# B. A program in Physical Education (Semester 2)
## College: Raniganj Girls College (K.N.U)
## Department: Physical Education
### Effects of exercise on the circulatory system

**Introduction: -** You probably know that exercise is healthy, but you might not know exactly why. Staying active does more than just improve your physique, and the long-term effects of exercise on the circulatory system can significantly improve your health. Your heart, lungs and blood vessels all benefit from regular workouts.

### Short term effects

- Increased heart rate
- Increased breathing rate
- Increase in systolic blood pressure
- Increase vasodilation of blood vessels in the working muscles
- Increased volume of air in the lungs
- Increased stroke volume
- Increased cardiac output

### Long term benefits

- Decreased resting and working heart rate
- Increased aerobic capacity
- Normalized blood pressure
- Hypertrophy of left ventricle
- Increased size and elasticity of arteries
- Increased capillary network
- Increased strength of diaphragm and intercostal
- Increased stroke volume and cardiac output
- Reduced levels of LDL cholesterol (harmful cholesterol)
- Increased blood volume
- Increased number and size of mitochondria

## Blood Pressure: -

Blood pressure is the force exerted by your blood against your arteries. As your heart pumps, it forces blood out through arteries that carry the blood throughout your body. The arteries keep tapering off in size until they become tiny vessels, called capillaries. At the capillary level, oxygen and nutrients are released from your blood and delivered to the organs.

### Types of Blood Pressure

**Systolic blood pressure** refers to the pressure inside your arteries when your heart is pumping. For example, 120/80 mm Hg. The top number refers to the amount of pressure in your arteries during the contraction of your heart muscle.;

**Diastolic pressure** is the pressure of the blood in the arteries when the heart is filling. It is the lower of two blood pressure measurements; for example, if the blood pressure is 120/80, then 80 is the diastolic pressure.

**Pulse pressure** is the difference between systolic and diastolic blood pressure. It is measured in millimeters of mercury (mmHg). It represents the force that the heart generates each time it contracts. Resting blood pressure is normally approximately 120/80 mmHg, which yields a pulse pressure of approximately 40 mmHg.

**Mean Pressure** in medicine, the mean arterial pressure is an average blood pressure in an individual during a single cardiac cycle.

### Measuring Blood Pressure

**Blood pressure is measured with an instrument called a sphygmomanometer.** First, a cuff is placed around your arm and inflated with a pump until the circulation is cut off. A small valve slowly deflates the cuff, and the doctor measuring blood pressure uses a stethoscope, placed over your arm, to listen for the sound of blood pulsing through the arteries. That first sound of rushing blood refers to the systolic blood pressure; once the sound fades, the second number indicates the diastolic pressure, the blood pressure of your heart at rest.

Blood pressure is measured in millimeters of mercury (mm Hg) and recorded with the systolic number first, followed by the diastolic number. For example, a normal blood pressure would be recorded as something under 120/80 mm Hg.

**Blood pressure readings can be affected by factors like:**

- ✓ Smoking
- ✓ Coffee or other caffeinated drinks
- ✓ A full bladder
- ✓ Recent physical activity

Blood pressure is also affected by your emotional state and the time of day. Since so many factors can affect blood pressure readings, you should have your blood pressure taken several times to get an accurate measurement.

# EFFECTS OF EXERCISE ON RESPIRATORY SYSTEM

Exercise or any physical activity has a special effect on respiratory system. We need oxygen at rest and during exercise, since energy supply to the active muscles increases demand of oxygen. Another important function of respiration is to eliminate carbon dioxide from the body. During exercise cellular oxidation increases and thereby carbon dioxide production increases. Respiratory system maintains an efficient balance between the oxygen and carbon dioxide in the blood at rest and also during exercise. There are some immediate changes that occur during exercise programmer. Also, there are some relatively permanent changes following long-term physical training, the magnitude of changes being dependent on type, intensity and duration of exercise.

## Immediate changes during exercise:

**a) Tidal Volume:** The amount of air which we inhale or exhale during quiet breathing is called tidal volume. It is around 500 ml. During exercise, this tidal volume increases. Depending on intensity it may be 1500-2000 ml for ordinary person and for well-trained athlete it may be increased to 2500 ml.

