COURSE GUIDE

KHE 436
PHYSIOLOGY APPLIED TO PHYSICAL CONDITIONING

Course Team Mrs. Katheleen C. IZUNWANNE (Course Writer/Developer) - Olabisi Onabanjo University
Prof. 'Tola ODUYALE (Course Editor) - Olabisi Onabanjo University

NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters
University Village
Plot 91, Cadastral Zone Nnamdi Azikiwe Expressway
Jabi, Abuja

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island, Lagos

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Printed 2021

ISBN: 978-978-058-278-4

CONTENT

MODULE 1 MODULE INTRODUCTION

COURSE GUIDE

Attaining and maintaining good health or keeping fit is in most cases a matter of choice. The implication of this is that an individual plays a very significant role in taking care of his health. However, it is important to note that one can only be willing to take up this responsibility if he or she is well informed about the importance of keeping fit. This course, therefore, provides substantial information needed by an individual in other take responsibility for his or her health.

INTRODUCTION

Technological developments in recent times have reduced the physical demands of daily activities like walking, doing chores such as cleaning, washing, gardening and walking to the workplace, and climbing the stairs. Automation has made more time available for leisure pursuits. Unfortunately, most of the newfound leisure time is used for sedentary pursuits, whereas, the human body is designed for strenuous physical activity. This has resulted in the decline of the functional ability of the human body. Exercise scientists and health professionals strongly believe that this increased physical inactivity has led to a rise in the incidence of several degenerative disorders like coronary heart diseases, diabetes, hypertension, obesity and overweight, osteoporosis, osteoarthritis, and some forms of cancer, like breast cancer and colon cancer. This trend in the deterioration of health and increase in the prevalence of these diseases can be arrested or at least minimised if people invest at least 30 minutes, three times a week, in moderate-to-vigorous physical activity.

COURSE OBJECTIVES

This course will enable us specifically to:

- Understand the concepts of physical activity, physical fitness, and physical conditioning, their benefits, and their components.
- Understand how the various body systems and organs adapt and react to exercise.
- Enable you to choose the right exercises.
- Understand physical training, its effects on the body, and how to prevent injuries during training.
- Appreciate the relationships between the circulatory system, respiratory system, and exercise.
- Familiarise yourself with various flexibility exercises

WORKING THROUGH THIS COURSE

Understanding this course requires that you read through the course material, unit by unit. At the end of the unit, ensure that you can achieve the stated objectives at the beginning of each unit read. The course material also provides you with references and suggestions for further reading. This is to enable avail yourself the opportunity of a deeper understanding.

STUDY UNITS

There are 16 study units in this course divided into six modules. The modules and units are presented as follows;

Module 1

Unit 1 Definition of Concepts: Physical Activity/Fitness Conditioning
Unit 2 Components of Physical Fitness

Module 2

Unit 1 Adaptation to Exercise
Unit 2 Conditioning Programmes
Unit 3 Choosing the Right Exercise

Module 3

Unit 1 Exercise and Fitness
Unit 2 Exercise and Body Reaction
Unit 3 Physical Fitness and Exercise Physiology

Module 4

Unit 1 Physical Training.
Unit 2 Effects of Physical Training
Unit 3 Preventing Injury

Module 5

Unit 1 The Circulatory System and Exercise
Unit 2 Respiratory System and Exercise

Module 6

Unit 1 Muscular Flexibility
Unit 2 Flexibility Exercises
Unit 3 Strength and Power Development

COURSE OUTLINE

1. Introduction
2. Definition of Physical Conditioning/Fitness/Exercise
3. Components of Physical Fitness
4. Adaptations to Exercise
5. Conditioning Programmes
6. Choosing the Right Exercise
7. Exercise and Fitness
8. Exercise and Body Reactions
9. Physical Fitness and Exercise Physiology
10. Physical Training
11. Effects of Physical Training
12. Preventing Injury
13. The Circulatory System and Exercise
14. The Respiratory System and Exercise
15. Muscular Flexibility
16. Flexibility Exercises
17. Strength and Power Development

MODULE 1 MODULE INTRODUCTION

Living healthy is important for every man. This is because it takes good health to achieve or attain any height in life. To live a healthy life, it is important to understand the concepts of what promotes good health. Part of the concepts is explained in this module.

COURSE GUIDE

KHE 436
PHYSIOLOGY APPLIED TO PHYSICAL CONDITIONING

Course Team Mrs. Katheleen C. IZUNWANNE (Course Writer/Developer) - Olabisi Onabanjo University
Prof. 'Tola ODUYALE (Course Editor) - Olabisi Onabanjo University

NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters
University Village
Plot 91, Cadastral Zone Nnamdi Azikiwe Expressway
Jabi, Abuja

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island, Lagos

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Printed 2021

ISBN: 978-978-058-278-4

CONTENT

MODULE 1 MODULE INTRODUCTION

COURSE GUIDE

Attaining and maintaining good health or keeping fit is in most cases a matter of choice. The implication of this is that an individual plays a very significant role in taking care of his health. However, it is important to note that one can only be willing to take up this responsibility if he or she is well informed about the importance of keeping fit. This course, therefore, provides substantial information needed by an individual in other take responsibility for his or her health.

INTRODUCTION

Technological developments in recent times have reduced the physical demands of daily activities like walking, doing chores such as cleaning, washing, gardening and walking to the workplace, and climbing the stairs. Automation has made more time available for leisure pursuits. Unfortunately, most of the newfound leisure time is used for sedentary pursuits, whereas, the human body is designed for strenuous physical activity. This has resulted in the decline of the functional ability of the human body. Exercise scientists and health professionals strongly believe that this increased physical inactivity has led to a rise in the incidence of several degenerative disorders like coronary heart diseases, diabetes, hypertension, obesity and overweight, osteoporosis, osteoarthritis, and some forms of cancer, like breast cancer and colon cancer. This trend in the deterioration of health and increase in the prevalence of these diseases can be arrested or at least minimised if people invest at least 30 minutes, three times a week, in moderate-to-vigorous physical activity.

COURSE OBJECTIVES

This course will enable us specifically to:

- Understand the concepts of physical activity, physical fitness, and physical conditioning, their benefits, and their components.
- Understand how the various body systems and organs adapt and react to exercise.
- Enable you to choose the right exercises.
- Understand physical training, its effects on the body, and how to prevent injuries during training.
- Appreciate the relationships between the circulatory system, respiratory system, and exercise.
- Familiarise yourself with various flexibility exercises

WORKING THROUGH THIS COURSE

Understanding this course requires that you read through the course material, unit by unit. At the end of the unit, ensure that you can achieve the stated objectives at the beginning of each unit read. The course material also provides you with references and suggestions for further reading. This is to enable avail yourself the opportunity of a deeper understanding.

STUDY UNITS

There are 16 study units in this course divided into six modules. The modules and units are presented as follows;

Module 1

Unit 1 Definition of Concepts: Physical Activity/Fitness Conditioning
Unit 2 Components of Physical Fitness

Module 2

Unit 1 Adaptation to Exercise
Unit 2 Conditioning Programmes
Unit 3 Choosing the Right Exercise

Module 3

Unit 1 Exercise and Fitness
Unit 2 Exercise and Body Reaction
Unit 3 Physical Fitness and Exercise Physiology

Module 4

Unit 1 Physical Training.
Unit 2 Effects of Physical Training
Unit 3 Preventing Injury

Module 5

Unit 1 The Circulatory System and Exercise
Unit 2 Respiratory System and Exercise

Module 6

Unit 1 Muscular Flexibility
Unit 2 Flexibility Exercises
Unit 3 Strength and Power Development

COURSE OUTLINE

1. Introduction
2. Definition of Physical Conditioning/Fitness/Exercise
3. Components of Physical Fitness
4. Adaptations to Exercise
5. Conditioning Programmes
6. Choosing the Right Exercise
7. Exercise and Fitness
8. Exercise and Body Reactions
9. Physical Fitness and Exercise Physiology
10. Physical Training
11. Effects of Physical Training
12. Preventing Injury
13. The Circulatory System and Exercise
14. The Respiratory System and Exercise
15. Muscular Flexibility
16. Flexibility Exercises
17. Strength and Power Development

MODULE 1 MODULE INTRODUCTION

Living healthy is important for every man. This is because it takes good health to achieve or attain any height in life. To live a healthy life, it is important to understand the concepts of what promotes good health. Part of the concepts is explained in this module.

MAIN COURSE

CONTENTS **PAGE**

MODULE 1

UNIT 1 DEFINITION OF CONCEPTS: PHYSICAL ACTIVITY/FITNESS/ CONDITIONING

CONTENTS

1.0 INTRODUCTION

Scientific findings have shown that physical inactivity seriously threatens the health and hasten the deterioration rate of the human body. Movement and physical activity are basic functions for which the human organism was created. Advances in technology, however, have almost eliminated the necessity for physical e**xe**rtion in daily life, and as such, physical activity is no longer a natural part of our existence. We now live in an automated society, where most of the activities that used to require strenuous exertion can now be accomplished with the simple pull of a handle or the push of a button. However, widespread interest in health and preventive medicine in recent years is now motivating people to participate in organized fitness and wellness programmes. The growing number of participants across the globe is attributed primarily to scientific evidence linking regular physical activity and positive lifestyle habits to better health, longevity, quality of life, and overall wellbeing. An attempt is made in this unit to define and explain the concepts of physical activity, fitness, and conditioning. The benefits of these concepts are also highlighted in this unit.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- define physical activity

- define physical fitness
- define physical conditioning
- differentiate physical activity from physical fitness and physical conditioning
- identify the benefits of physical activity, physical fitness, and physical conditioning to health.

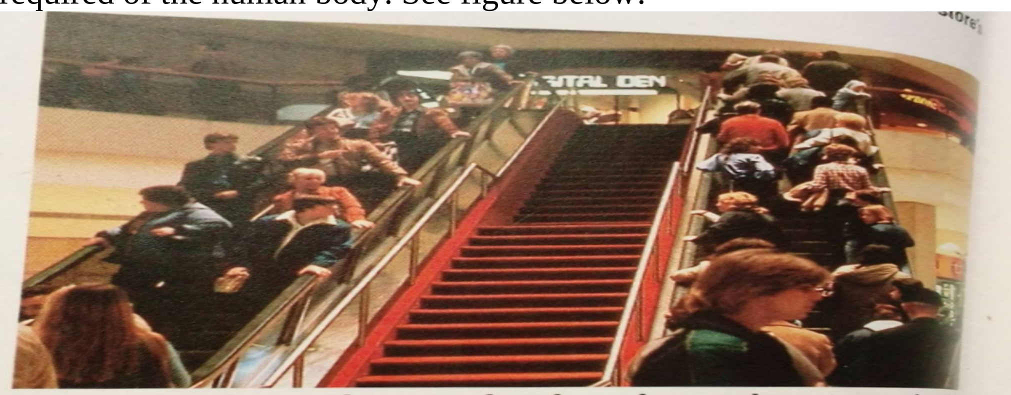
3.0 MAIN CONTENT

3.1 Meaning of Physical Activity

Physical activity is bodily movement produced by skeletal muscles. It requires energy expenditure and produces progressive health benefits. Physical activity typically requires only a low to moderate intensity of effort. Physical activity is used as a means of promoting health. Examples of physical activity include walking to and from work, taking the stairs instead of elevators and escalators, gardening, doing house chores, dancing, and washing the car by hand.

Physical activity, unfortunately, is no longer a natural part of our existence. Technological developments have driven most people in developed countries into a sedentary lifestyle. For instance, when many people go to a store, only a couple of blocks away, most drive their automobiles and then spend a couple of minutes driving around the parking lot to find a spot 20 yards closer to the store's entrance. They do not even have to carry the groceries to the car, as an employee working at the store usually offers to do this for them.

Similarly, during a visit to a multi-level shopping mall, almost everyone chooses to take the escalator instead of the stairs (which tend to be inaccessible). Automobiles, elevators, escalators, telephones, intercoms, remote controls, electric garage door openers- all are modern-day commodities that minimise the number of movements and efforts required of the human body. See figure below:



Advances in modern technology have almost completely eliminated the need for physical activity, significantly enhancing the deterioration rate of the human body.

The followings are the well-established health benefits of physical activity:

- Reduced risk of premature death.
- Reduction of blood pressure in people with high blood pressure.
- Reduction of depression and anxiety.
- Control of body weight
- Development of healthy and strong bones, joints, and muscles
- Development of strength and agility in older people that enable them to move better without falling and the promotion of psychological well-being.

A balanced plan of physical activity and exercise should be followed to promote a healthy lifestyle and to improve physical fitness. In this plan, one should engage in physical activities around the workplace or home regularly to lay a strong foundation. These activities should be such that they develop aerobic capacity and flexibility. They should be performed at least three to five days per week.

The Physical Activity Pyramid

***Source: Hoeger & Hoeger (2007). Fitness and Wellness Inc*.**

Health Benefits of physical activity

Moderate physical activity can prevent premature death, unnecessary illness, disability, and provide substantial benefits to health and wellbeing for the vast majority of people who are not physically active. Individuals who are already moderately active can achieve even greater health benefits by increasing their physical activity.

Among the benefits of regular physical activity and exercise are significantly reduced risks for developing or dying from heart disease, stroke, type 2 diabetes, colon and breast cancers, high blood pressure, and osteoporotic fractures. Regular physical activity also is important for the health of muscles, bones, and joints, and it seems to reduce symptoms of depression and anxiety, improve mood, and enhance one's ability to perform daily tasks throughout life. It also can help control healthcare costs and maintain a high quality of life into old age.

Moderate physical activity has been defined as any activity that requires an energy expenditure of 150 calories per day, or 1,000 calories per week. The general health recommendation is that people should strive to accumulate at least 30 minutes of physical activities per day, most days of the week (see table 1.1). while 30 minutes of continuous activity is preferred, on days when time is limited, 3 activity sessions of at least 10 minutes each provide half the aerobic benefits. Examples of moderate physical activities are walking, cycling, playing basketball, or volleyball, swimming, water aerobics, dancing fast, pushing a stroller, raking leaves, shoveling snow, washing or waxing a car, washing windows, or floors, and even gardening.

Daily Physical Activity Recommendations.

Total Time	**Outcome**
30 minutes	Health benefits
60 minutes	Weight gain prevention
60 to 90 minutes	Weight regain prevention

3.2. Meaning of Physical Fitness

Fitness is the degree to which a person functions physically, mentally, emotionally, and socially, all of these interrelate to modify the functionality of the human being. Physical fitness is defined as a condition in which an individual has adequate vigour and vitality to perform daily tasks and recreational activities without undue fatigue. Physical fitness is an important component of total fitness. It is more than the development of muscular strength or stamina; it implies efficient performance in exercise or work and a reasonable measure of skill in the performance of selected physical activities. Physical fitness emphasises the promotion of vigour, vitality, and energy for participation in physical work and exercise.

It is important to note that the same level of physical fitness is not essential for everyone. It depends on the tasks, an individual's potential for physical effort, and the relationship of his physical fitness to his total self or total fitness. For instance, the university student who plays football needs a different type of physical fitness than the student who plays in the schools' musical club.

To achieve physical fitness, regular strenuous physical activity is very contributory. It is also significant to note that one cannot build up in school days a store of health that will last for the rest of life. Habituation to physical activity is one of the goals that should be set not only for every student but for all persons in the formative periods of life. A programme of physical exercise and body conditioning is often desired to achieve this goal.

Benefits of Physical Conditioning

- It aids in weight management
- Helps in protection against chronic diseases
- Aids in maintaining muscle strength and balance
- Reduces blood pressure and improves heart health
- Helps in combating cancer-related fatigue
- Aids in reducing feelings of anxiety and depression
- Improves respiratory and cardiovascular health
- Promotes strong muscles and bones.

3.3 Meaning of Physical Conditioning

Physical conditioning is the adjustment of the body chemistry or metabolism to a stressful workout thereby improving the aerobic and anaerobic energy capacity, the work rate of the muscle tissues through an exercise programme. For athletes under the age of 12 or 13, the technique is the most important factor to consider when conditioning for best performance. After this age, physical conditioning becomes more important and will require a more structured approach. After the age of 16, studies show that physical conditioning is the second most important factor in sports performance. Physical conditioning includes cardiovascular endurance, flexibility, muscular strength and endurance, and skill development.

Benefits of physical conditioning

- Better performance
- Ensures quality practice
- Delayed fatigue when playing
- Promoting mental strength
- Increased technique and power
- Quick and fuller recovery
- Decreased number and severity of sports injuries
- Increases self-confidence on and off of the playing field
- Makes athletes better at their sport and potentially other sports (www.onlinemasters.ohio.edu, 2020).

4.0 CONCLUSION

Advances in technology, however, have almost eliminated the necessity for physical e**xe**rtion in daily life, and as such, physical activity is no longer a natural part of our existence. We now live in an automated society, where most of the activities that used to require strenuous exertion can now be accomplished with the simple pull of a handle or the push of a button.

5.0 SUMMARY

Physical activity, fitness, and conditioning, play a very significant role in the lives of an individual as they play vital roles in the health and wellbeing of individuals. If one wants to live a healthy life, engaging in physical activities and bring sedentary behaviours to the barest minimum is very important. The relevance of physical fitness which is an important part of total fitness cannot also be overemphasized because of the role(s) it plays in healthy living. Physical conditioning is also required especially for athletes in other to reach one's potential as far as athletic performance and training is concerned.

In this unit, we learned the meaning of physical activity, physical fitness, and physical conditioning. The importance/ benefits of physical activity, physical fitness, and physical conditioning were also highlighted.

6.0 TUTOR-MARKED ASSIGNMENT

Different between physical activity, physical fitness, and physical conditioning.

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Mayo Clinic, "Fitness basics". The basics of Physical Conditioning (2020). www.onlinemasters.ohio.edu.

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125- 870-0.

UNIT 2 COMPONENTS OF PHYSICAL FITNESS

CONTENT

1.0 INTRODUCTION

There are two major components of physical fitness. These are health-related components and motor or skill-related components of physical fitness. These components are discussed in this unit.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- identify the three components of physical fitness
- differentiate clearly among the three components of physical fitness.

3.0 MAIN CONTENT

3.1 Components of Physical Fitness

As the fitness concept grew at the end of the last century, it became clear that several specific components contribute to an individual's overall level of fitness. **Physical fitness** is classified into health-related, skill-related, and physiologic fitness.

3.2. Health-related component of physical fitness

This is characterised by the ability to perform daily activities with vigour and is associated with a low risk of chronic disease. Health-related fitness has three main components, which include cardiorespiratory (aerobic) endurance, musculoskeletal fitness (muscular strength and endurance, and flexibility), and optimal body composition. Musculoskeletal fitness includes muscular strength and endurance, and flexibility.

Cardiorespiratory Endurance

It is the ability to work for a prolonged period. It reflects the ability of tee art, lungs, circulatory and respiratory systems to supply oxygen and nutrients to working muscles. It is also called **aerobic fitness**. It is assessed by measuring maximum oxygen consumption ($V0_2$ max), or the rate of oxygen utilization by the muscles during endurance or aerobic exercise.

Musculoskeletal fitness

This is the ability of the skeletal and muscular systems to perform work, which involves muscular strength, muscular endurance, bone strength, and flexibility. Muscular strength is the maximal torte that can be exerted against resistance. Muscular endurance is the ability to produce submaximal force repeatedly over a prolonged period. Bone strength reflects the risk of bone fracture. It is the function of the mineral content and bone density. Flexibility is the ability of the joints to move to a full range of movement. Examples of muscular strength include lifting heavy weights. Muscular endurance is involved in such activities as sit-ups, push-ups, and lifting weights 10-15 times. Flexibility is involved in touching the toes with less trait from a sitting position. One of the most effective ways of developing muscular and bone strength and muscular endurance is through resistance training.

Body Weight and Body Composition

Bodyweight refers to the mass of the individual. It is viewed in terms of the absolute and relative amount of muscle, bone, and fat tissue. Body composition refers to the relative amounts of fats and lean body mass, which includes muscle, bone, water, skin, blood, and other non-fat tissues. It is usually expressed as percent body fat. Aerobic exercise and resistance training are very effective in modifying body weight and composition.

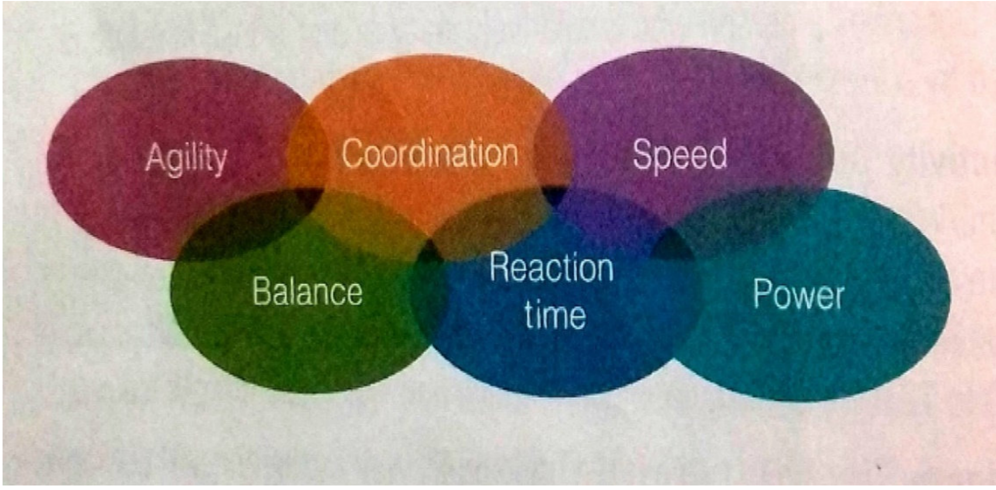
Neuromuscular Relaxation

It refers to the ability to reduce or eliminate muscular tension. Progressive relaxation exercises, meditation, and yoga are effective means of reducing stress and neuromuscular tension.

There are many exercise protocols and sports that develop components of both skills and health-related physical fitness. Sports like soccer, basketball, handball, maximum oxygen consumption ($V0_2$ max), or rate of oxygen utilisation by the muscles during endurance or aerobic exercise.

