FOOTBALL FOR THE HEART

Training manual developed in collaboration between the Danish Football Association, the University of Southern Denmark and the Danish Heart Foundation with support from TrygFonden.

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TRAINING MANUAL 2024
Football for the Heart

This material is produced by the Department of Sports Science and Clinical Biomechanics at the University of Southern Denmark, the Danish Heart Foundation and the Danish Football Association.

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INTRODUCTION

Football for the Heart is a recreational football training programme for people with cardiovascular disease. The concept has been offered in selected municipalities since 2019. The project was supported by TrygFonden from 2019-2022 and is based on documented health effects.

It is estimated that half a million Danes are affected by heart disease, and thousands of Danes die every year as a result. Moreover, cardiovascular disease leads to reduced life expectancy and impaired quality of life. But exercise can both prevent cardiovascular disease and help people to live longer, more positive lives; and good habits will not be abandoned in the long run if people adopt the right exercise programmes.

Recreational football offers major potential in terms of player retention. Unity, community and good, varied exercise for everyone means that football can be the key to a better life for women and men with cardiovascular disease. This is why the partners, University of Southern Denmark, DBU and the Danish Heart Foundation teamed up to produce Football for the Heart, which initially aimed to get at least 800 people with cardiovascular disease playing football and exercising together with others. Ten municipalities and 30 clubs took part in Football for the Heart between 2019 and 2022. A specific Football for the Heart training course was being developed as an integral part of the project. This course was being developed in collaboration between DBU, SDU and the Danish Heart Foundation and is being offered to all coaches working with the Football for the Heart project.

In this course material, participants will be introduced to the scientific background of the concept, the circulatory system, cardiovascular diseases and symptoms, first aid and points to consider when training with the target group. A training programme and suggestions for training exercises will also be presented. The football-related content of the course is based on the Football Fitness basic training programme, and so it's assumed participants will be familiar with the content of the basic training programme.

Target group
The target group for Football for the Heart is very broad, and the programme focuses on both primary and secondary prevention. Overall, Football for the Heart is available to all patients with the following cardiovascular diseases: High blood pressure, heart failure, lower-limb atherosclerosis ("intermittent claudication") and blood clots in the heart, irregular heartbeat (arrhythmias), pacemakers and ICD, valve failure and stroke. A Football for the Heart programme can be started directly at the football club; but for certain target groups, especially people who have suffered from stroke (bleeding or blood clots in the brain), the programme at the football club can take place as a phase two initiative following an initial rehabilitation programme under the auspices of the municipality or with the Danish Heart Foundation.

SCIENTIFIC BACKGROUND

Physical activity is important, and not only for preventing the development of lifestyle diseases – including cardiovascular disease. In its book "Fysisk aktivitet – Håndbog om forebyggelse og behandling" (Physical activity – Handbook on prevention and treatment), which was updated in 2018, the Danish Health Authority focuses on the importance of physical activity to prevent and treat 31 different disorders/diseases, including several cardiovascular diseases or related risk factors of relevance to the Football for the Heart target group.

As the biggest organised sport – in terms of both membership and number of clubs – football has enormous potential to reach many Danes, as there are football clubs in almost every local community. At the same time, scientific psychological and sociological studies have shown that team game activities provide more motivation for both men and women compared to activities that have focus more on the individual, such as spinning and crossfit. Participants in team game activities experience higher levels of enjoyment and internal motivation, which is related to the social interaction that occurs more in team games than in individual activities. Such individual activities may be organised as team training, but without the participants being reliant on each other. In these groups, the biggest motivating factor was the importance of doing something to promote health. This is why the activity here was perceived more as a necessary duty. The studies also show that being part of a community, where you are part of a team and others are waiting for you, has a major impact on motivation and so ensures that people continue pursuing the activity for longer periods.

Not only is football training motivational, and not only does it lead to a sense of community. Football training for three to twelve months has also been shown to be highly effective in the prevention of cardiovascular disease and the treatment of several physiological parameters and risk factors related to cardiovascular disease. For instance, scientific studies have shown that football training can improve heart function during both the contraction (systole) and filling (diastole) phases. Endothelial function, i.e. the reactivity of the innermost cell layer of the artery wall – which is important for preventing blood clots – can also improve after football training.

Systolic and diastolic blood pressure, which are key risk markers for cardiovascular disease, also decrease significantly on average (11/7 mmHg) following football training in both men and women with mild to moderate high blood pressure (hypertension). A drop in blood pressure of this magnitude is equivalent to effective treatment with antihypertensive medication.

Elevated cholesterol levels are another significant risk marker, and several scientific studies have reported decreases in total cholesterol levels, especially LDL cholesterol (popularly known as "bad cholesterol"). Cholesterol is deposited in the artery walls during atherosclerosis, potentially leading to vasoconstriction and blood clots. An improved cholesterol profile will therefore help to improve cardiovascular health and reduce the risk of blood clots.

Two other significant risk markers for cardiovascular disease are obesity and aerobic fitness, the latter typically being assessed by means of fitness levels. Body composition also improves after three to twelve months of football training: muscle mass increases (0.5 kg) and fat mass decreases (1.7 kg), leading to a significantly lower body fat percentage. However, major US cohort studies suggest that body composition and obesity are less important for cardiovascular disease if aerobic fitness is good. Aerobic fitness was found to have improved by an average of 3.5 ml/min/kg after just three months of football training. Such an increase may in itself result in a significant reduction in the risk of cardiovascular disease.

As cardiovascular disease is closely linked to age, a significant portion of the target group for Football for the Heart will be made up of older people, who often have multiple health issues and may experience a generally lower level of functionality. However, a number of scientific studies have demonstrated that football is an effective way of promoting health in older people, even if the participants do not necessarily have any experience of ball games. Football is a good all-round form of exercise that, as can be seen from the figure on page 7, has positive effects on cardiovascular fitness, metabolic fitness and musculoskeletal fitness. Moreover, football is perceived as a healthy, fun and sociable pursuit; all aspects that are crucial for recruitment and retention.

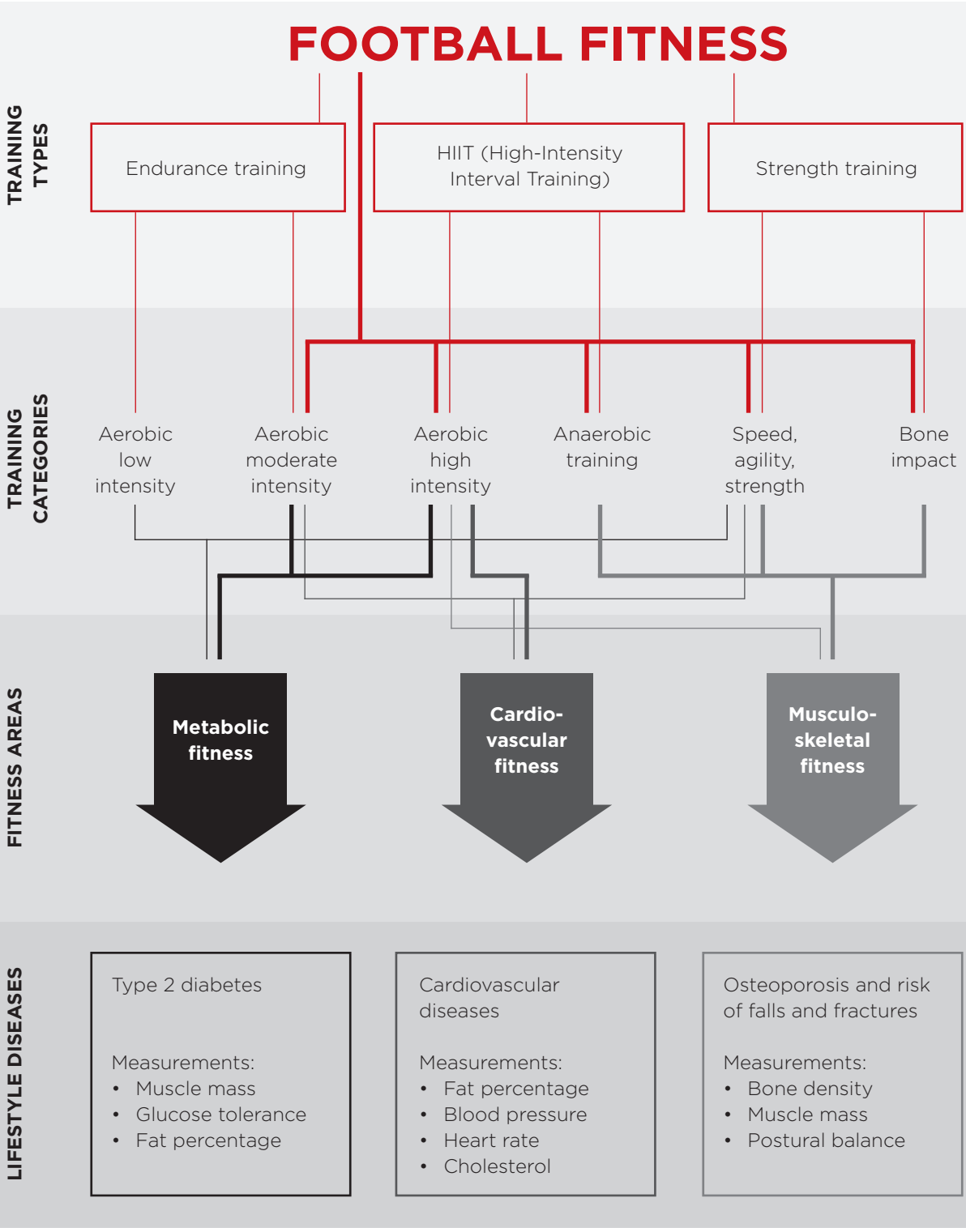


Figure 1 *Impact of different exercise categories on fitness areas and lifestyle diseases. Krustrup and Krustrup 2018, modified from Krustrup et al., 2010.*

FACTS

Football for the Heart is an evidence-based concept based on 15 years of research into the health effects of football training. Research shows that football training is a healthy, versatile, intensive and effective form of interval training that combines endurance training, high-intensity interval training (HIIT) and strength training. The key research findings relevant to untrained adults with cardiovascular disease can be found here:

- ✓ **Playing football for one hour a week, twice a week for 12 to 16 weeks increases fitness by 3.5 ml/min/kg, which is equivalent to an 11 per cent increase and a 40 to 50 per cent reduction in the risk of cardiovascular disease.**
- ✓ **Playing football for one hour a week, twice a week for 12 to 26 weeks lowers blood pressure by 11/7 mmHg in people aged 30 to 75 with mild to moderate high blood pressure, which is equivalent to successful pill treatment for high blood pressure.**
- ✓ **Playing football for one hour a week, twice a week for 12 to 26 weeks lowers fat mass by 1.7 kg and LDL cholesterol levels by 0.2 mmol/l, while muscle mass increases by 0.5 kg.**
- ✓ **Recreational football for one hour a week, twice a week increases heart function, including elasticity, in 3 to 4 months and creates positive effects on heart structure and dimensions in 6 to 12 months.**
- ✓ **Recreational football for one hour a week, twice or three times a week has positive effects – for male and female prediabetes and type 2 diabetes patients – on heart rate, blood pressure, long-term blood sugar and bone density in the leg and hip region.**
- ✓ **The strongest evidence for the health benefits of sport is associated with football and running, particularly in relation to positive cardiovascular and metabolic effects.**

SYMPTOMS OF CARDIOVASCULAR DISEASE

Chest pain
New, unprovoked, sudden and persistent chest pain, possibly accompanied by shortness of breath, cold sweating, vomiting and fainting, are typical signs of a blood clot in the heart. That is why it is important to seek medical attention quickly and call 1-1-2. The pain of a blood clot in the heart is often described as tightness or pressure ("there's an elephant sitting on my chest"), while the common stabbing chest pain that appears as a sore spot over a limited area of the chest is usually related to muscle pain, which is quite harmless. Chest pain that comes on during physical activity but disappears when the activity stops can be a symptom of atherosclerosis in the coronary arteries, the blood vessels supplying blood to the heart. Such chest pain (angina pectoris) requires medical supervision. The pain is rarely indicative of a blood clot in the heart if it occurs when breathing, but you should still see a doctor if the pain persists. Acute, severe chest pain radiating to the back may indicate a tear in the aorta (aortic dissection) and should be investigated immediately. This is most commonly seen in people with known aneurysms of the aorta, high blood pressure and atherosclerotic disease.

