Level 2 Certificate in Fitness Instructing:

Principles of Exercise, Fitness and Health

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Principles of Exercise, Fitness and Health

This unit will cover the importance of 'Health and Fitness'.

Any good Fitness Professional will need to have a full understanding of what defines 'Health' and 'Fitness' as two separate elements, and then must understand the relationship between the two.

Objectives

By the end of this section, the learner should be able to:

- understand the effects of exercise on the body
- understand the components of fitness
- understand how to apply the principles and variables of fitness to an exercise programme
- understand the exercise contraindications and key safety guidelines for special populations
- understand how to safely monitor exercise intensity
- understand the health benefits of physical activity
- understand the importance of healthy eating

What is Health?

Health is a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity (World Health Organisation, 1946).

Physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure. Physical inactivity is an independent risk factor for chronic disease and is estimated to cause 1.9 million deaths globally.

Regular physical activity is one of the most important things that can be done to benefit health. According to the Chief Medical Officer (CMO), guidelines for physical activity (health benefits) 'Start Active Stay Active' report states that different types and amounts of physical activity are required for different age groups and the health benefits can be as follows:

- decreasing the risk of coronary heart disease
- decreasing the risk of some cancers
- normalising blood pressure
- decreasing high cholesterol
- promoting bone density to protect against osteoporosis and falls in older age
- decreasing the risk of type 2 diabetes
- promoting healthy growth in children
- managing weight
- improving confidence and well-being
- strengthening bones, joints and muscles to improve joint stability and posture
- decreasing the risk of injury

The report clearly links the lack of regular physical activity to the likelihood of developing diseases, such as coronary heart disease (CHD), some cancers, type 2 diabetes, hypertension, obesity and osteoporosis, and explains how taking the prescribed levels of activity can dramatically reduce the chances of developing one of these diseases.

What is Fitness?

Fitness' means - the condition of being physically fit and healthy (Oxford Dictionaires.com). Fitness is a multidimensional concept, and the level of fitness in one area can influence other areas, including:

- emotional and mental - this is concerned with psychological well—being. The pressures of daily life can have a negative effect on mental and emotional fitness. This affects the ability to think clearly and constructively, leading to stress, which is a contributory factor to CHD.
- social - an individual's ability to interact, communicate, establish and maintain relationships with others.
- medical - an individual's state of health and the absence of disease, illness, injury or disability so that the body is in optimal working order.
- nutritional - eating a well-balanced diet to ensure the body has sufficient energy and ability to carry out daily life.
- spiritual - an individual's attitude, honouring one's own and others' basic human values and beliefs.
- physical fitness - a combination of attributes that allow you to function effectively, to enjoy leisure and to cope with emergencies. Fitness is the capacity to combine all these aspects to facilitate positive health and maintain optimal quality of life. This is often referred to as 'total fitness'.

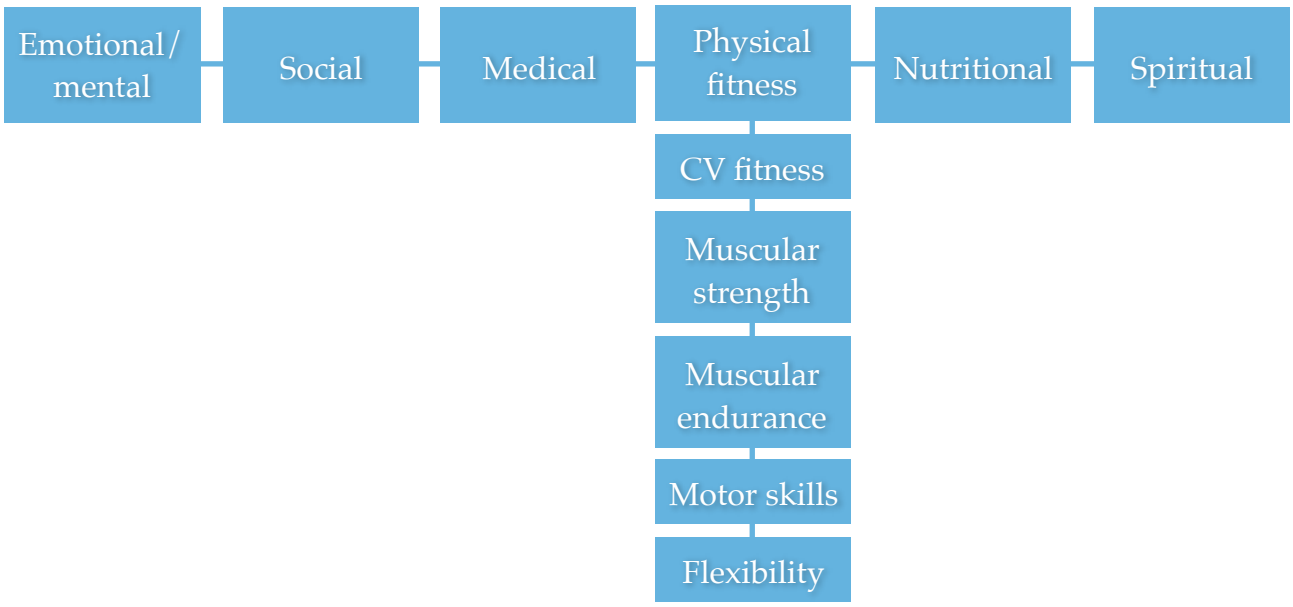
The components of physical fitness

Physical fitness is a combination of the following five components, which helps to explain why no single type of exercise will achieve total physical fitness.

- Cardiovascular fitness - the ability of the heart and lungs to take in, transport and utilise oxygen.
- Muscular strength - the ability of muscle to create high force to lift a heavy weight.
- Muscular endurance - the ability of a muscle or muscle group to keep contracting and work for a long period of time.
- Motor skills - the ability of the nervous system to control the movement of the body to perform a range of skills, such as balance, coordination, speed, agility and reaction time.
- Flexibility - the range of movement achievable about a joint or joint complex.

All of these components of physical exercise are important for the development of a well balanced exercise programme.

Total Fitness



Factors affecting health, physical fitness and training potential

Health, physical fitness and training potential are determined by several variables, including:

Heredity

The genetic make-up of an individual can, in part, pre-determine health and the responsiveness of an individual to training.

Medical

Some hereditary medical conditions will affect physical performance (eg, cerebral palsy, Down's syndrome and type 1 diabetes).

Gender

There are many gender differences that are apparent when looking at physical fitness. Men and women have different levels of certain hormones that affect their physical fitness and training potential. In general terms, women tend to have greater flexibility around the hip joint and good buoyancy for water activities like swimming. Men are generally larger and tend to have a greater physical capacity than women. Men also have greater upper body strength and a bigger heart and lung capacity. In terms of health, women generally tend to live longer than men and are more likely to suffer from certain types of cancer; men are more likely to suffer from coronary heart disease (CHD).

Age

Fitness inevitably declines due to hormonal changes, metabolic changes and simply the accumulation of many years of wear and tear. While it is impossible to change one's chronological age, it is possible to offset many age-related changes by remaining fit and active, looking after the body and by making good lifestyle choices.

Body type
Closely related to the heredity factor is the morphic shape of an individual. This shape can influence physical capabilities. The three main body types each have their own characteristics.

Ectomorph
Typically tall and lean. Such individuals are generally better at endurance events, such as marathon running and long-distance cycling.

Examples:
Mo Farah, Paula Radcliffe, Bruce Lee, David Beckham, Cameron Diaz.

Mesomorph
Typically athletic, with a muscular physique. Such people tend to do well in sports that involve jumps, throws and sprints.

Examples:
Arnold Swarzeneggar, Rhonda Rousey,

Endomorph

Typically with a soft, rounded shape and shorter limbs. Such individuals tend to do well in long-distance swimming, wrestling and judo.

Examples:
Nia Jax (WWE Wrestler), Dan Cole(English Rugby Prop)

Rather than categorising an individual into a specific body type, individuals usually have a leaning towards one type or another.

Lifestyle factors
These are factors over which individuals have some control and can make positive choices to enhance their health and physical fitness.

Lifestyle habits
Certain lifestyle habits, such as smoking, heavy alcohol consumption and substance abuse, can have negative effects on health and physical fitness.

Everyday activity
An individuals general level of everyday activity can affect physical fitness. This includes not only exercise and playing sports, but also daily activities such as levels of occupational activity (eg, office/sedentary vs. postman/active), housework, gardening, DlY projects, walking to the shops and other activities that require a low to moderate degree of physical effort.

Health status
Physical performance can be severely affected by poor health, injury or disability. A simple cold virus can be as limiting as asthma or a sprained ankle.

Diet
It is important to establish healthy eating patterns to provide the body with sufficient nutrients to sustain physical activity and maintain a healthy state of function.

Exercise prescription for health

To improve health, the Chief Medical Officer (CMO) and Department of Health (DH) published the 'Start Stay Active' report, which outlines the guidelines for physical activity for health, for the various age ranges. They are as follows:

- under-fives -180 minutes each day once a child is able to walk
- children and young people (5 to 18 year-olds) - 60 minutes and up to several hours every day of moderate to vigorous intensity physical activity on three days per week. Should include vigorous activity that strengthen muscles and bones
- adults (19 to 64 year olds) and Older people (65+) - 150 minutes each week of moderate to vigorous intensity physical activity (adults should do some physical activity every day). Muscle strengthening activity should also be included twice a week

Barriers to fitness and exercise

Despite being aware of the benefits of regular exercise, individuals can find it difficult to adhere to exercise programmes.

Some common barriers to exercise include:

- physical - age, injury, ill health and disability
- physiological - anxiety and fear of feeling out of comfort zone
- financial - cost of buying equipment or joining a health club
- time - family and work commitments and overall lack of time
- motivational — lack of support from family and friends, not enjoying exercise or boredom.

In spite of how common these barriers are, these issues don't need to stand in the way of exercise. With some careful thought, practical strategies can be implemented for overcoming these common barriers to achieving fitness. See the next section, 'Know how to support clients who take part in exercise and physical activity', for more detail on helping clients to overcome their barriers.