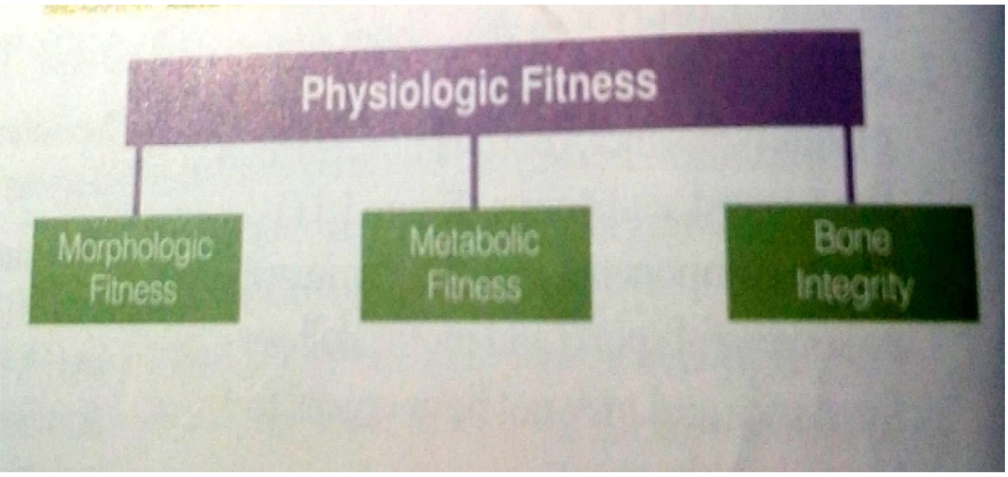
Some individuals prefer sports to pure fitness activities, like running and cycling to improve their fitness. One of the most important reasons for this preference is that the competitive and social aspects of sports make them enjoyable, which helps in the promotion of long-lasting compliance. However, sports like table tennis, volleyball, softball, and bowling contribute little to the development of health-related fitness, although, they do demand some athletic skills. This is mainly because they are inadequate to stimulate cardiovascular, respiratory, and muscular systems at a level to produce positive change. It is, therefore, necessary that these sports should be supplemented with fitness activities, like running, brisk walking, and cyclin to promote long-term health benefits. It is important to note that regular participation in physical activities to develop cardiorespiratory endurance, musculoskeletal fitness, and optimum body composition promotes the basic energy levels of participants and helps them to be at lower risk for chronic diseases, like cancer, osteoporosis, heart diseases, and diabetes. It is with this view that the American College of Sports Medicine has defined health-related fitness as "a state characterised by an ability to perform daily activities with vigour and a demonstration of traits and capacity that are associated with low risk of premature development of hypokinetic diseases (diseases associated with physical inactivity)."

3.3 Skill-related Components of Physical Fitness.



This includes agility, coordination, balance, reaction time, speed, and power. It is more related to sports skills and has nothing to do with health and disease prevention. It is essential for success in sports like soccer, basketball, tennis, and volleyball.

3.4 Physiologic fitness



This term is used primarily in the field of medicine about biological systems that are affected by physical activity and the role of physical activity in preventing disease. The components of physiologic fitness are **metabolic fitness (**denotes reduction in the risk of diabetes and cardiovascular disease through a moderate-intensity exercise programme despite little or no improvement in cardiorespiratory fitness**), morphologic fitness** (used about body composition factors such as percent body fat, body fat distribution, and body circumference) and **bone integrity (**used to determine risk for osteoporosis based on bone mineral density).

4.0 CONCLUSION

This unit discussed the components of physical fitness. We were able to learn about the three (3) components of physical fitness, (health-related, skill-related and physiologic fitness). Health-related fitness is characterised by the ability to perform daily activities with vigour and is associated with a low risk of chronic disease. Skill-related fitness on the other hand is more related to sports skills and has nothing to do with health and disease prevention. It is essential for success in sports like soccer, basketball, tennis, and volleyball, while physiologic fitness is the term used primarily in the field of medicine about biological systems that are affected by physical activity and the role of physical activity in preventing disease.

5.0 TUTOR-MARKED ASSIGNMENT

Identify the components of:

a. Health-related fitness
b. Skill-related fitness
c. Physiologic fitness.

6.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978- 0-495-01202-3.

Mayo Clinic, "Fitness basics". The basics of Physical Conditioning (2020). www.onlinemasters.ohio.edu

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125- 870-0.

MODULE 2

MODULE INTRODUCTION

The first module introduced us to the concepts of physical activity, physical fitness, and physical conditioning and their parts. In this module, we shall be considering how the human body or various organs of the human body adapts to exercise, how exercise programmes are conditioned to yield positive results, and how to choose the right exercise.

UNIT 1 ADAPTATION TO EXERCISE

CONTENT

1.0. INTRODUCTION

The human body is designed for work. The arrangement of the muscle groups, tendons, and ligaments allow the arms and legs to move in a wide variety of activities. The brain controls and regulates the distribution of blood, oxygen, and nutrients from tee art and lungs. The different systems of the body are in communication with each other through hormonal and nervous pathways to achieve coordination in the performance of an activity. The more these systems are involved the more enjoyable and efficient exercise becomes. Contrary to this, inactivity leads to poor health. An attempt is made therefore in this unit to discuss the major benefits of exercise training to the human body and also the influence of genetics, gender, and age.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- discuss the effects of exercise on:

a. the heart
b. the lungs
c. the skeletal muscles.

3.0 MAIN CONTENT

3.1 Effects of Exercise on the Body

The rate of breathing increases about three times above resting levels and the amount of air entering the lungs is 20 times higher during exercise performed for 30-40 minutes. During the same exercise, the heart rate increases 2-3 times the resting level, the volume of blood pumped by the heart increases by 4 times above the resting levels. These temporary different functions of the body caused by exercise are acute responses to exercise. These responses disappear soon after exercise. If such exercise is performed almost every day for several weeks, the functions of the body, both at rest and during exercise, change. The resting heart rate slows down by 10-30 beats per minute and the heart rate during a given exercise slows down because training makes the heart pump more efficiently pump. The trained heart can pump more blood per beat, both at rest and during exercises and the lungs can take in more air during intense exercise. These changes make it possible to deliver more oxygen to the muscles to produce more energy for exercise. The maximum amount of oxygen that the body can consume at maximal exertion increases significantly. This increase changes in the 10-20% with training and may be higher in the case of overweight and unfit people. In addition, the muscles become more efficient in storing and utilizing fats and carbohydrates.

These changes in the structure and function of the body caused by exercise training are a chronic adaptations to exercise. Many of these changes take place within a short time. Significant improvement, for example, in maximal oxygen consumption, resting and exercise heart rate, and lung ventilation can be expected within the first one to three weeks of intensive aerobic exercise training. Some adaptations to aerobic exercise training, like an increase in the number of capillaries in the muscles, may take a much longer time. The magnitude of these chronic adaptations depends upon the volume and intensity of exercise, and also or, the initial fitness level of the individual. Overweight, middle-aged inactive people, for example, can improve maximal oxygen consumption ($V0_2$ max) by about 100%, whereas college students can only gain only about 10.3%. It should also be noted that these adaptations are lost just as rapidly as they are gained after aerobic exercise training is stopped. Some of these changes in different organs and systems of the body are discussed below.

3.2 The heart

The major difference between endurance-trained and untrained individuals is the amount of blood pumped by the heart during each heat, which is called ***stroke volume***. Aerobic exercise training makes the heart bigger and stronger. This causes a decrease in resting and exercise heart rate in trained individuals. Due to these changes, trained individuals can perform a task faster as the heart pumps more blood, delivers more oxygen to the working muscles.

The heart is about the size of a fist. At rest, it pumps about 5 litres of blood through 60,000 miles of blood vessels per minute. As an average adult has about 5 litres of blood, almost all of this blood passes through the heart every minute. The average resting heart rate of untrained adults is about 60-80 beats per minute. With each beat, 55-75 milliliters of blood are pumped by the heart. A trained heart can pump more blood per minute which is called ***cardiac output***, because training makes the heart bigger and stronger. This implies that at rest, the trained heart pumps more blood per beat. That is why athletes have greater stroke volume (100 milliliters per beat). The increase in stroke volume makes the heart pump more slowly, decreasing the resting heart rate by about one beat per minute for one to two weeks of aerobic exercise training, for about 10-20 weeks.

During exercise, heart rate increases proportionally to the intensity of exercise. The maximum heart rate is the highest heart rate recorded at the point of exhaustion during an all-out exercise. When the age of an individual is subtracted from 220, it will give a rough estimate of his or her maximal heart rate. For example, a 60-year-old is estimated to have a maximal heart rate of 160 beats per minute (220-60=160). Most experts and professional organisations recommend that people should exercise at 60-90% of their maximal heart rate to improve cardiorespiratory fitness. For a 60-year-old individual, this would be 96-144 beats per minute. When the exercise is performed at the higher end of the range, it would produce greater training benefits. It should also be noted that as one continues to train, he or she will have to increase the speed of the exercise to achieve the same heart rate. this is because, as the heart gets bigger and stronger with training, it will perform the same work at a lower heart rate because of it; increases the ability to pump more blood and oxygen. In other words, to maintain the heart rate at the predetermined level, the trained individual will have to exercise faster to continue to derive training benefits.

Exercise training increases blood volume. Inactive people have about 5 litres, trained people about 5.5 litres, and elite athletes 6 litres of blood. During exercise, blood is diverted away from inactive organs, like kidneys and intestines to muscles. At rest, only one-fifth of the blood pumped by the heart goes to the muscles. This increases to three-fourths during strenuous prolonged exercise. Regular exercise training increases blood flow to the exercising muscles by opening more of their capillaries and diverting blood from inactive organs. This is made possible because blood vessels, which are made up of smooth muscle, become fit with training and can constrict and dilate better to send blood to where it is needed most.

Exercise training increases blood volume, which makes the body better equipped to divert blood to muscles and skin to supply nutrients and oxygen, eliminate waste products, and dissipate heat. As the blood gives up fluid in the skin to produce heat, and to the muscles to make them contract better, it becomes thicker. Similarly, as the trained heart becomes bigger and stronger to pump more blood for every heat, muscles become more capable to extract and use oxygen at a higher rate than in untrained conditions. The higher $V0_2$ max found in endurance-trained individuals is thus due to a greater cardiac output and a greater oxygen extraction capacity of the muscles.

3.3 Lungs

The size of the lung hardly changes with exercise training. However, fit people ventilate much larger volumes of air during strenuous prolonged exercise. This is because endurance-trained athletes are more efficient in the transportation and utilization of oxygen. This makes them capable of using less oxygen at a given workload than the untrained people.

When atmospheric air is breathed in, lungs pass oxygen to the blood through 300 million tiny air sacs called ***alveoli.*** The surface area of these alveoli is equal to about the area of a tennis court, which allows rapid diffusion of oxygen into the blood. Also, exchanged along with oxygen is carbon dioxide that is produced by the body and then exhaled out to the atmospheric air. As atmospheric air contains only about 21% oxygen, lungs take in large amounts of air during strenuous exercise to be able to supply oxygen to muscles. Normal adults require about 250ml of oxygen each minute at rest. This amount of oxygen is supplied by breathing about six litres of air per minute. However, during strenuous exercise, this amount increases by about 10-12 folds higher, which requires about 100 to 200 litres of air per minute. Highly endurance-trained and tall individuals have lung ventilation areas of more than 240 litres per minute. In other words, the more fit an individual is, the more air he or she can breathe in during maximal exercise.

Normally, an adult breath 12 times per minute. This brings in about 1.5 litres of air per breath or six litres per minute. However, during maximal exercise, this frequency of breathing increases to about 55 to 60 breaths per minute in athletes. Moreover, they breathe in more than three litres of air in each breath during such an exercise. However, it should be noted that the lung size and the amount of air breathed in at rest hardly changes due to training, but a trained individual ventilate less air while achieving the same oxygen intake and workload as the untrained. This is because the trained body is more efficient and effective in transporting and utilizing oxygen.

The increase in blood volume due to training is mainly because of an increase in plasma volume (fluid portion of blood). Red blood cells, which transport oxygen from the lungs to the muscles, increase in number due to training. However, the increase in plasma volume is much more than the increase in the number of red blood cells, which results in more fluid blood. The increased blood volume due to training increases the total amount of oxygen in the blood. But the oxygen content: per unit of blood hardly changes due to endurance training. Thus, the lungs can transport enough oxygen to meet the increased demands during exercise.

3.4 The Skeletal Muscles

Continuous improvement in $V0_2$ max during training is dependent mainly on changes place in the muscles after the changes in the cardiorespiratory system in the few weeks of training. Endurance-trained muscles have more capillaries, mitochondria, enzymes, and myoglobin. While strength training increases the size of slow-twitch fibres. Different people are born with different ratios of slow-twitch to fast-twitch muscle fibre. These individual differences are not affected by exercise training.

Significant adaptations take place within the muscle due to endurance training. Muscle becomes more efficient in utilizing fat for fuel that helps the conservation of muscle glycogen, which is in short supply that can be used towards the end of prolonged exercise. Muscles store more food and develop more capillaries, mitochondria, and enzymes with training.

Oxygen attaches to myoglobin when it enters the muscles. This pigment called myoglobin, gives the slow-twitch muscle fibres their dark appearance. It turns red when oxygen attaches to it and transports oxygen to mitochondria, which use it for burning fuel to produce energy. Muscle myoglobin content can increase by 75 80 per cent to endurance training, it becomes easier for oxygen delivery, and for the removal of carbon dioxide and heat, which together improve the capacity for exercise performance.

HEREDITY AND CARDIORESPIRATORY FITNESS

Available evidence suggests that hereditary accounts for about 25-50% of the variation in $V0_2$ max among people. It also appears to influence the ability of an individual to improve cardiorespiratory fitness through training. Although genetic factors and training conditions are important determinants of $V0_2$ max, genetic factors seem to set upper limits for what can be achieved through training. World-class endurance athletes have been shown to have $V0_2$ max of more than 80ml.Kg per minute. Even when they stop training, they still show values higher than well-conditioned people who have over 65ml.Kg per minute. This shows that some people can improve their aerobic fitness more than others because of their favourable genetic factors. Severe prolonged training helps individuals to reach the upper limits of $V0_2$ max set by genetic factors.

GENDER AND CARDIORESPIRATORY FITNESS.

In sports like running and swimming, world record times for women are about 6-13% slower than for men. In addition to socio-cultural factors, several biological factors appear to be responsible for these gender differences in performance. Even among elite athletes, women have greater body fat percent, higher heart rate, smaller fat-free mass, smaller stroke volume, lower blood volume, hemoglobin content, $V0_2$ max, and strength.

In recent years, there has been a tremendous increase in the number of women participating and competing in both recreational and competitive sports. This increase has brought about dramatic improvements until the mid-1980s, when improvement in women's performance levelled off. At present, women’s world records are about 10-135 slower than those of men. It appears that these gender differences will remain because of a variety of biological factors. Major differences between men and women in body size, composition, and fitness begin to surface around the time of puberty. Some of these differences are discussed below:

a. Fat-free mass increases more in men than in women due to hormones like testosterone. An adult woman has only $^{3}/4$ the fat-free mass of an adult man. A female is 40-60% weaker in lower body strength. However, for the same amount of muscle, there are no strong differences between men and women. This is because strength gains are related more to neural factors than to increases in muscles size, which is minimal in most women.

b. The female hormone, estrogens, broadens the pelvic area of the female, stimulates breast development, and increases that disposition in hips and thighs. The body fat percent average adult female is 6-105 above that of a man. The body fat percent of an average adult female is 20-25% and that of an adult male is 13-15%.

c. Because of smaller body size, a female has a smaller heart size and lower blood volume. Similarly, a female has lower hemoglobin content than a male, which implies that a female gets less oxygen per unit of blood for the working muscle than the male. Because of these differences, an average adult female has a smaller stroke volume and a higher heart rate than an average adult male at a given exercise workload.

d. An average adult female has $V0_2$ max that is only about 70-75% of an average adult male. Much of this difference is attributed to the relatively lower activity of the female.

AGE AND CARDIORESPIRATORY FITNESS

It appears that much of the decrease in cardiorespiratory fitness attributed to aging is because people exercise less as they age. Normally, $V0_2$ max decreases by 8-18% per decade after 25 years of age. Much of this loss can be regained if every individual becomes fitter through regular exercise training than an untrained person. However, older people gain less fitness than younger people when both of them train due to the process of aging. As with $V0_2$ max, muscular strength decreases by 5-10% per decade after 45 years of age. Much of this loss can be regained if weight training programmes is followed by older people.

Participating in regular physical activity leads to healthy ageing. Although older people have better gains than other groups through training, only very few old people exercise regularly compared to other age groups. It should also be noted that the ageing process is real and the ability to train vigorously decreases with age. It appears that this age-related decrease cannot be prevented through training. A lower ability to utilize oxygen and a lower heart rate and stroke volume with age seem to be responsible for this age-related decrease in aerobic fitness. Similarly, muscular strength declines by 5-105 per decade after age 45.s an average individual loses about 30% of muscular strength and about 40% of muscular size between 20 and 70 years of age. This process is known as ***sarcopenia***, which is a major reason for the decrease in strength among older people. This decrease in muscular strength and size with an increase in age can be minimized by adequate resistance training.

4.0 CONCLUSION

In this unit, attempts were made to discuss the effects of exercise of the organs of the human body; the heart, the lungs and the skeletal muscles. It noted that organs in the body are in communication with each other through hormonal and nervous pathways to achieve coordination in the performance of an activity. It also noted that the more these organs and systems are involved, the more enjoyable and efficient exercise becomes. The unit also discussed the influence of exercise on genetics, gender, and age

5.0 SUMMARY

The different systems of the body are in communication with each other through hormonal and nervous pathways to achieve coordination in the performance of an activity. The more these systems are involved the more enjoyable and efficient exercise becomes

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the changes that take place during exercise in the heart, lung, and skeletal muscles.
2. Explain the relationship between gender and age on cardiorespiratory fitness.

7.0 REFERENCES/FURTHER READING

Baechle, T. R. (1994). Essentials of Strength Training and Conditioning. Champaign, IL: Human Kinetics.

Bouchard, C., Shepherd, R. J. & Stevens, C. (1994). Physical activity, fitness and health: International proceedings and consensus statement. Champaign, IL: Human Kinetics.

Shoenhair, C. L. & Wells, C. L. (1995). Physical activity and coronary heart disease: *A review, Medicine, Exercise, Nutrition and Health,* 4, 200-206.

Wells, C. L. (1996). "Physical Activity and Women's health". In Corbin & Bangrazi, P. (eds.). Physical activity and fitness series 2 (5), 1-6. Washington D.C President's Council on Physical Fitness and Sports.

Kraemer, W. J., Patton, J., Gorgon, S.E., Harman, E. A., Deschenes, N. R., Reyholds, K. & Dziados, J. E. (1995). "Strength and Power Training Physiological Mechanism Adaptation". *Exercise and Sports Science Reviews*. Baltimore. 24, 363-397.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

UNIT 2 CONDITIONING PROGRAMMES

CONTENT

1.0 INTRODUCTION

It is very important that a person possesses some healthful qualities such as organic soundness, strength, vitality, emotional stability, social consciousness, knowledge, and insight to face his daily tasks squarely. To achieve this, the person must be exposed to both preventive and therapeutic nature depending on need.

2.0 OBJECTIVES

By the end of this unit, will be able to:

- identify basic conditioning principles and;
- explain the basic conditioning principles.

3.0 MAIN CONTENT

3.1 Basic Principles of Body Conditioning

1. **Warm-up:** Adequate warm-up should precede all major tasks. Warming-up should be progressive from general to remedial exercises before going into specifics. It is dangerous not to do thorough warm-up before embarking on a major physical task.

2. **Progression:** This is a vital factor of conditioning whether for prevention or therapy. There should be progressive increase in

exercise work load, intensity and frequency of exercise. This gradualness would help the worker to adjust steadily to future task thereby preventing unnecessary accidents and injuries.

3. **Timing:** This refers to exercise scheduling or conditioning sessions per day. It is advisable to exercise twice daily for optimal conditioning, early in the morning before setting out to do the major tasks of the day and later in the evening before going to sleep. With this practice, the body is expected to work optimally with reduced risks of accidents.

4. **Intensity:** The exercise intensity per activity during conditioning should be emphasized as opposed to the quantity of activities packaged. Rather than increasing workload during conditioning, it is wiser to increase intensity. As work becomes more challenging or the state of the condition improves, the intensity of the conditioning programme must be correspondingly reviewed to meet up with the new demands on the body. Intensity is synonymous with increasing repetitions per activity rather than a loan of activity.

5. **Capacity Level:** Every individual has a work performance limit. This implies that a person can only improve on his performance if he could be physically trained to achieve his own established work performance limit, and subsequently target to exceed that limit which is the whole essence of conditioning. Usually, a person can work above his physiological limit if he is so conditioned to do so (endurance).

6. **Strength:** The development of strength should be emphasized when conditioning the body for ultimate performance. Endurance both muscular and general can only be achieved if strength developing exercises are induced into a physical conditioning programme. Increased strength guarantees an increased performance at work and injury is reduced to the barest minimum provided the person is skilled at work.

7. **Motivation:** There should be a motivational force behind each conditioning exercise. It is sometimes very difficult to get a deconditioned body reconditioned just as it costs a lot of money to return a grounded vehicle to good condition. There is thus the need for a variety of activities in the conditioning programme, the conditioner has a pool of activities to choose from, e.g., cycling, swimming, dancing, climbing are enjoyable aerobic activities that could be mixed to ensure optimum gain from the conditioning programme. The activities should be enjoyable enough to encourage the conditioner to continue to exercise.

8. **Specialization:** jobs do vary in nature; conditioners should keep this at the back of their mind when developing conditioning exercises. It is therefore important to emphasize conditioning activities that would improve an individual's job specialization. In the final analysis, special conditioning exercises tailored to specific demands made upon the body by various jobs or types of work should be applied to develop exercise conditioning programmes for developmental or therapeutic purposes.

9. **Relaxation:** It is also good to relax when conditioning. Therefore, special relaxation exercises should be included in the conditioning programme. Many workers are tensed on the job which often lead to injury or industrial accidents. Relaxation would also help to reduce fatigue from work because it teaches to economise muscular effort.

10. **Routine:** The development of individual exercise routines is paramount to successful conditioning programmes. The worker can't be guided by an expert all the time, particularly through the physical conditioning exercise. Therefore, one routine has been established by the expert, the worker must work towards conditioning himself whenever the guide is not available. If the worker could discipline himself this way, it would help to yield good results at various work performance.

4.0 CONCLUSION

This unit identified and discussed the basic principles of body conditioning, which are specialization, relaxation, routine, capacity level, motivation, strength, intensity, timing, progression and warm-up.

5.0 SUMMARY

It is very important that a person possesses some healthful qualities such as organic soundness, strength, vitality, emotional stability, social consciousness, knowledge, and insight to face his daily tasks squarely.

6.0 TUTOR-MARKED ASSIGNMENT

1. Identify 10 basic principles of conditioning
2. Discuss the principles identified in (1) above.

7.0 REFERENCES/FURTHER READING

Adeyeye, A. O. (2009). *Strategies for Fitness Management*. Marvelous Mike Press Ltd, Garki, Abuja. Nigeria. ISBN 978-978-436-1.

Hoeger, W. W. K. & Hoeger, S. A. (2007*). Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978- 0-495-01202-3.

Mayo Clinic, "Fitness basics". The basics of Physical Conditioning (2020). www.onlinemasters.ohio.edu

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

Ute, J. O. & Ojeme, E. O. (1996). Comprehensive Physical Education. Nigeria: Africana FEP Publishers' Limited.

