk reduction in this category of patients identifies the nine components (goals and recommendations) as a result of the various intervention strategies.

In particular, it needs to be achieved:

- Smoking (complete cessation)
- Lipid management (LDL<100mg/dL, HDL>35mg/dL, TG<200mg/dL)
- Physical activity* / Exercise training** (minimum goal: 30 minutes, 3-4 times/week)
- Weight management (intensive diet & appropriate exercise intervention), as outlined above, in patients > 120% of ideal weight for height[#]).
- Antiplatelet agents / anticoagulants (start aspirin 80 to 325 mg/dL if not contraindicated or manage warfarin)
- ACE inhibitors post-MI (start early post-MI in stable high-risk patients, continue indefinitely for all with ejection fraction ≤ 40%, manage blood pressure)
- Beta-blockers (start in high-risk post-MI patients, manage angina, rhythm, or blood pressure)
- Estrogens (in all postmenopausal women with other health risks
- Blood pressure control (goal: ≤ 140/90mmHg, initiate lifestyle modification & add blood pressure medication)

* ***Physical activity*** *simply means movement of the body that uses energy.*

** ***Exercise*** *is any bodily activity that enhances or maintains physical fitness and overall health and wellness.*

\# ***%IDEAL BODY WEIGHT*** *= WEIGHT x 100 / IDEAL BODY WEIGHT*

References is consistent with such an approach, and it provides a clear notion that demonstrates the greatest risk reduction involves increasing activity in the least active/least fit people or patients (Figure 2).

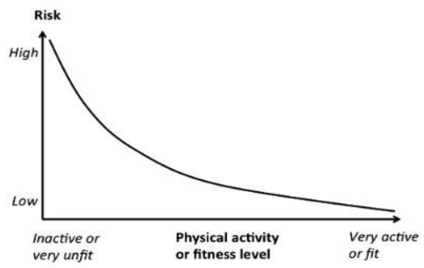


Figure2. Schematic representation of the dose–responserelationship between physical activity or physical fitness level and risk of disease (5).

Physical activity

Physical activity simply means movement of the body that uses energy. Walking, gardening, briskly pushing a baby stroller, climbing the stairs, playing soccer, or dancing the night away are all good examples of being active. For health benefits and safety, physical activity should be moderate intensity and thus to prevent the possibility of CDV. Light and moderate physical activities include:

- Walking briskly (about 3½ miles per hour)
- Bicycling (less than 10 miles per hour)
- General gardening (raking, trimming shrubs)
- Dancing
- Golf (walking and carrying clubs)
- Water aerobics
- Canoeing
- Tennis (doubles)

You can choose light or moderate intensity activities, or a mix of both each week. These activities can be considered light or moderate in intensity, while they make you breathe harder and your heart beat faster.

Exercise training

Exercise, however, is planned, structured, repetitive and intentional movement intended to improve or maintain physical fitness. Exercise is a subcategory of physical activity. Research provides significant evidence that **all** systematic training positively contributes to overall health and well-being. Also, exercise assists with the improvement of physical fitness, which consists of five specific components:

- Cardiorespiratory fitness
- Muscular strength fitness
- Muscular endurance fitness
- Flexibility fitness
- Body composition

Exercise training or systematic exercise training performed for various reasons like to aid growth and improve strength and joint flexibility and keep muscles limber, preventing aging, developing muscles and the cardiovascular system, helping weight loss or maintenance, improving health and also for enjoyment. People or patients who exercise regularly (systematic), at least 3 d/wk with a structured training program) have a stronger endurable musculoskeletal system than physically inactive population. In addition, adults with stronger muscles have a 20% lower risk of mortality than adults with low muscle strength.