**b) Respiratory rate:** Number of times one takes inspiration or expiration in each minute is called Respiratory rate. At rest, respiratory rate is around 16 per minute. During exercise, for ordinary persons it may be increased to 25-30 per minute and for well-trained athlete it may be around 38-40 per minute.

**c) Pulmonary Ventilation:** The amount of air which passes through lungs is each minute is called Pulmonary ventilation. The Pulmonary ventilation (PV) = Tidal volume (TV) X Respiratory rate (RR) and therefore at rest it is around 8 lit / min. During exercise since both TV and RR increases, PV will also increase depending on the intensity of exercise. For ordinary person, the value of PV may be 40-50 lit / min and for well-trained athlete, it may be around 100 lit / min.

**d) Oxygen uptake:** The amount of oxygen which we take inside the body from ambient air in each minute at rest is called resting oxygen uptake. It is around 200-300 ml / min. During exercise oxygen uptake increases to 3.5 lit / min for ordinary person and 4.5 lit/min for well-trained athlete.

**e) Lung diffusion capacity:** Diffusion is the process of movement of gas molecules ($O_2$ and $CO_2$) that takes place in the lungs and tissues. During exercise there will be more movement of gas molecules and diffusion capacity increases.

**f) Lung volume:** For normal breathing at rest lung expand and there is a change in air pressure. During exercise due to rapid movement of diaphragm and intercostal muscles total area of lung expands to accommodate more exchange of gases.

## Long-term effect of training on Respiratory system

**a) Tidal Volume (TV):** Trained athlete's capacity to inhale or exhale air during exercise increases to the tune of 2500 ml. Untrained persons cannot increase up to this level because their capacity is less than trained athletes.

**b) Respiratory rate (RR):** Trained athlete may increase their rate to 40 in each minute from 16 / min at rest. Untrained persons will not be able to reach to this level. They may increase their rate up to 25-28 / min.

**c) Pulmonary ventilation (PV):** A trained athlete may increase PV to around 100 lit/min. This is because their TV and RR both increases during exercise. Untrained persons may increase it up to 50-60 lit/min.

**d) Oxygen uptake:** During exercise, after a long term training, a trained athlete may consume around 5 lit oxygen per minute. Untrained persons may go up to the level of 3.5 lit oxygen per minute.

**e) Lung diffusion capacity:** During exercise, the lung diffusion capacity increases in both trained and untrained persons. However, trained athletes may increase their diffusion capacity 30% more than that of an untrained person because athlete's lung surface area and red blood cell count is higher than that of the non-athletes.

**f) Vital capacity:** It is the maximum volume of air forcefully expired after a maximal inspiration. For a healthy adult male, it is around 4.8 lit and for women 3.1 lit. The athletes who are under training for a long period may increase vital capacity to around 6 lit.

**g) Efficiency of lung:** An athlete's total efficiency of the lung remain at higher level than the non-athletes. This efficiency is the key factor for higher rate of oxygen uptake than non-athletes.

**h) Second wind:** This term is usually described as a sudden transition from an ill-defined feeling of distress or fatigue during the early portions of prolonged exercise to a more comfortable, less stressful feeling later in exercise. It has been observed that trained athletes get their second wind comfortably and easily than non-athletes.

## Oxygen Debt

During muscular exercise, blood vessels in muscles dilate, and blood flow is increased to increase the available oxygen supply. Up to a point, the available oxygen is sufficient to meet the energy needs of the body. However, when muscular exertion is very high, oxygen cannot be supplied to muscle fibres fast enough, and the aerobic breakdown of pyruvic acid cannot produce all the ATP required for further muscle contraction.

### Lactic Acid

During such periods, additional ATP is generated by anaerobic glycolysis. In the process, most of the pyruvic acid produced is converted to lactic acid. About 80% of the lactic acid diffuses from the skeletal muscles and is transported to the liver for conversion back to glucose or glycogen.

### Oxygen

Ultimately, once adequate oxygen is available, the lactic acid must be entirely catabolized into carbon dioxide and water. After exercise has stopped, extra oxygen is required to metabolize lactic acid; to replenish ATP, phosphocreatine, and glycogen; and to pay back any oxygen that has been borrowed from hemoglobin, myoglobin (an iron-containing substance similar to hemoglobin that is found in muscle fibres), air in the lungs, and body fluids.

The additional oxygen that must be taken into the body after vigorous exercise to restore all systems to their normal states is called oxygen debt (Hill 1928).