Key points for physical fitness and health

- Total fitness is a multidimensional concept that includes various fitness aspects, including emotional, mental, social, medical, nutritional, spiritual and physical.
- Regular physical activity is beneficial to health.
- Physical fitness has five components: cardiovascular fitness, muscular strength, muscular endurance, flexibility and motor fitness.
- Physical fitness is affected by factors such as heredity, body type, gender, level of daily activity, health status lifestyle habits, age and diet.
- Common barriers can influence an individual's participation in regular exercise.

Principles of Training

For any component of physical fitness to improve, the body must be trained in an effective manner. It must be trained to the point of overload, followed by sufficient recovery time to allow adaption to take place. Training is a slow and subtle process that can not be rushed. Conducted safely and correctly, training leads to improved performance as well as physiological and psychological changes. A carefully structured exercise programme uses the principles discussed below.

Overload principle

The overload principle states that in order to make improvements, a body system must work at a level slightly higher than that to which it is accustomed. For example, an individual whose cardiovascular fitness is low due to years of sedentary living can overload the heart, lungs and circulatory system simply by walking at a faster pace than normal. However, gradually, the heart gets stronger and the individual has to walk faster still to overload the heart.

The appropriate overload level is achieved by combinations of the **FITT** principle.

Frequency - the number of sessions in a given period (how often).
Intensity - the level of work performed during an activity session (how hard).
Time - the duration of a given session (how long).
Type - the choice of activity. For example, running, weight training, stretching, etc.

Progressive principle

This relates to the 'intensity' part of the **FITT** principle. To achieve more training gains as the body adapts to the initial overload, training should become more intense to achieve progressive overload - that is, overload should be increased gradually over time. This can be achieved by:

- repetitions - increasing the number of repetitions
- resistance — increasing resistance by using gravity, length of lever, external weight, body weight and surface area in water
- rate - changing the speed of the exercise (eg, slowing a muscular strength exercise down will increase the intensity, whereas speeding up a cardiovascular exercise will increase the intensity)
- rest - decreasing the rest periods (between sets, exercises and training sessions)
- range - increasing the range of movement applied to the exercise
- complexity - using exercises with more complex movement patterns.

Specificity principle

The specificity principle refers to the adaptations that are specific to the type of training performed and the demands placed on the body. Simply stated, different forms of exercise produce different results. Each sport or activity has its own particular muscular and movement characteristics. If an individual wants to improve their performance in a particular sport or activity, the training needs to be specific to those characteristics. For example, a marathon runner would be unlikely to improve their marathon performance by participating in a sprinting programme.

This is easily remembered by the SAID principle:

Specific
Adaptation
Imposed
Demand

Reversibility principle

This principle states that training adaptations will gradually decline if training stops or a maintenance programme is not followed. Some decline in fitness occurs naturally with the ageing process, especially between the ages of 50-70 years. However, by remaining active much of this degeneration can be avoided.

Adaptability

This is the ability of the body to cope with and adapt to specific training needs.

Individuality

One size does not fit all. A training programme should be relevant and appropriate for the individual and their specific training requirements.

Recovery time

Rest is required for the body to recover from the training session and to allow adaptation to take place. This includes the heart becoming stronger, the lungs becoming more efficient and the muscles becoming more toned, thereby improving fitness. It is important to know that without sufficient recovery time, improvements in fitness will not take place. The exact amount of time will vary depending on the type of training session; however, typically 24 to 48 hours rest is required.

Plateau

Plateau occurs when continued adaptations no longer occur. In order for further adaptations and responses to take place, some aspects of the training must change (ie, FITT principles would need to be altered).

These principles encompass factors that affect the training outcome. They equally apply to a variety of exercises, as well as the chosen discipline (eg, exercise to music, weight training, stretching, cardiovascular training and neuromuscular training).

Changing any aspect of the various principles can lead to adaptation. For example, an additional session per week, increasing intensity or using a different training method may subject the system to unused stimuli and overload, initiating an adaptation.

It is important to remember that individuals may require modifications, adaptations and progression to different exercises and training methods to meet their needs. These include:

- individual needs
- fitness level
- skill level
- experience
- injury or disability
- medical conditions
- environment.

Regression

It is important to recognise when to regress a training programme. Individuals who come back to training after illness, injury or a break will need to have their programme regressed to avoid overworking and possible further injury.

What happens to the body during training?

When we begin to exercise, the body has to respond to the change in activity. These changes are usually referred to as short-term responses to training and are listed below.

- Activity of the nervous system increases in order to control the various changes that take place during activity.
- Heart rate, blood flow, oxygen uptake, cardiac output and stroke volume all increase.
- Blood vessels dilate.
- Concentration of CO2 in the blood increases, thereby increasing breathing rate.
- Muscle temperature and overall core body temperature increase.
- Levels of lactic acid in the blood rise, causing a burning or aching sensation in the muscles.
- Blood pressure increases. Systolic pressure rises, and diastolic pressure remains the same.
- Joints become more mobile due to increased flow and viscosity of the synovial fluid.

Once training stops, the body returns to its normal resting state. However, it is important to ensure that this is a gradual process in order to avoid blood pooling.

Blood pooling

When exercising, your heart is pumping large amounts of blood to the working muscles to provide them with the level of oxygen and nutrients they need. When they are used up, the force of the contracting (exercising) muscles pushes the blood back to the heart to be re-oxygenated.

However, when the exercise stops, so does the force that pushes the blood back to the heart. This blood, and waste products such as lactic acid, stays in the muscles. This process is referred to as 'blood pooling'. Stopping exercise suddenly reduces the oxygen supply to the brain, leading to dizziness or fainting.

An effective cool down is one in which the intensity is reduced gradually. This helps to keep the blood circulating and helps to prevent blood pooling, assisting in removing waste products from the muscles. This cool down also helps your body with its repair process and helps to reduce post-exercise soreness, or DOMS (delayed onset muscle soreness).

Key points for principles of training

- The principles of training are: overload, progression, specificity, individuality, recovery time and plateau.
- Overload can be applied by using the FITT principle: Frequency, Intensity, Time and Type.
- Modifications, adaptation and progression are required to meet individual needs, fitness level, experience, skill level, injury, disability, medical conditions and the environment.
- An effective cool down after exercise will ensure that the short-term effects of exercise safely enable the body to return to normal.

Cardiovascular Fitness

Cardiovascular fitness is often referred to as stamina, endurance, cardiorespiratory fitness (heart and lungs) or aerobic fitness. The lungs take in oxygen, the heart and circulation transport oxygen and the muscles utilise the oxygen. Therefore, cardiovascular fitness is a measure of the efficiency of all of these systems.

A measure of this ability is 'maximum oxygen uptake' (called VO2 max). Maximum oxygen uptake involves the measurement of oxygen, carbon dioxide and the volume of expired air during maximal exercise, normally assessed under laboratory conditions.

Cardiovascular exercise can be defined as any activity that is rhythmic in nature, continuous and using large muscle groups under low to moderate tension over an extended period of time. This type of exercise is frequently referred to as 'aerobic exercise'. Some common exercises of this type include, walking, cycling, swimming and jogging.

Exercise intensity and heart rate

Exercise intensity refers to the degree of difficulty experienced during exercise. A quick and simple method for measuring exercise intensity, particularly for aerobic work, is to use the heart rate.

Resting heart rate

Resting heart rates vary tremendously among individuals and between genders. Women generally average about 5-10 (bpm) higher than men, mainly due to their proportionately smaller hearts. Fit individuals tend to have lower resting heart rates, sometimes below 40 bpm. Inactive and unfit individuals can often have high resting heart rates, sometimes over 100 bpm. The average adult resting heart rate is in the range of 60-80 bpm.

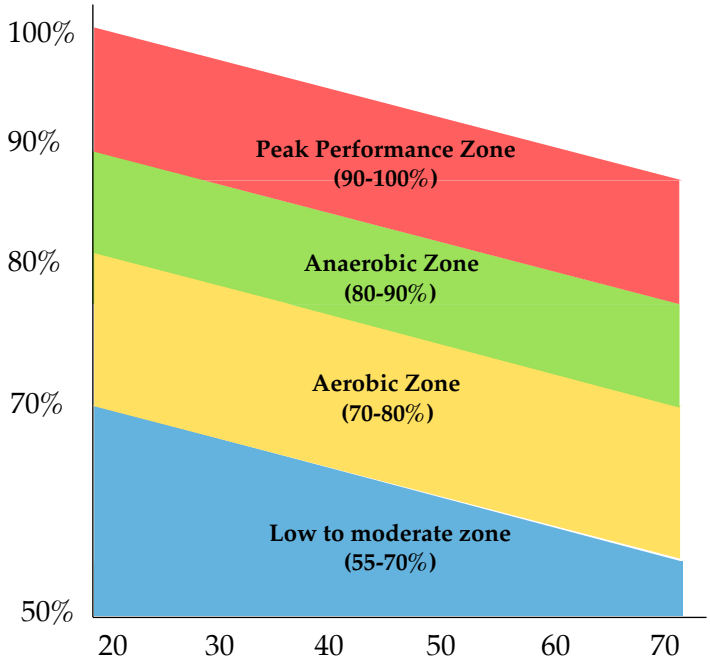
Maximum heart rate

Exercise intensity for aerobic work is generally expressed as a percentage of the maximum heart rate (Max HR, or MHR). Your maximum heart rate is literally just that: the maximum number of times in one minute that your heart can contract when exercising. The simplest way to estimate your maximum heart rate is by the formula below:

age-adjusted maximum heart rate formula = 220 - age

The maximum heart rate is somewhat variable, and is in part genetically determined. A major factor affecting the maximum heart rate is the ageing process, which progressively decreases it.

Relationship between heart rate training zones and age:



The four heart rate training zones of aerobic training

A useful way to look at the aerobic training zone is to view it as consisting of four different training zones, with each zone able to assist in achieving a specific cardiovascular health or fitness goal. Heart rate training zones are calculated by exercising at a specific percentage of your max HR.