UNIT 3 CHOOSING THE RIGHT EXERCISE

CONTENT

1.0 INTRODUCTION

There are many forms of exercise, and each type of exercise has its advantages and disadvantages. For example, walking is relatively easy on the joints; during walking, at least one foot is on the ground at all times, so the force with which the foot strikes the ground is never more than a person's weight. However, walking burns fewer calories than does running. Swimming rarely results in muscle tears, because the muscles are supported by the water. However, because swimming is not a weight-bearing exercise, it does not help prevent osteoporosis. Bicycles are pedaled in a smooth circular motion that does not jolt the muscles, but bicycling requires balance, and it is not always possible to enjoy this sport free of traffic and the dangers of cars.

Other choices regarding exercise exist as well. Some people prefer to exercise in a gym or at home, whereas others prefer outdoors. Some people have a very structured exercise routine, whereas others simply incorporate exercise into their lifestyle, for example, by walking rather than driving. Choosing the right exercise is a matter of finding an activity that is fun, safe, and sustainable.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- identify different safe exercises
- describe the different safe exercises
- identify the advantages and disadvantages of choosing different exercise.

3.0 MAIN CONTENT

3.1. Different Exercises to Choose from Walking:

This is a well-balanced form of exercise for most people, regardless of age. Many older people can keep fit through regular walking programmes. However, walking slowly will not make a person very fit. To walk faster, a person can take longer steps in addition to moving the legs faster. The step can be lengthened by swiveling the hips from side to side so that the feet can reach further forward. Swiveling the hips tends to make the toes point outward when the feet touch the ground, so the toes do not reach as far forward as they would if they were pointed straight ahead. Moving the arms faster helps them move faster. To move the arms faster, a person bends the elbows to shorten the swing and reduce the time the arms take to swing back and forth from the shoulder. People with instability or severe joint injury may find walking difficult.

Walking is the most natural aerobic exercise.

Swimming

This exercises the whole body- the legs, arms, and back, without stressing the joints and muscles. Often, swimming is recommended for people who have muscle and joint problems. Swimmers, moving at their own pace and using any stroke, can regularly work up to 30minutes of continuous swimming. If weight loss is one of the major goals of exercise, swimming is not the best choice. Exercises out of water are more effective because air insulates the body, increasing body temperature and metabolism for up to 18 hours. This process burns extra calories after exercise as well as during exercise. In contrast, water conducts heat away from the body, so that body temperature does not rise and metabolism does not remain increased after swimming.

Riding a bicycle

This is good exercise for cardi-vascular fitness. Pedaling a bicycle strengthens the upper leg muscles. With a stationary bicycle, the tension on the bicycle wheel should be set so that the rider can pedal at credence of 60 rotations per minute. As they progress, riders can gradually increase the tension and the cadence up to 90 rotations per minute. A regular bicycle adds the challenges and joys of balance and coping with the challenges in terrain but adds the dangers of dealing with traffic. However, some people cannot maintain their balance, even on a stationary bicycle, and others will not use one because the pressure of the narrow seat against the pelvis feels uncomfortable.

A recumbent stationary bicycle is both secure and comfortable. It has a contoured chair that even a person who has had a stroke can sit in. also, if one leg is paralyzed, toe clips can hold both feet in place, so that the person can pedal with one leg. A recumbent stationary bicycle is a particularly good choice for older people, many of whom have weak upper leg muscles. As a result of having weak upper legs muscles, many older people have difficulty rising from a squatting position, getting up from a chair without using their hands, or walking up stairs without holding on to the railing

Aerobic dancing

This is a popular type of exercise offered in many communities, exercises the whole body. People can exercise at their own pace with guidance from experienced instructors. Lively music and familiar routines make the workout fun, and committing to a scheduled and exercising with friends can improve motivation. Aerobic dancing also can be done at home with videotapes. Low-impact aerobic dancing eliminates the jumping and pounding of regular aerobic dancing, thus decreasing stress on the knee and hip joints. However, the benefits of aerobic dancing, especially in terms of weight loss, are proportional to the intensity.

Step aerobics

This exercise stresses primarily the muscles in the front and back of the upper legs (the quadriceps and hamstrings) as a person steps up and down on a raised platform (a step) in a routine set to music at a designated pace. As soon as these muscle starts to feel sore, exercisers should stop, do something else, and return to step aerobics a couple of days later.

Water aerobics

This is an excellent choice for older people and those with weak muscles because it prevents falls on a hard surface and provides support for the body. It is often used for people with arthritis. Water aerobics involves doing various types of muscle movement or simply walking in waist-to shoulder-deep water.

Water aerobics offers fitness, fun, and safety to people of all ages.

Resistance training

This is an anaerobic exercise meant to build strength and muscle mass. It is far more effective than other forms of exercise for achieving these goals but is less effective than aerobic exercise for burning calories (and thus losing weight) or improving cardiovascular performance at similar intensity. However, increased muscle mass may eventually help maintain lean body weight, because muscle uses more calories than fat. The aerobic component of resistance training can be increased by increasing the repetitions performed at each station and by decreasing the time for rest between each set.

4.0 CONCLUSION

In this unit, we learned that there are different exercises. However, the right exercise that is safe is important to an individual's health. The different safe exercise was highlighted and described. The advantages and disadvantages of these exercises were also discussed.

5.0 SUMMARY

There are many forms of exercise, and each type of exercise has its advantages and disadvantages. Choosing the right exercise is a matter of finding an activity that is fun, safe, and sustainable.

6.0 TUTOR-MARKED ASSIGNMENT

1. List 5 different safe exercises that an individual may choose from.
2. Describe the exercises listed in (1) above.
3. what are the advantages and disadvantages of choosing different exercises listed in (1) above?

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Insel, P. M. & Roth, W. t. (2004). *Selected Material from Core Concepts in Health. 9th Edition.* The McGraw-Hill Companies, Inc. USA. ISBN 0-07-294026-3

Kraemer, J. K. & Ratamess, N. A. (2004). "Fundamentals of Resistance Training: Progression and Exercise Prescription," *Medicine and Science in Sports and Exercise.* 36, 674-688.

Mayo Clinic, "Fitness basics". The basics of Physical Conditioning (2020). www.onlinemasters.ohio.edu

Oduyale, O. (2004). *Physical Conditioning for Healthy Living and Sports*. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

MODULE 3

MODULE INTRODUCTION

The significance of exercise to the fitness of an individual cannot be overemphasized. The relationship between exercise and fitness, exercise and body reaction, and the relationship between fitness and exercise physiology are explained in this module.

UNIT 1 EXERCISE AND FITNESS

CONTENT

1.0 INTRODUCTION

Exercise is a physical activity performed repetitively to develop or maintain fitness. Regular exercise is one of the best things that a person can do to help prevent illness and preserve health. With so many ways to exercise, almost everyone can participate in some way.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- discuss the benefits of exercise
- explain how to start an exercise programme
- identify the two types of exercise
- explain the meaning of intensity, duration, and frequency of exercise

3.0 MAIN CONTENT

3.1 Benefits of Exercise

Regular exercise makes the heart stronger and the lungs fitter, enabling the cardiovascular system to deliver more oxygen to the body with every heartbeat and increasing the maximum amount of oxygen that the body can take in and use. Exercise lowers blood pressure and reduces the levels of total and low-density lipoprotein (LDL) cholesterol (the bad cholesterol), which in turn reduces the risk of heart attack, stroke, and coronary artery disease. Other conditions that are less likely to occur with regular exercise include colon cancer and some forms of diabetes.

Exercise makes muscles stronger, allowing people to perform tasks that they otherwise might not be able to do. Most everyday tasks require muscle strength and a good range of motion in joints and regular exercise can improve both.

Exercise stretches muscles and joints, which in turn can increase flexibility and help prevent injuries. Weight-bearing exercise strengthens bones and helps prevent osteoporosis. Exercise can improve function and reduce pain in people with osteoarthritis, although exercises that put undue stress on joints, such as running may need to be avoided.

Exercise increases the body’s level of endorphins, Endorphins are chemicals in the brain that pain and induce a sense of well-being, Thus, exercise appears to help improve mood and energy levels and may even help alleviate depression. Exercise also helps boost self-esteem by improving a person's overall health and appearance. Besides how exercise benefits people of any age, regular exercise helps older people of any age, independent by improving functional ability and by preventing falls and fractures, it can strengthen the muscles of even the frailest older person living in a nursing home. It tends to increase appetite, reduce constipation, and promote sleep.

The benefits of exercise diminish within months after a person stops exercising. Heart strength, muscle strength, and the level of high-density lipoprotein (HDL) cholesterol (the good cholesterol) decrease, whereas blood pressure and body fat increase. Even former athletes who stop exercising do not retain measurable long-term benefits. They have no retained measurable long-time benefits. They have no greater capacity to perform physical activities and no fewer risk factors for heart attacks than those who have never exercised, nor do they regain fitness any faster.

3.2 Starting an Exercise Programme

Many people can begin an exercise program without consulting their doctor. However, people who have heart and lung disease, diabetes, or any other serious medical condition should talk with their doctor first, as should older people. People taking medication, especially for chronic illness should consult with their doctor as well. Certain drugs may limit the ability to exercise, such as beta-blockers which slow the heart rate, sedatives, which can cause drowsiness and increase the risk of falling. People who have done no exercise previously and who are seriously out of shape may benefit from consulting their doctor before starting an exercise program. In some cases, exercise must be supervised by a physical therapist or other health care professional; or by an experienced, licensed trainer.

The safest way to start an exercise programme is to perform the chosen exercise or sport at a low intensity until the legs or arms ache or feel heavy. If muscles ache after just a few minutes, the first workout should last only that long. As fitness increases, a person should be able to exercise longer without feeling muscle pain. However, some discomfort is necessary for developing stronger, larger muscles. Over time a person can increase the intensity and duration of exercise.

3.3 Types of Exercise

Examples of aerobic activities.

Examples of anaerobic activities.

A major distinction among different types of exercise is whether they are aerobic (with oxygen) or anaerobic (without oxygen) Most forms of exercise have components of both.

Aerobic Exercise

This term refers to exercise that requires oxygen from the air to get to the muscles, thus the heart and lungs are forced to work harder than normal. Running biking, swimming and skating are examples of aerobic exercise. Aerobic exercise tends to burn a lot of calories and improves cardiac function more than does anaerobic exercise. However, it is less effective at building strength and muscles mass.

Anaerobic Exercise.

This term refers to exercise that requires intense straining for a short time. Weight lifting and isometrics (in which one part of the body is used to resist the movement of another part) are examples of anaerobic exercise. Anaerobic exercise relies on an energy source that is stored in the muscles and, unlike Anaerobic exercise, is used to resist the movement of another part) are examples of anaerobic exercise. Anaerobic exercise relies on an energy source that is stored in the muscle and unlike aerobic exercise, is not dependent on oxygen from the air. Overall, anaerobic exercise burns fewer calories than does aerobic exercise and may be somewhat less beneficial for cardiovascular fitness. However, it is better at building strength and muscle mass helps a person become leaner and lose weight because muscle uses large amounts of calories.

3.4 Intensity, Duration, and Frequency

Exercise is always a balance between intensity (how hard the exercise is) duration (how long a person exercises), and frequency (how often a person exercises). For most people intensity should continue to increase as they get stronger, whereas duration and frequency remain constant once a certain level is reached. To strengthen the heart, exercise must be performed at a reasonably high intensity. Intensity can be assessed in several ways. In one method intensity is considered adequate (that is, enough to be beneficial) if the heart rate (measured in beats per minute) increases at least 20 beats above the resting heart rate. in another, more complex method intensity is considered adequate if the heart rate is between 70% and 85% of a person's estimated maximum heart rate, which is 220 minus the person’s age. However, this calculation is somewhat conservative, especially for people who are physically fit. A less quantitative approach is to consider intensity to be adequate if exercise is accompanied by reasonable heavy breathing and sweating, assuming that the environmental temperature is not inordinately hot. Very heavy breathing and profuse sweating indicate a high level of intensity. Another method by which intensity is considered adequate is to work to failure. This approach is often used by weight lifters, who continue lifting until they cannot possibly do one more repetition.

At first, most people can exercise for only a few minutes before they fatigue. For most people, exercise eventually should perform at the most tolerable intensity for about 30 to 60 minutes at a time. This duration provides optimal benefits both for training muscles and cardiovascular conditioning. Extending the duration much beyond this amount of time does not substantially improve strength or endurance.

Most people do not benefit from exercising more than 3 to 4 times a week. Although the heart can be exercised several times a day every day, skeletal muscles start to break down when exercised intensely more often than every other day. The day after adequate work out bleeding and microscopic tearing can be seen in muscle fibers, which is why muscles feel sore. Exercises should allow about 48 hours for the muscle to recover after exercise. After very vigorous exercise, a muscle group may take several days to heal completely. Allowing the muscle to heal makes them stronger.

Different exercises stress different muscle groups. In aerobic exercise, for example, running stresses primarily the lower leg muscles landing on the heels, and rising on the toes exerts the greatest force on the ankle. Riding a bicycle stresses primarily the lower leg muscles pedaling works the front thigh muscles (quadriceps) and hips. Rowing and swimming stress the upper body and back. These exercises can be alternated daily to avoid injury. In anaerobic exercise, such as weight lifting, it is usually best to alternate the muscle groups being trained. An ideal schedule, for example, alternates, exercise for the lower body on the next. Additionally, people should vary the way they train their muscles over time. The body adapts to the routine so that performing the same exercise over time becomes less effective in building strength and cardiovascular fitness. Therefore, weight lifters should alter their routine every few weeks, and aerobic exercise should alternate among the different forms of aerobic exercise available.

4.0 CONCLUSION

In this unit, the benefits of exercise were discussed. An attempt was made to explain how an exercise programme can be started. The two types of exercise were highlighted with relevant examples. The unit also **e**xplained the meaning of intensity, duration, and frequency concerning exercise.

5.0 SUMMARY

Regular exercise is one of the best things that a person can do to help prevent illness and preserve health.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the benefits of exercise.
2. Explain how to start an exercise programme
3. Identify and discuss the two types of exercise with relevant examples.

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

UNIT 2 EXERCISE AND BODY REACTION

CONTENT

1.0 INTRODUCTION

Exercise can be pleasurable if you can manage to get through the initial weeks when the dropout rate is high. You would probably discover this as millions of others have before you. Once you start exercising regularly, it becomes fun and you feel good and relaxed.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- discuss systemic (oxygen transport system) changes induced by training at rest
- identify systemic (oxygen transport system) changes induced by training during sub-maximal exercise
- discuss systemic (oxygen transport system) changes induced by training during maximal exercise
- expalin respiratory changes induced by training.

3.0 MAIN CONTENT

3.1 Body Reactions During Exercise

These are the body reactions during exercising;

- Increased myoglobin content
- Increased oxidation of carbohydrates (glycogen)
- Increased oxidation of fat.
- Increased muscular stores of ATP and PC.
- Increased glycolytic (lactic acid system) capacity.

3.2 Systemic (Oxygen Transport System) Changes Induced by Training at Rest Includes the Following:

- Cardiac hypertrophy.
- Decreased heart rate.
- Increased stroke volume.
- Increased blood volume and hemoglobin.
- Hypertrophy of skeletal muscles.

3.3. Systemic (Oxygen Transport System) Changes Induced by Training during Sub-maximal Exercise Includes the Following:

- No change or slight decrease in maximum temperature.
- Decreased muscle glycogen utilization.
- Decreased lactic acid accumulation.
- No change or slight decrease in cardiac output.
- Increased stroke volume.
- Decreased heart rate.
- Lower blood flow per kilogram of active muscle.

3.4. Systemic (Oxygen Transport System) Changes Induced by Training During Maximal Exercise Includes the Following:

- Increased maximum temperature.
- Increased lactic acid accumulation.
- Increased cardiac output.
- Increased stroke volume.
- No change or slight decrease in heart rate.
- No change in muscle blood flow per kilogram of muscle.

3.5 Respiratory Changes Induced by Training Includes the Following;

- Increased pulmonary ventilation.
- increased ventilatory efficiency.
- Increased lung volume.
- Increased diffusion capacity.
-

3.6. Other Changes Resulting from Training are;

- Decreased blood fat.
- Decreased blood levels of cholesterol and triglyceride.
- Decreased blood pressure during rest and exercise.
- Increased heat acclimatization.
- Increased breaking strength of bone, ligaments, and tendons.

The effects of training are influenced by many factors. Generally.

The greater the intensity, frequency, and duration of the training programme, the greater the improvement will be in most functions. Training effects are specific to the type of training programme used e.g., running versus bicycling, sprint versus endurance, and arm versus leg training. Genetic limitations play an influential role in determining the final magnitude of the training effect. The maximum temperature, muscle fibre types, lactic acid capacity, and maximal heart rate are to a large extent genetically determined. Most modes of exercise (e.g., walking, running, jogging, bicycling, and swimming), when used in a training programme structured on sound principles, will lead to substantial and equal gains in total fitness. Most of the beneficial effects of training return to pre-training levels within 4 to 8 weeks of stopping. Some training benefits such as an increased maximum temperature and a decreased lactic acid production during sub-maximal exercise can be maintained for several months with the maintenance programme consisting of 1 or 2 days of exercise per week. Contrary to popular belief, prior training does not hasten the rate nor increase the magnitude of training benefits gained from a subsequent training programme. Brief periods of detraining (inactive) such as those caused by minor injuries can significantly decrease performance and level of fitness (Fox, Bowers and Foss, 1988).

4.0 CONCLUSION

This unit presented exercise and body reaction. It highlighted the major changes that occur during exercise training. The following changes were noted; systemic (oxygen transport system) changes induced by training at rest, systemic (oxygen transport system) changes induced by training during sub-maximal exercise, systemic (oxygen transport system) changes induced by training during maximal exercise, respiratory changes induced by training and **o**ther changes resulting from training.

5.0 SUMMARY

Exercise can be pleasurable if you can manage to get through the initial weeks when the dropout rate is high.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss systemic (oxygen transport system) changes induced by training at rest.
2. Discuss systemic (oxygen transport system) changes induced by training during sub-maximal exercise.
3. Explain systemic (oxygen transport system) changes induced by training during maximal exercise.
4. Explain respiratory changes induced by training.

7.0 REFERENCES/FURTHER READING

Adeyeye, A. O. (2009). *Strategies for Fitness Management*. Marvelous Mike Press Ltd, Garki, Abuja. Nigeria. ISBN 978-978-436-1.

Fox, L., Bowers, W. & Foss (1988). The physiological basis of physical education and athletics. 4th edition. Dubuque, lowa: Brown Publishers

Jacob, N. (2003). Preventive Management of Hypertension and Diabetes Stress. Nigeria: The CIBN Press Limited.

Katch, V. (1999). Exercise Physiology; Energy Nutrition and Human Performance, 4th edition. Philadelphia; Lea and Febiger.

Ute, J. O. & Ojeme, E. O. (1996). Comprehensive Physical Education. Nigeria: Africana FEP Publishers' Limited.
www. Fitness.com.

UNIT 3 PHYSICAL FITNESS AND EXERCISE PHYSIOLOGY

CONTENT

1.0 INTRODUCTION

Exercise physiology is the subdivision of general physiology that is concerned with the description and explanation of functional changes brought on by single or repeated bouts of exercise, to improve human functional capacities.

A single bout of exercise is called acute, whereas repeated bouts of exercise over several weeks or months are called chronic. Functional changes that occur with acute exercise are called responses to exercise. These responses include a rise in heart rate, blood pressure, ventilation, sweating rate, etc. These responses are temporary and disappear shortly after the exercise is over.

With repeated bouts of exercise, an adaptation takes place. An adaptation is a more or less persistent change in structure and/or function following training, which enables the body to respond more easily to subsequent exercise bouts. One example is the decrease in heart rate. Another is the increase in stroke volume. Yet another example is muscle strength and bulk. All of these changes enable the heart, pump out more blood at a lower energy cost to the heart and to generate more force in the muscle than before training.

As mentioned earlier exercise physiology concerns itself with the improvement of functional capacities. This interest may be directed to:

(a). enhancement of health and physical fitness for the general population and
(b). towards optimizing performance in the various types and levels of competitive athletics.

2.0 OBJECTIVES

At the end of this unit, you will be able to:

- define exercise physiology
- state the difference between acute and chronic exercise
- state the two main concerns of exercise physiology; and
- explain how exercise physiology relates to fitness for all and fitness for athletes.

3.0 MAIN CONTENT

3.1 Physical Fitness and Exercise Physiology

Physical fitness has been defined in many ways. It means different things to different people. However, there seems to be a basic premise upon which most definitions are based. The health of the individual is of major concern, and the highest priority is given to the efficiency of his energy systems. Physical fitness may, therefore, be thought of as a way of life in which there is a healthful interrelatedness of the body, mind, and spirit life as an interdependent interrelated whole. A person who is physically fit, therefore, possesses strength and stamina commensurate with his medical limitations, to carry out his occupational and leisure time activities, without undue fatigue. This definition implies that physical fitness is personal.

The upper limits of physical fitness that an individual can achieve are determined by genetic factors, and physical fitness requirements for individuals are related to different types of physical challenges that different people face. Thus, physical fitness for an athlete means intensive regular work to improve and maintain his muscular strength and endurance, power, and other functions required to be a successful athlete, for a non-athlete who may never need to run fast nor generate a great deal of muscular power, physical fitness may mean maintaining enough strength and endurance to perform daily work with ease, participate successfully in recreational activities and to help prevent degenerative diseases. Since the nature of physical fitness is personal, exercise programmes that lead towards improved fitness must reflect a personal exercise prescription. General physical fitness training provides for general needs. Specific needs are met by training that is specifically prescribed for the individual. Besides, physical fitness needs are not the same for a given individual at all times throughout his life and by no means the same for all peoples of a certain age or both males and females.

Just as physicians choose from many drugs when they are prescribed for a particular ailment, there are also many exercise training and conditioning modalities, each of which can be modified or administered in terms of intensity, frequency, and duration to achieve optimal physical fitness for each individual. Since exercise physiology is the study of how the body reacts to single and repeated bouts of exercise, the knowledge gained from it, therefore, can be used to decide how much exercise is enough, the relationship between exercise physiology and physical fitness lies in the fact that improvement of physical fitness can only be optimally achieved through the application of the principles of exercise physiology to physical fitness training.

3.2 Athletic Conditioning and Exercise Physiology

Athletic conditioning refers to the process by which individuals become physically fit for specialized athletic competitions. It is a special case of physical fitness. Athletic conditioning does not include the acquisition of motor skills used in different athletic performances, like the Fosbury flop in the high jump, or the trap in soccer. It simply means being physically fit to meet the unique challenges of competitive sports. This type of fitness involves displaying a high level of muscular strength and endurance, power, speed, agility, coordination, reaction time, or flexibility according to the demands of a particular sport. Through athletic conditioning, for instance, a basketball player can develop optimal leg power, speed, as well as augment the energy capacity of the muscle for success in competitive basketball.