Eventually, muscle glycogen must also be restored. This is accomplished through diet and may take several days, depending on the intensity of exercise. The maximum rate of oxygen consumption during the aerobic catabolism of pyruvic acid is called "maximal oxygen uptake". It is determined by sex (higher in males), age (highest at about age 20) and size (increases with body size).

Highly trained athletes can have maximal oxygen uptakes that are twice that of average people, probably owing to a combination of genetics and training. As a result, they are capable of higher muscular activity without increasing their lactic acid production, and their oxygen debts are less. It is for these reasons that they do not become short of breath as readily as untrained individuals.

**Oxygen consumption following exercise**

After a strenuous exercise, four tasks need to be completed:

- ✓ Replenishment of ATP
- ✓ Removal of lactic acid
- ✓ Replenishment of myoglobin with oxygen
- ✓ Replenishment of glycogen

The need for oxygen to replenish ATP and remove lactic acid is referred to as the "Oxygen Debt" or **"Excess Post-Exercise Oxygen Consumption" (EPOC) -** the total oxygen consumed after exercise above a pre-exercise baseline level.

In low-intensity, primarily aerobic exercise, about one half of the total EPOC takes place within 30 seconds of stopping the exercise, and complete recovery can be achieved within several minutes (oxygen uptake returns to the pre-exercise level).

Recovery from more strenuous exercise, which is often accompanied by an increase in blood lactate and body temperature, may require 24 hours or more before re-establishing the pre-exercise oxygen uptake. The amount of time will depend on exercise intensity and duration.

**The two significant components of oxygen recovery are:**

**Alactacid oxygen debt (fast component)**

the portion of oxygen required to synthesize and restore muscle phosphagen stores (ATP and PC)

**Lactacid oxygen debt (slow component)**

the portion of oxygen required to remove lactic acid from the muscle cells and blood

The replenishment of muscle myoglobin with oxygen is normally completed within the time required to recover the Alactacid oxygen debt component.

The replenishment of muscle and liver glycogen stores depends on the type of exercise. In essence, short distance, high-intensity (e.g. 800 metres) may take up to 2 or 3 hours and long endurance activities (e.g. marathon) may take several days.

Replenishment of glycogen stores is most rapid during the first few hours following training and then can take several days to complete. Complete restoration of glycogen stores is accelerated with a high carbohydrate diet.

## Measurements of Cardiorespiratory Endurance & Muscular Endurance

**Cardiorespiratory endurance** is the ability to perform large-muscle, whole-body exercise at moderate to high intensities for extended periods of time (Saltin, 1973). Numerous terms have been used to denote this component of physical fitness, including aerobic fitness and aerobic capacity. These terms are essentially synonymous with cardiorespiratory endurance, which is the term used in this report. Forms of exercise that depend on cardiorespiratory endurance include vigorous distance running, swimming, and cycling. This fitness component also affects a person's ability to perform, without undue fatigue, less intense, sustained whole-body activities, such as brisk walking, stair climbing, and home chores. People with good levels of cardiorespiratory endurance can perform large-muscle, whole-body exercise at high intensity for at least moderate durations before experiencing fatigue, and they can comfortably perform light- to moderate-intensity exercise for extended periods.

**Cardiorespiratory endurance** depends on the body's ability to support skeletal muscle activity through high rates of aerobic metabolism. The ability to produce energy at high rates through aerobic metabolism during exercise depends on three physiologic functions: **(1)** transport of oxygen from the atmosphere to the active muscles through the actions of the cardiorespiratory system, **(2)** consumption of oxygen in the aerobic metabolic process in the cells of the active muscles, and **(3)** removal of waste products. People with high levels of cardiorespiratory endurance typically have highly functional cardiorespiratory systems (i.e., heart, lungs, blood, blood vessels), and their skeletal muscles are well adapted to the use of oxygen in aerobic metabolism.

**CARDIORESPIRATORY ENDURANCE TESTS**

**The gold standard measure** of cardiorespiratory endurance is maximal aerobic power (VO2max)—the greatest rate at which a person is able to consume oxygen during sustained, exhaustive exercise. In the laboratory, VO2max is typically measured while a person performs maximal, graded exercise on a treadmill or cycle ergometer. VO2max can be expressed in terms of liters of oxygen consumed per minute (l/min), or the values can be normalized for differences in body size and expressed as milliliters of oxygen consumed per kilogram of body weight per minute (ml/kg/min). VO2max is known to be a key physiologic determinant of cardiorespiratory endurance and has typically been used as the criterion measure in the validation of field measures of cardiorespiratory endurance.