The low-end moderate zone

This zone begins at 50% of maximum heart rate (MHR) and is mainly for the unfit or sedentary individual. It represents a level of intensity that most people find comfortable and can maintain for extended periods of time, without breaking out into a sweat or risking injury. This zone also represents a realistic first step for the inactive and unfit person who wants to improve their cardiovascular fitness and health status.

The moderate zone

This zone of 60-70% of maximum heart rate (MHR) is often referred to as the 'fat-burning zone'. That is because this level of intensity is moderate enough for most people to be able to exercise comfortably for long periods of time while utilising fat as the primary fuel source.

For individuals who want to manage their weight, this zone can be used effectively, provided longer training durations are emphasised. This zone also represents the next step up the exercise intensity and fitness scale for the unfit person.

The aerobic zone

This zone of 70-80% of maximum heart rate (MHR) is mainly recommended for the improvement of cardiovascular fitness and health and is often referred to as the 'aerobic training zone', or the 'training sensitive zone'.

Training in this zone represents a vigorous and challenging level of exercise intensity for most individuals. This is because, after a few weeks of training in this zone, you should notice the training effect. That means the same pace will feel easier than a few weeks ago.

For active and trained individuals, this zone can provide an endurance base for more intense aerobic exercise.

The performance anaerobic zone

This zone of 80-90% of maximum heart rate (MHR) represents the highest level of aerobic training and is only recommended for the very well-trained individual. Working in this zone can help to increase speed and pace and prepare for competition.

The main training adaptation for the well-trained individual working at this intensity is the 'shift', or elevation of the anaerobic threshold. The anaerobic threshold is the intensity point where one shifts from aerobic to anaerobic energy production. This elevation of the anaerobic threshold is achieved by increasing the body's ability to metabolise lactic acid.

Monitoring exercising heart rate

Using the palpation method (finding pulse with index finger), to measure heart rate while exercising, is notoriously difficult. Recent research has indicated that palpation can be unreliable and inaccurate when exercising. For this reason, a heart rate monitor is suggested for this purpose. A heart rate monitor measures the number of times the heart beats in one minute using electrodes that measure the heart's electrical changes.

Alternative approaches to monitoring intensity

As well as monitoring heart rate, it is also possible to monitor intensity of exercise in a variety of ways, with the use of visual and verbal instruction.

The most popular ways include: talk test, observation of facial expressions, pallor or colouring and observation of technique using a scientifically validated test called the rating of perceived exertion (RPE) scale.

The RPE scale was devised by Borg (1967, 1982) to show that individuals can perceive how hard they are working on a scale. The scale runs from 6-20, with verbal anchors to suggest the intensity of the activity, reflecting heart rates ranging from 60-200 bpm.

It is a valid and simple method for determining an estimate of exercise intensity. It is generally recommended that during aerobic work, the intensity should remain somewhere between 11-16 on the scale. It has been estimated that ratings between 12-13 are equal to 60% of MHR and 16 is equal to about 90% of MHR (Pollock, Wilmore and Fox). It may take time and practice to become proficient in using the scale.

An adapted scale has been devised that is simpler for individuals to use. This scale is known as the Borg CR10 scale. The Borg CR-10 scale is a category scale with ratio properties consisting of numbers related to verbal expressions, which allows rate comparison between intensities as well as a determination of intensity levels, it has been used for more than two decades (Borg and Kaijser, 2006; Neely et al., 1992). Again, verbal anchors are used, this scale is not parallel to other physiological measures of intensity (heart rate/oxygen uptake), but it has been reported that if one person suggests that they are working harder than another person, it is legitimate that they are actually working harder.

The 6-20 Borg scale

6	**No exertion at all**
7	**Extremely light**
8	
9	**Very light**
10	
11	**Light**
12	
13	**Somewhat hard**
14	
15	**Hard (heavy)**
16	
17	**Very hard**
18	
19	**Extremely hard**
20	**Maximal exertion**

The Borg CR10 scale

0	**Nothing at all**
0.5	**Extremely light - just noticeable**
1	**Very light**
2	**Light**
3	**Moderate**
4	**Somewhat hard**
5	**Hard**
6	
7	**Very hard**
8	
9	**Extremely hard (almost maximal)**
10	**Maximal**

Cardiorespiratory fitness

The ACSM recommends the guidelines below for improving the heart and lungs capacity to deliver oxygen to the working muscles and in the muscles to increase the ability to generate energy with oxygen. This range is intentionally broad and reflects the fact that unfit or deconditioned individuals may achieve a training effect at the lower end of the range, while those that are already physically active require higher intensities to further improve their cardiorespiratory fitness.

ACSM guidelines to achieve and maintain cardiovascular health and fitness benefits	
Frequency	3-5 days per week
Intensity	Moderate and vigorous intensity
Time	Moderate 30 mins x 5 days per week or vigorous 20-25 mins x 3 days per week
Type	Rhythmic aerobic activity that involves large muscle groups

Source: ACSM Guidelines for Exercise Testing and Prescription (8th Edition)

These guidelines are intended to assist in the development of an individually tailored exercise programme. They are to be used as a guide for an apparently healthy adult. There will be situations in which they do not apply because of individual characteristics, such as health status, physical ability, age or athletic performance goals.

The long-term benefits of cardiovascular activity

Long-term, moderate levels of cardiovascular fitness can provide protection against many major medical problems, such as heart disease, stroke, high blood pressure and high blood cholesterol, some cancers and type 2 diabetes. In addition, this can also provide additional benefits, including reducing or controlling body fat, easing of daily tasks, greater independence and quality of life, and improved self-confidence and body image.

Regular training over a period of time causes the body to make the following physiological adaptations over the long term:

The lungs

Training causes the lungs to take in more oxygen, making the lungs more efficient. Rather than the lungs growing bigger, the body simply utilises more of the available lung tissue that is already present. This means that at any one time, more air can be sucked into the lungs, thus more oxygen is available to be exchanged into the blood system for carbon dioxide.

The breathing process becomes more efficient, as the respiratory muscles get trained and can continue to work aerobically for longer periods of time or at higher levels of exercise intensity.

The heart

In response to regular cardiovascular training, the left ventricle increases in volume and its muscular wall becomes stronger. The stroke volume of the heart increases, this means that each time the heart beats, a greater volume of blood is pumped out of the left ventricle into the aorta to be sent around the body. This may be accompanied by a lower resting heart rate because the same amount of blood can be pumped out in one minute with fewer beats.
In the same context, for any given level of exercise intensity, more blood can be pumped out of the heart each minute (i.e, the cardiac output increases).

Circulatory efficiency

With training, arteries and veins become better at delivering oxygen and removing waste products. There is an increase in the number of blood capillaries within the body, in part due to the manufacture of new blood vessels and in part due to the previously dormant vessels being used. This extra capillarisation occurs in and around muscle tissue; consequently, the delivery of freshly oxygenated blood to the working area is improved. There is a similar increase in capillarisation in and around the lungs and also the heart, which allows both of these organs to function more efficiently for longer.

The blood

To transport more oxygen around the body, there is an increase in both the blood volume and the number of red blood cells in which oxygen is carried.

As cardiovascular exercise promotes fat metabolism, there is an important health benefit related to the way in which fats are transported around the bloodstream. Fats are carried in the blood, combined with proteins as lipo-protein (lipids is another name for fats). The lipo-proteins that have a high proportion of fat compared to protein are known as low density lipo-proteins (LDL), as fat is much less dense than protein. Conversely, lipo-proteins that have a higher proportion of protein to fats are known as high density lipo-proteins (HDL).

The LDLs have a tendency to stick to the blood vessel walls during transportation, and this may lead to an accumulation of fat deposits, which cause a blockage in the blood vessel (atherosclerosis or atheroma). Regular cardiovascular exercise improves the blood fat profile by causing more of the fat to be carried as HDL rather than LDL.

Blood pressure

As a result of this extra capillarisation, there are more avenues through which blood can flow. This means that the actual pressure of blood flow along any one vessel may be lower than before the aerobic adaptations occurred and overall blood pressure may be reduced.

The skeleton

Cardiovascular training that has a degree of impact can provide benefits to the skeletal system. The stress of the pulling effects of the muscles on the bones stimulates the activity of the osteoblasts to lay down new bone. This strengthens the bones, providing protection against osteoporosis (bone thinning). Connective tissue such as ligaments and tendons also benefit by becoming stronger, thereby improving the stability of the joints.
Non weight-bearing aerobic activities, such as cycling or swimming, will not have the same level of effect on bone density.

The muscles

Within the muscles, training causes an increase in both the number and size of mitochondria. There is also an increase in the amount of aerobic enzyme activity, and together this results in the muscles being capable of utilising more oxygen and fat at any given time. The muscles can continue to produce energy aerobically for longer or at somewhat higher intensities of exercise. As a result, at a given exercise intensity less lactic acid will be produced and so fatigue will be offset for longer.

Special populations and cardiovascular training

Children

Younger people need to work harder than adults during aerobic activity in order to supply the muscles with the amount of oxygen they are burning. They are not well equipped to tolerate anaerobic exercise and therefore respond best to interval and fartlek training (a type of interval training using speed play) which are more suitable to their energy systems development.

Children tend to heat up and cool down faster than adults due to an inferior and underdeveloped cooling mechanism. They don't carry as much water in their body and can dehydrate during activities more easily. Heart rate training with children can be tricky; it is safer and more effective to use the RPE scale, talk test and visual observation.

Pregnancy

During pregnancy, low to moderate exercise intensity is recommended in order to preserve blood flow to the foetus. Individual target heart rates depend on the level of fitness and the stage of pregnancy. The body's normal heating process increases, which can lead to overheating. Pregnant women feel more breathless due to weight gain and hormonal influences.

When monitoring exercise intensity, it is best to use the talk test and client's appearance, rather than other methods of monitoring.