The relationship between athletic conditioning and exercise physiology is similar to that between physical fitness and exercise physiology. Athletic conditioning is the application of the knowledge gained in exercise physiology to improve the body's capacity to successfully respond to special physical challenges of athletic competitions.

4.0 CONCLUSION

Exercise physiology describes and explains functional changes brought about by exercise. Changes that occur can be temporal or long-term. It also concerns itself with the improvement of functional capacities. The knowledge gained in exercise physiology is applied to improve the body's capacity to respond to physical challenges in daily life and athletic competitions.

5.0 SUMMARY

Exercise physiology is the subdivision of general physiology that is concerned with the description and explanation of functional changes brought on by single or repeated bouts of exercise, to improve human functional capacities.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is the difference between acute and chronic exercise?
2. Discuss the relationship between physical fitness and exercise physiology.

7.0 REFERENCES/FURTHER READING

Fox, L., Bowers, W. & Foss (1988). The physiological basis of physical education and athletics. 4th edition. Dubuque, Iowa: Brown Publishers.

Igbanugo, V. C. (2006). *Exercise Physiology*. Distance Learning Centre, University of Ibadan. Funto Printing Press, Ibadan. Nigeria. ISBN 978-021-231-0.

Jacob, N. (2003). Preventive Management of Hypertension and Diabetes Stress. Nigeria: The CIBN Press Limited.

Katch, V. (1999). Exercise Physiology; Energy Nutrition and Human Performance, 4th edition. Philadelphia; Lea and Febiger.

Waugh, A. & Grant, A. (2014). *Ross and Wilson Anatomy and Physiology in Health and Illness*. 12th Edition. Churchill Livingstone Elsevier. ISBN 978-0-7020-5326-9.

MODULE 4

MODULE INTRODUCTION

Training helps in building the body by aiding physical fitness. An injury-free training and exercise are very important to attaining the potentials in training and exercise. The effects of this training on the body and how injuries can be prevented during training and exercise are discussed in this module.

UNIT 1 PHYSICAL TRAINING

CONTENT

1.0 INTRODUCTION

Different systems and organs systems are affected by several factors. One of such factors is training. The effects of an acute exercise are transient but the effect of exercise undertaken regularly lasts a long time, that is, an adaptation takes place which is beneficial. A well-designed programme of exercise is required to condition the systems in other to function optimally. These training methods and factors affecting the training methods will be discussed.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- define physical training
- list and describe the principles of training
- list and describe different types of training methods.

3.0 MAIN CONTENT

3.1 Principles of Training

In developing any training programme, several factors must be considered. These include progressive overload, duration of the training session, frequency of the training sessions, the intensity of the training sessions, the purpose of the training sessions, and specificity.

Progressive Overload Principle

This principle of training means that for any improvement to occur, the workload for the training must be greater than the load that can be comfortably performed (overload) and that this workload must be gradually increased and the athlete becomes better conditioned (progressive overload). The training load is therefore relative to the level of fitness of the individual. The fitter the person is, the more it will take to improve that fitness. Finally, it becomes a matter of time and motivation to continue as in the case of the athlete who must devote several hours a day to training to improve.

The duration of the training session depends on the type of activity or sport which the athlete is pursuing and the intensity of the training sessions. For example, the marathon rummer may spend several hours a day running while a soccer player may spend 30 minutes or so jogging for general conditioning.

The frequency of the training sessions will depend on the intensity and type of sport. For an endurance-training programme of moderate to high intensity, three to four sessions a week is adequate for improvement. For a low to medium-intensity exercise, five days a week or daily exercise is recommended. For a strength training programme that emphasizes high intensity, 3 to 4 training sessions a week is best.

The intensity of the training programme can be determined using the heart rate method. It has been shown that the magnitude of the heart rate response to an exercise load can be used as an indicator of the overload that is being placed on the body in general, and the cardio-respiratory system specifically. The higher the heart rate response is, the grater is the intensity of the exercise. Therefore, the idea of determining a target heart rate (THR) to be reached during endurance training sessions has been developed. One method of determining THR is the maximal Heart Rate Reserve Method (HRR). The HRR is simply the difference between the resting heart rate (RHR) and the maximal heart rate (MHR).

HRR = MHR – RHR

For example, suppose your resting heart rate is 65 beats per minute (bpm) and your maximal heart rate 200 beats per minute.

HRR = 200 – 65
HRR = 135 beats per minute

The THR can then be determined as a percentage (%) of HRR plus RHR. Using the HRR from our previous example, a THR of 75% of HRR would be calculated as follows:

75% of THR = (0.75 x 135) + 65
= 101.25 + 65
= 166 beats per minute

The exercise during the training programme, then, should be intensive enough to cause the heart rate to reach 166 bpm.

To use the above method to determine training intensity, the resting and maximal heart rate must be known. The resting heart rate may be determined by palpating the radial artery (at the wrist). The number of pulses should be counted for 15 or 10 seconds and multiplied by 4 or 6 for an accurate estimate of the heart rate in beats per minute. The time should start on the first beat palpated, but the count should start on the second beat. This is because the heart rate is taken as the time between two or more consecutive beats. Therefore, for an accurate count, the first beat palpated is not counted.

Direct examination of maximal heart rate is difficult and involves exercising the person to a maximal level while at the same time determining heart rate with an electro-cardiograph. However, estimates based on age may be made from the following formula:

Maximal Heart Rate = 220 – age

As an example, a 30-year-old person would have an estimated MHR of 220 – 30 = 190 bpm.

Specificity

Specificity is another training principle that is important for the success of any training programme. To be effective, training must be specific to the sport. The long-distance runner must run to maximise the conditioning process for his sport. Two hours of hard swimming training each day will do to improve your running ability. Likewise, a soccer player will gain little help for his game of soccer by shooting free throws on the basketball court. The body adapts to the specific type of stress under which it trains and the adaptation is specific to the training activity.

The implication of this is that training must be specific for not only developing the specific muscle groups involved along with the exact movement skill, but also the major energy systems predominantly used during the performance of the sport or activity in question. For example, the jogger interested in improving physical fitness would want to concentrate primarily on developing the aerobic (oxygen) system, the sprinter who is training for the 100-meter dash would devote most of his time to the ATP-PC and the lactic (anaerobic) system. At the same time, a person who is training to compete in middle-distance events would have to devote sufficient time to all three energy systems.

3.2 Training Methods

Several training programmes have worked for different people depending on the type of sport. These are interval and continuous training methods.

Interval Training

This type of training involves short periods of work alternated with short periods of rest or reduced activity. The concept of interval training is based on sound physiological principles. It has been found that athletes can do a greater amount of work if the total work is broken into short intense bouts- with short intervals of rest or reduced activity relief between consecutive work bouts. This is due to the different interactions between the energy systems involved. During intermittent as compared to continuous running, for instance, the energy supplied through anaerobic glycolysis will be less and that via the phosphagen system will be more. This means that less lactic acid is accumulated and thus less fatigue is associated with intermitted work. During the rest interval, a portion of the ATP and PC depleted during the preceding work bout is replenished via the aerobic system. In addition, a portion of oxygen bound to myoglobin is restored. Thus, during each run that follows a rest interval, the replenished ATP and PC, and oxygen stores will again be available.

In addition to work and relief intervals, other variables to be considered in an interval-training programme are the number of sets to be performed per session, The number of repetitions per set, training time, training distance, and frequency. For example:

Set 1: 6 x 200 at 0: 30 sec (1: 30 sec rest)
Set 2: 6 x 400 at 0: 70 sec (0: 85 sec slow jog)

In the first example, the athlete would run 6 repetitions of 200 meters each completing the work interval in 30 seconds and resting one minute, thirty seconds. In the second example, the set consists of running six repetitions of 400 meters each, completing the work interval in 70 seconds. and resting 85 seconds between work intervals with slow jogging.

The interval training approach can be used for almost any sports activity, although it has received its greatest use in track, cross country, and swimming. In designing an interval-training programme, five variables must be individual must be individually adjusted for each athlete.

a. Rate and distance of the work interval.
b. Number of repetitions and sets during each training session.
c. Duration of the rest and relief interval.
d. Type of activity during the rest interval.
e. Frequency of training per week.

Continuous Training

This form of training involves continuous activity without relief intervals. The training varies from high-intensity continuous activity of moderate duration to low-intensity activity of extended duration. High-intensity continuous activity (continuous fast running) is performed at work intensities that represent 85-95% of an individual's maximal heart rate (max HR) or 80-905 of HRR. A middle-distance of 5 miles at an average pace of 5 minutes a mile with an HR of 180 bpm. A long-distance runner may maintain a pace that is just below his racing pace. This method appears to be a very effective way of training endurance athletes without requiring high levels of work, which is both stressful and uncomfortable. The constant pace at the near competition level of this type of training is advantageous since it is the most efficient and physiologically sound way by which an athlete attains the best time. This type of training would therefore aid in preparing for active competition. However, since it is very demanding particularly when extended over weeks and months, it is suggested that it be alternated periodically with slower pace variations like long slow distance running (LSD) or Fartlek.

With LSD training, the athlete performs at a relatively low intensity e.g., 60-80% of max HR or 55-75% of HRR. The pulse rate seldom gets above 160 bpm for a young athlete who is twenty-five to thirty years old, and 140 bpm for the older athletes. An endurance runner using LSD may run 15-20 miles a day with weekly distances of 100 – 200 miles. The pace is considerably lower than the maximum pace the athlete can sustain. The athlete capable of a 5-minute mile pace can train at a 7 – 8 minutes mile pace. Though the stress on the cardi-respiratory system is less and more tolerable compared to high-intensity continuous running, the extreme distances required can result in significant muscle and joint discomfort and actual injury.

The LSD training programme is probably the most widely used since it is suitable for several conditions. For example, it is useful for the athlete who participated in team sports and games to stay in condition during the off-season period, the older individual who wants to attain and maintain an acceptable level of physical fitness, and other individuals who train for health-related reasons.

Fartlek training or speed play is another form of continuous exercise used primarily by long-distance runners. The athlete varies his pace as he wishes, from high speed to jogging. Fartlek training is performed in rural lands where there are a variety of hills. Each athlete is free to run whatever course and speed he prefers, although the speed should periodically reach high-intensity levels. Fartlek training could be used to supplement either high-intensity continuous running or interval training since it provides variety for the normal training routine. Its duration is usually 45 minutes or longer.

4.0 CONCLUSION

The unit highlighted the basic principles of any physical training methods as progressive overload, duration, and intensity of the training programme, the purpose of training, and specificity.

The overload principles require that the training be greater than the load the athlete is used to and that the workload is increased as he becomes better. For endurance training programmes, training intensity can be judged from heart rate response to exercise. The target heart rate (THR) should be between 80 and 90% of the maximal heart rate reserve (HRR). For anaerobic training, the heart rate should be 180 bpm or more.

The interval training system involves repeated bouts of hard work alternated with rest or reduced activity. Intermittent work delays fatigue and allows work to be performed at maximal intensity. Manipulation of the rate and distance of the work interval, the number of repetitions, and the time and type of relief interval provide for a training programme that can meet the needs of everyone.

5.0 SUMMARY

Other training methods include continuous fast running, long slow running (LSD), and speed play (Fartlek) training.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is Physical training?
2. List and describe the principles of training.
3. List and describe different types of training methods.

7.0 REFERENCES/FURTHER READING

Fox, L., Bowers, W. & Foss (1988). The physiological basis of physical education and athletics. 4th edition. Dubuque, lowa: Brown Publishers

Igbanugo, V. C. (2006). *Exercise Physiology*. Distance Learning Centre, University of Ibadan. Funto Printing Press, Ibadan. Nigeria. ISBN 978-021-231-0.

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

UNIT 2 EFFECTS OF PHYSICAL TRAINING

CONTENT

1.0 INTRODUCTION

Earlier, we considered physical training, principles of training, and training methods. We noted that chronic exercise is accompanied by changes. In this unit, some of these changes as well as certain factors that will modify these changes will be discussed.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- state major physiological adaptations that result from training.
- list changes that occur in skeletal muscles with training
- state the major adaptations that occur in the respiratory and circulatory systems
- list other changes that occur.

3.0 MAIN CONTENT

3.1 Physiological Adaptions to Training

The ability of man to excel in athletic performance is brought about by a series of reactions within the body's systems. As the activity is prolonged. The muscles perform at their best, the heart and blood vessel supply oxygen and nutrients, the nervous and endocrine systems integrate these activities while the kidneys and skin assist in maintaining fluid balance. As these different systems; cardiovascular, respiratory, metabolic, and so on performing their roles in exercise they are in turn developed.

3.2 Neuromuscular Adaptation to Training

Skeletal muscle constitutes the single largest tissue mass of the body and has a remarkable ability to adapt to various forms of training.

Studies have indicated that chronic exercise brings about changes in the thickness of cartilages, makes ligaments tendons, and muscles strong. The increase in muscular strength is brought about by gains in muscle size. This gain in size is referred to as hypertrophy. A loss in muscle mass of a male is far greater than that of a female due predominantly to the male hormone known as testosterone. This hormone is suppressed in the female sex, and this accounts for the more increased muscle mass and strength in the male. However, it has been observed that some females tend to have increased muscles mass as a result of weight training. This increase is probably due to the presence of higher naturally occurring levels of testosterone but can never rival the level in men.

Physical training causes muscular hypertrophy due to a change in the structural components of the muscle. This structure change could be an increase in the number of the fibers (hyperplasia) or an increase in the size of the muscle fibers. Studies have; however, indicate that the number of muscle fibers is fixed at birth. Hypertrophy is then due largely to the increase in the size of fibers.

3.3 Changes in the Circulatory System

The circulatory or cardiovascular system performs the role of delivering blood, and supplying oxygen and nutrient to, and removing waste products of metabolism from the tissues. From resting to exercise state, several cardiovascular adoptions take place.

The changes include:

1. Decreased heart rate.
2. increased stroke volume.
3. increased cardiac Output.
4. increased Blood pressure.
5. changes in heart size.

Decreased heart rate

This means that the heart will not need to beat many times a minute at rest as it did before training decreasing stress. The heart rate will be lower at the same workload after training than it was before training. The heart rate will return quickly to pre-exercise level following exercise.

Stroke Volume

Stroke volume is known to increase with training. The increased stroke volume attributable to endurance training is related to an increased heart volume, which itself, also results from endurance training. It follows then that a conditioned heart can deliver more blood than an unconditional heart. Some authors have claimed that high stroke volumes are sometimes found in the absence of cardiac hypertrophy. This is attributed to greater contractility of the heart muscle.

Cardiac Output

The cardiac output is the volume of blood ejected by the heart each minute. The cardiac output at rest is 4 to 6 liters per minute. This value can be increased 6-8 folds per minute in a well-conditioned athlete. Cardiac output is one of the limiting factors in athletic performance. Cardiac output is a product of two factors heart rate and stroke volume. The cardiac output thus equals heart rate times stroke volume.

Cardiac output rises with training. For example, it has been shown to rise from untrained values of 22 and 16 L/min to 24 and 18 L/min for adult males and females respectively with training. this increase in cardiac output in endurance training is not a function of higher maximal heart rate since heart rate decreases with training. It is related to a greater stroke volume.

Increase in blood volume and blood flow

Training enhances blood flow through the muscles. The increase in blood flow is facilitated by increased muscle strength. The increase in muscle strength in muscle strength in the trained individual facilitates better extraction of oxygen needed during exercise.

In general, the blood flow from the heart is not constant through all tissues but varies with the tissue needs. Blood is shunted from areas of less metabolic activity to those areas that are actively involved in the exercise.

Change in heart size

Training leads to an increased in heart volume. The size of the heart of an athlete in terms of volume is found to be greater than that of a non-athlete. This increased in the volume means an increase in the blood that fills the ventricle during systole. There is also an increase in size (hypertrophy). Differences in cardiac hypertrophy and volume are related to the type of sports and physical activities the individuals undertake.

3.4 Respiratory System Adaptations to Training

Pulmonary ventilation is increased with training. The value could change from 100 liters per minute to above 200 liters per minute in well-conditioned male athletes. The increase is brought about by both tidal volume and respiratory frequency.

Training also brings about increased ventilatory efficiency. Thus, a conditioned individual would record less oxygen to inactive muscles but more to the working muscles.

Training results in improved pulmonary functions and larger lung volumes in most cases. Trained and well-conditioned individuals record larger lung volumes than unconditioned persons except for residual volume. The diffusion capacity of conditioned individuals is larger than that of unconditioned persons. This phenomenon is attributed to training. It could also be due to larger lung volumes, which will facilitate greater alveolar capillary surface area.

3.5 Biochemical (Metabolic) Adaptations to Training

Training is associated with certain biochemical changes. These changes are both aerobic and anaerobic.

Aerobic changes

These changes include:

a. Increased myoglobin: The myoglobin in the working muscle increases substantially with training. Myoglobin stores oxygen.

This aids the delivery of oxygen from the cell membrane to the mitochondria where it is utilised.

b. Increased oxidation of carbohydrates. The capacity of the skeletal muscles to oxidize carbohydrates (glycogen) to produce ATP is increased substantially with training. There is also in the amount of glycogen stored in the muscle following training.

c. Increased oxidation of fat: following endurance training the oxidation of fat, like glycogen, in the presence of oxygen is increased. Fat is a major nutrient that supplies energy to the skeletal muscles during endurance exercise. In endurance exercise, trained individuals oxidize more fat and less carbohydrate than untrained persons.

Anaerobic changes

Two important anaerobic changes are related to training:

a. Increased ATP-PC capacity. With endurance training, the capacity of the phosphagens (ATP-PC) increases. For example, the muscular store of ATP has been shown to increase by about 40% after some months of training.

b. Increased anaerobic glycolysis. Training affects anaerobic glycolysis. The activities of glycolytic enzyme activities are considered advantageous because they speed up the rate and quantity of glycogen broken down to lactic acid. This increases the energy derived from the lactic acid system.

3.6 Body Composition Adaptations to Training

Many changes occur in body composition after endurance training. These changes include a decrease in total body fat, an increase in lean body weight, and a decrease in body weight. These changes are readily seen in the sedentary or obese individual than in the active person. The amount of exercise that will bring about a given body composition change depends on the subject's body weight, the subject's average daily caloric intake, and the desired weight reduction.

Regular physical exercise causes a substantial reduction in both blood cholesterol and triglycerides levels. This change is more pronounced in individuals who initially have high blood cholesterol and triglyceride levels.

Similar regular exercise is beneficial in reducing resting blood pressure in individuals with high blood pressure.

3.7 Factors Influencing Training Effects

Many factors are known to influence training effects. They include:

i. intensity of training
ii. duration of training
iii. frequency of training
iv. mode of exercise
v. hereditary.

4.0 CONCLUSION

Certain changes accompany physical training. These changes are seen in the muscular, respiratory and circulatory systems. There is an increase in muscular strength and circulatory efficiency.

Other changes seen include reduction in body fat with an increase in lean body tissue. Training also enhances aerobic capacities. Certain actors affect training effects. Such factors are intensity, duration, training mode and hereditary.

5.0 SUMMARY

The ability of man to excel in athletic performance is brought about by a series of reactions within the body's systems. As the activity is prolonged. The muscles perform at their best, the heart and blood vessel supply oxygen and nutrients, the nervous and endocrine systems integrate these activities while the kidneys and skin assist in maintaining fluid balance.

6.0 TUTOR-MARKED ASSIGNMENT

1. State major physiological adaptations that result from training.
2. List changes that occur in skeletal muscles with training
3. State the major adaptations that occur in the respiratory and circulatory systems.

7.0 REFERENCES/FURTHER READING

Igbanugo, V. C. (2006). *Exercise Physiology*. Distance Learning Centre, University of Ibadan. Funto Printing Press, Ibadan. Nigeria. ISBN 978-021-231-0.

Insel, P. M. & Roth, W. t. (2004). Selected Material from Core Concepts in Health. 9th Edition. The McGraw-Hill Companies, Inc. USA. ISBN 0-07-294026-3

Kraemer, W. J., Patton, J., Gorgon, S.E., Harman, E. A., Deschenes, N. R., Reyholds, K. & Dziados, J. E. (1995). "Strength and Power Training Physiological Mechanism Adaptation". *Exercise and Sports Science Reviews*. Baltimore. 24, 363-397

Mayo Clinic, "Fitness basics". The basics of Physical Conditioning (2020). www.onlinemasters.ohio.edu

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

UNIT 3 PREVENTING INJURY

CONTENT

1.0. INTRODUCTION

More than 6 out of 10 people who start an exercise program drop out in the first 6 weeks often because of an injury. Injuries can be prevented by scheduling workouts 48 hours apart. It is also important to state that, people should stop exercising immediately if they feel pain.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- identify common causes of injuries
- explain acute sports injuries
- describe overtraining and its common causes.

3.0 MAIN CONTENT

3.1 How to Prevent Injury

Two types of muscle discomfort may be felt after exercise. The desirable type, delayed onset muscle soreness does not start until several hours after exercising intensely. Usually, it affects both sides of the body equally, goes away 48 hours later, and feels better after the warm-up for the next workout. The undesirable type, which indicates injury, is usually felt soon after it occurs, is worse on one side of the body, does not disappear 48 hours later, and becomes much more severe if a person tries to exercise.

Injury is best prevented by warming up the muscles before exercising, followed by stretching and cooling down after exercising.

Warming Up: starting exercise at a lower intensity (for example, walking rather than running or using lighter weights) raises the temperature of muscles by increasing blood flow. Warm muscles by increasing blood flow. Warm muscles are more pliable and less likely to tear than cold muscles, which contract sluggishly. Therefore, warming up helps prevent injuries.

Stretching: stretching lengthens muscles and tendons, and thereby improves flexibility. Longer muscles can generate more force around joints, helping a person jump higher, lift heavier weights, run faster, and throw farther. However, stretching, unlike exercising against resistance (as in weight training), does not strengthen muscles. There is scant evidence that stretching prevents injuries or delayed-onset muscle soreness, which is caused by muscle fiber damage. A person should stretch only after warming up or exercising when the muscles are warm and less likely to tear.

Cooling Down: slowing down gradually (cooling down) at the end of exercise helps prevent dizziness. When the leg muscles relax, blood collects (pools) in the veins near them. To return the blood toward the heart, the leg muscles must contract. When exercise is suddenly stopped, blood pools in the legs, and not enough blood goes to the brain, causing dizziness. By preventing blood from pooling, cooling down also helps the bloodstream to speed up its removal of lactic acid, a waste product that builds up in the muscles after exercise. Lactic acid does not cause delayed-onset muscle soreness, so cooling down does not prevent this soreness.

3.2 Common Causes of Injuries

a. high-impact activities,
b. rapid conditioning programmes (doing too much too quickly),
c. improper shoes or training surfaces, and
d. anatomical predisposition (that is, body propensity).