The most commonly used field tests involve distance/timed runs of varying length and graded-pace shuttle runs. Various types of distance/timed runs have been used to measure cardiorespiratory endurance in fitness test batteries since the advent of large-scale fitness testing in the post–World War II era. The tests vary in structure, some being based on a distance limitation in which performance is measured as time required to complete the specified distance (often 1 or 1.5 miles), and others on a time limitation in which performance is measured as the distance covered in the specified time (often 9 or 12 minutes). While runs as short as 600 yards were used in early versions of fitness test batteries, distance runs using the 1 mile or 9-minute format have been most common since the 1970s.

Shuttle runs measure cardiorespiratory endurance when an individual run to and from two different points, usually around 20 meters apart, at a set pace. **The progressive aerobic cardiovascular endurance run (PACER),** a variation on the shuttle run, is a maximal cardiorespiratory endurance test in which lines are placed 15 or 20 meters apart, and the participant runs repeatedly between the two lines within prescribed times. The time decreases periodically while the distance remains the same until the participant cannot run fast enough to reach the finish line in the prescribed time.

Alternatively, some fitness surveys use quasi-laboratory tests (i.e., those that measure VO2max but can be conducted in the field). These tests involve the performance of graded, submaximal exercise on a **treadmill or cycle ergometer.**

**Muscular Endurance**

Strength, power and muscular endurance are fitness components with many things in common. They require the application of muscular force to overcome resistance while in motion; they involve muscular contraction of a specific muscle or muscle group; and they are measurable components of fitness.

**Muscular endurance** is the ability of a muscle or muscle group to exert force to overcome a resistance many times. Often the resistance is the body itself. The measurement of muscular endurance is based on the number of repetitions performed. Muscular endurance is specific to the assessment.

**McGill core endurance test**

**Purpose of test:** To assess muscle endurance of the torso stabilizer muscles

**Test procedure:** The protocol consists of four tests that measure all aspects of torso strength via isometric muscle endurance.

**1.Trunk flexor test (TFT)**

• The TFT is used to assess the endurance of the anterior musculature of the core (rectus abdominis) (Brumitt, 2010).

• The flexor endurance test begins with the person in a sit-up position with the back resting against a jig angled at 60 degrees from the floor. Both knees and hips are flexed 90 degrees, the arms are folded across the chest with the hands placed on the opposite shoulder, and the feet are secured. To begin, the jig is pulled back 10 cm, and the person holds the isometric posture as long as possible. Failure is determined when any part of the person's back touches the jig.

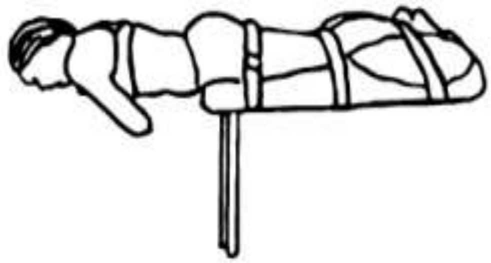
• Record how long in seconds the client is able to maintain the position.

**2.Trunk extensor test (TET)**

• The TET is used to assess the erector spine and the multifidi's.

• The clinician stands to the side of the client's torso to ensure correct alignment.

• The back extensors are tested with the upper body cantilevered out over the end of the test bench and with the pelvis, knees, and hips secured. The upper limbs are held across the chest with the hands resting on the opposite shoulders. Failure occurs when the upper body drops below the horizontal position.



**3. Lateral musculature test and right lateral musculature test**

• The lateral musculature tests (LMT) are used to assess the oblique's, transverse abdominals and quadratus lumborum.

• The following protocol is for both the le! and right lateral musculature tests: 'The lateral musculature is tested with the person lying in the full side-bridge position (le" and right side individually). Legs are extended, and the top foot is placed in front of the lower foot for support. Clients support themselves on one elbow and on their feet while laying their hips of the floor to create a straight line from head to toe. The uninvolved arm is held across the chest with the hand placed on the opposite shoulder. Failure occurs when the person loses the straight-back posture and/or the hips return to the ground.