Abdominal pain and nausea
Abdominal pain and nausea can sometimes be symptoms of a blood clot in the heart, but these pains are most commonly linked to diseases of the stomach or oesophagus. It may be difficult to pinpoint the origin of the pain, but do not hesitate to call 1-1-2 if you suddenly experience severe abdominal pain.

Palpitations
Palpitations are often a completely harmless phenomenon due to extrasystoles (extra beats of the heart), which can be caused by alcohol, smoking, stress and coffee consumption. However, palpitations can also be caused by a more regular arrhythmia or be a symptom of coronary atherosclerosis, heart failure or valve failure. Extrasystoles occur daily in almost everyone. However, you should seek medical attention immediately if you experience persistent palpitations accompanied by chest pain, shortness of breath or fainting, for example.

Pain in the arms
Pain, heaviness and numbness in the arms can, in rare cases, also be a sign of a blood clot in the heart and is often accompanied by chest pain, etc. Such pain can also be caused by overexertion, but you should contact your doctor if it persists.

Pain in the legs
If leg pain occurs while walking and disappears when resting, this may be a sign of atherosclerosis, with narrowed or blocked arteries in the legs. Atherosclerotic leg disease is most common in diabetics and smokers or ex-smokers. Leg ulcers that fail to heal are often a sign of poor circulation in the legs, too, and such symptoms require medical attention.

Pain in the jaw and/or back
In rare cases, a blood clot in the heart may cause jaw and/or back pain. A doctor should be consulted if the pain does not subside.

Swollen legs and ankles
Accumulation of fluid in the legs, resulting in swollen ankles or legs, can be caused by heart failure. In such cases, both legs will usually be swollen. Swelling in just one leg may indicate a blood clot in the veins (deep vein thrombosis), or possibly an infection in the leg. You should consult your doctor if the swelling does not go down.

Choking sensation
Choking sensations may accompany chest pain or shortness of breath. You should, of course, contact your doctor for an evaluation if the sensation is persistent or frequent.

Shortness of breath
Shortness of breath is commonly associated with lung or heart conditions including smoker's lung disease (Chronic Obstructive Pulmonary Disease, COPD), pulmonary fibrosis, heart failure, fluid accumulation in the lungs or a collapsed lung. When a patient is experiencing heart failure, shortness of breath will typically worsen when lying down and improve when sitting up. Fluid will often build up in the legs as well, and the ankles will be swollen. If shortness of breath occurs along with chest tightness, this may be due to a blood clot in the heart,

and shortness of breath along with palpitations can be a symptom of heart rhythm disturbances. Call 1-1-2 immediately if you experience acute shortness of breath.

Dizziness
Dizziness can be a sign of low blood pressure, which may occur due to heart rhythm disturbances, such as heart block causing a slow heart rate. More often, however, dizziness is related to dehydration, alcohol intake, side effects from medication or mental disorders. Seek medical attention immediately if severe dizziness occurs acutely.

Fainting
Fainting is an acute, short-term loss of consciousness caused by reduced oxygen supply to the brain. There can be many causes, but fainting is a danger sign. Seek medical attention if fainting is preceded by shortness of breath, palpitations or chest pain. If you experience pain, nausea or general discomfort before fainting, this is typically an "ordinary" fainting episode triggered by a reflex mechanism in the autonomic nervous system and is less harmful. Fainting can also occur, especially after prolonged periods of standing, due to blood pooling in the legs and insufficient return flow to the heart. This reduces blood pressure and, consequently, the oxygen supply to the brain.

Fatigue
Fatigue can be caused by many things, but fatigue could be a symptom of heart failure if it occurs without typical triggers such as a hard day, increased stress and lack of sleep, or if it is accompanied by shortness of breath and fluid retention. A doctor should be consulted your fatigue is pronounced but has no obvious triggers.

GIVE LIFE – EMERGENCY FIRST AID

- ✔ Ten important minutes!
- ✔ When someone is in cardiac arrest, the heart is not pumping blood around the body.
- ✔ This means that the body's organs are deprived of oxygen and begin to deteriorate.
- ✔ After a few minutes, the brain starts to shut down.
- ✔ For every minute that passes without resuscitation, the chances of survival are reduced by 7 to 10 per cent.
- ✔ Most people will suffer permanent damage or die unless resuscitation is provided within no more than ten minutes.
- ✔ Very few people will survive if it takes ten minutes for help to arrive.
- ✔ Time is of the essence when someone has had a cardiac arrest! The risk of death or severe permanent damage is high unless help is given immediately. You have to take action – that person's life depends on it!
- ✔ The first aid section, led by an instructor from the Danish Heart Foundation, covers the following points:
  - Why resuscitation is important
  - How to stay safe in an emergency
  - How to examine an unconscious person whose breathing is abnormal
  - Why it is important to call 1-1-2, who you will talk to and what help will be available
  - How to give cardiac massage and artificial respiration
  - How to use an AED (Automatic External Defibrillator)

EXERCISING WITH CARDIOVASCULAR DISEASE

Exercise is a key part of the treatment of most cardiovascular diseases. Having a trained cardiovascular system will make it easier to cope with everyday physical tasks such as climbing stairs, shopping and gardening. Not having physical limitations enhances wellbeing and quality of life. At the same time, having a stronger body boosts confidence and alleviates concerns about physical strain and relapse.

Before starting training, it is advisable for the player to have consulted their doctor to find out whether there are any specific precautions they should take during exercise. Physical exercise offers numerous potential benefits, including improved cardiovascular function and positive impacts on risk factors for cardiovascular disease, such as lower blood pressure, healthier cholesterol levels, weight loss and enhanced blood sugar regulation. This is described in greater detail in the section entitled "Scientific background".

The Danish Cardiology Society recommends that exercise interventions should continue for at least twelve weeks, not only to achieve beneficial physiological effects, but also to promote the development of new exercise habits.

Exercise is recommended for all players with stable ischaemic heart disease. Starting to exercise one week after balloon therapy and four to six weeks after bypass surgery is usually recommended for patients with acute blood clot in the heart or unstable angina pectoris. If the treatment does not reopen all the large coronary arteries (i.e. the patient is not "fully revascularised"), the patient must be assessed by a cardiologist before starting an exercise programme.

All participants with heart failure should be assessed by a cardiologist before starting an exercise programme. Exercise is recommended for people with NYHA functional class I, II or III heart failure (see appendix) when the patient's medication dose has been adjusted and their condition has been stable for three weeks.

For players with heart failure, please note that training is not recommended before consulting a doctor if the following symptoms are experienced:

- Sudden weight gain of more than 1.8 kg in one to three days
- Resting heart rate over 100 beats per minute
- Heart rhythm disturbances (arrhythmia) at rest or during work
- Blood pressure drop during work

As a general rule, exercise is not recommended for people with NYHA functional class IV heart failure.

A French exercise risk assessment for patients with ischaemic heart disease, a third of whom had chronic heart failure, showed that the risk of a serious cardiac complication was one per 50,000 hours of exercise. The risk has been found to be slightly higher during unsupervised exercise compared to exercise in a hospital setting, which is probably due to higher training intensity when unsupervised. This is why the Danish Cardiology Society recommends exercising at a moderate intensity corresponding to no more than 80 per cent of maximum oxygen uptake. The average intensity during football games has been shown to be around 70 per cent of maximum oxygen uptake, with short-term intense actions.

Insecurity when exercising – shortness of breath, palpitations and increased heart rate

About five litres of blood is pumped around at rest, while up to five to seven times as much blood can be pumped during strenuous work. How much blood the heart is able to pump per minute depends on the pulse rate (how many times per minute the heart beats) and the stroke volume (how much blood is pumped per beat). When you go from resting to physical activity, such as walking, running or football, you can feel your pulse rate increase, meaning your heart is beating faster. But stroke volume increases even at lower intensities, so the heart also pumps more blood per beat. When playing football, the intensity is constantly changing between walking, fast running, standing

still, jogging, etc., which causes frequent changes in heart rate and breathing, which can quickly lead to breathlessness. The heart beats harder, and you may feel palpitations. This is completely normal and nothing to worry about.

Some people with cardiovascular disease are nervous about the extent to which they can be physically active. That is why it is important for such people to get started quickly with an activity such as football. It is important for the coach to allow players the space to test their limits and step out of the game if needed, giving them time to adjust to playing, experience breathlessness and become comfortable with an elevated heart rate. The coach may possibly facilitate a switch to goalkeeper, where the player is involved but to a lesser extent. Some players with heart conditions may use nitroglycerin, either as an inhaler spray or a sublingual tablet, during training or intense physical activity. Nitroglycerin can be taken to treat or prevent angina and acts quickly to relieve symptoms.

SAFETY

There are a number of precautions that should be observed when training Football for the Heart teams:

- ✓ **The coach must be familiar with cardiac massage, artificial respiration (mouth-to-mouth) and how to use a defibrillator.**
- ✓ **A defibrillator must be available in the immediate vicinity of the training facilities.**
- ✓ **There should also be access to a telephone so that the emergency call centre can be reached in an emergency.**
- ✓ **The coach should be very familiar with the symptoms of heart problems.**

TRAINING THE FOOTBALL FOR THE HEART PLAYERS

As described earlier in this course material, football training offers a number of highly beneficial effects on both cardiovascular health and overall well-being. Since most cardiovascular diseases are associated with age and so typically affect middle-aged and older people, the primary age group for Football for the Heart will be middle-aged and older people.

As some cardiovascular diseases are congenital and other factors such as obesity, smoking and physical inactivity are also significant risk factors for cardiovascular disease, younger participants can certainly benefit from Football for the Heart as well. As mentioned above, cardiovascular disease affects both genders; with men being at greater risk than women until the age of 60, after which the gender gap closes. In fact, the lifetime risk of cardiovascular disease is higher for women than for men. This is why the Football for the Heart training is specially adapted for older people who typically have lower muscle mass, poorer balance and lower fitness levels, in addition to cardiovascular disease. Typically, people with conditions such as obesity, type 2 diabetes and other chronic conditions will also be involved.

Balance between skill and challenge
It is important for players to leave training sessions with a sense of achievement, as this boosts self-confidence and helps ensure the player keeps turning up to sessions. A sense of enjoyment in movement provides powerful motivation, encouraging players to keep participating. There is no guarantee that only former football players will take part in Football for the Heart. Many people, particularly retirees, take on new interests and challenges to fill the many hours freed up by leaving the workforce.