High-impact activities and a significant increase in quantity increase in quantity, intensity, or duration of activities are by far the most common causes of injuries. The body requires time to adapt to more intense activities. Most of these injuries can be prevented through more gradual and correct conditioning (low-impact) programme.

Proper shoes for specific activities are essential. Shoes should be replaced when they have a lot of wear and tear. Softer training surfaces, such as grass and dirt, produce less trauma than asphalt and concrete.

Because few people have perfect body alignment, injuries associated with overtraining may occur eventually. In case of injury, proper treatment can avert a lengthy recovery process. A summary of common exercise-related injuries and how to manage than follows.

3.3 Acute Sports Injuries

The best treatment always has been prevention. If an activity causes unusual discomfort or chronic irritation, you need to treat the cause by decreasing the intensity, switching activities, substituting equipment, or upgrading clothing (such as buying properly-fitting shoes).

In cases of acute injury, the standard treatment is rest, cold application, compression or splinting (or both), and elevation of the affected body part.

This is commonly referred to as **RICE:**

R = Rest
I = Ice (cold) application
C = Compression
E = Elevation

Cold should be applied three to five times a day for 15 minutes at a time during the first 24 to 36 hours, by submerging the injured area in cold water, using an ice bag, or applying ice massage to the affected part. An elastic bandage or wrap can be used for compression. Elevating the body part decreases blood flow (and therefore swelling) in that part of the body.

The purpose of these treatment modalities is to minimise swelling in the area, which hastens recovery time. After the first 36 to 48 hours, heat can be used if the injury shows no further swelling or inflammation. If you have doubts as to the nature or seriousness of the injury (such as suspected fracture), seek a medical evaluation.

Obvious deformities (exhibited by fractures, dislocations, or partial dislocations, as examples) call for splinting, cold application with an ice bag, and medical attention. Do not try to reset any of these conditions by yourself, because you could further damage muscles, ligaments, and nerves. Treatment of these injuries always should be in the hands of specialised medical personnel. A quick reference guide for the signs or symptoms and treatment of exercise-related problems is provided in the table below:

INJURY	SIGNS/SYMPTOMS	TREATMENT
Bruise (contusion)	Pain, swelling, discoloration	Cold application, compression, rest.
Dislocations/Fracture	Pain, swelling, deformity	Splinting, cold application; seek medical attention
Heat cramp	Cramps, spasms, and muscle twitching in the legs, arms, and abdomen	Stop activity, get out of heat, stretch, massage the painful area, drink plenty of fluids.
Heat exhaustion	Fainting, profuse sweating, cold/clammy skin, weak/rapid pulse, weakness, headache	Stop activity, rest in a cool place, loosen clothing, rub body with cool/wet towel, drink plenty of fluids, stay out of heat for 2-3 days.
Heat stroke	Hot/dry skin, no sweating, serious disorientation, rapid/full pulse, vomiting, diarrhea, unconsciousness, high blood temperature.	Seek medical attention, request help and get out of the sun, bathe in cold water/spray with cold water/rub body with cold towels, drink plenty of cold fluids.
Joint sprains	Pain, tenderness, swelling, loss of use, discolouration	Cold application, compression, elevation, rest; heat after 36 to 48 hours (if no further swelling)
Muscle cramps	Pain, spasm	Stretch muscle(s), use mild exercises for involved area.
Muscle soreness and stiffness	Tenderness, pain	Mild stretching, low-intensity exercise, warm bath.
Muscle strains	Pain, tenderness, swelling.	Cold application, compression, elevation, rest, heat after 36 t0 48 hours (if no further swelling)
Shin splints	Pain, tenderness	Cold application prior to and following any physical activity, rest; heat (if no activity is carried out)

Side stich	Pain on the side of the abdomen below the rib cage	Decrease level of physical activity or stop altogether, gradually increase level of fitness
Tendinitis	Pain, tenderness, loss of use.	Reat, cold application; heat after 48 hours.

Source: Hoeger & Hoeger, 2007.

3.4 Overtraining

In any fitness conditioning programme, rest is important. Although the term **overtraining** is associated most frequently with athletic performance, it applies just as well to fitness participants. We all know that hard work improves fitness and performance. Hard training without adequate recovery, however, breaks down the body and leads to loss of fitness.

Physiological improvements in fitness and conditioning programmes occur during the rest periods following training. As a rule, a hard day of training must be followed by a day of light training. Equally, a few weeks of increased training **volume** are to be followed by a few days of light recovery work. During these recovery periods, body systems strengthen and compensate for the training load, leading to a higher level of fitness. If proper recovery is not built into the training routine, overtraining occurs. **Overtraining** is an emotional, behavioural, and physical condition marked by increased fatigue, decreased performance, persistent muscle soreness, mood disturbances, and feeling of “staleness” or “burnout” as a result of excessive physical training.

3.5 Common Signs of Overtraining

- Decreased fitness
- Decreased sports performance
- Increased fatigue
- Loss of concentration
- Staleness and burnout
- Loss of competitive drive
- Increased resting and exercise heart rate
- Decreased appetite
- Loss of body weight
- Altered sleep patterns
- Decreased sex drive
- Generalised body aches and pains
- Increased susceptibility to illness and injury
- Mood disturbances
- Depression.

4.0 CONCLUSION

To enjoy and maintain physical fitness, preventing injury during a conditioning programme is essential. Exercise-related injuries are common in individuals who participate in the exercise programme. Some of the injuries identified in this unit are: Bruise, Dislocations/Fracture, Heat cramp, Heat exhaustion, Muscle cramps, Muscle strains, Shin splints, etc. Overtraining and its common signs were also discussed.

5.0 SUMMARY

The ability of man to excel in athletic performance is brought about by a series of reactions within the body's systems. As the activity is prolonged.

6.0 TUTOR-MARKED ASSIGNMENT

1. How can you prevent injuries during a conditioning programme?
2. List 10 acute sports injuries and explain their symptoms and treatment.
3. What is overtraining?
4. What are the causes of overtraining?

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalised Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Thacker, S. B., Gilchrist, J., Stroup, D. E. & Kimsey, Jr., C. D. (2004). The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature, *Medicine and Science in Sports and Exercise*. (36), 371-378.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Kraemer, J. K. & Ratamess, N. A. (2004). "Fundamentals of Resistance Training: Progression and Exercise Prescription," *Medicine and Science in Sports and Exercise.* 36, 674-688.

Kokkonen, J. & Lauritzen, S. (1995). "Isotonic Strength and Endurance Gains Through PNF Stretching," *Medicine and Science in Sports and Exercise.* 22, 27.

Williams & Wilkins. (2006). American College of Sports Medicine, *ACSM's Guidelines for Exercise Testing and Prescription*. Baltimore.

Venkateswarlu. K. (2011). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press Limited, Zaria, Kaduna. Nigeria. ISBN 978-125-870-0.

MODULE 5

MODULE INTRODUCTION

Exercise is very effective in the proper functioning of the circulatory and respiratory systems. The roles exercise plays in the functioning of these systems are discussed in this module.

UNIT 1 THE CIRCULATORY SYSTEM AND EXERCISE

CONTENT

1.0 INTRODUCTION

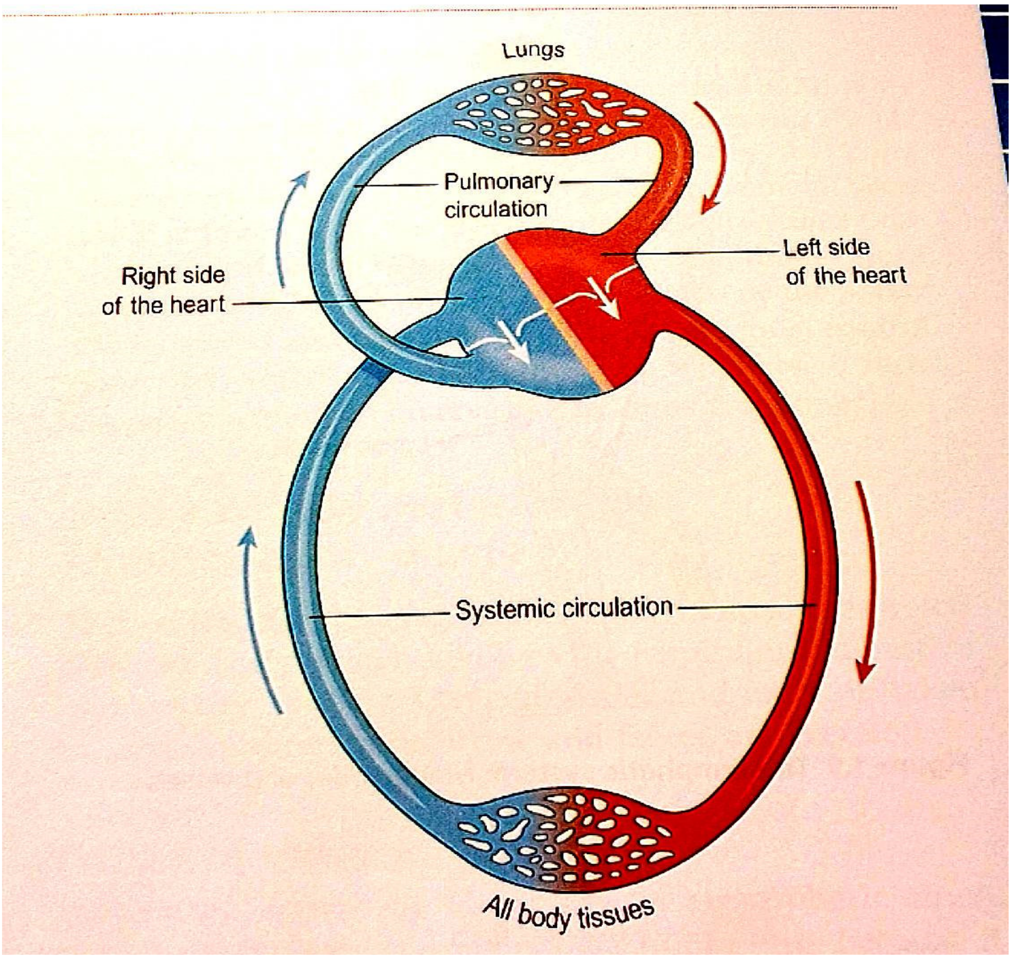
In this unit, we shall be looking at the circulatory system and how it functions in exercise. The circulatory system is the system that transports gas and gas exchange between the blood and the tissues occur.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- list the functions of the circulatory system
- describe the components of circulation
- distinguish between Heart Rate, Stroke Volume, and Cardiac Output
- describe how blood is distributed during rest and exercise
- define blood pressure and
- list and describe factors that affect blood flow.

3.0 MAIN CONTENT



3.1 Definition of the Circulatory System

The circulatory system is a transport system, which carries important nutrients to the tissues, supplies oxygen to the tissues, and removes wastes products of metabolism like CO_2, lactic acid, and heat. It also helps to regulate the body temperature. The system consists of the heart and the blood vessels.

3.2 The Heart

The heart is a hollow muscular organ the size of a closed fist, located in the chest between the two lungs. It has four chambers. The upper chambers are known as the right and left atria, and the lower ones, the right, and left ventricles. The upper chambers are separated from the lower chambers by valves, atrial on the left and the tricuspid valve on the right side. The ventricles are also separated from the large vessels that carry blood away from the heart by valves, aortic valves on the left and pulmonary valves on the right. The valves regulate the flow of blood.

3.2 Components of Circulation

The circulatory system has two components; systemic and pulmonary circulation. Systemic circulation circulates oxygenated blood from the left ventricle to all parts of the body. Pulmonary circulation carries deoxygenated blood from the right ventricle to the lungs for oxygenation.

Blood flow and Gas Transport.

The oxygen and carbon dioxide content of blood is different at rest and during exercise. During exercise, there is a large increase in gas transport due to an increase in cardiac output and redistribution of blood.

3.3 Cardiac Output

This is the amount of blood pumped by the heart each minute. When the heart contracts (beats) as much blood leaves the right side to the left side. Cardiac output increases during exercise about five-fold (times) from rest. Cardiac output is larger in trained than untrained individuals. Cardiac output is made up of stroke volume and heart rate. stroke volume is the amount of blood pumped by the heart each beat. Heart rate is the number of times the heart beats in one minute. Therefore, cardiac output is stroke volume times heart rate. increase in cardiac output is brought about by the increase in heart rate or stroke volume or both.

Stroke volume increases from rest to submaximal exercise but not from submaximal to maximal workload. Maximal stroke volume is therefore reached at submaximal workload when oxygen is about 40%. Stroke volume increases with training because stronger resulting in more complete emptying. The heart rate at rest decreases with training because, with the increase in stroke volume, the heart does not need to beat often.

The heart rate is often the most used index of circulatory function during exercise. Heart rate can be used to achieve the following:

- as a guide to the severity of work
- to assess the effects of training
- to develop training methods.

A large stroke volume and a slow heart rate indicate an efficient system.

Redistribution of blood

At rest muscles receive 15-20% of cardiac output, the rest goes to the rest of the body. During exercise, 85-905 of the cardiac output goes to the working muscles. The redistribution of blood is due to a) vasoconstriction of vessels supplying the inactive muscles and b) vasodilation of vessels supplying the active muscle. Blood flow is also affected by blood pressure and resistance.

3.4 Blood Pressure

Blood pressure is the amount of force that the blood exerts on the walls of the blood vessels in which it is contained. Blood-like gas moves from an area of high to that of low pressure. Blood flows from the left ventricle to the aorta because of higher pressure in the heart. In the same way, blood flows from the aorta to the other vessels and back to the heart for the same reason.

The pressure fluctuates in the arteries. It is the highest during systole (contraction of the heart) and the lowest during diastole (relaxation). Blood pressure is measured in millimeters of mercury (mmHg) with arterial blood pressure (BP) expressed as the systolic value over the diastolic value e.g., 120/80mmHg. BP affects flow. The higher the BP, the more the flow, the lower the BP, the less the flow.

3.5 Resistance

This is the resistance offered to the driving force (BP) by the system caused by friction between blood and vessel. The greater the friction, the greater the resistance. Resistance is due to the **viscosity** and **diameter of the vessel.** The more viscose (thick) the blood, the more the resistance. The smaller the diameter of the vessel, the more the resistance. The vasodilation and vasoconstriction occurring in the arterioles control blood flow to an extent. Vessels supplying the working muscles dilate during exercise while the others constrict. This increases the blood flow to the working muscles.

4.0 CONCLUSION

The circulatory system, which carries oxygen and nutrients to all parts of the body and removes wastes, does so through the heart and the blood vessels. It has two components, pulmonary and systemic.

Cardiac output is the amount of blood pumped out by the heart every minute. Stroke volume is the amount pumped out per beat. Heart rate is the number of times the heart beats per minute. The product of stroke volume and heart rate is cardiac output.

Blood pressure is the amount of force that the blood exerts on the walls of the blood vessels. There is usually friction between the blood and the vessels due to the thickness of the blood and the diameter of the blood vessels. This causes resistance that can increase blood pressure.

5.0 SUMMARY

The circulatory system is the system that transports gas and gas exchange between the blood and the tissues occur.

6.0 TUTOR-MARKED ASSIGNMENT

1. State the functions of the circulatory system.
2. How is blood distributed during rest and exercise?
3. Describe the components of circulation.
4. Distinguish between Herat Rate, Stroke Volume, and Cardiac Output.

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Igbanugo, V. C. (2006). *Exercise Physiology*. Distance Learning Centre, University of Ibadan. Funto Printing Press, Ibadan. Nigeria. ISBN 978-021-231-0.

Waugh, A. & Grant, A. (2014). *Ross and Wilson Anatomy and Physiology in Health and Illness*. 12th Edition. Churchill Livingstone Elsevier. ISBN 978-0-7020-5326-9.

Williams & Wilkins. (2006). American College of Sports Medicine, *ACSM's Guidelines for Exercise Testing and Prescription*. Baltimore.

UNIT 2 RESPIRATORY SYSTEM AND EXERCISE

CONTENT

1.0 INTRODUCTION

Cardio-respiratory considerations involve the consideration of respiratory and circulatory systems and their involvement during exercise. In this unit, we will consider the respiratory system. It is in this system that the movement of air to and from the lungs takes place along with the exchange of oxygen and carbon dioxide between the lungs and the capillaries.

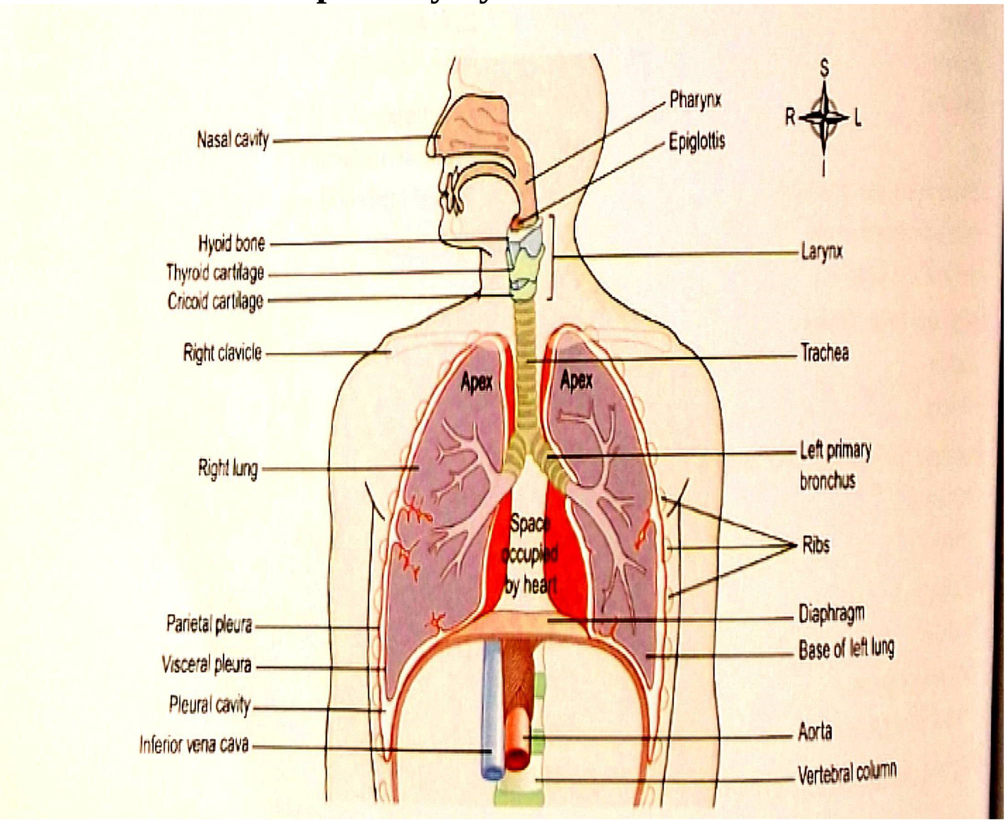
2.0 OBJECTIVES

By the end of this unit, you will be able to:

- describe briefly the structure of the respiratory system
- list the functions of the respiratory system
- define the various static and dynamic volumes
- list the muscles that operate in quiet respiration and during exercise and
- explain how gases are transported.

3.0 MAIN CONTENT

3.1. Structure Respiratory System



The cells of the body need energy for all their metabolic activities. Most of this energy is derived from chemical reactions, which can only take place in the presence of oxygen (O_2). The main waste product of these reactions is carbon dioxide (CO_2). The respiratory system provides the route by which the supply of oxygen present in the atmospheric air enters the body, and it provides the route of excretion for carbon dioxide.

The condition of the atmospheric air entering the body varies considerably according to the external environment, e.g., it may be dry or moist, warm or cold, and carry varying quantities of pollutants, dust, or dirt. As the air breathed in moves through the air passage to reach the lungs, it is warmed or cooled to body temperature, saturated with vapour and *cleaned* as particles of dust stick to the mucus which coats the lining membrane. Blood provides the transport system for O_2 and CO_2 between the lungs and the cells of the body. The exchange of gases between the blood and the lungs is called *external respiration* and that between the blood and the cells is called *internal respiration*. The following are the organs of the respiratory system;

- Nose
- Pharynx
- Larynx
- Trachea
- Two bronchi (one bronchus to each lung)
- Bronchioles and smaller air passages
- Two lungs and their coverings, the pleura and
- Muscles of breathing-the intercostal muscles and diaphragm.

3.2 Functions of the Respiratory System

The followings are the major functions of the respiratory system;

- Exchange of gas i.e., oxygen and carbon dioxide between the lungs and the atmosphere, between the blood and tissue cells.
- It also helps in the regulation of acid-base (ph., hydrogen ions concentration in the blood) and
- In the production of sound.

3.3 Mechanics of Respiration

The gas exchange between the atmospheric air and the air in the lungs is brought about by pressure changes (gradient). For air to flow into the lungs during inspiration the atmospheric pressure must be higher than the pressure in the lungs and for air to leave the lungs during expiration the pressure in the lungs must be higher than atmospheric pressure. The same principle holds for the gaseous exchange in the tissue between the blood and tissue cells.

3.4 Muscles of Respiration

The most important muscle of respiration is the diaphragm. The lowering of pressure in the lungs during inspiration is brought about by the descent of the diaphragm and the contraction of the external intercostal muscles, which raises the ribs in quiet inspiration. Quiet expiration is passive and largely brought about by the elastic recoil of the muscles by inspiration.

During exercise, the metabolic demands are greater and therefore the rate and depth (frequency and tidal volume) are increase. More muscles assist respiration during exercise. Inspiration is brought about by the diaphragm, external intercostal muscles, sternocleidomastoids, and scalene muscles. Expiration during exercise is aided by the abdominal muscles and internal intercostal muscles that draw the lower ribs down and medially.

Lung Volumes and Capacities

Respiratory volumes and capacities are measured with a spirometer.

Static Volumes

These include Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Vital Capacity (VC), Residual Volume (RV), Total Lung Volume (TLV).

TV is the amount of air moved in or out of the lungs with each breath. Normal values = 0.4 to 0.6 liters.

IRV is the amount that can be inhaled at the end of normal inspiration. Normal value is 2.5 to 3.5 liters.

ERV = Amount that can be exhaled at the end of normal expiration. Normal value is 1.0 to 1.5 liters.

VC = Amount of air that can be forcefully exhaled, after maximal inspiration. Average value is 3 to 4 liters for women, and 4 to 5 liters for men.

RV = Volume of air left in the lung after maximal expiration. Average value is 1.0 to 1.2 for women, 1.2 to 1.4 for men.

TLC = Volume of air that the lungs can hold and it is made up of VC and RV. Lung volumes change with age, sex and body size especially height. For this reason, lung volumes should only be evaluated about these variables.

Dynamic Volumes

Dynamic volumes are important in evaluating lung function. An individual can sustain high levels of airflow, rather than the quantity of air in the lungs that is indicative of good lung function.