Ageing

Older adults tend to tire more easily and are less able to maintain their maximum pace than those younger. There is a decrease of 30% in the efficiency of the cardiovascular system between the ages 30-70 years. Older adults have a lower tolerance to lactic acid, need longer to recover and can overheat rapidly. Some individuals may also have age-related increased blood pressure. When moving from one position to another, in particular from lying to standing, older adults may experience dizziness. Therefore, position changes should be made slowly to allow time for the blood to redistribute.

Loss of flexibility in the rib cage leads to increased frequency of breathing (shallow and fast). There is also a reduced ability for exchange of gases, leading to breathlessness.

Due to the changes in the bones and joints associated with ageing, continuous high-impact cardiovascular activities should be avoided, as these can damage the joints.

Disability
Individuals with disabilities may have limitations specific to their disability. Their fitness level may be low due to inactivity caused by their disability. These factors should be carefully considered prior to exercising.

Key points for cardiovascular fitness

- Cardiovascular fitness refers to the body's ability to take in, transport and utilise oxygen.
- Cardiovascular exercise is classified as being rhythmic, continuous and using large muscle groups under moderate tension over an extended period of time.
- The maximum heart rate can be estimated using the formula 220 minus age.
- The four aerobic heart rate training zones are: the moderate aerobic zone (50-60%), the fitness zone (60-70%), the performance zone (70-80%) and the performance (anaerobic) zone (80-90%).
- Heart rate during exercise is best monitored by using a variety of methods (including: heart rate monitor, talk test, observation and use of an RPE scale).
- The benefits of cardiovascular exercise can provide protection against chronic heart disease (CHD) and provide health-related benefits for most people.

Muscular strength and muscular endurance

Muscular fitness is of fundamental importance to everyday life and necessary for the maintenance of an independent lifestyle. Research from the Allied Dunbar National Fitness Survey revealed that 30% of men and 50% of women aged 65-74 years did not have sufficient strength in their dominant leg to exert a force required to lift 50% of their body weight. Consequently, a simple task, such as rising from a chair, would be difficult without using the arms to assist in standing up. Muscular fitness can determine an individual's mobility, work performance and ability to enjoy leisure activities.

Muscular strength

Muscular strength refers to the maximal tension or force that is produced by a muscle or muscle group. Absolute strength is usually measured by determining how much weight can be lifted in a single effort. This can be expressed as the one repetition maximum (1 RM).

To improve muscular strength, training intensity should be high and the number of repetitions of each lift or movement should be kept relatively low. This is expressed as:

Very high resistance x low repetitions 75% (or above) of l RM x low repetitions (l-10)

Muscular endurance

Muscular endurance refers to the ability of a muscle, or muscle group, to exert sub-maximal forces against a resistance over an extended period of time.

To improve muscular endurance, training intensity should be low to moderate and the number of repetitions kept relatively high. It is expressed as:

Low to moderate intensity x high repetitions 40-60% of 1 RM x high repetitions (15-25)

Muscular strength and endurance can also be effectively trained in a studio or sports hall, or outside of the gym by using exercise bands or body weight exercises such as push-ups, squats and abdominal curls. Body weight exercises like these can be easily adapted for strength or endurance by increasing the lever length or changing the body position or the angle of the movement.

The usual rule for muscular strength and endurance training is to perform exercise with a slow and controlled technique, keeping the muscles under tension. An exercise performed at a faster pace will develop power. This may be important when training for certain sports.

Power is defined as: force x speed

A jumping squat, performed at speed, is an example of an exercise that will effectively develop power.

The muscular strength and endurance continuum

The relative intensity of any given exercise can be placed on a continuum according to an individuals muscular fitness. The continuum ranges from pure strength at one end to muscular endurance at the other. For example, as you move away from the strength end, the gains in muscular strength diminish and the gains in muscular endurance increase. To put this in simple terms, an individual who can only perform five full push-ups would be working towards improving muscular strength, whereas an individual who can perform 30 full push-ups would be working towards muscular endurance.

Everyday tasks require varying degrees of muscular effort. Some may lean more towards strength (eg, lifting a wardrobe or carrying a heavy bag of shopping), whereas others may be more endurance-based (e.g, digging the garden).

Muscular strength and endurance continuum		
1-8 reps	8-12 reps	12-25 reps
Strength	Strength and endurance	Endurance
Heavy resistance	Heavy / moderate resistance	Moderate / light resistance
PC energy system	PC / Lactic acid energy system	LA / Aerobic energy system
Fast-twitch muscle fibres	Mix of fibre types	Slow-twitch muscle fibres

Remember that the changes in a muscle are specific to the stimulus placed upon it (the SAID principle). If the stimulus is of low intensity and towards the endurance end of the continuum, then the changes will improve endurance capabilities. If the stimulus is very high in intensity, then the changes will improve strength capabilities. When one trains on this continuum, remember that the resistance must be sufficient to overload the muscles, otherwise no improvements will occur.

When training with resistance equipment, it is easy to determine whether it is best to work towards muscular strength or endurance; one simply employs the appropriate resistance and number of repetitions. However, when using one's own body weight, it is important to take a more ‘scientific’ approach by altering the body position, lever length or exercise angle to achieve the desired strength or endurance goal. For example, the shorter lever is closer to the pivot point, thereby decreasing the exercise intensity. Conversely, the longer lever is further away from the pivot point, thereby increasing the exercise intensity.

Gravity and body position also affect exercise intensity. For example, performing a standing squat in which the whole body is being used against gravity is more intense than a lying leg lift in which the leg only is being used as the resistance without the influence of gravity.

Muscular response to strength training

Over a period of time, long-term strength training brings about physiological changes within the muscle that occur due to the specific stress placed on it. The muscle adapts to enable it to meet these new physical demands .

Strength training largely utilises fast-twitch muscle fibres and is primarily fuelled by the phosphocreatine energy system. Therefore, this system will adapt and increase its efficiency.

This type of training causes microscopic tears to the contractile proteins, actin and myosin filaments in the muscle fibres. Providing there is adequate rest and nutrition following training, it is thought that the repair process results in extra contractile proteins being laid down, increasing muscle size and strength. The increase in muscle size is referred to as 'muscular hypertrophy'. As the muscles become stronger, they will start to burn more calories. However, muscular hypertrophy is not permanent. With muscle disuse (eg, as in cessation of training or disuse due to an injury or disability), muscular atrophy occurs (reduction or wasting of the muscle fibres).

Connective tissues become stronger. Adaptations to ligaments make the joints more stable, and the pulling effects of the tendons on the bones can result in increased bone density at the site of muscle attachment.

Adaptations of the nervous system, or neuromuscular adaptations, can also include improved synchronisation of motor unit firing and improved ability to recruit motor units to enable a person to match the strength elicited by electrical stimulation. This adaptation explains the rapid gains in strength that often occur in the first few weeks of strength training without any increase in muscle size.

Delayed onset muscle soreness (DOMS)

Strength training puts stress on the connective tissues and muscular structure of the body. It can produce micro-tears in the tissues, resulting in pain, soreness, stiffness and inflammation.

Delayed onset muscle soreness (DOMS) describes muscle pain, soreness or stiffness that is felt 12-72 hours after exercise. This is particularly the case at the beginning of a new exercise programme, after a change in sports activities or after an increase in the duration or intensity of exercise or activity. DOMS should not be confused with the muscle discomfort experienced immediately following severe physical stress due to an increased in carbon dioxide in the muscles.

Eccentric training is a method of training that allows a person to push his or her muscles past their normal point of failure. It allows one to lift, eccentrically (the lowering/negative phase of an exercise), 30-40% more resistance than the concentric (lifting/positive phase of an exercise). However, this is much more demanding on your muscles and produces a high level of muscle damage in the form of micro-tears. It is a method of training that carries the highest risk of DOMS and is not suitable for the deconditioned individual.

Muscular response to endurance training

Long-term endurance training brings about its own specific physiological changes within the muscle that occur due to the stress placed on it. The resultant adaptations differ from those that occur following strength training.

Endurance training largely utilises slow-twitch muscle fibres and is primarily fuelled by the lactic acid energy system. This system will adapt and increase its efficiency. It is the gradual accumulation of lactic acid in the muscle that leads to fatigue, as the sliding filament process of muscle contraction is inhibited. To offset this fatigue and improve muscle endurance, it is necessary to improve the supply of oxygen to the muscle, and the muscle's ability to use this oxygen, reducing the build-up of lactic acid. The supply of oxygen is improved by an increase in blood capillaries in and around the muscle, as well as an increase in both the number and size of mitochondria in the muscle.

This type of training maintains muscle mass, which is often referred to as muscle tone. As the muscles become more toned, they will start to burn more calories.

Changes to the nervous system or neuromuscular changes will also occur.

In the middle of the continuum, at 8-12 reps, both strength and endurance will be training in equal balance. This makes it an ideal range for individuals who want to train for general fitness and health benefits. The American College of Sports Medicine (ACSM) recommends the following guidelines for improving muscular fitness.

ACSM guidelines for improving muscular fitness	
Frequency	2-3 times per week with 48 hours separating the training sessions
Intensity	2-4 sets at 8-12 repetitions, with a rest interval of 2-4 minutes between sets. For older adults and the deconditioned, 1 or more sets of 10-15 repetitions
Time	Relative to the number of exercises and sets/reps
Type	Whole-body, multi joint exercises for the major muscle groups Free weights, resistance machines, body weight, etc.