Football for the Heart has space for both beginners and experienced players, which places additional demands on the coach. Former football players can be an excellent resource for introducing newcomers to the joys of the game. Coaches should alternate between pairing experienced and inexperienced players together and organising training by skill level. This allows participants to sometimes work with others at a similar level, whether high or low.

Cognitive function
Although it is possible to learn new skills throughout life, older adults may find it more challenging to understand overly detailed instructions. Cardiovascular disease can further impair cognitive function, while physical exercise has been shown to improve it. Likewise, older participants may also have difficulty remembering information or instructions given during previous sessions. The age-related difference in learning ability often depends on the time available for learning. Providing opportunities for participants to learn at their own pace creates the best chances of success. So make sure you keep training and exercises simple. Offer brief instructions and then start the activity. Then you can modify and customise the exercise and slowly build on it.

Also demonstrate the exercise when explaining it, or immediately afterwards. However, be aware that some participants may have hearing loss. This can make outdoor activities particularly difficult due to wind and other background noise. You should speak loudly and clearly, and address participants directly. It is essential to capture participants' full attention when giving explanations or demonstrating exercises. But avoid overloading participants with too much information all at once!

Individual differences
Just like any other target group, there will be differences between participants: both cognitively and functionally. As a coach, you should always be aware of individual needs and be ready to adapt the difficulty of the exercise. A useful tool for this is the game wheel, which you may remember from the Football Fitness basic training programme. However, you need to consider alternatives during the planning phase. The exercise descriptions will also include suggestions for variations.

For instance, if you work with new movement skills such as kicking, many people will typically progress well in the beginning, after which they will experience a plateau with no further development. The timing of this plateau will vary greatly from player to player. It is very natural for all age groups to plateau, but the plateau may continue a little longer in older people. The coach must be aware of this and provide support to players who may feel frustrated by a perceived lack of progress during these periods.

A recognising and inclusive approach
A positive attitude towards all players is really important. As a coach, it is important to give players feedback. Everyone should feel seen and acknowledged, regardless of their footballing ability. Focus on the positives. The coach should recognise a well-taken free kick, for example, and not just praise the goal scored afterwards. When giving feedback, the coach must be careful not to provide too much information at once. The amount of information should be limited when giving feedback, just like when giving instructions for an exercise. Also, take care not to talk all the time, as key points can get lost in a constant stream of words. You should also encourage participants to praise and support one another. This fosters camaraderie, which is ultimately what keeps players coming back and playing Football for the Heart.

The coach should play a crucial role in building this sense of community. Training should reflect the inclusive spirit of the programme, ensuring that all participants feel welcome, regardless of their footballing ability or functional level. That is why age restrictions, permanent skill divisions or other forms of exclusion commonly found in regular football training should be avoided. Consider whether training both genders together is the most ideal solution. For some women, training alongside men may present too much of a challenge if there is a significant gap in physical fitness and/or footballing skills. Training does not have to be divided by gender, but the coach should be aware of whether the training works best by dividing the team – possibly during specific parts of the training where physicality is important, such as during games.

How much impact should the disease have?
It is not the coach's primary responsibility to create opportunities for discussions about illness. Let each person decide whether they want to talk about their condition or their journey with the disease. A pat on the shoulder or a nod of acknowledgement will often be enough to make someone feel acknowledged and understood. For some, football can serve as a vital sanctuary where the physical limitations caused by their condition are momentarily set aside, allowing them to focus on the joy of playing and connecting with others. Training should, therefore, be a space free from the obligation to discuss personal health or feelings in a group setting. Players attend training to play football and enjoy that connection, not to feel like patients.

This is especially true for many men, who may not be particularly interested in discussing their health or illness during training. This does not mean they are indifferent to their condition or unwilling to share experiences, but these conversations are often more appropriate outside of training sessions and should not be something you spend time on during training time. Such discussions can take place naturally in the changing room or over a cup of coffee in the club rooms afterwards, when players feel ready to open up. But it is fine to encourage this by giving players a gentle nudge to socialise after training. This can provide an opportunity to talk about the impact of their condition and their treatment.

CHECKLIST FOR THE COACH

1. Always offer a warm welcome.
2. Everyone should feel acknowledged at every training session.
3. Adopt a playful approach to the exercises.
4. Do not include static strength exercises like the plank, where players hold the same position for any length of time.
5. Be aware that players' balance may possibly be impaired.
6. Be clear in your instructions, and avoid long explanations.
7. Remember that some people may have hearing loss.
8. Make sure the exercises progress in difficulty over time, but begin with simple ones.
9. It is important not to have too many different exercises in each training session.
10. Take care not to vary the training too much from session to session. It is useful to have recognisable exercises so that not everything is new.
11. Select exercises that are appropriate for the players in order to guarantee their success.
12. Recognise the positives of good passing, not just scoring.
13. Create a positive community around football training.
14. Create a space where players do not have to feel they are ill.

RECRUITMENT

The Danish Cardiology Society estimates that 50 to 80 per cent of all patients with ischaemic heart disease and chronic heart failure are suitable for a training programme, of whom 50 to 80 per cent are capable of maintaining participation. As mentioned earlier in this booklet, football has been shown to be particularly effective in keeping people active by fostering a sense of teamwork and community through training.

The report "Fysisk træning efter hjertekarsygdom – hvad oplever patienterne?" (Physical exercise after cardiovascular disease – what do patients experience?), published by the Danish Heart Foundation in 2010, concludes that cardiovascular patients want to get started with physical exercise quickly after being released from hospital. However, if the patient has participated in a training programme during their hospital stay, it can be challenging to maintain that momentum once the programme ends. DBU, SDU and the Danish Heart Foundation are stepping up efforts to raise awareness of the Football for the Heart programme. But you can also contact your local branch of the Danish Heart Foundation and call attention to what you are offering. They will certainly be happy to refer patients to Football for the Heart at your club. Reaching out to local medical clinics can also be beneficial, as experience shows that personal contact is by far the most effective recruitment method.

RECOMMENDATIONS

The following recommendations are made:

- ✓ **ensure regularity in training. Feel free to offer one-hour training sessions twice a week at set times.**
- ✓ **train all year round. If facilities are unavailable, consider alternatives that you can share instead, such as walks or other physical activities.**
- ✓ **be mindful of individual differences in physical ability. Make space for everyone and foster inclusion.**
- ✓ **play with a smaller and lighter ball, such as size 4.**
- ✓ **be mindful of cognitive impairments. Provide short, simple instructions.**
- ✓ **create a disease-free space where you can focus on football.**
- ✓ **social activities off the pitch. Provide opportunities for participants to share their experiences with illness and recovery at their own initiative.**

EXERCISE CATALOGUE

BUILDING UP TRAINING

A good Football for the Heart training session starts off with a welcome. The training is then structured with three elements:

1. Warm-up exercises
2. Exercises in pairs and small groups, e.g. technical exercises
3. Playing

Training should always include a 15 to 20-minute warm-up session (see further details and suggestions later on) and playing. The duration of the warm-up, exercises and play can be varied to suit the group's wishes.

Heart rate and activity levels increase the most during games, making this the time when the health benefits are at their peak. So do not be nervous about prioritising playing this is what motivates your players. Aim to spend at least a third of your training time playing games.

Welcome
It is important for players to feel acknowledged right from the start of training. The coach should be attentive right from the start of the training session, and it is a good idea to welcome players to each training session. Remember that new players may join the team on a regular basis, and that this requires an extra introduction for both the new player and the existing players on the team.

Of course, it is important for the coach to get to know the players' names quickly, thereby creating a sense of security for the players.

Warming up
For this target group, a thorough warm-up is especially important to prepare the body for playing football. During the warm-up, heart rate and breathing gradually increase to adapt to the upcoming physical demands during the game. This gradual progression helps prevent sudden spikes in cardiac load, which could otherwise result in angina, blood pressure fluctuations or rapid muscle fatigue. In rare cases, a sudden increase in cardiac load can lead to heart rhythm disturbances. That is why warming up, with a slow increase in intensity, is particularly important for this target group.

The warm-up also raises muscle temperature and "lubricates" joints, reducing the risk of injury during the quick and unexpected movements that occur in football games. A warm-up should last 15 to 20 minutes. A suggestion for a good warm-up programme is presented on the following pages. If you devise your own warm-up programme, bear in mind the following:

- Gradual progression – start slowly and increase intensity throughout the warm-up
- Focus on movements that involve the large muscle groups and central joints
- Work on mobility
- Include balance and strength
- Heart rate towards the end of the warm-up
- Short explanations – demonstrate actions/"follow me"
- Create a sense of community – include pair or group exercises

Categorisation of exercises
The exercises in this catalogue are divided into three intensity categories, allowing the coach to tailor the activities according to the target group's capabilities and needs:

A Exercises suitable for everyone. The exercises require only walking, no running. Light to moderate intensity.

B Exercises involving running, without or with light resistance. Collaborative team exercises or light competitive exercises without body contact. Moderate intensity.

C Running activities with challenges and multiple opponents. High intensity.

WARM-UP PROGRAMME

Running exercises – 8 minutes
The warm-up is organised by setting out two rows of cones (6 to 10 cones in each row), with 6 to 8 metres between rows and 4 to 6 metres between cones in each row.

Participants pair up, placing one person in each row. Each exercise is performed with a partner. After completing each exercise at a cone, both run along opposite sides of the cones to the back of their respective rows. Each exercise is done twice.

1. Calmly run past all the cones, staying in sync with your partner.
2. Jog forward. At each cone, lift one leg until the thigh is horizontal, then move the lifted bent leg as far outwards as possible. The leg is then lowered and the pairs jog on to the next cone, where the opposite leg is lifted and moved outwards.
3. Similar to exercise 2, but moving the leg from the outside in. Jog forward. At each cone, lift one leg until the thigh is horizontal, then move the knee as far outwards as possible. The leg is then lowered and the pairs jog on to the next cone, where the opposite leg is lifted.
4. Jog to the cone, then sidestep towards the centre, round your partner and sidestep back to the cone. Then jog to the next cone and repeat the exercise.
5. Jog forward to the cone and sidestep from there towards the centre, meeting your partner with light shoulder contact – either by both standing on the ground, or both jumping slightly before contact. Sidestep back to the cone and jog to the next cone, where the exercise is repeated.
6. Run slightly faster to the second cone ahead. Brake at the cone and jog backwards to the cone you just passed. Repeat by running forwards two cones at a faster pace, one cone backwards and so on until all cones are completed.

Strength, jumping and balance exercises – 5 minutes
- Do 2 x 6 squats.
- Walk forwards with long strides, 2 x 6 lunges on each leg.
- Stand on both feet, then tilt up and stand on tiptoe before slowly lowering back down – 5 times in total.
- Perform 10 jumps on the spot.
- Jump back and forth 5 times (10 jumps in total).
- Jump sideways to the right and back to the left 5 times (10 jumps in total).
- Stand on one leg (30 seconds on each) and throw the ball to your partner.

Running exercises – 2 minutes
- Run twice across the pitch, increasing your pace.
- Run slalom twice across the pitch, increasing your pace.
- Jog halfway across the pitch, then run as fast as possible the rest of the way. Turn around and do the same on the way back.

Variation
The warm-up can be varied with the FIFA 11+ exercises from the Football Fitness base material.

BALANCE EXERCISES

Playing football is excellent for balance training. However, poor balance and fear of falling present older participants with significant challenges, making balance exercises a valuable addition to warm-ups or standalone elements in training sessions. Balance is closely related to strength – especially in the leg muscles. A few suggestions for balance exercises that can easily be included in a warm-up are presented below.