Dynamic volumes depend on VC and the speed with which this volume (VC) can be moved. This speed (velocity of airflow) is in turn dependent on the resistance offered by the chest and lung tissue to a change in shape during breathing.

A person with severe lung disease can return a normal VC value if no time is placed on it. This is why physicians use dynamic volumes, which places time on VC to evaluate lung function. Two dynamic volumes are normally used. These are Forces Expiratory Volume ($FEV_{1.0}$) and Maximum Voluntary Ventilation (MVV)
$FEV_{1.0}$ = the percentage of vital capacity that can be expired in one second.

This provides an indication of expiratory power and overall resistance to air movement in the lungs. Normally about 80% of vital capacity can be expelled in one second. This amount is severely reduced in obstructive lung disease like emphysema or bronchial asthma.

MVV = the maximal amount of air that can be moved in and out of the lungs in one minute. Usually, the test is for 15 seconds and then the amount for one minute is extrapolated.

MVV in normal people is 140-180 in men and 80 to 120 liters in women. The value is higher in athletes. In lung disease, the value is about 40%. Breathing exercise is useful in improving dynamic volumes.

3.5 Ventilation During Exercise and Rest

Pulmonary ventilation comprises inspiration and expiration i.e., movement of air in and out the lungs. The amount of air inspired or expired in one minute is called minute ventilation VE. This is made up of tidal volume and frequency (breaths per minute). At rest time ventilation is between 4 and 15 liters. Tidal volume is between 0.4 and 0.6 liters while frequency is between 10 and 25 breaths per minute.

During exercise minute ventilation increase to 100 or even 150 liters per minute depending on the intensity of exercise and the amount of oxygen consumed and carbon dioxide produced. Minute ventilation is disproportionate to oxygen consumption at a near maximal level of oxygen consumption. It is proportionate to workload. The higher the exercise intensity, the higher the ventilation. Ventilation, therefore, does not limit exercise.

Anaerobic Threshold

During steady rate exercise (exercise of low to moderate intensity) sufficient oxygen is supplied to muscles. Under this condition, lactic acid does not accumulate. However, if aerobic metabolism is insufficient to produce all the ATP required, anaerobic metabolism contributes and lactic acid builds up. The onset of this anaerobic contribution is called the anaerobic threshold. This occurs normally between 55 and 65% of maximum oxygen uptake in healthy individuals. It is higher in trained than untrained people.

Dead Space

Only a part of the inspired air reaches the alveoli and takes part in the exchange of gases. That portion that takes part in alveoli ventilation is called effective tidal volume. The volume that remains in the respiratory passage is called dead space air. Dead space air depends on the size in Ibs. If you weigh 200Ibs, your dead space air is about 200 milliliters (mls).

3.6 Gas Exchange and Transport Diffusion

The exchange of gas between the alveoli and the blood and between the blood and tissue fluid is due to the process of diffusion. This is the random movement of gas from an area of high concentration or pressure to that of lower concentration or pressure due to their kinetic energy.

Partial Pressure of Gases

The movement of gas is dependent on the partial of gases. The partial pressure of a gas is defined as the pressure exerted by that gas. For oxygen to diffuse from the air in the alveoli to pulmonary capillary blood, the blood pressure of oxygen ($P0_2$) in the alveoli must be higher than the pressure of oxygen ($P0_2$) in the blood. Just the opposite is true of carbon dioxide. The pressure of carbon dioxide ($P0_2$) in the blood must be higher than in the alveoli. The exchange of gas in the tissue follows the same pattern.

3.7 Other Factors Affecting Diffusion

Apart from partial pressure which is the most important, three other factors affect gaseous exchange these are:

1. The thickness of the membrane across which the gases exchange occurs (The length of the diffusion path). The thicker the membrane (like in lung disease), the lesser the diffusion.

2. The number of red cells which transports the gas and the amount of hemoglobin. The more of these variables, the greater the diffusion.

3. The surface area available. This deals with the number of open capillaries that are in direct contact with the ventilated alveoli or tissue. Exercise increases the number of ventilated alveoli and open capillaries. That is why athletes have higher diffusion capacities than non-athletes.

3.8 Transport of Gases

Oxygen and carbon dioxide are carried in the blood in two ways: (1) Dissolved in plasma (2) attached to hemoglobin. Ver little gas is carried and dissolved in plasma 1.5 and 5 percent for 0_2 and $C0_2$ respectively. On average, approximately 20ml. of oxygen is carried with hemoglobin in each 100ml, of blood when hemoglobin is fully saturated with oxygen. This amount is significantly reduced in anemia. In the lungs at the normal alveoli $P0_2$ of 100mmHg, hemoglobin carries about 19.7 mls of oxygen while 0.3ml of oxygen is carried dissolved in solution. The saturation of hemoglobin changes very little until the pressure falls below 60mmHg. This is a safety measure, which assures that the blood is adequately loaded with oxygen. Even if the alveolar pressure of oxygen ($P0_2$) is reduced to 75mmHg as might happen in altitude or certain lung diseases hemoglobin saturation is only lowered by 6%. Below this pressure, however, there is a sharp drop in hemoglobin saturation with 0_2.

At rest, the tissue $P0_2$ in the cell fluids is about 40mmHg. Dissolved oxygen diffuses into the cells this reduces the plasma $P0_2$ below the $P0_2$ in the red blood cell, and hemoglobin is not able to maintain its high oxygen concentration. At the tissue level therefore with a $P0_2$ of 40 mmHg hemoglobin holds 70% total oxygen. Blood leaving the tissues carries about 15mls of oxygen every 100mls of blood. Nearly 5mls of oxygen has been released to the tissue. These differences in the oxygen content of arterial and mixed venous blood are referred to as arterio-venous oxygen differences or a – $V0_2$ differences.

During exercise the tissue $P0_2$ decreases and can decrease to about 15mmHg and only about 5ml of 02 remain bound to hemoglobin and the a- Vo_2 difference increase to 15mls. During exhaustive exercise when tissue $P0_2$ falls to about 3mmHg. Almost all of the 0_2 bound to hemoglobin is released to the tissue cells. It is evident then that even without an increase in blood flow, the amount of oxygen released to the muscle can increase almost three times above that normally supplied at rest just by more complete unloading of hemoglobin.

Apart from partial pressure, a saturation of hemoglobin with oxygen is affected by such factors as the temperature of the blood the pH (acidity) of the temperature and carbon dioxide in the blood decreases the effectiveness of hemoglobin to hold oxygen, especially in the $P0_2$ range of 20-50mmHg. This is usually the case during vigorous exercise and is important since it causes more oxygen to be released to the working muscles.

This phenomenon referred to as "Bohr effect" is minimal in the lungs during exercise. This is important because it allows the complete loading of hemoglobin in the lungs.

Transport of carbon dioxide

Like oxygen-carbon dioxide is carried by the blood in physical solution (dissolved) and in a chemical solution. About 5% of $C0_2$ produced is carried in physical solution in the plasma. The $C0_2$ carried in chemical combination is in two forms one form is bicarbonate ion. About 65% of $C0_2$ is carried in that form. The other chemical form is called carbomino compound. The carbon dioxide is combined with the globin of hemoglobin and proteins found in plasma. About 30% of the total $C0_2$ is carried in that form.

4.0 CONCLUSION

Pulmonary ventilation is the movement of air in and out of the lungs the respiratory system functions to exchange gases, regulated acid-base balance, and helps in the production of sound.

Gas exchange is determined by the partial pressure of oxygen and carbon dioxide. The most important muscle of respiration is the diaphragm. It is assisted by the external intercoastal in quiet respiration. During exercise, other muscles assist.

There are static and dynamic lung volumes that can be measured with a spiro and used to evaluate lung function.

5.0 SUMMARY

Cardio-respiratory considerations involve the consideration of respiratory and circulatory systems and their involvement during exercise. In this unit, we will consider the respiratory system. It is in this system that the movement of air to and from the lungs takes place along with the exchange of oxygen and carbon dioxide between the lungs and the capillaries.

6.0 TUTOR-MARKED ASSIGNMENT

1. What muscles operate in the quiet respiratory, and which ones help during exercise?
2. What is partial pressure? What is its role in respiration?

6.0 REFERENCES/FURTHER READING

Bouchard, C., Shepherd, R. J. & Stevens, C. (1994). Physical activity, fitness, and health: International proceedings and consensus statement. Champaign, IL: Human Kinetics.

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978- 0-495-01202-3.

Igbanugo, V. C. (2006). *Exercise Physiology*. Distance Learning Centre, University of Ibadan. Funto Printing Press, Ibadan. Nigeria. ISBN 978-021-231-0.

Kraemer, W. J., Patton, J., Gorgon, S.E., Harman, E. A., Deschenes, N. R., Reyholds, K. & Dziados, J. E. (1995). “Strength and Power Training Physiological Mechanism Adaptation”. *Exercise and Sports Science Reviews*. Baltimore. 24, 363-397.

The Merck Manual of Medical Information. (2003). 2nd Home Edition. Merck Research Laboratories. USA. ISBN 0-911910-35-2.

Waugh, A. & Grant, A. (2014). *Ross and Wilson Anatomy and Physiology in Health and Illness*. 12th Edition. Churchill Livingstone Elsevier. ISBN 978-0-7020-5326-9.

Kraemer, J. K. & Ratamess, N. A. (2004). “Fundamentals of Resistance Training: Progression and Exercise Prescription,” *Medicine and Science in Sports and Exercise.* 36, 674-688.

Kokkonen, J. & Lauritzen, S. (1995). “Isotonic Strength and Endurance Gains Through PNF Stretching,” *Medicine and Science in Sports and Exercise.* 22, 27.

MODULE 6

MODULE INTRODUCTION

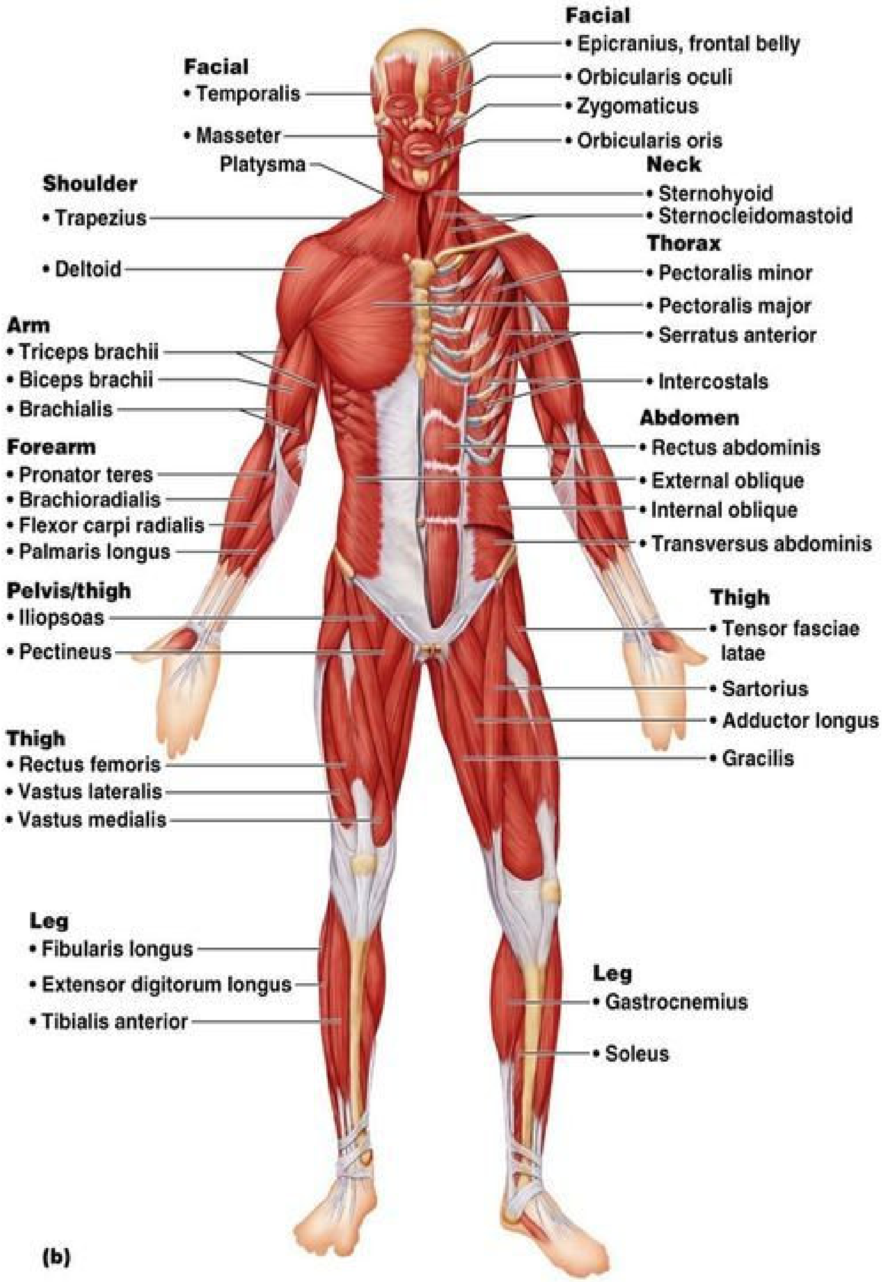
Flexibility is a significant component of physical fitness with various effects on the body. With different flexibility exercises, muscular flexibility can be attained. This module therefore, presents and explains muscular flexibility, flexibility exercises and how strength and power can be developed.

UNIT 1 MUSCULAR FLEXIBILITY

CONTENT

1.0 INTRODUCTION

Most people who exercise do not take the time to stretch, and many who do stretch don’t stretch properly. When joints are not regularly moved through their normal range of motion, muscles and ligaments shorten in time, and flexibility decreases. Most fitness participants underestimate and overlook the contribution of good muscular flexibility to overall fitness and preventive health care.



2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain the importance of muscular flexibility to adequate fitness
- identify the factors that affect muscular flexibility
- explain the health-fitness benefits of stretching
- discuss the principles that govern the development of muscular flexibility.

3.0 MAIN CONTENT

3.1 Flexibility

Flexibility refers to the achievable range of motion at a joint or group of joints without causing injury. Some muscular/ skeletal problems and injuries are related to a lack of flexibility. In daily life, we often have to make rapid or strenuous movements we are not accustomed to making. Abruptly forcing a tight muscle beyond its achievable range of motion may lead to injury.

A decline in flexibility can cause poor posture and subsequent aches and pains that lead to limited and painful joint movement. Inordinate tightness is uncomfortable and debilitating. Approximately 80 percent of all low-back problems in the United States stem from improper alignment of the vertebral column and pelvic girdle, a direct result of inflexible and weak muscle.

3.2 Benefits of Good Flexibility

Improving and maintaining a good range of motion in the joints enhances the quality of life. Good flexibility promotes healthy muscles and joints. Improving the elasticity of muscles and connective tissue around joints enables greater freedom of movement and the individual's ability to participate in many types of sports and recreational activities. Adequate flexibility also makes activities of daily living such as turning, lifting and bending much easier to perform. A person must take care, however not overstretch joints. Too much flexibility leads to unstable and loose joints, which may increase injury rates, including joint dislocation and subluxation.

Taking part in a regular stretching programme increases circulation to the muscle's being stretched, prevents low-back and other spinal column problems, improves and maintains good postural alignment promotes proper and graceful body movement, improves personal appearance and self-image, and helps to develop and maintain motor skills throughout life.

Flexibility exercises have been prescribed successfully to treat dysmenorrhea (painful menstruation) general neuromuscular tension (stress) and knots (trigger points) in muscles and fascia. Regular stretching helps decrease the aches and pains caused by psychological stress and contributes to a decrease in anxiety, blood pressure, and breathing rate. stretching also helps relieve muscle cramps encountered at rest or during participation in exercise.

Mild stretching exercises in conjunction with calisthenics are helpful in warm-up routines to prepare for more vigorous aerobic or strength-training exercises, and in cool-down routines following exercise to facilitate the return to a normal resting state. Fatigue muscles tend to contract to a shorter-than-average resting length and stretching exercises help fatigued muscles reestablish their normal resting length.

3.3 Flexibility in Older Adults

Similar to muscular strength good range of motion is critical in older life. Because of decreased flexibility, older adults lose mobility and may be unable to perform simple tasks such as bending forward or turning. Many older adults cannot turn their heads or rotate their trunks to look over their shoulder but, rather must step around 90^0 to 180^0 to see behind them. Adequate flexibility is most important in driving, individual who loses range of motion with age are unable to look over their shoulder to switch lanes or parallel-park, which increases the risk for automobile accidents.

Physical activity and exercise can be hampered severely by a lack of a good range of motion. Because of the pain during activity, older people who have tight hip flexors (muscles) cannot jog or walk very far. A vicious circle ensues, because lack of flexibility also may be a cause of falls and subsequent injury in older adults. A simple stretching program can alleviate or prevent this problem and help people return to an exercise program.

3.4 Factors Affecting Flexibility

The total range of motion around a joint is higher specific and varies from one joint to another (hip, trunk, shoulder) as well as from one individual to the next, muscular flexibility relates primarily to genetic factors and physical activity. Joint structure (shape of the bone) joint cartilage, ligaments, tendons, muscles, skin, tissue, injury, and adipose tissue (fat)—all influence range of motion about a joint. Body temperature, age, and gender also affect flexibility.

The range of motion about a given joint depends mostly on the structure of that joint. A greater range of motion, however, can be attained through plastic and elastic elongation. Plastic elongation is the permanent lengthening of soft tissue. Even though joint capsules, ligaments, and tendons are nonelastic, they can undergo plastic elongation. This permanent lengthening, accompanied by an increase range of motion, is best attained through slow-sustained stretching exercise.

Elastic elongation is the temporary lengthening of soft tissue. Muscle tissue has elastic properties and responds to stretching exercises by undergoing elastic or temporary lengthening. Elastic elongation increases extensibility, the ability to stretch the muscles. Changes in muscle temperature can increase or decrease flexibility by as much as 20 percent. Individuals who warm up properly have better flexibility than people who do not. Cool temperatures have the opposite effect, impeding range of motion. Because of the effects of temperature on muscular flexibility, many people prefer to do their stretching exercise after the aerobic phase of their workout. Aerobic activities raise body temperature, facilitating plastic elongation.

Another factor that influences flexibility is the amount of adipose (fat) tissue in and around joints and muscle tissue. Excess adipose tissue will increase resistance to movement, and the added bulk also hampers joint mobility because of the contact between body surfaces.

On average, women have better flexibility than men do, and they seem to retain this advantage throughout life. Aging does decrease the extensibility of soft tissue, though, resulting in less flexibility to both sexes.

The most significant contributor to lower flexibility is sedentary living. With less physical activity, muscles lose their elasticity and tendons and ligaments tighten and shorten. Inactivity also tends to be accompanied by an increase in adipose tissue, which further decreases the range of motion around a joint. Finally, injury to muscle tissue and tight skin from excessive scar tissue have negative effects on a range of motion.

3.5 Principles of Muscular Flexibility Prescription

Though genetics play a crucial role in body flexibility, the range of joint mobility can be increased and maintained through a regular stretching programme. This is because the range of motion is highly specific to each body part (ankle, trunk, shoulder), a comprehensive stretching programme should include all body parts and follow the basic guidelines for the development of flexibility. To increase the total range of motion of a joint, the specific muscles surrounding that joint have to be stretched progressively beyond their accustomed length. The principles of mode, intensity, repetitions, and frequency of exercise can also be applied to flexibility programmes.

Modes of Stretching

Three modes of stretching exercises can increase flexibility:

a. ballistic stretching.
b. slow-sustained stretching
c. proprioceptive neuromuscular facilitation (PNF) stretching.

Although research has indicated that all three types of stretching are effective in improving flexibility, each technique have certain advantages.

Ballistic Stretching

Ballistic (or dynamic) stretching exercises are done with jerky, rapid, and bounty movements that provide the necessary force to lengthen the muscles. Although this type of stretching helps to develop flexibility, the ballistic actions may cause muscle soreness and injury from small tears to the soft tissue.

Precautions must be taken not to overstretch ligaments because they will undergo plastic or permanent elongation. If the stretching force cannot be controlled as often occurs in fast, jerky movements, ligaments can easily be overstretched. This in turn, leads to excessively loose joints, increasing the risk for injuries. Slow, gentle, and controlled ballistic stretching (instead of jerky, rapid, and bounty movements), however, is effective in developing flexibility, and most individuals can perform it safely.

Slow-sustained Stretching

With the slow-sustained stretching technique, muscles are lengthened gradually through a joint's complete range of motion and the final position is held for a few seconds. A slow-sustained stretch causes the muscle to relax and thereby achieve greater length. This type of stretch causes little pain and has a low risk for injury. Inflexibility development programmes, slow-sustained stretching exercises are the most frequently used and recommended.

Proprioceptive Neuromuscular Facilitation (PNF)

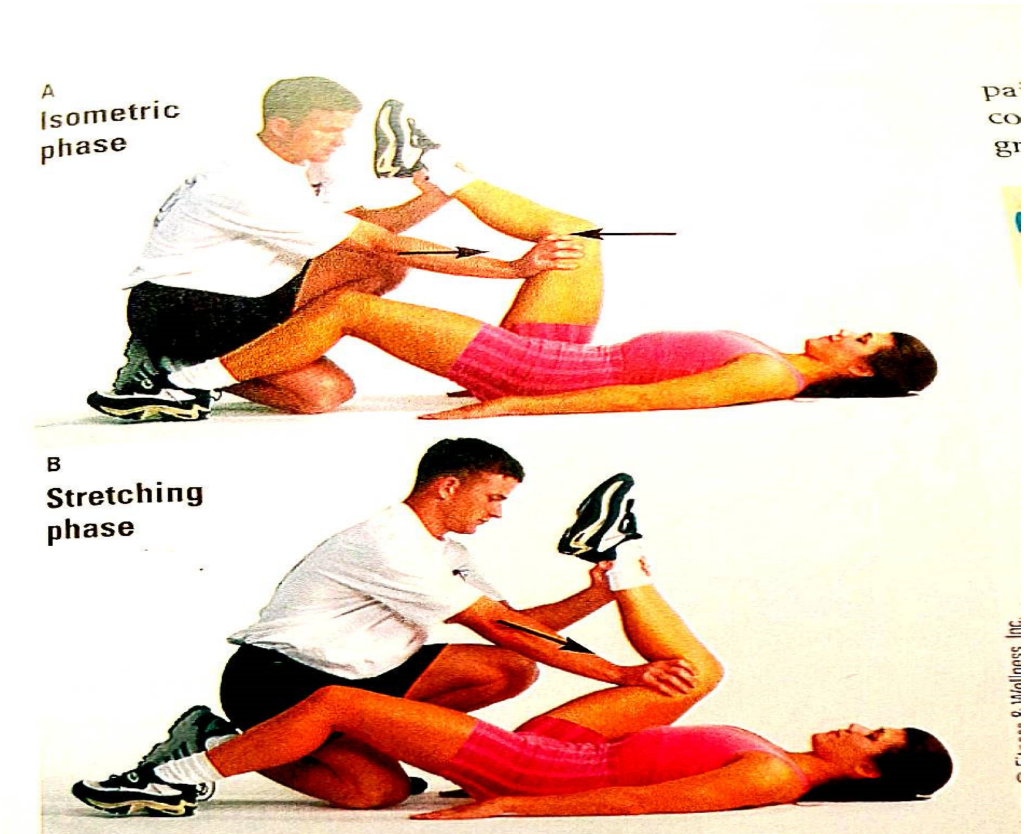
This stretching is based on a "contract-and-relax" method and requires the assistance of another person. The procedure is as follows:

1. The person assisting with the exercise provides initial force by pushing slowly in the direction of the desired stretch. This first stretch does not cover the entire range of motion.
2. The person being stretched then applies force in the direction of the stretch, against the assistant, who tries to hold the initial

degree of a stretch as close as possible. This results in an isometric contraction at the angle of the stretch.