**The number of sets, reps and rests can be manipulated to accommodate specific muscular strength or muscular endurance training goals.*

Summary of the benefits of muscular fitness training

Over the last 10 years, numerous studies have shown that muscular fitness training produces many benefits for all ages and both genders. These include:

- increased bone density - studies have shown that women over the age of 35 can lose about 1% of bone mass per year, a figure that tends to be significantly increased after the menopause. Regular muscular fitness training has been shown to increase bone mineral content. For example, one study found that women who performed resistance training twice a week for a year significantly increased their bone density. Regular muscular fitness training reduces the risk of osteoporosis and bone fractures in later life.
- increased metabolic rate and calorie expenditure - long-term resistance training has been shown to increase the resting metabolic rate (i.e, the energy required to maintain the functioning of the body at rest). This helps to reduce body fat and control body weight.
- decreased blood pressure - regular muscular fitness training has been shown to reduce both systolic and diastolic blood pressure.
- decreased blood cholesterol - numerous studies have shown that regular muscular fitness training can improve the blood cholesterol profile.
- improved self-image - changes in muscle tone, shape and size can contribute greatly to enhanced self-image.
- daily activities - activities such as lifting children, carrying heavy shopping bags and standing up from a chair become easier.
- decreased risk of injury - increased mobility and stability of the joints and stronger muscles and connective tissue result in a stronger body. A stronger body and core is better able to avoid or resist injuries and knocks from falls or other physical activities.
- improved core stability - the core includes the back, pelvis and shoulder girdle. Improving the ability of the core, or trunk, to support your everyday functional activities enables the muscles and joints to perform at their safest and most effective position. Typical exercises for this include the plank, crunches, oblique crunches and back extension. Core stability is the ability to move the limbs (arms and legs) while maintaining correct alignment of the spine.
- improved posture - employing functional, push-pull type muscular strength and endurance training can help to correct muscular imbalances, which can lead to postural problems.

Posture

To improve posture, there must be an appropriate choice of exercises; this could involve strengthening weak muscles and stretching tight ones. For example, if a client has an increased curvature of the upper back, they may benefit from strengthening the rhomboids and mid trapezius and stretching the pectorals. This combination of strengthening and stretching could counteract the stooped position often associated with sitting and working at a desk all day.

A client with an increased arching of the lower back will usually benefit from exercises to strengthen the abdominals and gluteus maximus muscles and stretch the hip flexors. This combination may counteract the excessive curve in the lower back and bring the spine into a more neutral alignment.

Special populations and muscular strength and endurance training

Children

Weight-bearing exercise for children is an important feature of their development. It is important to remember that weight-bearing exercises that employ the appropriate repetitions and resistance stimulate bone growth. Very high intensity strength training for children should be avoided, as it may damage bone and the growth plates. Note that muscle growth does not keep up with bone growth, although both are an important consideration when training children.

Pregnancy

The hormone relaxin affects joint stability, making the joints more lax - especially those in the pelvis. Because all the joints are affected, there is a greater risk of injury. Changing body shape during pregnancy, brought about the growth of the foetus and lax ligaments, leads to postural changes and changes in gravity.

A supine lying position should be avoided after the first trimester, due to the restriction of blood return to the heart and the pressure on internal organs.

The timescales for release and withdrawal of relaxin should be considered for exercise, as relaxin could remain, diminishing gradually, in the system for up to around five months after childbirth.

Ageing

With age, the metabolic rate tends to decrease. This decrease is largely thought to be due to the loss of muscle tissue (particularly fast-twitch muscle fibres), which is more a product of inactivity than ageing. Regular resistance training is an excellent way to preserve muscle mass, prevent a reduction in metabolic rate and avoid putting on weight (fat) with age.

Regular muscular fitness training reduces the risk of osteoporosis and bone fractures in later life and can reduce the frequency and severity of falls and fractures.

Disability

Individuals with disabilities may have limitations specific to their disability. Their muscles may be deconditioned or atrophied due to inactivity caused by their disability. These factors should be carefully considered prior to exercising.

Key points for muscular fitness

- Muscular strength can be achieved by using high-resistance, low-repetition training regimes.
- Muscular endurance can be achieved by using low-resistance, high-repetition training regimes.
- Power is defined as force x speed.
- The main muscular adaptations to strength training are increased fast-twitch muscle fibre motor unit recruitment and hypertrophy of fast-twitch muscle fibres.
- The main muscular adaptations to endurance training are increased capillarisation, increased size and number of mitochondria in the slow-twitch muscle fibres and increased recruitment of slow-twitch muscle fibres.
- DOMS describes micro-tears in the tissues, with resulting pain, soreness, stiffness and inflammation, and is brought about by very high intensity training.
- Body weight exercises can be simply adapted for strength or endurance by increasing the length of the lever or changing body position or the angle of movement.
- The ACSM guidelines for improving muscular fitness are: 2-3 times per week, 2-4 sets of 8-12 reps or 1 or more set of 10-15 reps. For older adults and the deconditioned, whole-body, multi joint exercises for the major muscle groups.
- The benefits of muscular strength and endurance training contribute to weight loss and management, decreased blood pressure and blood cholesterol, improved posture and core stability, improved self-image, reduced risk of falls and injury, ease of daily activities and increased bone density.

Flexibility

Flexibility is a measure of the maximum possible range of movement (ROM) around a joint or joints. Flexibility is specific to a particular joint or set of joints.

Most individuals only become aware of flexibility as they get older or if they participate in activities in which its presence or absence affects their performance (eg, yoga or Pilates). However, lack of flexibility at any age will make the body stiff, less mobile and restrict everyday movements.

Flexibility is probably the most underrated components of physical fitness, yet there is a wide range of health—related benefits to be gained from a regular stretching programme. Flexible joints and muscles contribute to the maintenance of correct posture and joint alignment. This aspect of physical fitness should be included at the end of every exercise session, when the muscles are at their warmest.

Types of stretching

Stretching exercises require the two ends of the muscle (the start/origin and end/insertion) to move further apart. This causes the muscle to lengthen and will potentially increase the range of motion at the joint. Remember that the muscles should always be thoroughly warm in order to facilitate effective stretching. There are several types of stretching to consider. These are outlined below.

Static stretching

This method of stretching involves a controlled lengthening of the muscle tissue under tension for a period of time (eg, sitting on the floor and gently leaning forwards over an extended leg to stretch the hamstrings). This type of stretching carries a lower risk of muscle damage and muscle soreness than other types and should be given preference when dealing with health-related exercise.

Static stretching can be subdivided into two further categories, based on the force that is generated in the stretch.

Active stretching - when the opposing muscle contracts and shortens to bring about a lengthening of the antagonistic muscle pairing (eg, when standing up and flexing the knee). This is an active stretch of the quadriceps caused by the contraction of the hamstrings to bring about a lengthening of the quadriceps.

Passive stretching - when an external force other than the opposing muscle brings about a stretch. This external force could be another body part, a wall or the floor in conjunction with gravity, or a partner (eg, taking the previous active quadriceps stretch, but instead, taking hold of the ankle. The stretch becomes passive as an external force - another body part - is now allowing the opposite muscle to relax. Notice that also it is now possible to significantly increase the range of movement.)

Ballistic stretching

Ballistic stretching involves a bouncing, bobbing, rhythmic or jerking movement. The aim of this type of stretching is to use the momentum generated in the movement to take the body part concerned through a greater range of movement. Results are usually positive; however, the increased range of movement is caused by the lengthening of tendons and ligaments. This will affect the joint stability and is potentially contraindicated. This type of stretching may be considered for persons whose sports activities involve ballistic movements. However, due to the high risk of injury involved, it is unsuitable for health-related improvements in flexibility.

Dynamic range of movement stretching

Dynamic range of movement stretching involves moving in and out of a controlled manner. The muscle is lengthened slowly to the end range of movement and then back to the start position. This process is repeated several times progressively and steadily. Care must be taken not to move too quickly or too far into the stretch, as otherwise the stretch may become *ballistic* in nature and could potentially cause injury. This type of stretching, if executed effectively, provides a safe alternative method to static stretching. It is particularly suitable for the warm-up phase of an exercise session.

When to stretch

During an exercise session, stretching exercises are normally performed at two points: the warm-up and cool down.

Short stretches should be included in the warm-up after the pulse raising and mobility section. The general aim of short stretches is to reduce the chance of injury by preparing the muscles for the range of movement expected within the workout. These stretches can be either static stretches or dynamic stretches.

Maintenance and developmental stretches are performed as part of the cool down. Maintenance stretches are for those muscles that simply need returning to their pre-exercise length after the workout, as no further increases in flexibility are required. However, developmental stretches are for targeted muscle groups that require improved range of movement or increased flexibility. The muscle is slowly lengthened until a point of tightness is felt and then held in that position. When the tension subsides the process can be repeated again. This type of stretching is the only type that actually aims to improve or increase flexibility.

Factors affecting flexibility

The structure of the joint
This is the biggest limiting factor in determining range of movement. It is not possible to force a joint to move beyond its anatomically functional range without risking injury.

The ligaments and tendons supporting the joint
The function of ligaments is to bind bone to bone and support a joint. They allow movement to occur, but are strong and inextensible, so as not to yield too easily to force. This is because they are made mainly of collagenous fibres.

Collagenous fibres are arranged in closely packed wavy bundles, similar to the wires in an electric cable. This arrangement provides them with the strength to resist high forces and is the reason why they are the main components of ligaments and tendons.

Muscles are attached to bones by the tendons, which transfer movement to the bones. Tendons provide about 10% of the total resistance to movement.

Opposing tissue bulk (muscle or fat tissue)
For an individual with large biceps, this will physically restrict the range of movement at the elbow joint when trying to stretch the triceps. Likewise, for an for an individual with a large belly who wants to stretch the hamstrings, their range will be limited by the fatty tissue.

The muscle and its connective tissues
Sheaths of connective tissue surround a muscle. This meshwork of connective tissue makes up 30% of the muscle mass and accounts for around 40% of the total resistance to movement. This resistance represents a large factor, which we can influence in flexibility development.

One of the most significant ways in which we can influence connective tissue is to ensure that the muscle is warm and to hold the stretch statically. As tissue temperature rises connective tissue stiffness decreases and extensibility increases.

There are a number of other non-structural factors that can affect one's degree of flexibility, as detailed below.

Gender
Any difference between the genders is probably anatomical. For example, women have broader and shallower hips, thus they have a greater potential range of movement than men in this area. However, there are lots of exceptions to this rule, such as male gymnasts and martial artists who have trained specifically to be flexible.