• If the client is unable to assume the correct position, a gross weakness in the lateral core muscles is evident.

• Ensure that the client remains in the correct posture for the duration of the test.

Record the total time that each isometric position can be held, allowing a minimum of 5 minutes' rest between each test.

### Plank hold

**Purpose of test:** To assess core muscular endurance.

**Equipment required:**

• Stopwatch

**Test procedure:**

• Begin with client lying prone on a stable, flat surface.

• Instruct client to place their forearms on the floor, allowing the elbows to be directly beneath shoulder girdle.

• Next, tuck the toes under to contact the floor.

• When ready, ask the client to use their arms to push o" the ground, hovering in the 'plank' position.

• Look for elevation of the hips or any shilling of position to either side.

• Timed version of plank hold test: Begin stopwatch when client is in position and stationary. Stop timing at one minute, or when client can no longer hold position.

### Static squat test

**Purpose of test:** Assess lower body muscular endurance

**Equipment required:**

• Wall

• Stopwatch

**Test procedure:**

• Client stands on both feet with the back to a wall, hips and knees flexed to a 90° angle.

• Instruct client to lifted one foot 5 cm o" the ground and hold for as long as possible.

• Timing begins when foot is lied and ends it when makes contact with the ground.

• Record maximum time for each leg.

**Maximal push test**

Purpose of test: To assess upper body muscular endurance.

**Test procedure:** The protocols for the Maximal Push Up Test and the Modified Push Up Test are as follows:

**Push-Up Test (Completed with the client on their toes)**

• Lie on the mat, hands shoulder-width apart & fully extend the arms.

• Lower the body until the elbows reach 90 degrees.

• Return to the starting position with the arms fully extended.

• The feet are not to be held for the client.

• The push up action is to be continuous with no rest.

• Complete as many press-ups as possible.

• Record the total number of full body press-ups.

**Modified Push-Up Test (Completed with the client on their knees)**

• Lie on the mat, hands shoulder width apart, bent knee position & fully extend the arms.

• Lower the upper body until the elbows reach 90 degrees.

• Return to the starting position with the arms fully extended.

• The feet are not to be held for the client

• The push up action is to be continuous with no rest.

• Complete as many modified press-ups as possible.

• Record the total number of modified press-ups.

# FATIGUE

**Fatigue** can be described as the lack of energy and motivation (both physical and mental). This is different than drowsiness, a term that describes the need to sleep. Often a person complains of feeling tired and it is up to the health care professional to distinguish between fatigue and drowsiness, though both can occur at the same time. Aside from drowsiness, other symptoms can be confused with fatigue including shortness of breath with activity and muscle weakness. Again, all these symptoms can occur at the same time. Also, fatigue can be a normal response to physical and mental activity; in most normal individuals it is quickly relieved (usually in hours to about a day, depending on the intensity of the activity) by reducing the activity.

**Fatigue** is a very common complaint and it is important to remember that it is a symptom and not a disease. Many illnesses can result in the complaint of fatigue and they can be physical, psychological, or a combination of the two.

**Types of Fatigue: -** There in sports mainly two types fatigue we are seen

**Acute fatigue**

Acute fatigue is the onset, during a competition, of a more or less marked condition of organic and functional exhaustion. In other words, acute fatigue may be defined as the inability to maintain the required or expect end force or power during exertion.

**Chronic fatigue**

The prerequisites for the achievement of high-level performance are genetic predisposition and the use of appropriate training methods. It is necessary, when drafting a training schedule, to ensure that the workloads administered are able to determine i) the acute biological reaction (adjustments) sought, so that ii) the desired adaptations are induced without producing, in the athlete, a state of iii) overtraining. For the purposes of this paper, overtraining denotes a situation characterised by an imbalance between training and recovery, between effort and ability to withstand effort, and ultimately between stress and tolerance of stress.