3. after 4 or 5 seconds of isometric contraction, the person being stretched relaxes the target muscle completely. The assistant then increases the degree of stretch slowly to a greater angle.
4. The isometric contraction is repeated for another 4 or 5 seconds, after which the muscle is relaxed again. The assistant then can increase the degree of stretch, slowly, one more time.

Steps 1 through 4 are repeated two to five times, until the exerciser feels mild discomfort. On the last trial, the final stretched position should be held for 15 to 30 seconds.



Proprioceptive neuromuscular facilitation (PNF) stretching technique.

Theoretically, with the PNF technique, the isometric contraction helps relax the muscle being stretched, which results in lengthening the muscle. Some fitness leaders believe PNF is more effective than slow-sustained stretching. Another benefit of PNF is an increase in the strength of the muscle(s) being stretched. Research has shown approximately 17 and 35% increases in absolute strength and muscular endurance, respectively, in the hamstring muscle group after 12 weeks of PNF stretching. The results were consistent in both men and women

and are attributed to the isometric contractions performed during PNF. Disadvantages of PNF are:
More pain.

- The need for a second person to assist, and
- The need for more time to conduct each session.

Intensity

The intensity, or degree of stretch, when doing flexibility exercises should be a point of mild discomfort or tightness at the end of the range of motion. Pain does not have to be part of the stretching routine. All stretching should be done to slightly below the pain threshold. As participants reach this point, they should try to relax the muscle being stretched as much as possible. If you feel pain, the load is too high and may cause injury. After completing the stretch, the body part is brought back gradually to the starting point.

Repetitions

The time required for an exercise session for development of flexibility is based on the number of repetitions and the length of time each repetition is held in the final stretched position. As a general recommendation, each exercise should be done 2 to 4 times, holding the final position each time for 15 to 30 seconds.

As flexibility increases, a person can gradually increase the time each repetition is held, to a maximum of 1 minute. Individuals who are susceptible to flexibility injuries should limit each stretch to 20 seconds. Pilate exercises are recommended for these individuals, as they increase joint stability.

3.6 Frequency of Exercise

Flexibility exercises should be conducted a minimum of 2 or 3 days per week, but ideally 5 to 7 days per week. After 6 to 8 weeks of almost daily stretching, flexibility can be maintained with only 2 or 3 sessions per week, doing about three repetitions of 15 to 30 seconds each. The table below summarises the guidelines for flexibility development:

Mode	Static or dynamic (slow ballistic or proprioceptive neuromuscular facilitation) stretching to include all major muscle groups.
Intensity	Stretch to tightness at the end of the range of motion.
Repetitions	Repeat each exercise 2 to 4 minutes and hold the final stretched positions for 15 to 30 seconds

Frequency	Minimal, 2 or 3 days per week. Ideal, 5 to 7 days per week.

Source: adapted from American College of Sports Medicine, *Guidelines for Exercise Testing and Prescription (Baltimore: Williams & Wilkins, 2006).*

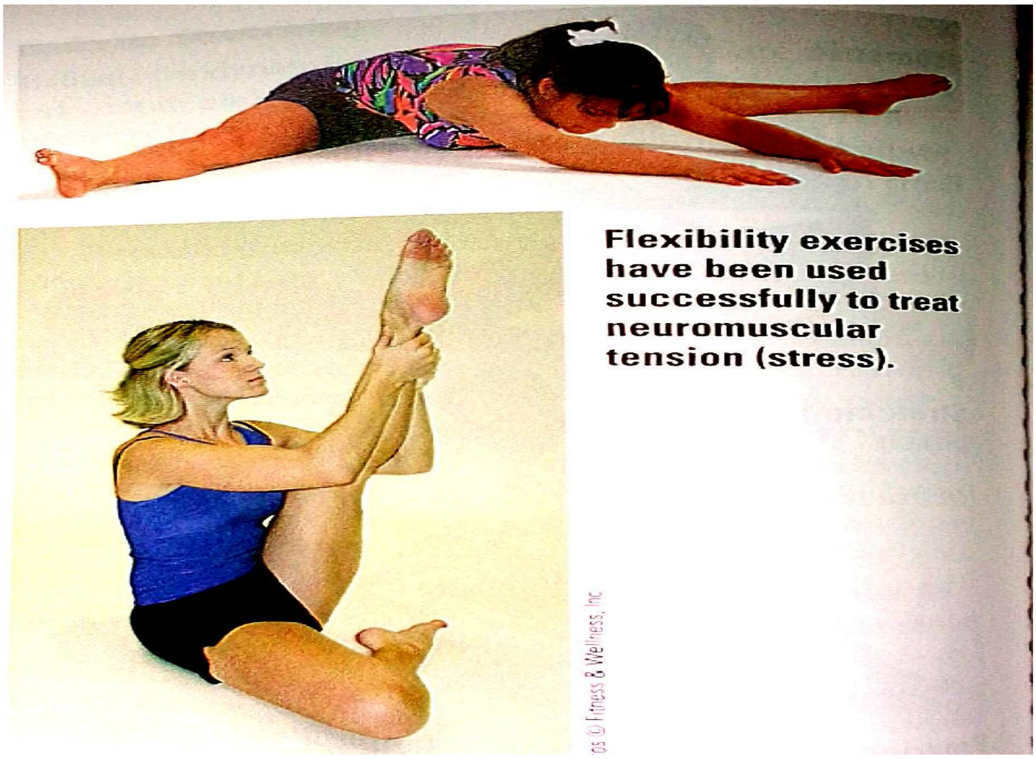
3.7 When to Stretch?

Many people do not differentiate a warm-up from stretching. Warming up means starting a workout slowly with walking, cycling, or slow jogging, followed by gentle stretching (not through the entire range of motion). **Stretching** implies the movement of joints through their full range of motion the final degree of a stretch according to recommended guidelines.

A warm-up that progressively increases muscle temperature and mimics movement that will occur during training enhances performance. For some activities, gentle stretching is recommended in conjunction with warm-up routines. Before steady activities (walking, jogging, cycling), a warm-up of 3 to 5 minutes is recommended. The recommendation is up to 10 minutes before stop-and-go activities (for example racquet sports, basketball, soccer) and athletic preparation in general (for example, gymnastics). Activities that require abrupt changes in direction are more likely to cause muscle strains if they are performed without proper warm-up that includes mild stretching.

Sports-specific/pre-exercise stretching can improve performance in sports that require a greater-than-average range of motion, such as gymnastics, dance, swimming, and figure skating. Some evidence, however, suggests that intense stretching during warm-up can lead to a temporary short-term (up to 60 minutes) decrease in strength. Thus, extensive stretching conducted before participating in athletic events that rely on strength and power for peak performance is not recommended.

In terms of preventing injuries, the best time to stretch is controversial. In limited studies on athletic populations, the evidence is unclear as to whether stretching before or after exercise is more beneficial in preventing injury. Additional research is necessary to clarify this issue.



In general, a good time to stretch is after aerobic workouts. Higher body temperature in itself helps to increase the joint range of motion. Muscles also are fatigued following exercise, and a fatigued muscle tends to shorten, which can lead to soreness and spasms. Stretching exercises helps fatigued muscles reestablish their normal resting length and prevent unnecessary pain.

4.0 CONCLUSION

This unit discussed muscular flexibility and it's to adequate fitness. Factors that affect muscular flexibility was also highlighted. Various principles that govern development of muscular flexibility was also discussed. To unit also presented an understanding of when to stretch.

5.0 SUMMARY

Flexibility refers to the achievable range of motion at a joint or group of joints without causing injury. Some muscular/skeletal problems and injuries are related to a lack of flexibility. In daily life, we often have to make rapid or strenuous movements we are not accustomed to making. Abruptly forcing a tight muscle beyond its achievable range of motion may lead to injury.

6.0 TUTOR-MARKED ASSIGNMENT

1. Muscular flexibility is defined as
   a. the capacity of joints and muscles to work in a synchronized manner.
   b. the achievable range of motion at a joint or group of joints without causing injury.
   c. the capability of muscle to stretch beyond their normal resting length without injury to the muscles.
   d. the capacity of muscles to return to their proper length following the application of a stretching force,
   e. the limitations placed on muscles as the joints moves through their normal planes.

2. Good flexibility
   a. promotes healthy muscles and joints.
   b. decreases the risk of injury.
   c. improves posture.
   d. decreases the risk of chronic back pain.
   e. all are correct choices.

3. Plastic elongation is a term used in reference to
   a. permanent lengthening of soft tissue.
   b. increased flexibility achieved through dynamic stretching.
   c. temporary elongation of muscles.
   d. the ability of muscles to achieve a complete degree of stretch.
   e. lengthening of muscles against resistance.

4. The most significant contributor to loss of flexibility are

   a. sedentary living and lack of physical activity.
   b. weight and power training.
   c. age and injury.
   d. muscular strength and endurance.
   e. excessive body fats and low lean tissue.

5. Which of the following is not a mode of stretching?
   a. proprioceptive neuromuscular facilitation.
   b. elastic elongation.
   c. ballistic stretching.
   d. slow-sustained stretching.
   e. all are mode of stretching

6. PNF can help increase
   a. muscular strength

b. muscular flexibility
c. muscular endurance
d. range of motion
e. all are correct choices.

7. When performing stretching exercises, the degree of stretch should be
a. through the entire arc of movement.
b. to about 80% of capacity.
c. to tightness at the end of the range of motion.
d. applied until the muscles start shaking.
e. progressively increased until the desired stretch is attained.

8. When stretching, the final stretch should be held for
a. 1 to 10 seconds.
b. 15 to 30 seconds.
C 30 to 90 seconds.
d. 1 to 3 minutes.
e. as long as the person is able to sustain the stretch.

6.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Kraemer, J. K. & Ratamess, N. A. (2004). "Fundamentals of Resistance Training: Progression and Exercise Prescription," *Medicine and Science in Sports and Exercise.* 36, 674-688.

Kokkonen, J. & Lauritzen, S. (1995). "Isotonic Strength and Endurance Gains Through PNF Stretching," *Medicine and Science in Sports and Exercise.* 22, 27.

Williams & Wilkins. (2006). American College of Sports Medicine, *ACSM's Guidelines for Exercise Testing and Prescription*. Baltimore.

Thacker, S. B., Gilchrist, J., Stroup, D. E. & Kimsey, Jr., C. D. (2004). The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature, *Medicine and Science in Sports and Exercise*. (36), 371-378.

www. fitness.com.

UNIT 2 FLEXIBILITY EXERCISES

CONTENT

1.0 INTRODUCTION

To improve body flexibility, each majo4r muscle group should be subjected to at least one stretching exercise. A complete set of exercises for developing muscular flexibility is presented in this unit.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- prevent low back pain
- identify flexibility exercises
- describe flexibility exercises.

3.0 MAIN CONTENT

3.1 Contraindicated Exercises

Most strength and flexibility exercises are relatively safe to perform, but even safe exercises can be hazardous if they are performed incorrectly. Some exercises may be safe to perform occasionally but, when executed repeatedly, may cause trauma and injury. Preexisting muscle or joint conditions (old sprains or injuries) can further increase the risk of harm during certain exercises. Contraindicated exercises may cause harm because of the excessive strain they place on muscles and joints, in particular the spine, lower back, knees, neck, or shoulders.

3.2 Preventing and Rehabilitating Low-Back Pain

Few people make it through life without having a low-back joint at some point. An estimated 60-80% of the population has been afflicted by back pain injury. Back pain is considered chronic if it persists longer than 3 months. It has been determined that backache syndrome is preventable about 80% of the time, and is caused by:

- Physical inactivity.
- Poor postural habits and body mechanics.
- Excessive body weight.
- Psychological stress. Data also indicates that back injuries are more common among smokers.

More than 95% of all back pain is related to muscle/tendon injury, and 1 to 5% is related to intervertebral disc damage. Usually, back pain is the result of repeated micro-injuries that occur over an extended time (sometimes years) until a certain movement, activity, or excessive overload causes a significant injury to the tissues.

People tend to think of back pain as a problem with the skeleton. The spine’s curvature, alignment, and movement are controlled by surrounding muscles. The most common reason for chronic low-back pain is a lack of physical activity. In particular, a major contributor to back pain is excessive sitting, which causes back muscles to shorten, stiffen, and become weaker.

Low-back pain frequently is associated with faulty posture and improper body mechanics, or body positions in all of life’s daily activities, including sleeping, sitting, standing, walking, driving, and exercising. Incorrect posture and poor mechanics, such as prolonged static postures, repetitive bending, and pushing, twisting a loaded spine, and prolonged sitting with little movement (more than an hour) increase strain on the lower back and many other bones, joints, muscles, and ligaments.

In the majority of back injuries, pain is present only with movement and physical activity. If the pain is present only with movement and physical activity. If the pain is severe and persistent even at rest, the first step is to consult a physician, who can rule out any disc damage and may prescribe proper bed rest using several pillows under the knees for leg support. This position helps release muscle spasms by stretching the muscles involved. In addition, a physician may prescribe a muscle relaxant or anti-inflammatory medication (or both) and some type of physical therapy.

In most cases of low-back pain, even with severe pain, people feel better within days or weeks without being treated by health care professionals. To relieve symptoms, you may use over-the-counter pain relievers and hot or cold packs. You should also stay active to avoid further weakening of the back muscles. Low-impact activities such as walking, swimming, water aerobics, and cycling are recommended. Once you are pain-free in the resting state, you need to start correcting the muscular imbalance by stretching the tight muscles and strengthening the weak ones. Stretching exercises always are performed first.

If there is no indication of disease or injury (such as leg numbness or pain), a herniated disc, or fractures, spinal manipulation by a chiropractor or other health care professional can provide pain relief.

Back pain can be reduced greatly through aerobic exercise, muscular flexibility exercise, and muscular strength and endurance training that includes specific exercises to strengthen the spine-stabilizing muscles. Exercises require effort by the patient, and it may create discomfort initially, but exercise promotes circulation, healing, muscle size, and muscle strength and endurance. Many patients abstain from aggressive physical therapy because they are unwilling to commit the time required for the programme.

Aerobic exercise is beneficial because it helps decrease body fat and psychological stress. During an episode of back pain, however, people often avoid activity and cope by getting more rest. Rest is recommended if the pain is associated with a herniated disc, but if your physician rules out a serious problem, exercise is a better choice of treatment. Exercise helps restore physical function, and individuals who start and maintain an aerobic exercise programme have back pain less frequently. Individuals who exercise also are less likely to require surgery or other invasive treatments.

In terms of flexibility, regular stretching exercises that help the hip and trunk go through a functional range of motion, rather than increasing the range of motion, are recommended. That is, for proper back care, stretching exercises should not be performed to the extreme range of motion. Individuals with a greater spinal range of motion also have a higher incidence of back injury. Spinal stability, instead of mobility, is desirable for back health.

A strengthening programme for a healthy back should be conducted around the endurance threshold 10-12 repetitions to near fatigue. Muscular endurance of the muscles that support the spine is more important than absolute strength because these muscles perform their work during an entire day.

3.3 Tips to Prevent Low-back Pain

- Be physically active.
- Stretch often using spinal exercises through a functional range of motion.
- Regularly strengthen the core of the body using sets of 10 to 12 repetitions to near fatigue with isometric contractions when applicable.
- Lift heavy objects by bending at knees and carry them close to the body.
- Avoid sitting (over 50 minutes) or standing in one position for lengthy periods.
- Maintain correct posture.
- Sleep on your back with a pillow under the knees or sideways with the knees drawn up and a small pillow between the knees.
- Try out different mattresses of firm consistency before selecting a mattress.
- Warm-up properly using mild stretches before engaging in physical activity.
- Practice adequate stress management techniques.

3.4 Flexibility Exercises

<u>Exercise 1: Arm Circles</u>
<u>Action:</u> Gently circle the arms all the way around. Conduct the exercise in both directions.
<u>Area Stretched:</u> Shoulder muscles and ligaments.

Exercise 2: Side Stretch

Action: Stand straight up, feet separated to shoulder-width, and place the hands on the waist. Now move the upper body to one side and hold the final stretch for a few seconds. Repeat on the other side.

Areas Stretched; Muscles and ligaments in the pelvic region.

Exercise 3: Body Rotation

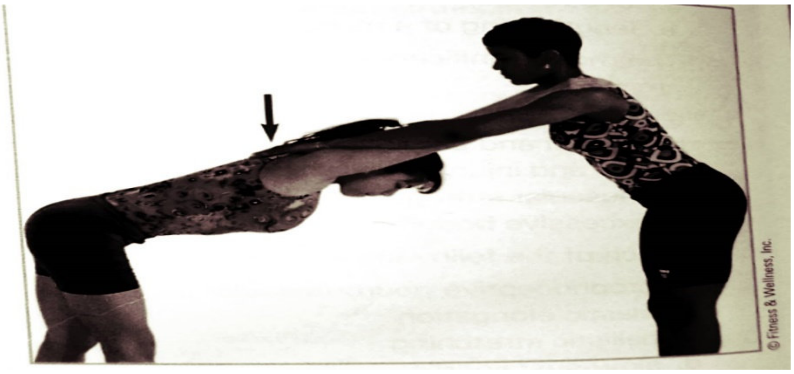
Action: Place the arms slightly away from the body and rotate the trunk as far as possible, holding the final position for several seconds. Conduct the exercise for both the right and left sides of the body. You also can perform this exercise by standing about 2 feet away from the wall (back toward the wall) and then rotating the trunk, placing the hands against the wall.

Areas Stretched: Hip, abdominal, chest, back, neck, and shoulder muscles, hip and spinal ligaments.

Exercise 4: Chest Stretch.

Action: Place your hands on the shoulders of your partner, who in turn will push you down by your shoulders. Hold the final position for a few seconds.

Areas Stretched: chest (pectoral) muscles; shoulder ligaments.



<u>Exercise 5: Shoulder Hyperextension Stretch</u>

<u>Action</u>: Have a partner grasp your arms from behind by the wrist and slowly push them upward. Hold the final position for a few seconds.

Areas Stretched: Deltoid and pectoral muscles; ligaments of the shoulder joints.

<u>Exercise 6: Quad Stretch</u>

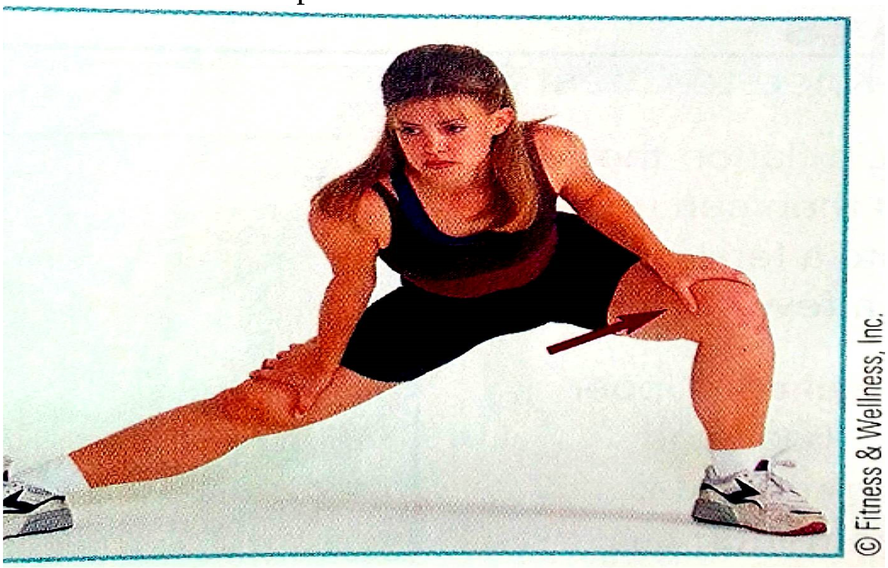
<u>Action</u>: Lie on the side and move one foot back by flexing the knee. grasp the front of the ankle and pull the ankle towards the gluteal region. Hold for several seconds. Repeat with the other leg.

Areas Stretched: Quadricep muscle: knee and ankle ligaments.

<u>Exercise 7: Abductor Stretch</u>

<u>Action:</u> Stand with the feet about twice shoulder-width and place the hands slightly above the knee. Flex one knee and slowly go down, holding the final position for a few seconds. Repeat with the other leg.

Areas Stretched: hip abductor muscles.



<u>Exercise 8: Shoulder Rotation Stretch</u>

<u>Action</u>: with the aid of surgical tubing or an aluminum or wood stick, place the tubing or stick behind your back and grasp the two ends using a reserve (thumps-out) grip. Slowly bring the tubing or stick over your head, keeping the elbow straight. Repeat several times (bring the hands closer together for additional stretch).

Area Stretch: Deltoid, latissimus dorsi, and pectoral muscles: shoulder ligaments.

Exercise 9: Sitting Abductor Stretch

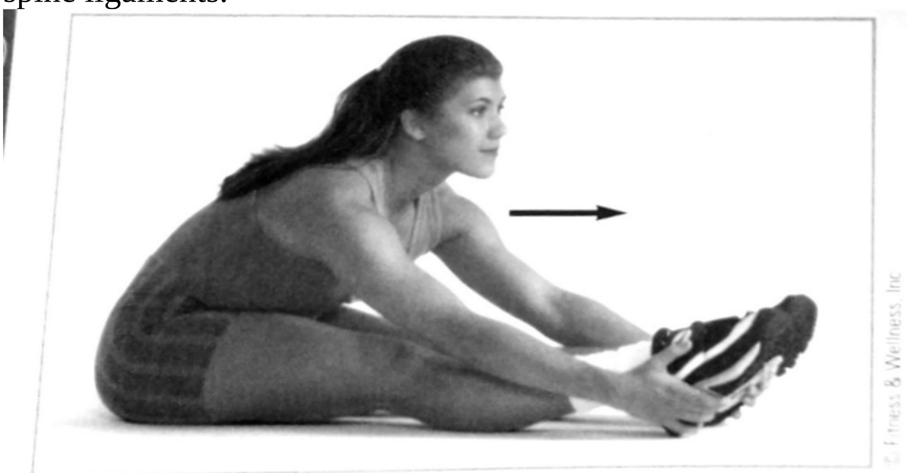
Action: Sit on the floor and bring in the feet close to you, allowing the soles of the feet to touch each other. Now place the forearms (or elbows) on the inner part of the thigh and push the legs downwards, holding the final stretch for several seconds.