Age
Flexibility can be developed at any age, given the appropriate training. However, due to a loss of water and an increase in calcium salt deposits associated with ageing, there is an increase in muscle stiffness that affects the muscle and its connective tissue. This is associated with a decreased potential among older exercises. It is generally thought that the greatest improvement in flexibility occurs between the ages of 7-15 years.

Pregnancy
During the later stages of pregnancy, the hormone relaxin affects ligaments and this makes all joints more flexible and less stable. After giving birth, the effects of relaxin remain in the body for several months.

Temperature
Warm muscles stretch more easily than cold ones. This is why it is important to ensure that muscles are warm prior to stretching.

Time of day
We all have our own unique body rhythm, called circadian rhythm. Our circadian rhythm influences blood pressure, body temperature, heart rate and hormone levels. It is not uncommon for people to feel more flexible in the evening than in the morning or vice versa.

ACSM guidelines for stretching	
Frequency	Minimum 2-3 times per week
Intensity	3-4 reps per muscle group to the end of the range of motion, without inducing discomfort
Time	15-60 seconds for each stretch
Type	Static, dynamic or PNF for the major muscle/tendon groups (whole-body approach)

Source: ACSM Guidelines for Fitness Testing and Exercise Prescription 8th Edition

Benefits of flexibility training

- Quality of life - if the normal free range of movement capabilities can be maintained or enhanced, then the ability to cope with everyday activities can be improved (eg, reaching for the top shelf or simply being able to tie your own shoelaces!).
- Improved posture - for example, tight hamstring muscles can pull the pelvis out of alignment and cause an arching of the lower spine (lordosis). Tight pectoral muscles can pull the shoulders forwards, causing a rounded upper back (kyphosis). Chronic back problems are a major cause of disability in the UK, and it is widely recognised that inflexible hamstrings, hip flexors and erector spinae muscles contribute to this condition. A regular stretching programme can help alleviate some of the problems associated with back pain.
- Improved sports performance - flexibility exercises are useful for sports performance because they increase the range of movement at a joint, thus allowing muscles to exert more force over an extended period of time. For example, in golf and tennis, increased flexibility in the shoulder, elbow and wrist joints can enhance performance by allowing a player to hit the ball harder by applying more force through a greater range of movement.
- Stress management - the process of stretching can produce profound changes in physical and mental relaxation. Wide ranges of stress management methodologies incorporate some form of stretching to induce a calm and relaxed state.

Special populations and flexibility training

Children

Stretching for this age group needs to be handled with care. The problems arise due to soft joints and growth spurts. In very young children, joints are still soft and can easily be injured if forced into certain positions. In older children, the muscles are already very tight, as the bones grow faster than the muscles can stretch.

Pregnancy

During pregnancy, especially the later stages of pregnancy, there is an increased ability to achieve a greater range of movement. This is predominantly due to the hormone relaxin, which increases the pliability of the connective tissue in readiness for birth. A fitness instructor must be very cautious to avoid permanent damage and advise the client to perform only short stretches, avoiding all developmental stretching at this time.

Ageing

Increased muscle stiffness affects the muscle and its connective tissue decreasing stretching potential among older exercisers. This age group tends to lose body heat quickly, which further affects stretching potential.

Disability

Individuals with disabilities may have limitations specific to their disability. Their range of movement may be impaired due to inactivity caused by their disability. These factors should be carefully considered prior to exercising.

Key points for flexibility training

- Flexibility is the range of movement around a joint or joints and is specific to each joint.
- The types of flexibility are: static (either active or passive), ballistic and dynamic.
- Stretching in an exercise session is usually performed with short stretches during the warm-up and with maintenance and developmental stretches in the cool down.
- Developmental stretches are the only stretches that improve flexibility (in a health-related context) and are used to target muscles where a greater range of movement would be beneficial.
- The recommended guidelines to improve flexibility are static stretching, 2-3 x per week, 3-4 reps per muscle group and 15-60 seconds for each stretch.
- The benefits of a flexibility programme are improvements in quality of life, sporting performance, posture and prevention of chronic back pain conditions.

Motor fitness

The skill-related component of physical fitness is referred to as motor skills, motor fitness or neuromuscular fitness. It is described as the ability of the brain and nervous system to control the movements of the body that are necessary to complete, or master, a prescribed action or task. It refers to a number of interrelated factors, which include:

- agility - the ability to rapidly change the position of the entire body in space with speed and accuracy
- balance - the ability to keep the body centred over a base of support
- speed - the rate or rapidity of any motion
- coordination - the ability to perform smooth and accurate movements requiring good awareness and integration of senses, muscles and body position involved in the movement
- power - the amount of work done per unit of time: work divided by time, force and speed
- reaction time - the interval between a stimulus and the initiation of a response.

Movement of any kind is influenced by responses from and to the nervous system. Together, these provide an individual with kinaesthetic awareness, a sensory skill that the body uses to know where it is in time and space.

Why we need motor fitness

Some exercises require a high level of motor skills to be performed correctly. Some examples are:

- yoga - for balance
- swiss ball exercises - for balance
- studio classes - for co-ordination
- racquet sports - for agility, co-ordination and reaction time
- Olympic weight-lifting - for power and co-ordination.

Motor fitness requires the effective transmission and management of messages and responses between the central nervous system (the brain and spinal cord) and the peripheral nervous system (sensory and motor). The peripheral nervous system collects information via the sensory system; the central nervous system receives and processes this information and sends an appropriate response via the motor system, which initiates the appropriate movement

Many everyday activities, sporting activities and specific types of exercise demand the acquisition of one or more of these components to produce a smooth, efficient action to master a particular task and improve performance. Within health-related fitness, skilful performance of specific exercises will contribute to both the safety and effectiveness of the specific exercise, thereby reducing the risk of injury.

Motor skill acquisition and the learning process

Individuals need both time and practice to develop new specific skills (eg, to perform a sequence of choreography in an exercise to music class, a new resistance lift or any other complex activity).

Managing body weight, manoeuvring one's centre of gravity, co-ordinating the body movements and moving at different speeds and in different directions and at different intensities, will in the long term help to improve your motor skills.

There are three main stages of learning when training motor skills: cognitive, motor and automatic.

Cognitive

This is the initial phase of skill development in which the performer finds out what they are expected to do. At this stage, they will be less co-ordinated and unfamiliar with the exercise or movement pattern. They may also tire easily, as concentration levels will need to be high. It is essential at this stage not to overload the individual with too much information; the exploratory nature of this stage will mean that errors are made.

Motor (associative)

Many learners stay at this stage of learning for a long period of time. They are more able to recognise mistakes, make comparatively fewer errors and are able to make some of the necessary adjustments to improve technique. Although learners are able to link together movement patterns, their movement is often slower, more deliberate and their concentration levels are high.

Automatic (autonomous)

At this stage of learning, individuals will have developed their reaction time, will be able to move faster and can perform multiple actions. They can also maintain a higher degree of accuracy in their movement. The level of anxiety regarding performance is also reduced. Movements are less cognitive and are performed more automatically. To maintain this level of skill, it will still be necessary to return to earlier stages of learning on occasion.

Factors affecting motor skills

Previous skill

If someone has previous experience of a skill, then it is much easier to re-acquire that skill at a later date. Skills such as riding a bike, used in childhood but not for several years, can be easily restored as the basic skill patterns still exist.

Kinaesthetic awareness

This means being aware of the position of the body without looking. Receptors in the muscles constantly feed information to the brain, which can then work out how the body is moving. This awareness is essential for good motor skills.

Special populations and motor skill training

Children
Motor skills are used in varying degrees in all physical activities. Young children will not have gained sufficient motor skills to participate in some activities with good technique. Children's lower limbs grow fast, so much so that their brain cannot keep up. This can make them un-coordinated and appear clumsy. It is imperative that all activities promote motor skills by rehearsal and repetition in a controlled manner.

Pregnancy
As the foetus grows the pregnant client will notice a change in spacial awareness and their centre of gravity These adaptations will have an effect on balance, co-ordination and speed. This will make it harder for the client to move swiftly from one exercise to another, so more time may be needed prior to a change in direction and/or activity.

Remember the impact that relaxin has on connective tissue - in particular, on joint stability, which, compounded with moving too fast in an un-coordinated manner, may lead to injury.

Ageing
Although the evidence is less conclusive than with some of the other components of fitness, it is generally accepted that with ageing there is a reduction in motor skill ability. This age group may need longer to process information and may have reduced concentration. This requires constant repetition and reinforcement when teaching a new exercise or movement pattern. Short-term memory is affected, which can lead to individuals forgetting a technique or movement pattern, so it is important to be patient and prepared to constantly repeat and reinforce. Reduced vision and hearing can compound the problem, so it may help to be more visual than verbal. Balance, co-ordination and reaction time are also affected, which can make older people slower to react, a little clumsy and prone to dizziness.

Disability
Individuals with disabilities may have limitations specific to their disability. Their motor fitness may be poor due to inactivity caused by their disability. These factors should be carefully considered prior to exercising.

Key points for motor skill training

- The learning process has three main stages: cognitive, motor and automatic.
- Motor fitness refers to the skill-related elements of fitness: agility, balance, speed, co-ordination, power and reaction time.
- Motor fitness is essential for everyday life, sporting activities and specific exercises to produce smooth, efficient actions and reduce the risk of injury.
- To develop motor fitness, skills need to be broken down in a logical learning process.

Working with older people

The advancement of age is something that happens to us all. As life expectancy is extending and people are living well into their eighties there is an increased need to be physically fit to enable individuals to be independent and enjoy life.

Age should not be a barrier to exercise. Regular physical activity can:

- stimulate physical and mental health
- increase mobility and independence
- improve stamina, strength, posture, co-ordination and reduce the risk of falls
- reduce the risks of osteoporosis and fractures
- help to overcome loneliness and isolation
- assist in reducing anxiety and depression and give a general sense of well-being.