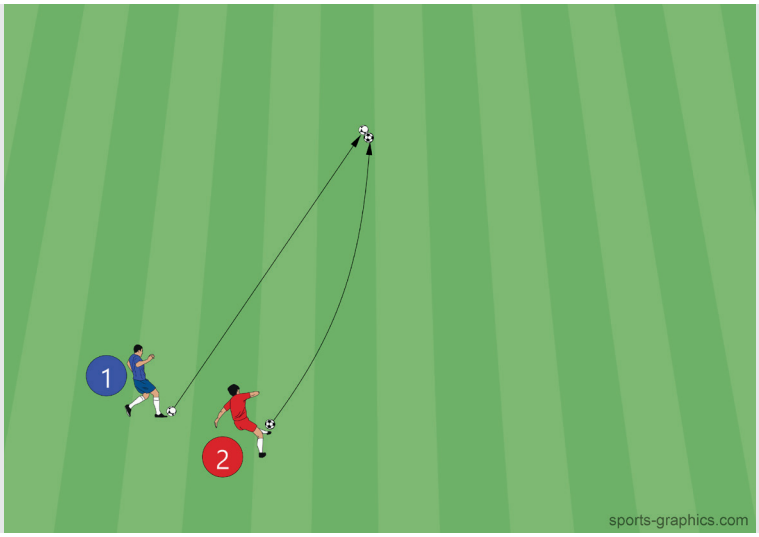
1. Step forward. Turn your head and look diagonally back over your shoulder while continuing forwards. This exercise can be made more difficult by walking with high knee lifts or speeding up.
2. Walk forward and balance on the lines on the pitch. If necessary, increase the speed to match the players' level. This exercise can also be done by walking backwards at a slow pace.
3. Walk forwards holding a ball. Throw the ball into the air, to one side, then catch it again. The player then switches sides and throws the ball to the other side while moving forwards. The exercise can be made more difficult by increasing the pace and/or throwing the ball higher.
4. Stand with your feet shoulder width apart. Straighten your body and tighten your abdomen slightly. Slowly raise up onto tiptoe and then back down again. Repeat this 10 times at a slow pace. Make sure to keep your ankles aligned with your feet so that they do not fall out to the side. The exercise can be made more difficult by closing your eyes for all or part of the exercise.
5. Stand with your feet shoulder width apart. Slowly raise up onto tiptoe, bend your knees to a 90-degree angle (or as low as you can), then straighten your knees and lower your heels. Try to keep your heels lifted throughout the exercise. Repeat this 5 to 10 times at a slow pace. Can be made more difficult by closing your eyes for all or part of the exercise.
6. Stand with your feet shoulder width apart. Try to touch the ground without bending your legs by leaning your upper body forwards, then straighten back up. Hold a ball between your hands if you like.
7. The most capable players can do the above exercises on one leg. The less capable players may need something to grab onto. This could be a fence, the barrier around the pitch or a partner – they can take turns doing the exercise.
8. Stand on one leg for 1 minute, then switch legs. If you like, bring the lifted leg up so that the thigh is horizontal. Can be made more difficult by turning your head from side to side or closing your eyes.
9. Stand on your left leg. Bring your right knee up to meet your left elbow in front of your body. Slowly lower your right leg. Then switch sides and stand on your right leg, lifting your left knee to your right elbow. Repeat 5 times.
10. Stand on your left leg. Extend your right leg as far forwards as possible without losing your balance. Touch the ground lightly with the toes of your right foot before bringing your leg back. Then move your right leg as far out to the right as possible, briefly touching the ground with the toes of your right foot before bringing your leg back again. You can also do this backwards and to the left. Towards your left side, cross your right leg behind your left leg. It is fine to bend the standing leg slightly when bringing the leg out to either side or forwards/backwards. Repeat with the other leg.

TECHNICAL EXERCISES

Many players want to increase their skill level. Players can improve their ball skills and technical level by doing technical exercises. Classic football guides often provide detailed descriptions of how to move the body correctly in order to perform skills correctly. Knowing how a movement is performed can help coaches. However, you need to be aware of what the purpose of the exercise is and what the player wants to achieve. The most important thing is to create great experiences by devising exercises that are appropriately challenging yet achievable. That is why it is important for the difficulty of the exercises to suit the participants.

A

Clink



Purpose
To practise kicking skills and precision. Competition. Low-intensity movement.

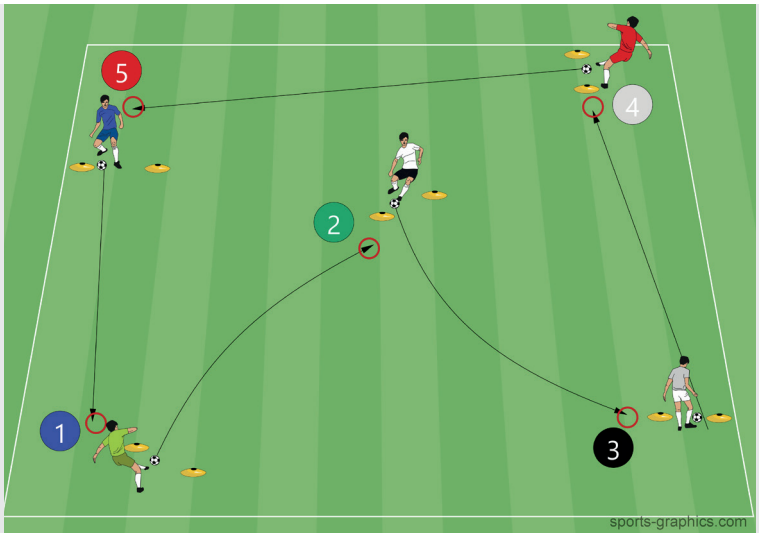
Props
1 ball per player.

Description
Pair up two players, each with their own ball. One of them kicks their ball first, followed by the other player. The goal is to hit the other person's ball with your ball. When the ball is hit, you start again and the players can agree to play for a set time or a specific number of points. Whoever scores a point starts in the next round.

Variation
- Players may be required to kick in a certain way, or to kick with both legs alternately, or only with the "bad" leg, etc.
- You can let each player take 2 kicks per turn.

A

Football golf



Purpose
To practise kicking skills and precision. Competition. Low-intensity movement.

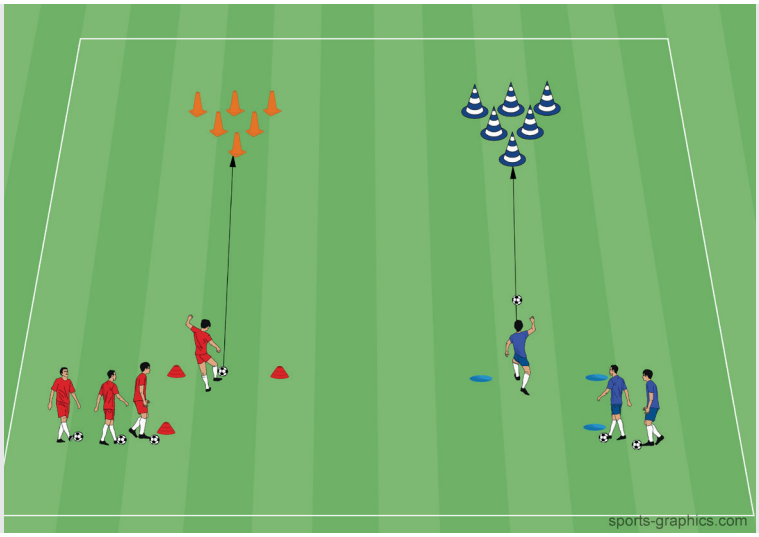
Props
1 ball per player. Flat markers, or possibly hula hoops.

Description
Pair up two (or more) players, each with their own ball. Starting from the tee mark, players aim to get their ball into the “hole” in the fewest strokes/kicks possible, similar to real golf. The “hole” can be marked out with hula hoops, or simply with a ring of flat markers or similar. A suitable number of holes are set up, and various obstacles can be incorporated if so desired.

Variation
Players may be required to kick in a certain way, or to kick with both legs alternately, or only with the “bad” leg, etc.

A

Football bowling



Purpose
To practise kicking skills and precision. Competition. Low-intensity movement.

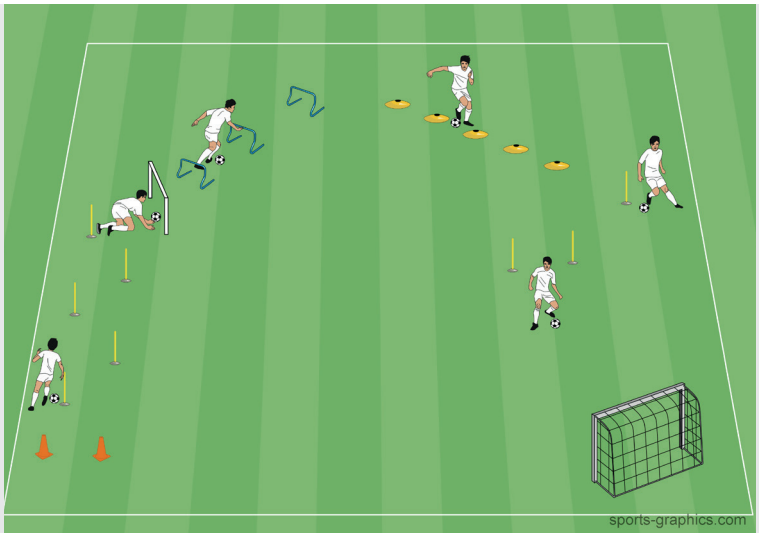
Props
Balls. Cones. Flat markers.

Description
Set up cones in a formation similar to bowling pins and mark a kicking spot at an appropriate distance. Players take turns kicking.
Each player gets two attempts to knock over all the cones. Points are tallied over a set number of rounds, e.g. 10 rounds.

Variation
- Players may be required to kick in a certain way, or to kick with both legs alternately, or only with the "bad" leg, etc.
- You can let each player take 2 kicks per turn.
- The intensity can easily be increased by setting up a cone that players have to move/run around, for example, before they can take another kick. For groups with varying physical abilities, adjust the activity by having fitter players run around cones while others remain stationary or run shorter distances.

B

Dribbling course



Purpose
Versatile movement, ball control.

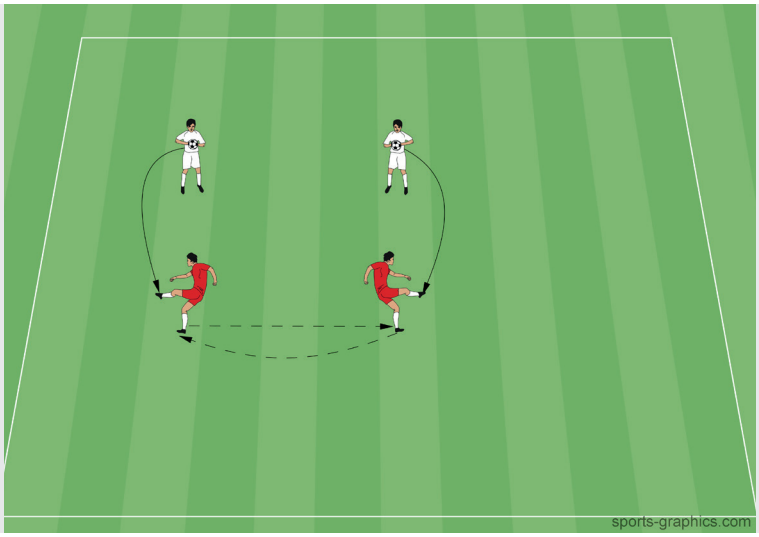
Props
1 ball per player. Cones, poles, flags, hurdles, goals, etc.