Areas Stretched: Hip abductor muscle.

Exercise 10: Sit-and -Reach-Stretch

Action: Sit on the floor with legs together and gradually reach forward as far as possible. Hold the final position for a few seconds. This exercise also may be performed with the legs separated, reaching to each as well as to the middle.

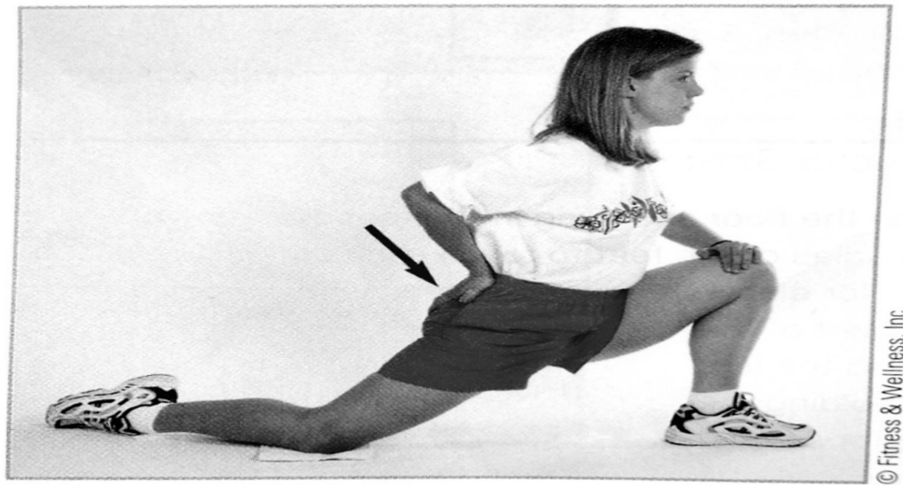
Areas Stretched: Hamstrings and lower back muscles: lumbar spine ligaments.



Exercise 11: Hip Flexors Stretch

Action: Kneel on an exercise mat, a soft surface, or a folded towel placed under your knees. Raise the left knee off the floor and place the left foot above 3 feet in front of you. Place the left hand over the left knee and the right hand over the back of the right hip. Keeping the lower back flat, slowly move forward and downward as you apply gentle pressure over the right hip. Repeat the exercise with the opposite leg forward.

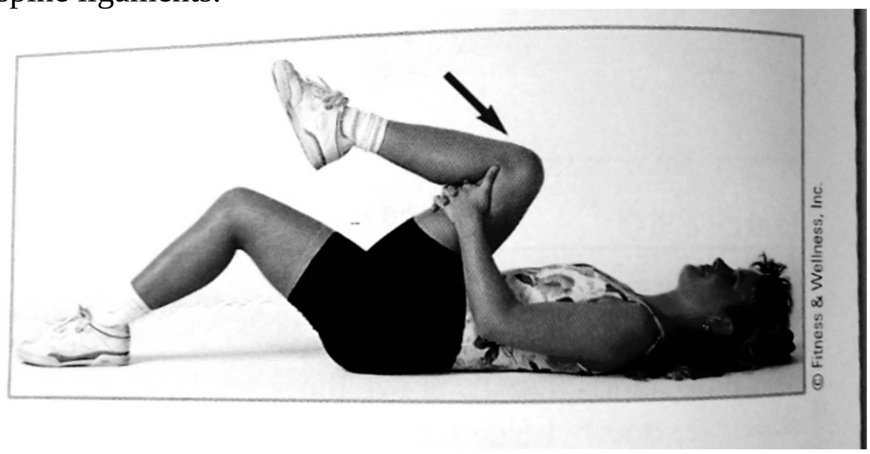
Area Stretched: Flexor muscles in front of the hip joint.



Exercise 12: Single-Knee-to-Chest Stretch

Action: Lie down flat on the floor. Bend one leg approximately 100 degree and gradually pull the opposite leg towards the chest. Hold the final stretch for a few seconds. Switch legs and repeat the exercise.

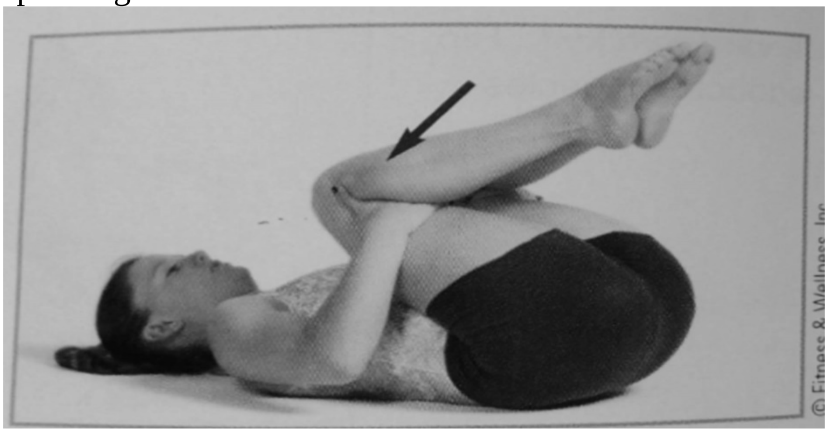
Area Stretched: Lower back and hamstring muscles: lumbar spine ligaments.



Exercise 13: Double-Knee-to Chest Stretch

Action: lie flat on the floor and then curl up slowly into a fetal position. Hold for a few seconds.

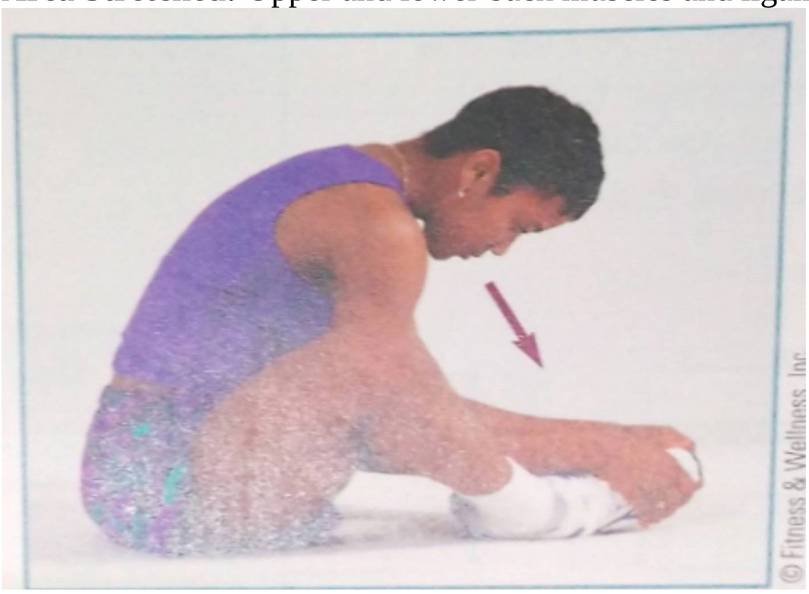
Areas Stretched: Upper and lower back and hamstring muscles: spinal ligaments.



Exercise 14: Upper and Lower Back Stretch

Action: Sit on the floor and bring the feet in close to you, allowing the soles of the feet to touch each other, holding on to your feet, bring your head and your upper chest gently towards your feet.

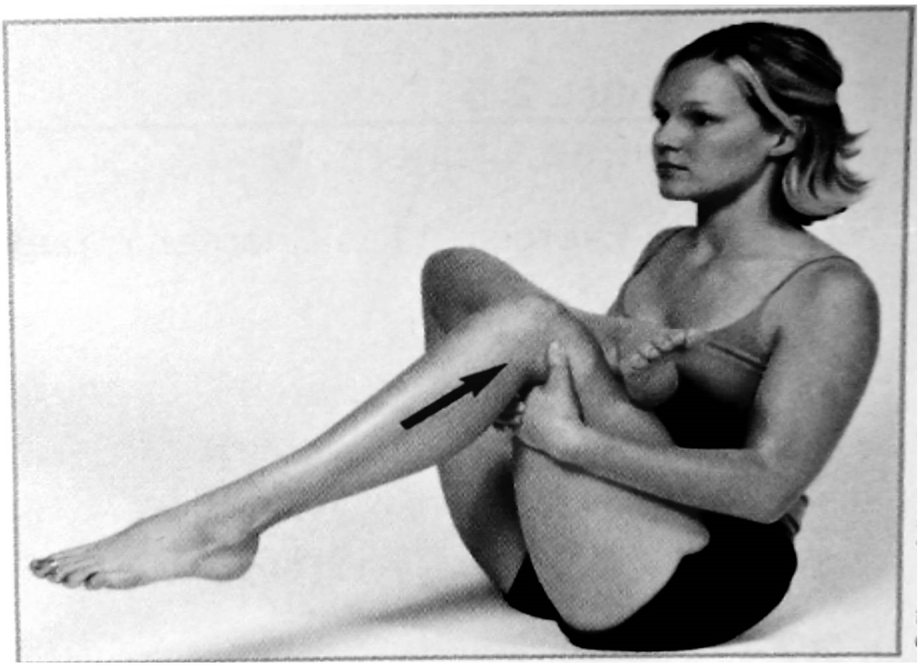
Area Stretched: Upper and lower back muscles and ligaments.



Exercise 15: Gluteal Stretch

Action: Sitting on the floor, bend the right leg and place the right ankle slightly above the left knee. Grasp the left thigh with both hands and gently pull the legs towards the chest. Repeat the exercise with the opposite leg.

Areas Stretched: Buttock area (gluteal muscles).



Exercise 16: Trunk Rotation and Lower Back Stretch

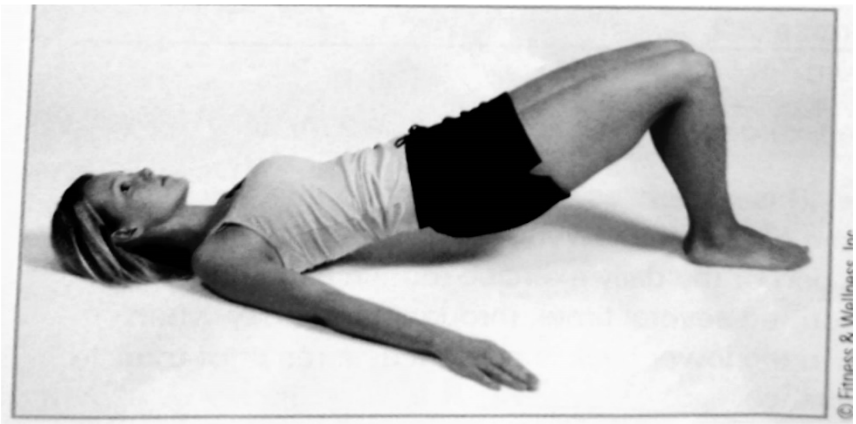
Action: Sit on the floor and bend the left leg, placing the left foot on the outside of the right knee. Place the right elbow on the left knee and push against. At the same time, try to rotate the trunk to the left (counter clock-wise). Hold the final position for a few seconds. Repeat the exercise with the other side.

Areas Stretched: Lateral side of the hip and thigh: trunk and lower back.

Exercise 17: Supine Bridge

Action: lie face up on the floor with the knee bent at about 120 degrees. Do a pelvic tilt and maintain the pelvic tilt while you raise the hips off the floor until the upper body and the upper legs are in straight line. Hold this position for up to 5 seconds.

Area Stretched: Gluteal and abdominal flexor muscles.



4.0 CONCLUSION

In this unit, we have been able to learn how to prevent low-back pain. Different flexibility exercises were also presented and discussed in this unit.

5.0 SUMMARY

Some exercises may be safe to perform occasionally but, when executed repeatedly, may cause trauma and injury. Preexisting muscle or joint conditions (old sprains or injuries) can further increase the risk of harm during certain exercises. Contraindicated exercises may cause harm because of the excessive strain they place on muscles and joints, in particular the spine, lower back, knees, neck, or shoulders.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss how to prevent low back pain.
2. Identify ten (10) flexibility exercises.
3. Describe the flexibility exercises identified in (2) above.

6. 0 REFERENCES/ FURTHER READING

Bracko, M. R. (2004). "Can We Prevent Back Injuries" *ACSM's Health & Fitness Journal*. 8 (4), 5-11.

Hoeger, W. W. K. & Hoeger, S. A. (2007*). Lifetime Physical Fitness and Wellness, A Personalized Program, 9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Kraemer, J. K. & Ratamess, N. A. (2004). "Fundamentals of Resistance Training: Progression and Exercise Prescription," *Medicine and Science in Sports and Exercise.* 36, 674-688.

Williams & Wilkins. (2006). American College of Sports Medicine, *ACSM's Guidelines for Exercise Testing and Prescription*. Baltimore.

www. fitness.com.

UNIT 3 STRENGTH AND POWER DEVELOPMENT

CONTENT

1.0 INTRODUCTION

Some people think that strength is necessary only for highly trained athletes, fitness enthusiasts, and individuals who have jobs that require heavy muscular workouts. A well-planned strength training programme leads to increased muscle strength and endurance, muscle tone, tendon and ligament strength, and bone density- all of which help to improve functional physical capacity

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain the concept of strength
- explain the importance of adequate strength levels in maintaining good health
- identify and explain the two types of fibre
- discuss anaerobic power and capacity.

3.0 MAIN CONTENT

3.1 Definition of Strength

Muscle strength is defined as the maximal one effort force that can be exerted against a resistance, it is the absolute maximum force that one can generate in the isolated movement of a single muscle or a group of muscles. It is the maximal force that can be put forth in one maximum contraction of one second duration. According to Jassen and Fisher (1979), strength involves a combination of three major factors:

a. Combined contractile force of the muscles causing the movement (agonists). This can be improved through resistance training.
b. The ability to co-ordinate the agonist muscle with antagonistic muscles, the neutralizers, and stabilizer muscles. This can be improved by a limited amount by practicing the particular movement.
c. The mechanical ratio of the lever (bone) arrangements involved. This depends on the angle of pull of the muscles and the relative length of the resistance arm and effort arm of each lever.

Strength is not simply a question of muscles but rather, a complicated phenomenon involving both muscles and the nervous system.

3.2 Benefits of Strength Training

Strength is a basic health-related fitness component and is an important wellness component for optimal performance in daily activities such as sitting, walking, running, lifting and carrying objects, doing housework, and enjoying recreational activities. Strength also is of great value in improving posture, personal appearance, and self-image; in developing sports skills; promoting the stability of joints, and in meeting certain emergencies in life.

From a health standpoint, increasing strength helps to increase or maintain muscle and a higher resting metabolic rate, encourages weight loss and maintenance, lessens the risk for injury, prevent osteoporosis, reduces chronic low-back pain, alleviates arthritic pain, aids in childbearing, improves cholesterol levels, promotes psychological well-being, and also may help to lower the risk of high blood pressure and diabetes.

With time, the heart rate and blood pressure respond to lifting a heavy resistance (a weight) decrease. This adaptation reduces the demands on the cardiovascular system when performing activities such as carrying a child, groceries, or a suitcase.

Regular strength also can help control blood sugar. Much of the blood glucose from food consumption goes to the muscles, where it is stored as glycogen. When muscles are not used, muscle cells become insulin-resistance and glucose cannot enter the cells, thereby increasing the risk for diabetes.

Another benefit of maintaining a good strength level is its relationship to human metabolism. A primary outcome of a strength-training programme is an increase in muscle mass or size (lean body mass), known as hypertrophy.

More specifically, good strength enhances the quality of life in that it:

- improves balance and restores mobility
- makes lifting and reaching easier,
- decreases the risks for injuries and falls,
- stresses the bones and preserves bone mineral density, thereby decreasing the risk for osteoporosis.

3.3 Muscle Fibre Composition

There are two types of fibres:

a. Slow-twitch fibre.
b. Fast-twitch fibre.

The slow-twitch fibre is also called red, oxidative or type 1 muscle fibre. While the fast-twitch is called white, glycolytic or type 2 muscle fibre. The fast-twitch and slow-twitch fibres also refer to fast-twitch units and slow-twitch units. The nerve supply of the slow-twitch fibres is from slow nerves which has a slow rate of stimulation. The nerve supply of fast-twitch is from fast nerves which has a fast-twitch stimulation. In essence, the nerve supply imposes their characteristics on the muscle fibre which they supply or innervate.

3.4 Differences Between Slow and Fast-twitch Fibre (Units)

The anaerobic capacity of fast twitch fibres is much greater than that of slow twitch fibres. Though both units contain enzymes involved in facilitating the reaction of the ATP-PC system. The enzymes in fast-twitch fibres are about 3 times as active as those in slow-twitch fibres (Fox, 1979). This is so because an enzyme is more active when it has greater functional capabilities than another enzyme. Similarly, some of the more important glycolytic enzymes are found in both units, but the enzymes in fast twitch fibres are up to 2 times more active than those in the slow twitch fibres. In other words, fast-twitch fibres are best suited, biochemically for “sprint-like” short burst activities.

On the other hand, the aerobic capacity of slow-twitch fibres is much greater than that of fast-twitch fibres. The enzymes involved in the reactions of the aerobic system have higher activities in the slow-twitch fibres. The number and size of mitochondria, where the aerobic reactions occur, as well as the number of capillaries per fibre, are much greater in slow-twitch fibres. Also, the higher myoglobin content contributes to the greater aerobic capacity of the slow-twitch fibres.

The glycogen store of slow and fast twitch fibres is the same. However, the triglyceride (fat) store of slow-twitch fibres is greater than that of fast-twitch fibres. On the speed of contraction, the time required for fast-twitch fibres to generate maximal tension is about one-third of that required by slow-twitch fibres. One of the reasons for faster contraction time in fast-twitch unit is their greater anaerobic capacity. The size of the motor neuron that innervates the fast-twitch fibre is also responsible for this. The motor-neuron innervating the slow-twitch fibre is larger than that of the motor-neuron on the slow-twitch fibre. This implies that individuals with a higher percentage of fast-twitch fibres should be able to contract their muscle faster. Because the size and the number of fibres is greater in fast-twitch unit, the force of contraction is much greater than that in slow-twitch units. It also implies that those individuals with higher percentages of fast-twitch fibres will exhibit a faster speed of contraction.

Summary of the differences in Fast-twitch and Slow-twitch Fibres

characteristics	**Fast-twitch**	**Slow-twitch**
Aerobic capacity	Low	High
Anaerobic capacity	high	Low
Capillary density	Low	High
Buffer capacity	High	Low
Contraction time	Fast	Slow
Triglyceride store	Low	High
Force of contraction	High	Low
Recruitment pattern	Sprint-like activities	Endurance-like activities
Distribution in athlete	High (non-endurance athletes)	High (endurance athletes)
Myoglobin content	Low	High
Fatigability	Rapid	Slow
Relaxation time	Fast	Slow
Glycogen store	High	high

(Mattew & Fox in Oduyale, 2004)

3.5 Anaerobic Power and Capacity

Anaerobic Power: This involves the ability of the individual to carry out short exhaustive activities without the use of oxygen. Anaerobic power is dependent on the intra-muscular store of ATP and PC. It is very useful when speedy generation of energy is demanded during

performance (Owolabi, 1988). However, the muscle stores of ATP and PC are very limited and are exhausted in under 10 seconds of maximal work but ATP is never exhausted beyond 60% of its initial value. This shows that ATP can not be completely exhausted. Sprints or anaerobically trained athlete have higher store of ATP and PC and chronic training at high intensity which of course is anaerobic increases muscle store of ATP and PC (Fox, 1979).
Some of the following variables are very critical in anaerobic power generation.

- There must be a high volume of active muscles.
- The percentage of fast-twitch fibres must be very high
- The initial phosphagens (ATP and PC) level store must be high.
- The high rate of ATP, PC splitting.

The shorter the duration of an athletic event, and the higher the intensity of performance, the higher the relationship with anaerobic power i.e., the higher is the need for anaerobic power.

3.6 Anaerobic Capacity

This is the total store of anaerobic energy, which is available to the individual. Muscle mass, level of nutrition and glycogen stores of the active muscles determines an individual’s anaerobic capacity (Owolabi, 1988).

The critical variables in anaerobic capacity are:

- The volume of active muscles.
- High percentage of fast-twitch fibres.
- Lactate tolerance i.e., ability to tolerate high muscle lactic acid concentrations

High buffering capacity; Buffers are organic sources meant to remove excess hydrogen from the blood and body systems.
High glycolytic enzymes. These enzymes include:

i. PFK-Phospo-Fructo-Kinase
ii. Phosphorylase
iii. NAD-Nicotinamide-Adenine-Dinucleotide.
iv. LDH-Lactate Dehydrogenase.
v. Creatine Kinase

- High muscular store of glycogen.

Anaerobic capacity is very vital in events lasting between 10- 50 seconds. It involves the ability to work maximally for a prolonged period usually under 60 seconds.

4.0 CONCLUSION

Muscle strength is defined as the maximal one effort force that can be exerted against a resistance, it is the absolute maximum force that one can generate in the isolated movement of a single muscle or a group of muscles.

5.0 SUMMARY

In this unit, we were able to explain the concept of strength and its importance in maintaining good health. The two types of fibre (fast-twitch and slow-twitch) were equally explained and their differences highlighted. The unit also presented the concept of anaerobic power, and anaerobic capacity was also explained.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the importance of adequate strength levels in maintaining good health.
2. Explain the differences between fast-twitch and slow-twitch fibres.
3. Discuss anaerobic power and capacity.

7.0 REFERENCES/FURTHER READING

Hoeger, W. W. K. & Hoeger, S. A. (2007). *Lifetime Physical Fitness and Wellness, A Personalized Program,9th Edition.* Thomas Wadsworth. USA. ISBN 978-0-495-01202-3.

Oduyale, O. (2004). Physical Conditioning for Healthy Living and Sports. Emosi Books, Shagamu, Ogun State. Nigeria. ISBN 978-30914-2-5.

Kraemer, J. K. & Ratamess, N. A. (2004). “Fundamentals of Resistance Training: Progression and Exercise Prescription,” *Medicine and Science in Sports and Exercise.* 36, 674-688.

Kokkonen, J. & Lauritzen, S. (1995). “Isotonic Strength and Endurance Gains Through PNF Stretching,” *Medicine and Science in Sports and Exercise.* 22, 27.

Williams & Wilkins. (2006). American College of Sports Medicine, *ACSM’s Guidelines for Exercise Testing and Prescription*. Baltimore.

Thacker, S. B., Gilchrist, J., Stroup, D. E. & Kimsey, Jr., C. D. (2004). The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Lite rature, *Medicine and Science in Sports and Exercise*. (36), 371-378.