## Causes of fatigue

There are many potential causes of fatigue. They can be divided into three general categories:

- ✓ lifestyle factors
- ✓ physical health conditions
- ✓ mental health issues

**Lifestyle factors**

If you’re experiencing fatigue, your activities and other lifestyle choices may be the root cause. For example, fatigue can result from:

- physical exertion
- lack of physical activity

- lack of sleep
- being overweight or obese
- periods of emotional stress
- boredom
- grief
- taking certain medications, such as antidepressants or sedatives
- using alcohol on a regular basis
- using illicit drugs, such as cocaine
- consuming too much caffeine
- not eating a nutritious diet

**Physical health conditions**

Many medical conditions can also cause fatigue. Examples include:

- anemia
- arthritis
- fibromyalgia
- chronic fatigue syndrome
- infections, such as cold and flu
- Addison's disease, a disorder that can affect your hormone levels
- hypothyroidism, or underactive thyroid
- hyperthyroidism, or overactive thyroid
- sleep disorders, such as insomnia
- eating disorders, such as anorexia
- autoimmune disorders
- congestive heart failure
- cancer
- diabetes
- kidney disease
- liver disease

- chronic obstructive pulmonary disease (COPD)
- emphysema

**Mental health issues**

Mental health conditions can also lead to fatigue. For example, fatigue is a common symptom of anxiety, depression, and seasonal affective disorder.

**Symptoms of fatigue**

Fatigue can cause a vast range of other physical, mental and emotional symptoms including:

- chronic tiredness or sleepiness
- headache
- dizziness
- sore or aching muscles
- muscle weakness
- slowed reflexes and responses
- impaired decision-making and judgement
- moodiness, such as irritability
- impaired hand-to-eye coordination
- appetite loss
- reduced immune system function
- blurry vision
- short-term memory problems
- poor concentration
- hallucinations
- reduced ability to pay attention to the situation at hand
- low motivation.

**Remedies of Fatigue**

Whether you are starting to work out for the first time or you are a professional athlete, muscle fatigue is a normal side effect of exercise that may put a damper on your routine. Fatigue is your body's way of adapting to a fitness regimen and making you aware that you have reached your metabolic/psychological limit.

The following healthy lifestyle changes and tips can help keep you from hitting a wall in your workout:

**1. Nutrition –** Maintain a well-balanced diet that includes complex proteins, fruits, vegetables, and carbohydrates. You should increase the amount of carbohydrates you eat, beginning seven days prior to exercising, to about 40-60% of your caloric intake for aerobic athletes and 30-35% for anaerobic (nonaerobic) athletes. This will maintain your muscles' glycogen levels, which are depleted during exercise.

**2. Eating Schedule –** Eat a light meal or snack about two hours before working out. It is not recommended to work out on a full stomach or an empty stomach. Make sure to eat within one hour after you work out. This will help repair and refuel the muscles that were broken down during exercise.

**3. Hydration –** Drinking water throughout the day and drinking sports drinks during exercise is crucial to prevent dehydration, electrolyte loss, and muscle fatigue. It is recommended to drink 10-12 8-oz glasses of water daily. While exercising, it is recommended to drink 125-250 ml of an electrolyte-rich sports drink every 10-20 minutes, or 1.5L per hour. This will replace the water and nutrients that are lost due to sweating.

**4. Endurance –** Improve your aerobic capacity. As your respiratory muscles begin to fatigue, oxygen will be redirected from the muscles of your limbs to those of your diaphragm. One way to improve your endurance is to gradually increase your aerobic workouts with interval training. You can also use a respiratory muscle-training device, a piece of equipment that allows you to inhale and exhale against resistance, increasing lung capacity. Whatever method you choose, as your endurance increases the added boost of oxygen in your blood will keep your muscles working for longer periods of time and prevent lactic acid buildup.

**5. Body Mechanics –** Use correct form when exercising. Pay attention to muscle imbalances and incorrect movement patterns; follow a regular stretching program. The right strength and flexibility will help you achieve correct form during exercising. If you can't perform an exercise with proper form, then you need to either decrease your weight or modify the exercise. Improper body mechanics decreases efficiency and in turn burns more energy than necessary.

**6. Rest/Recovery –** Complete a warm up and cool down for 5 to 10 minutes each time you exercise. Start off slowly and gradually increase workout intensity levels so that your muscles are gradually challenged and can build over time. Allow adequate rest between workout sessions and strength repetitions. Make sure the rest break is enough to catch your breath between exercise sets. Listen to your body – fatigue is a sign that recovery has not taken place yet. If that is the case, then perform active recovery, which means participating in low impact, low intensity exercise such as walking, light swimming, or yoga. Do not return to higher intensity exercise until you feel fully recovered and recharged.

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