Description
A dribbling course is set up using various obstacles – the sky's the limit. Players now have to take turns trying to complete the course. Start players at appropriate intervals to avoid congestion or collisions.

Variation
- Incorporate specific dribbling requirements, such as using a particular foot or a specific part of the foot in different sections of the course.
- Set up two identical courses and let players compete against each other.

B

Technical training in pairs



Purpose
To practise better ball control. Movement with moderate intensity.

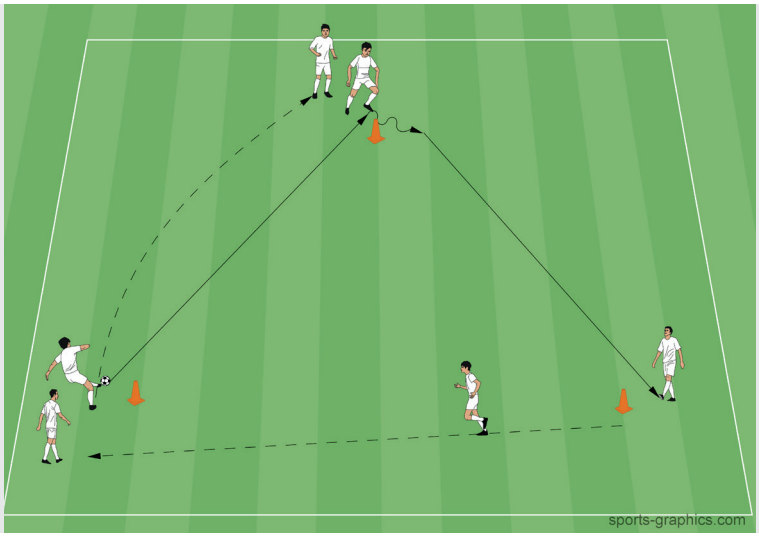
Props
1 ball for every 2 players.

Description
Players form pairs, with one ball per pair. Two pairs group together. Each pair stands 2 to 3 metres apart, and the partner pair stands 3 to 4 metres to the side. In each group now has 2 players who each have a ball, and 2 without. The two players who have a ball throw the ball to the two without, who return it using techniques like an inside-foot pass, for example, after which they swap places and receive the next throw from the opposite "server".
They continue for 30 to 45 seconds until switching roles. Players can alternate between throws and ground passes, and all kinds of techniques for returning the ball. Players can return the ball on the first touch, striking the ball with the inside of the foot, instep, outside, knee/thigh, chest, shoulder or head. Players can return the ball on the second touch after a first touch, striking the ball with the inside of the foot, instep, outside, knee/thigh, chest, shoulder or head.

Variation
The tasks and the length of work periods can be adjusted as needed.

B

The Ajax triangle passing drill



Purpose
To practise accuracy in passing and ball control in receiving. Movement with moderate intensity.

Props
1 ball. 3 cones/flat markers.

Description
Create a triangle with sides about 10 to 12 metres long. Place 1 to 3 players behind each cone. The ball starts at the cone with the most players. The front player now passes to the front player at the next cone and runs with the direction of the ball to the back of the queue at the next cone. The receiver makes a first touch before then passing to the player at the next cone and running with the direction of the ball.

Variation
- Incorporate requirements for both receiving and delivering the ball, such as deciding which leg or which part of the foot should be used.
- The direction can be changed, and you can try playing with first-time passes.


adidas
PUMA

PLAYING

Playing football is a excellent all-round exercise that effectively stimulates improvements in cardiovascular, musculoskeletal and metabolic fitness. Playing football, scoring goals and experiencing the sense of community built through teamwork make football highly motivating. That is why playing should take up at least a third of each session. To optimise gameplay, it is important not to overcrowd the pitch. Playing five a side will typically be appropriate. This allows for plenty of ball touches while still providing enough players on the pitch to maintain the flow of the game without requiring constant readiness.

The size of the pitch should be adapted to the participants. A larger pitch provides ample space for fast runs and counter-attacks, giving players more time to control the ball. However, it may also lead to players moving more slowly with the ball and having fewer goal-scoring opportunities due to the increased distance between goals.

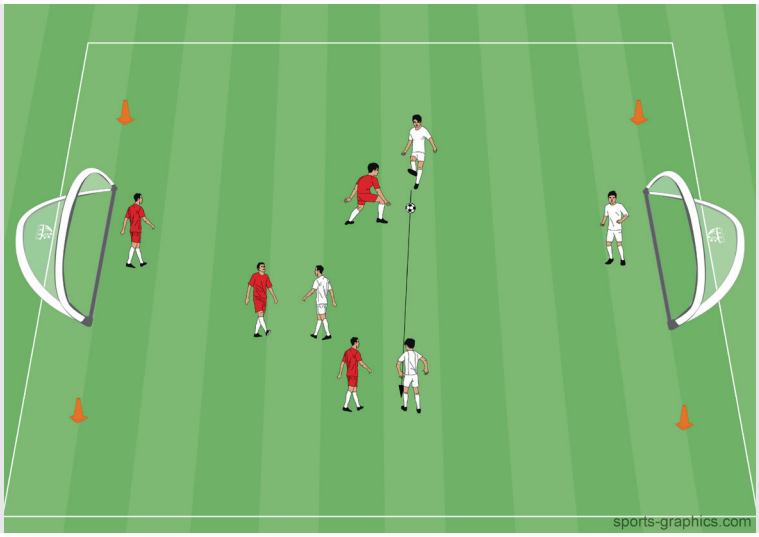
If the pitch is too small, the ball will often go out and stop play. A small pitch keeps players closer together and so there will always be an opponent close by, creating pressure on the ball. This can make it hard to control the ball, especially for beginners. There is no room for sprinting, so players will primarily move with short bursts of acceleration and deceleration to create space to receive the ball.

Finding the right pitch size requires experimentation to suit the group's skill level and the specific game being played. You may often find you have an odd number of players at training sessions. In this case, you can add a joker element to your games. With this, you have one player (who wears a different coloured shirt) who always plays for the team in possession of the ball. Do not be afraid make adjustments during gameplay and use the game wheel from the Football Fitness programme.

Figure 2 *The game wheel.*

B

Walking football



Purpose
Playing. Competition. Overview. Low to moderate-intensity movement.

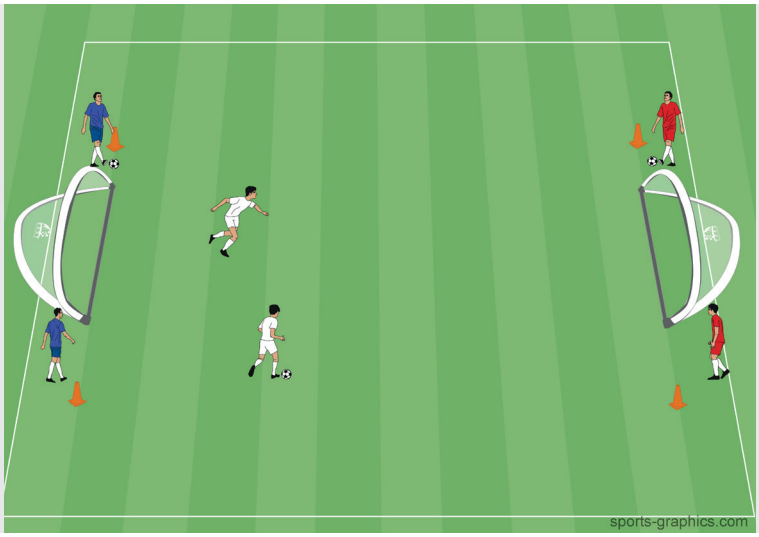
Props
2 goals per pitch (or 4 cones). At least 1 ball – preferably a futsal ball that does not bounce too much. Training bibs. Delineation of the pitch, where necessary – lines or flat markers.

Description
Walking football can be used for participants who, for various reasons, cannot take part in regular football. Running is not permitted, which slows down the pace of the game. Additionally, players are not allowed to kick or pass the ball above hip or head height. That is why playing with a futsal ball is recommended, as it is slightly smaller and does not bounce as much as a regular football. Hard tackles are also prohibited. Since goals cannot be scored above hip height, the goals should be wide and low. Regular 5-a-side or 8-a-side goals can be used, or else you can play with cone goals. When playing within a marked area, throw-ins are replaced by kick-ins.

Variation
Most other games can be played as walking football. The games are played as stated, with the added restriction that running is not allowed.

B

2 vs 0



Purpose
To score lots of goals. Interaction. To control the ball while moving at different speeds.

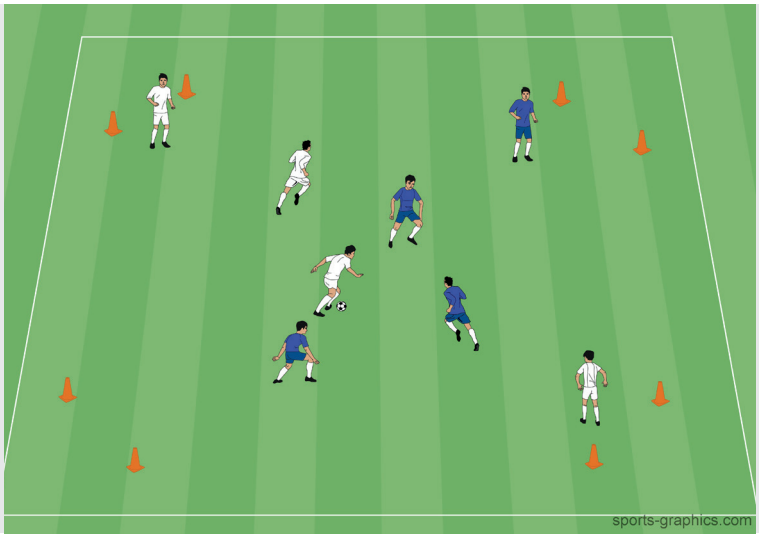
Props
2 goals per pitch. 1 ball per pair. Flat markers for marking the pitch.

Description
Set up 2 goals at either end of a pitch. Use a 3-a-side pitch if necessary. Players are paired up, with one ball per pair. 2 pairs stand near the goal but off the pitch at one end, and 1 pair stands up at the other end. At the end with two pairs, one pair starts by passing the ball to each other as they move towards the opposite goal and take a shot at the goal. When the shot is taken, the team standing beside the goal where the shot has just been taken starts to move. The exercise continues along the same lines.

Variation
- You can start off by requiring 5 passes before taking a shot. If a pair score, you can reduce the number of passes they are required to make for the next turn. If they fail to score, you can add a pass.
- If there are fewer or more players, all pairs on the pitch can attack in the same direction. They then attack in the opposite direction. Ensure that breaks between attacks are tailored to maintain an elevated heart rate, but avoid long rest periods that lower the heart rate. But also avoid overly short breaks that make the exercise too physically demanding to sustain over the scheduled time.