The effects of ageing vary greatly between individuals. Although the effects of ageing are inevitable, activity is an excellent way of slowing down the ageing process. Simple adaptations to mainstream exercise sessions can be made to accommodate those in this age group who are apparently healthy (eg, the use of chairs or additional tools to help balance and support allow this age group to integrate with everyone else). The key safety guidelines as defined by the National Occupational Standards for older people are as follows.

Exercises to **include** for this age group include:

- back extension (in particular thoracic extension) to improve posture
- interval-type activities that allow for rest between harder bouts of activity
- multi-joint, functional activities to assist in everyday tasks
- balance activities and core stability activities
- longer warm-ups.

Exercises to **avoid** for this age group include:

- high-impact
- prone/flexion activities
- complex choreography/exercises.

Working with young people (14-16 years of age)

A sedentary lifestyle in young people can have negative health consequences both now and later in life. An obese child has an 80% chance of growing up to be an obese adult. This could be due to unhealthy lifestyle choices and learned behaviours from parents or guardians, coupled with becoming increasingly self-conscious about their body while growing up.

A young person who is active will have:

- stronger muscles and bones
- a leaner body, controlled body fat and be less likely to become overweight
- a decreased risk of developing type 2 diabetes
- possibly lower blood pressure and blood cholesterol levels
- more confidence and a better outlook on life.

If through the usual screening process, it is apparent that the individual has a specific condition, an instructor must refer them to a specialist instructor.

Note: A young person's parent or guardian should complete the screening form. If there are any questions regarding the safety of continuing with the exercise session, it is essential to contact the parent and discuss the best course of action.

General exercise guidelines for young people include:

Exercises to **include**:

- interval-type training (i.e, reducing the impact and intensity in between heavier bouts of exercise)
- body weight exercises incorporating gravity and lever length as resistance
- functional activities such as pulling and pushing
- activities to develop motor skills (eg, balance and co-ordination).

Exercises to **avoid**:

- prolonged high-intensity training (anaerobic training)
- high-resistance training, which can cause damage or fractures to the growth plate.

Boys' and girls' lower limbs grow fast, so much so that their brain cannot keep up. This can make them seem un-coordinated and clumsy. Therefore, it is imperative that all activities promote motor skills by rehearsal and repetition in a controlled manner.

Child protection

Before working with this age group, all instructors will be required to adhere to government policy regarding the safety and welfare of children under the Child Protection Act, 2004. This requires individuals to undertake a CRB (criminal records bureau) check to become registered. The act requires the registered person to comply with local child protection procedures approved by the Area Child Protection Committee and ensures that all adults working with and looking after children in the provision are able to put the procedures into practice.

Working with ante-natal and post-natal clients

Exercise plays an important role in promoting health and well-being before, during and after pregnancy.

Women who exercise during pregnancy have reduced weight gain, more rapid weight loss after delivery, improved mood and improved sleep patterns. Some studies have demonstrated that women who exercise regularly during pregnancy have less incidence of induction, faster labours, are less likely to require epidural analgesia, have fewer operative births and have a quicker recovery from delivery. These are persuasive arguments for staying active.

Pregnancy is a highly complex physiological process, and precautions are needed to ensure that exercise does not contribute to any complications.

After birth, most of the physiological changes persist for 4-6 weeks; therefore, gradual introduction of pre-pregnancy exercise should be based on capability.

The following guidelines will help to ensure the safety and well-being of mother and baby.

Exercise to **include**:

- interval-type exercises (i.e, reducing intensity in between heavier bouts of exercise)
- maintenance stretches (eg, static stretches)
- core stability exercises
- balance exercises.

Exercises to **avoid**:

- supine positions and exercises after the first trimester (restriction of blood return via inferior vena cava)
- developmental, proprioceptor neuromuscular facilitation (PNF) or ballistic stretching due to the effects of the hormone relaxin on connective tissue
- high-impact exercises
- exercises that carry a risk of falling or abdominal trauma.

Working with disabled clients

It is estimated that there are over 10 million disabled people in the UK, almost a quarter of whom will experience disability, most of them as a result of age related changes. While people are now living longer, some are doing so with disabling medical conditions.

Only 7% of disabled people are sufficiently physically active for disease prevention. Appropriate levels of physical activity are known to reduce the incidence of certain chronic diseases by as much as 50%, including cancers and cardiovascular diseases - two of the leading causes of early death.

Disabled people may have an even greater opportunity for benefiting from keeping physically active, as it can help to reduce, manage or even reverse some of the effects of their impairment. When dealing with clients with a disability, precautions are needed to ensure that the exercises do not contribute to complications or make their condition worse.

An instructor should always seek information from the client concerning their individual disability. Adaptations should be made to facilitate participation specific to the individual's condition, ability and experience. For example, an individual with a hearing or sight impairment can easily be integrated within a regular training environment with some careful planning, by ensuring they are always in a position where they can best follow the instructor.

Note: There are many physiological changes that take place with these specialist populations. It is important to appreciate the scope of one's own personal ability in teaching these individuals in a gym or studio setting. If in any doubt as to whether these individuals can be included into a mainstream session, or for individuals with specific conditions, it is essential to refer them to a specialist instructor, who will be able to deal with them safely and effectively.

Specialist training

The number of individuals requiring specialist instruction for one reason or another is on the increase. Specialist exercise instructors can make a big contribution to the overall health of this population, contributing to an overall improvement to their quality of life.

Gym instructors, group exercise instructors and personal trainers without additional qualifications are restricted to working with the 'apparently healthy' category of individuals.

Undertaking specialist training in one or more of the above populations demonstrates that an instructor has the knowledge and skills necessary to provide more in-depth advice and exercise programming for a particular population. It also provides an instructor with the ability to work with a range of fitness, health and medical professionals in a particular field (eg, personal trainers, physiotherapists, ante-natal/post-natal clinics and other healthcare organisations).

Key points for special populations

- Due to the physiological differences in children, older adults, ante-natal/post-natal and disabled clients, specialist training is required.
- For those who are apparently healthy, simple adaptations to mainstream exercise sessions can be made to accommodate specialist populations.
- Working with specialist populations can be rewarding and fun for the instructor and potentially life-changing for the participant.

Our understanding of the relationship between nutrition and health has dramatically improved due to recent research and scientific studies.

The following information will help an instructor to make recommendations in line with healthy eating guidelines in order to achieve a 'balanced diet' . Without further training, an instructor's role in making dietary recommendations is limited to advising based on this information.

Food and drink are central to life, and we cannot survive without them. However, the quantity and quality of the food and drink we consume can have an enormous influence on body weight, complexion, concentration, energy levels and mood. Inadequate or poor nutrition can lead to vitamin and mineral deficiencies. It can also dramatically influence the risk of developing many diseases such as coronary heart disease (CHD), obesity, cancer and diabetes and can help in the treatment and recovery from other illnesses.

Nutrients

The body needs fuel in order to provide energy for all organs and cells to perform their job of maintaining health (including the building and repair of body tissues) and to drive activity patterns.

These fuels are provided in the form of the following macronutrients:

Macronutrient	Example foods	Necessary for
Carbohydrates	Rice, pasta, potatoes, bread, cereals and grains	Energy production
Fats	Dairy, oils, nuts, seeds and fish	Insulation and energy production
Proteins	Meat, dairy, nuts, pulses and fish	Growth and repair of body tissues

Carbohydrates in the food we eat come in two different forms:

- **simple carbohydrates** - these are naturally occurring sugars found in fruits and milk.
- **complex carbohydrates** - these are the starches found in plants, particularly grains, seeds and root vegetables, such as potatoes.

Dietary fats are complex organic substances that are not soluble in water. There are two basic types of fat: saturated and unsaturated.

Type of fat	Example foods
Saturated fats (solid at room temperature)	Butter, suet and lard. Meat, meat products, cheese and cream also contain a high percentage of saturated fats.
Unsaturated fats Poly unsaturated, mono unsaturated (very soft or liquid at room temperature)	Nuts, fish and many types of seed and plant product.

In addition, we need the following micronutrients:

- **vitamins** - to enable us to effectively use the energy from the macronutrients.
- **minerals** - these are necessary for a range of very specific tasks.

Sources and functions of minerals		
Mineral	**Found in**	**Necessary for**
Calcium	Milk, cheese, green vegetables, soya	Hardening of bones and teeth, muscle contraction
Phosphorus	Cheese, oatmeal, liver, kidney	Needed to work with calcium in the formation of bone
Iron	Liver, beef, egg yolk, cereals, green vegetables	Production of haemoglobin in red blood cells
Sodium	Fish, meat, eggs, milk, cooking and table salt	Regulating the body's water content
Potassium	Most foods	Water and electrolyte balance and normal functioning cells
Iodine	Most foods and drinking water	Essential component of thyroid hormones
Zinc	Nuts and fish	Growth and tissue repair

Deficiencies in vitamins and minerals can lead to anaemia, reduced bone mineral density / osteoporosis, digestive disorders such as constipation and diarrhoea, reduced muscle mass, weight loss / gain and deficiencies in essential fatty acids.

Fibre

In addition, the human body also needs fibre, which is a form of carbohydrate that is found in plant cell walls. Fibre is essential for optimum function of the digestive system and is sometimes referred to 'roughage'.

The fibre content of a variety of foods	
Food	**% fibre**
Wheat bran	44.0
Coconut (fresh)	13.6
Cornflakes	11.0
Peanuts	8.0
Muesli	7.4
Sweetcorn (canned)	5.7
Brown rice	5.5
Brown bread	5.1
Spring greens (boiled)	3.8
Bananas	3.4

Water

Water provides the right conditions for all other functions. Approximately 80% of the weight of a newborn child is made up of water. Even in adulthood, water accounts for approximately two-thirds of our weight. We could all survive for a number of weeks without food, but four to five days without water would kill any human.