GENERAL CONSIDERATION FOR EXERCISE PRESCRIPTION

The optimal "exercise prescription" should address the disease-related physical fitness components of aerobic exercise, muscular strength and endurance, flexibility, body composition, and neuromotor health. Outpatient cardiac rehabilitation programs may begin as soon as possible after hospital discharge. At program entry, the following assessments should be performed:

- Medical and surgical history
- Cardiopulmonary exercise testing with ECG monitoring
- Review of recent cardiovascular tests (coronary angiogram, echocardiogram etc)
- Current medications including dose, route of administration, and frequency
- Cardiovascular disease risk factors

In cardiovascular exercise training programs, the prescription of aerobic and resistance exercises is frequently used and involved 4 major factors including mode, frequency, duration, and intensity of physical exercise. The guidelines also indicate that rating of perceived exertion (RPE) may be used to monitor exercise intensity, with the goal of keeping the intensity at a moderate level (6). Generally, the American Heart Association recommended that resistance training be implemented in cardiovascular rehabilitation programs 2 times per week (7). Recently, several experimental trials have demonstrated the safety and effectiveness of interval training in cardiovascular patients. Aerobic interval training, which involves alternating brief (20–

300 sec) higher intensity (>75% VO_{2peak} or RPE>15) and moderate-intensity workloads (throughout an exercise session), has been shown to result in greater improvements in physiological parameters when compared with other types and protocols of exercise for patients at high risk of developing and those with overt CVD. All modes and factors are summarized in Table 2.

Routine pre-exercise assessment of risk for exercise should be performed before, during, and after each rehabilitation session, as deem appropriate by the qualified exercise-training staff and include the following:

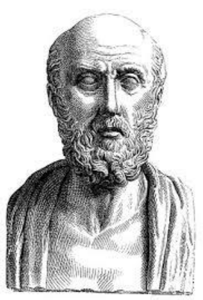
HR - Heart Rate (beats/min)	**BP - Blood Pressure (mmHg)**	**Rate Pressure Product (No)**
		RPP = $S_{ystolic}$BP x HR

Table 2. Exercise prescription in secondary CVD prevention	
Mode	**Aerobic exercise*: walking, jogging, cycling, swimming, rowing, stair climbing, elliptical trainers, aerobic dance ***Resistance training*: hand weights, elastic bands, weight machines, calisthenics, strength and aerobic exercise program performed in water (not swimming) ****Interval training*: cycle ergometer or treadmill walking/running
Duration	*Aerobic exercise*: at least 20-30 min (preferably 45-60min) *Resistance training*: 10-15 repetitions, 1-3 sets of 8-10 different exercises for both upper and lower extremities *Interval training*: at least 10-20 min
Frequency	*Aerobic exercise*: most days (at least 5/week and preferably 6-7 days *Resistance training*: 2-3 sessions/week (nonconsecutive days) *Interval training*: 1 session/week
Intensity	*Aerobic exercise*: 50-75% of peak VO_{2max} or 65-85% of maximal heart rate and always 10-15 beats/min below the level of exercise-induced ischemia *Resistance training*: moderate intensity *Interval training:* >75% VO_{2peak} or RPE>15
Months after the disease	******Aerobic exercise***: 0-3 months (I & II phase of rehabilitation)** *******Resistance training***: 4-12 months (III phase of rehabilitation)**

	***<u>*Interval training*</u>: >12 months (IV phase of rehabilitation)**

SUMMARY

Worldwide, efforts to reduce CVD are incomplete, the states should initiate a CVD programs that focus on education, policies, and lifestyle changes. To ensure that these changes occurs in a long-term and safe manner, health care professionals (physicians, qualified exercise-training staff, and others) must assume leadership to set an “good” example for every citizen. Furthermore, following recommendation and planning steps will help to decline mortality and morbidity rate of disease. In this effort, the vision of Exercise is Medicine (EIM) is to make physical fitness (with right dose) assessment and promotion a standard in clinical care, connecting health care with evidence-based physical fitness resources for all people. EIM encourages physicians to include physical fitness (strength, endurance, flexibility, etc.) when designing treatment plans and to refer patients to evidence-based exercise programs and qualified exercise professionals.



If we could give each person the right dose of diet and exercise - not much less, or much more - then we would have found the safest way for Health.

Hippocrates

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