C

4-a-side with diagonal goals



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

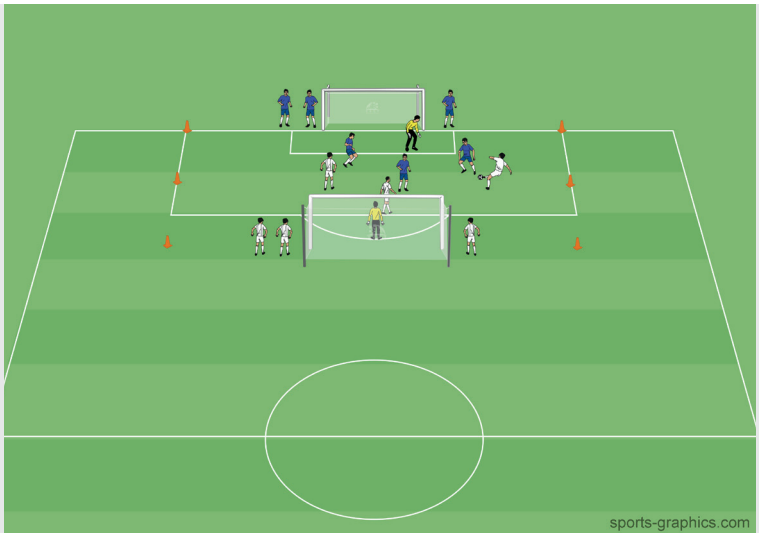
Props
1 ball. 4 small goals or 8 large cones for goals. 4 bibs. Flat markers for marking the pitch.

Description
A pitch is marked out, with goals in each corner facing the centre of the pitch. One team defends the two goals diagonally opposite, while the other team defends the other two goals. Players can score in two opposite corners of the pitch while defending the other two corners, which requires plenty of overview and cooperation.

Variation
Set a limit on the number of touches each player is allowed. The pitch can be made bigger/smaller.

C

Interval games



Purpose:
Battle. Competition. High-intensity movement.

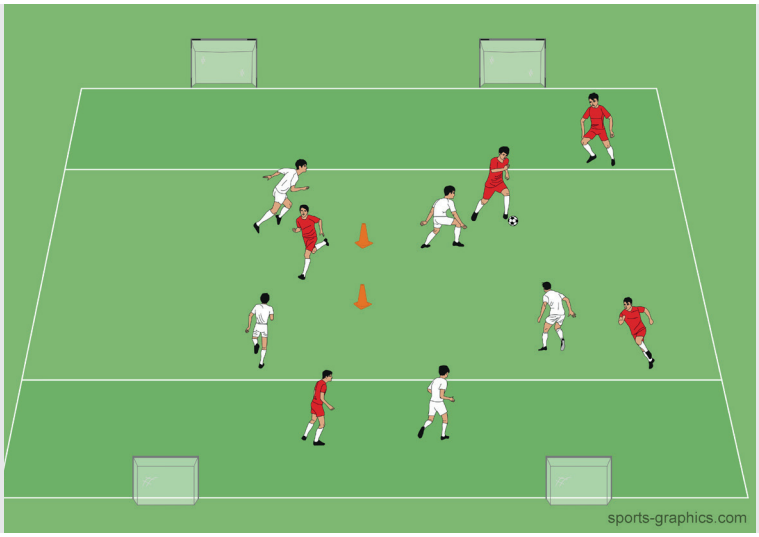
Props
2 goals. Bibs for half of the players. Lots of balls. Flat markers for marking the pitch.

Description
A relatively small pitch is set up with 2 large goals. The players are divided into 2 teams, each divided into 2 equal groups. One group plays on the pitch, while the other group has a break. When a goal is scored, the scoring team starts with a new ball. The players swap places after 1 to 1½ minutes and play for 2 x 3 periods for each group, for example.

Variation
The periods can be varied, as can the pitch size.

C

5-a-side with 5 small goals



Purpose
Playing. Competition. Movement with relatively high intensity.

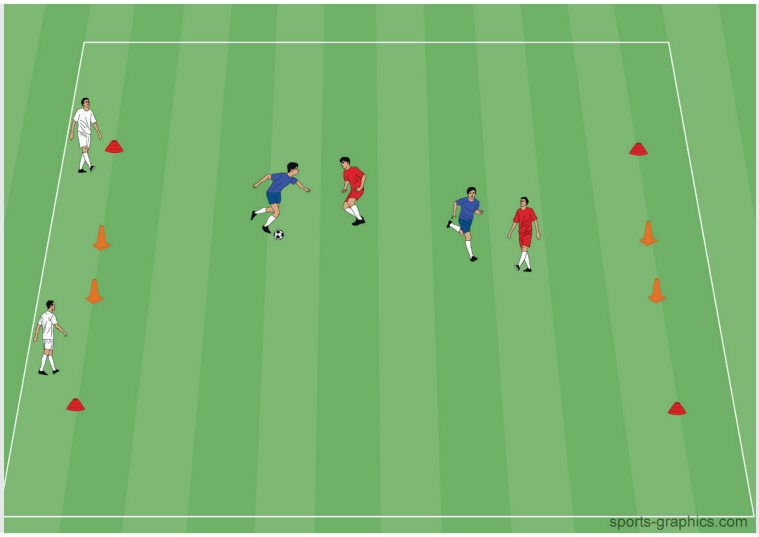
Props
1 ball. Cones/flat markers to mark the pitch. 5 bibs. 4 small goals and 2 large cones (or 10 large cones) for goals.

Description
Set up a pitch with 2 small goals at either end and a cone goal across the middle of the pitch. Each team defends the 2 goals at their own end, while the centre goal is shared.

Variation
Set a limit on the number of touches each player is allowed. The pitch can be made bigger/smaller.

C

2 vs 2 vs 2



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

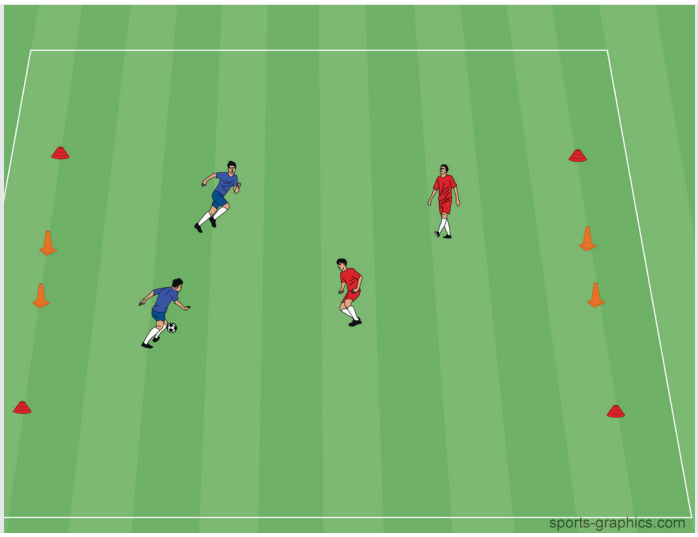
Props
1 ball. 4 large cones for goals. 2 x 2 bibs. Flat markers for marking the pitch.

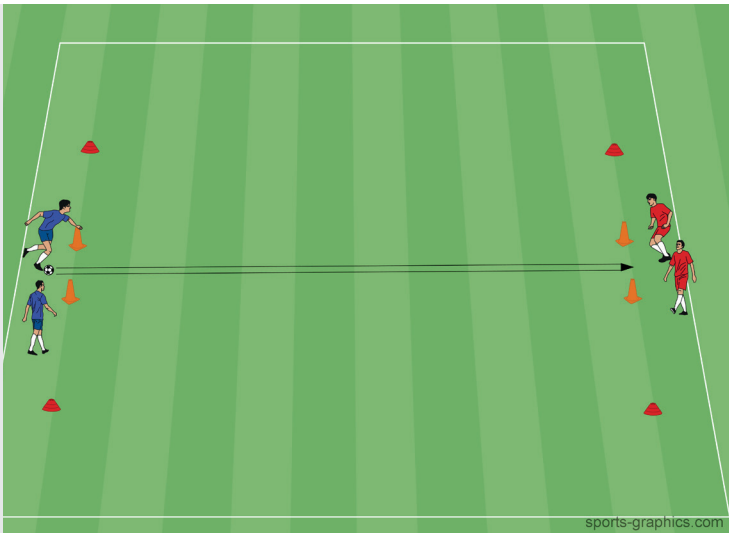
Description
A pitch 15 metres long and 10 metres wide is set up, with cones 1.5 metres apart at the ends. Two pairs play on the pitch at a time, while the third pair waits off the pitch. Goals can only be scored below knee height. When a team concedes a goal, they leave the pitch and are replaced by the waiting team. If the same team remains on the pitch for three consecutive battles, a 1–2 minute break is taken before the other two teams start the next round.

Variation
Instead of the conceding team leaving the pitch, the scoring team can leave and allow the waiting team to take over.

C

2-a-side – playing and precision kicking





Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

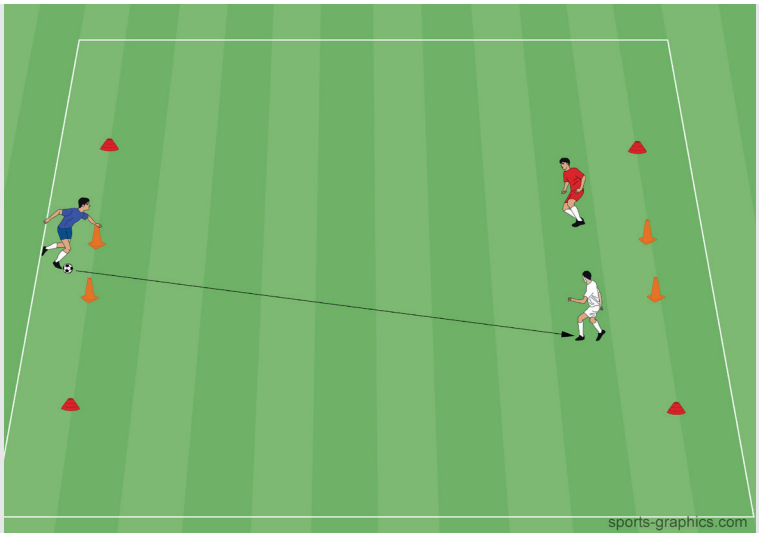
Props
1 ball. 4 large cones for goals. 2 training bibs. Flat markers for marking the pitch. Multiple pitches can be set up next to each other.

Description
As with 2 vs 2 vs 2, a pitch 15 metres long and 10 metres wide is set up, with cones 1.5 metres apart at the ends. Two pairs play against each other on the pitch. Goals can only be scored below knee height. The game is played 2 vs 2 for 1 minute, after which the players practise precision kicking for 1 minute. Precision kicks are taken from the player's own goal line, with the objective of kicking the ball into the opponent's goal. All players are off the pitch, so no one can defend the goals. Resume 2 vs 2 play after 1 minute of precision kicks. Alternate between gameplay and precision kicks for an appropriate number of rounds.

Variation
Specific requirements can be established for how precision kicks are executed.

C

2 vs 1



Purpose
Interaction. Competition. Overview. Movement with relatively high intensity.