Water is the main component of cells and blood, and the body needs a constant amount of it. This means that whatever we lose in a day MUST be replaced. Water is lost from our bodies in a number of ways: through urine and faeces, evaporation from the skin as sweat and from expired breath. Even without moving around, we lose 2-2.5 litres of water per day via these routes. Approximately 50% of this can be replaced from the foods that we eat, but it is still necessary to drink plenty of fluids. Current guidelines state we should drink on average 2 litres of water per day, and this should increase with exercise.

An inactive person needs to drink about six glasses of fluid a day. A sportsperson in training would need to drink much more, as up to 4-5 litres of water can be lost in sweat in a day, and even more in hot environments. If one loses too much water from the body without it being replaced, then the building of body tissues, temperature regulation and metabolic rate are all affected. The resulting dehydration can lead to fatigue, headaches, lack of concentration and constipation. A loss of only 10% of normal bodily requirements can result in severe dehydration that may be fatal.

Metabolism and energy balance

The range of internal activities that take place in our bodies is known as metabolism, and the amount of energy that is required at rest to drive metabolism is known as our basal metabolic rate (BMR). BMR is measured in calories.

BMR will be different for each individual, as it predominantly depends on how much of us there is (i.e, our body weight and how active we are). Another contributory factor is the ratio of fat-free mass to fat mass, or body composition. Fat-free mass is made up of our body fluids, bones and muscle tissue and is more metabolically active (therefore will require more energy) than fat mass.

BMR is usually around 1,500 kcals (kilocalories) for an average female and 2,000 kcals for an average male.

Note: The above is an estimation and will vary from one person to another. These figures do not take into consideration individual activity levels.

The energy balance equation

The energy balance equation states that body weight will remain the same when calorific intake equals calorific expenditure. The energy content of food is constantly being transformed into other forms of energy. If the intake of energy exceeds the energy output, the excess energy is stored as fat. The key to losing fat is to create an imbalance between energy expenditure and energy intake. Thus, it is not a prerequisite to work in this zone to lose fat if one is well-conditioned, only if you have low fitness and are overweight.

Energy in > energy out = weight gain.
Energy in < energy out = weight loss.
Energy in = energy out = weight maintenance.

To lose fat, a deficit must be achieved. A deficit of 3,500 kcals is required to lose 1lb of stored fat. This deficit for weight management is generally best achieved through a combination of increased physical activity and a slight reduction in daily consumption of calories.

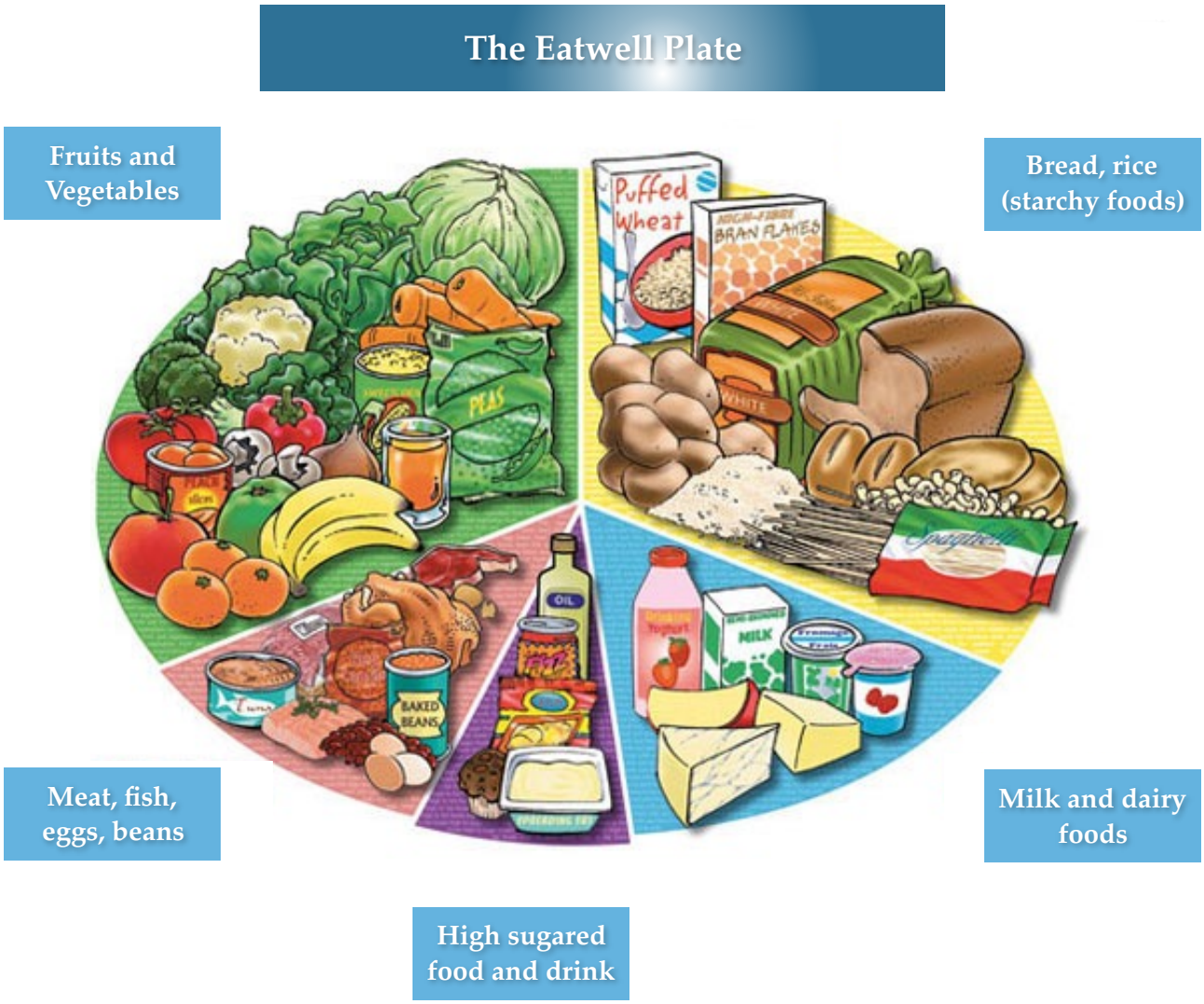
Regardless of the actual amount of calories necessary to sustain our basic daily body functioning and activity levels, we should all consume a balanced diet. This means that we should consume a certain percentage of these calories from each food group.

Recommendations for a healthy diet

It is always advisable to check the current national guidelines, as these do have a tendency to change over time. Currently, the NHS Live Well website offers the most up-to-date guidance and emphasises the importance of getting your five a day. The 'eatwell plate' also features on this website and is a good visual representation of how different foods contribute towards a healthy balanced diet (this is not recommended for children under the age of two).

The eatwell plate is based on the five food groups, which include:

- bread, rice, potatoes, pasta and other starchy foods
- fruits and vegetables
- milk and dairy foods
- meat, fish, eggs, beans and other non-dairy sources of protein
- foods and drinks high in fat and/or sugar.



The eatwell plate makes healthy eating easier to understand by showing the types of food we need to have a healthy and well-balanced diet. It encourages each one of us to choose different foods from the first four groups every day, to help ensure that we all obtain the wide range of nutrients our body needs to remain healthy and to function properly.

Choosing a variety of foods from within each group will add to the range of nutrients consumed. Foods in the fifth group - foods and drinks high in fat (trans-fat) and/or sugar - are not essential to a healthy diet.

Below is a summary of the most important tips on healthy eating.

- Carbohydrates - eat predominantly complex carbohydrates. They supply energy, fibre vitamins and minerals. They supply energy at a more sustained rate throughout the day than simple carbohydrates.
- Fruits and vegetables - eat 5-7 portions per day. Fruits and vegetables contain vitamins, minerals and fibre. They are also low in fat. Evidence shows that plenty of fruits and vegetables in the diet help to protect against heart disease and some cancers.
- Protein - eat moderate intakes of protein and less protein from animal sources. Protein from beans, pulses and cereals are naturally lower in fat and less expensive.
- Sugar - restrict intakes of food that are high in sugar.
- Fats - eat less saturated fat. Saturated fats from meats and dairy products are thought to increase the risk of heart disease. Replace these with mono-unsaturated and poly-unsaturated fats, such as olive oil and oily fish.
- Fluids - drink at least two litres of water per day.
- Salt - reduce salt intake. Excessive sodium in salt can cause high blood pressure in some people.

The health risks of poor nutrition

Poor nutrition can increase the risk of many health problems. Deficiencies in certain food groups can result in a lack of vitamins, minerals and essential fatty acids, each of which can cause a wide range of health problems. In general terms, poor nutrition can lead to increased risk of type 2 diabetes, high cholesterol, high blood pressure, heart disease, osteoporosis and some cancers.

A bad diet causes both physical and mental fatigue, slower problem-solving ability and decreased alertness and muscle response time. Nutrition affects the production of certain hormones, which have many negative effects on health.

Eating too many calories will result in weight gain (obesity). Obesity contributes to a number of health problems, including high blood pressure, type 2 diabetes, coronary heart disease and osteoarthritis. Eating too few calories due to a very low calorie diet or clinical eating disorder can lead to lots of nutrient deficiencies and is very unhealthy.

Key points for nutrition

- Good quality foods of the correct quantity are essential to a healthy body weight, good concentration, mood and complexion and high energy levels.
- The main food groups are carbohydrates (eg, rice, pasta and potatoes for energy production), fats (eg, dairy, oils and nuts for insulation and energy production) and protein (eg, meat, dairy for repair and growth of tissues).
- Vitamins, minerals, fibre and water are also necessary for a variety of bodily processes.
- The energy balance equation states that if one consumes more calories than are burned, weight will be gained; if one burns more calories than consumed, weight will be lost.
- A deficit of 3,500 kcal is required to lose 1lb of stored fat. This is best achieved by a combination of increasing physical activity and reducing calorie intake.
- The NHS Live Well website can provide current, up-to-date healthy eating guidance.
- A poor diet can lead to many physical and psychological health problems.
- Fitness instructors without further training are limited to providing information to clients. Instructors should recommend that clients look at current national healthy eating guidelines for the most up-to-date information.