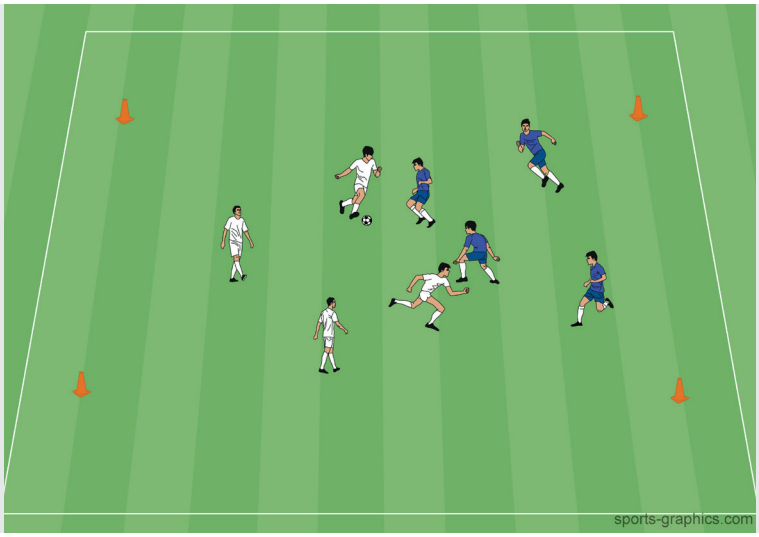
Props
1 ball. 4 large cones for goals. Flat markers for marking the pitch.

Description
An order is agreed: first, player 1 plays against players 2 and 3. Then 2 plays against 3 and 1, and finally 3 plays against 2 and 1 before a new round begins. Player 1 stands behind their own goal line and passes the ball over to their opponents (players 2 and 3), who get a chance to score. Player 2 then runs out and retrieves the ball, while players 1 and 3 run to the opposite end. Player 2 then passes the ball to players 1 and 3, who try to score against player 2; and the game then continues with player 3 against players 1 and 2, and so on.

Variation
Specific requirements can be established for the number of passes the two players have to make before taking a shot.

C

Scoring on the goal line



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

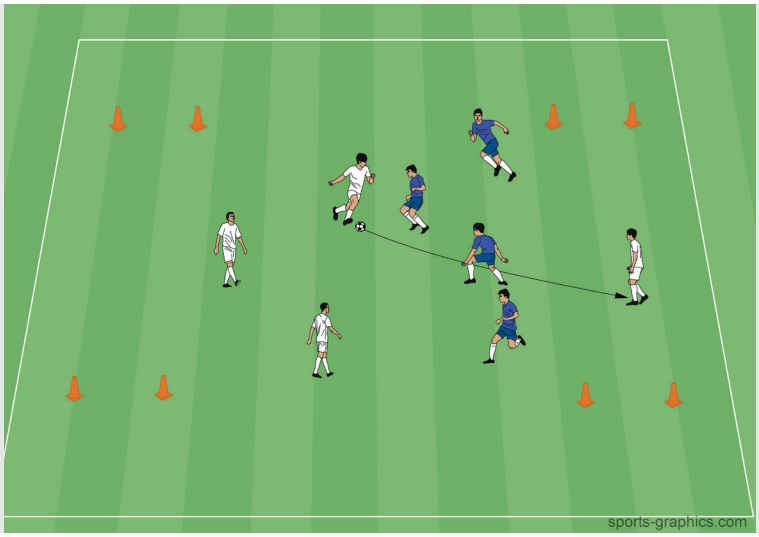
Props
1 ball. 4 training bibs. 4 flat markers for marking the pitch.

Description
The game is played 4 vs 4 on a pitch 25 to 30 x 15 to 20 metres in size. Goals are scored by dribbling the ball over the goal line. Players can score across the entire width of the goal line.

Variation
Scoring by placing the ball dead on the goal line. However, stepping on the ball to stop it can make it easier for players to lose their balance. For this reason, this variation should only be used with younger players who do not have balance issues or weaker bones.

C

End zone



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

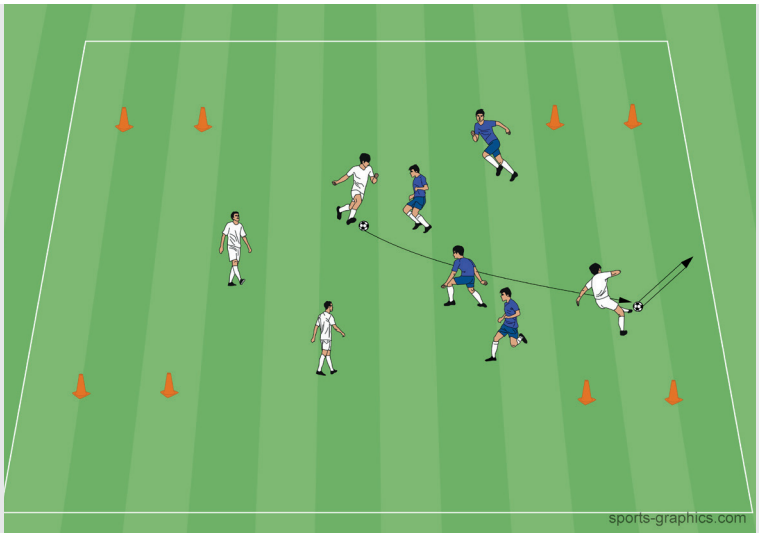
Props
1 ball. 4 training bibs. 8 flat markers for marking the pitch.

Description
The game is played 4 vs 4 on a pitch 30 x 20 metres in size. At each end, an end zone is created about 5 metres inside the pitch, so the pitch consists of a total of 5 metres of end zone, 20 metres of centre area and another 5 metres of end zone. Players score by passing the ball to a teammate in an end zone. Everyone can move into the end zones.

Variation
- You can make things a bit easier by only allowing attacking teams to run into the end zone.
- You can define a time limit for how long an attacker can remain in the end zone before having to return to the centre area.
- One variation could involve requiring the ball to be passed back to a teammate in the centre area from the end zone before the goal is counted.

C

End zone with goal line



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

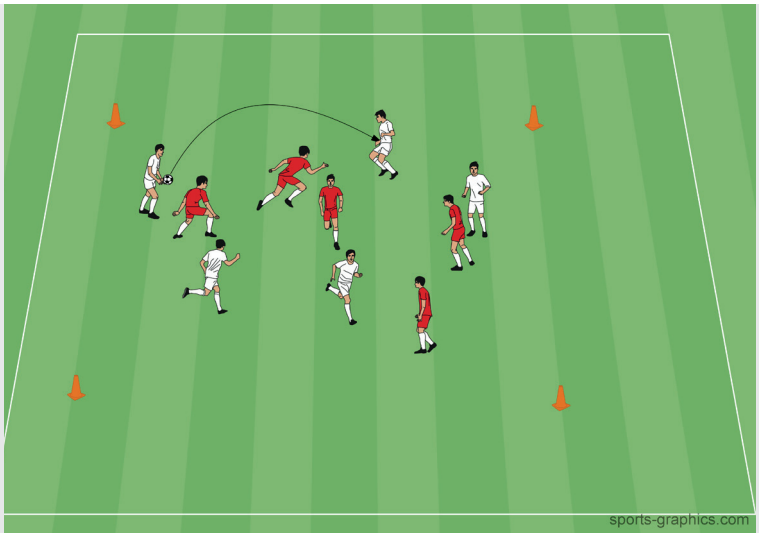
Props
1 ball. 4 training bibs. 8 flat markers for marking the pitch.

Description
The game is played 4 vs 4 on a pitch 30 x 20 metres in size, or 3 vs 3 on a pitch 25 x 15 metres in size. At each end, an end zone is created about 5 metres inside the pitch, so the pitch consists of a total of 5 metres of end zone, 20 metres of playing area (15 metres for 3 vs 3) and another 5 metres of end zone. Goals are scored by playing the ball over the goal line. Goals can only be scored from the end zone, ensuring that goals are taken from a short distance. All players have to move around the pitch. Goals are scored with the ball kept on the ground, e.g. below knee height.

Variation
- You can make this harder by limiting the number of touches per player.
- You can also add a rule stating that players can only score over the goal line if they receive the ball in the end zone from a pass from the centre area.

C

Partyball



Purpose
Playing. Competition. Overview. Movement with relatively high intensity.

Props
1 ball. Training bibs for one team. 4 flat markers for marking the pitch.

Description
A pitch is set up to suit the number of participants. The ball is passed between players on the same team, with the objective of preventing the opposing team from gaining possession. Players are limited to one step while holding the ball, and dribbling is not allowed. Body contact is not allowed.

Variation
- You can count the number of passes and award 1 point every time a team reaches 10 or 20 consecutive passes. After scoring, the ball can be passed to the other team.
- Rules can be introduced stating that passes must remain below head height, or that they have to be bounce passes (where the ball is thrown to the ground before the other player has to take it). You can also allow players to play with their feet, which is slightly harder.

FURTHER INFORMATION

Much more information is available on the following websites:

- **www.dbu.dk/fodbold-for-hjertet**
- **www.hjerteforeningen.dk**

Hjertelinjen – advice over the phone:

- **If you have any questions, the Danish Heart Foundation's advisors are ready to help. Just phone +45 70 25 00 00 00 between 9am and 4pm on weekdays.**

APPENDIX

FOOTBALL IS MEDICINE

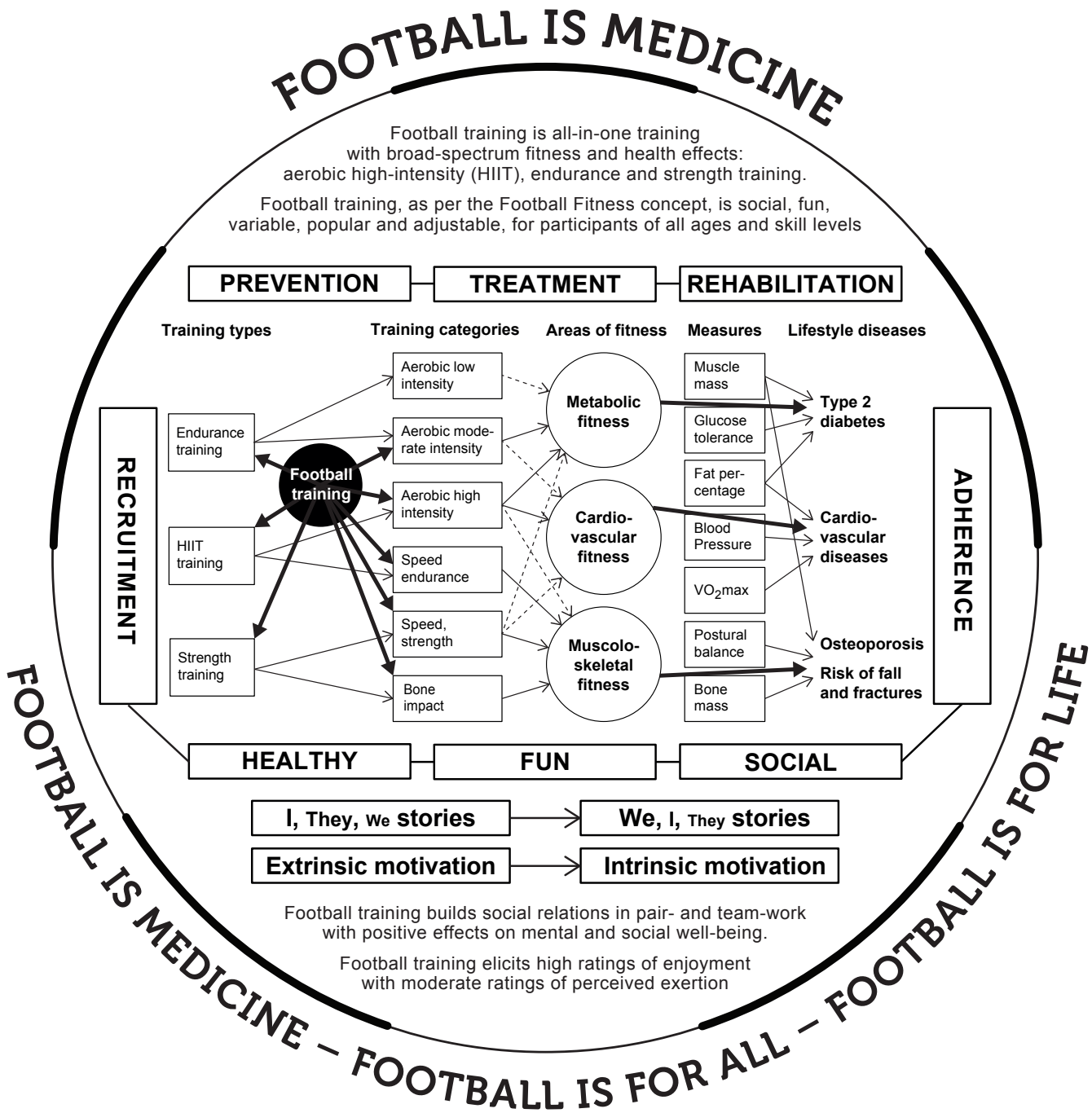


Figure 3 *A holistic model describing the physiological and psychosocial effects of Football Fitness. The model shows training effects on fitness and health variables, the relationship between Football Fitness training and cardiovascular, metabolic and musculoskeletal health, as well as acute and long-term psychosocial effects that influence maintenance of a physically active lifestyle. Krustrup and Krustrup, 2018.*

THE CIRCULATORY SYSTEM

The circulatory system connects the body's organs and muscles so that nutrients, oxygen and waste products can be transported around the body. The heart is the pump that pushes blood around the tubes in the body, so it is vital to the functioning of the circulatory system. Besides the heart and blood vessels, the circulatory system also consists of the lymphatic system, whose purpose is to drain fluid back into the circulation. However, this is disregarded in this material. The circulatory system can be divided into the pulmonary circulation (small circulation) and the systemic circulation (large circulation).

The pulmonary circulation
The pulmonary circulation starts from the right ventricle, where deoxygenated blood is pumped into the pulmonary artery, which distributes it to the two lungs. In the lungs, the blood flows into a fine network of small blood vessels (arterioles and capillaries) that lie close to the tiny air sacs (alveoli). Here, the blood absorbs oxygen from the air in the lungs and releases carbon dioxide (CO_2), which is expelled from the body by means of exhalation.

Once the blood is oxygenated, it is collected in the pulmonary veins and flows into the left atrium of the heart, then into the left ventricle, from where it is pumped into the systemic circulation.

The systemic circulation
The systemic circulation starts in the left ventricle, where the heart pumps oxygen-rich blood into the main artery (aorta). From there, the blood flows through progressively smaller vessels until it reaches the capillaries, where thin vessel walls allow the exchange of oxygen, nutrients and waste products with the surrounding cells. From there, the blood returns to the heart through small vessels that merge into vessels of increasing size (venules and veins), ultimately reaching the right atrium.

The purpose of the pulmonary circulation is to oxygenate the blood and remove carbon dioxide, while the systemic circulation delivers oxygen and nutrients to organs and muscles and removes waste products. Though interconnected, the two circulations function as two separate systems originating from the heart.

The heart

The function of the heart is to pump blood around the body. The heart is a muscle that pushes blood around the two circulations when it contracts. Hence the heart is divided into a right side that supplies the pulmonary circulation and a left side that supplies the systemic circulation. Each half is divided into an atrium and a ventricle. There are two heart valves – one on either side – between the atrium and the ventricle, and there are heart valves between the ventricles and the aorta and pulmonary artery respectively. The heart valves ensure that blood can only flow in one direction.

Contraction of the heart is controlled by the autonomic nervous system. As the name suggests, the autonomic nervous system works autonomously – that is, without you having to think about it. The signal that causes the heart to contract starts in the right atrium and propagates through the left atrium to the AV node, which causes the atria to contract and push blood into the ventricles. From the AV node, the electrical signal travels to the two chambers of the heart, which contract and push blood out into the two circulations. An automatic electrical signal is sent to the heart's muscle cells approximately once a second during rest. Although this is completely automatic in a healthy heart, the contraction of the heart can also be influenced by hormones, and by nerve cells from the brain.

When the heart is drained of blood after the contraction, the heart muscle relaxes and new blood is sucked back into the heart. The phase where the heart contracts and pushes blood out into the circulatory system is known as systole, while the phase where the heart fills with blood is known as diastole. In terms of time, systole is about half as long as diastole. The pressure wave created when the heart contracts in systole propagates through the blood vessels and can be felt as a pulse at the wrists or neck. This represents the upper value in the medical blood pressure reading, known as the systolic blood pressure. The lower value of the blood pressure reading is the diastolic blood pressure, which is the pressure when the heart relaxes and fills with blood. Blood vessel pressure fluctuates during the cardiac cycle as a result, peaking during systole and reaching its lowest point during diastole. The walls of the blood vessels (arteries) are elastic, which causes pressure differences to equalise, allowing blood to flow more smoothly.

For the heart to function, it also needs a functioning oxygen and nutrient supply itself. This is provided by the coronary arteries, which originate from the aorta – right at the start of the systemic circulation – and run along the outside of the heart, where they branch out to supply the entire heart muscle with nutrients and oxygen.

CARDIOVASCULAR DISEASES

High blood pressure (hypertension)
Blood pressure should be below 140/90 when measured at a doctor's surgery, while it should be below 135/85 when at home. Your blood pressure should be below 130/80 if you have diabetes, cardiovascular disease or kidney disease. Blood pressure changes throughout the day and increases with physical activity and stress. This is why blood pressure should be measured after five to ten minutes of rest while seated.

There is usually (in 95 to 99 per cent of all cases) no one cause of high blood pressure, but obesity, alcohol, smoking, physical inactivity, age and genetics all play a role. High blood pressure is often asymptomatic, but high blood pressure is associated with an increased risk of blood clots in the heart or brain, as well as brain haemorrhage.

High blood pressure is broken down into three levels (mmHg):

1.	Systolic blood pressure:	140-159
	Diastolic blood pressure:	90-99
2.	Systolic blood pressure:	160-179
	Diastolic blood pressure:	100-109
3.	Systolic blood pressure:	>180
	Diastolic blood pressure:	>120

When the systolic blood pressure is higher than 140 and the diastolic blood pressure is less than 90, this condition is referred to as isolated systolic hypertension, which is most commonly seen in older people where the arteries have become more rigid with age. As the vessel wall becomes more rigid and offers more resistance, the heart has to pump at a higher pressure to deliver the same amount of blood.

Heart failure (cardiac insufficiency)
If the heart is unable supply the body with enough oxygen-saturated blood, this is known as heart failure (cardiac insufficiency). Typical symptoms are shortness of breath, extreme fatigue and fluid retention in the body, especially the legs. There are two main types of heart failure, often referred to as systolic and diastolic heart failure. Formally, heart failure is classified into three categories: heart failure with reduced ejection fraction (HFrEF), heart failure with mildly reduced ejection fraction (HFmrEF), and heart failure with preserved ejection fraction (HFpEF). Systolic heart failure is typically caused by a weak heart muscle, which is often caused by a previous blood clot in the heart, where a calcified coronary artery closes and the affected part of the heart muscle ends up turning into scar tissue. Scar tissue is unable to contract, so the heart loses systolic pumping capacity. Diastolic heart failure, the second type of heart failure, is often caused by the heart muscle becoming thickened, stiff and inflexible, which can be caused by issues such as high blood pressure, obesity or diabetes. As a result, the heart muscle is less elastic and so does not fill properly with blood in diastole. Ultrasound scanning of the heart (echocardiography) is a crucial diagnostic tool in heart failure. It evaluates the systolic function of the left ventricle by measuring the ejection fraction (EF), which normally averages around 55 per cent.

Patients with heart failure are divided into four functional classes, namely New York Heart Association (NYHA) classes I to IV, where NYHA I is the group with the fewest limitations, who only experience symptoms of heart failure (shortness of breath, etc.) during strenuous physical activity, while NYHA class IV patients experience symptoms even at rest.

Atherosclerosis and blood clots in the heart

Cholesterol builds up on the inside of the artery walls and contributes to atherosclerosis, a chronic inflammatory condition of the vessel walls that can lead to narrowing of the vessels and restricted blood flow. Atherosclerosis is a common disease, and its earliest measurable sign, long before visible atherosclerosis has developed, is what is known as endothelial dysfunction. This dysfunction occurs when endothelial cells, which line the inside of the vessel wall, fail to produce enough signalling substances to maintain a healthy vessel wall. Endothelial dysfunction can be detected using ultrasound and has been observed even in children with risk factors such as obesity. It can fluctuate, being temporarily impaired by factors like mental stress or smoking a single cigarette. If atherosclerosis restricts blood flow, it can cause symptoms in organs and tissues served by the affected arteries, such as the heart or leg muscles. These symptoms, like chest pain (angina pectoris), shortness of breath or leg pain (claudication), typically occur during physical activity when blood flow demand increases, while rest may provide sufficient circulation. This is why patients with calcified arteries in their legs, for example, often experience muscle pain after walking a certain distance and need to stop and rest.

If a calcified area in the vessel wall becomes unstable, often due to inflammation causing a tear in the calcification, the platelets in the blood stick to the damaged area and accumulate. This can rapidly lead to the formation of a blood clot (thrombus), which may grow and block the artery completely. When this occurs, the oxygen supply to the cells in the affected area is cut off, resulting in a blood clot in that organ. A "blood clot in the heart" (acute myocardial infarction) refers specifically to a blood clot in the coronary arteries, which supply the heart. When an artery is acutely blocked, the cells in its supply area begin to die immediately, making every minute count. In the case of a blood clot in the heart, this often involves "emergency balloon therapy" to reopen the artery. Another treatment for symptomatic calcification of the coronary arteries is bypass surgery. This procedure involves using veins harvested from the leg or other vessels to create bypass pathways, allowing oxygen-rich blood from the aorta to flow directly to the coronary arteries below the narrowed or blocked sections.

Arrhythmias, pacemakers and ICDs

Heart rhythm disturbances range from physiological extrasystoles to life-threatening conditions such as cardiac arrest. One common arrhythmia, atrial fibrillation (AF), affects 5 to 10 per cent of people over 70, either intermittently or persistently. Atrial fibrillation can cause palpitations, shortness of breath, etc. and the condition is diagnosed using an electrocardiogram (ECG). In atrial fibrillation, the heart rhythm becomes irregular and blood flow in parts of the fibrillating left atrium slows down, increasing the risk of local blood clot formation. These emboli (detached clot material) can break loose and travel to the brain, causing a stroke. The likelihood of atrial fibrillation increases with age, heart failure, hypertension and diabetes, for example, so blood-thinning (anticoagulation/AC) medications are recommended for most people over 65 with atrial fibrillation.

In atrial fibrillation (AF), the heartbeat can sometimes be too fast or too slow, and treatment includes medication, direct current (DC) conversion, which involves delivering an electric shock to the chest under short-term general anaesthesia to restore normal sinus rhythm. Alternatively, catheter treatment, known as radiofrequency ablation (RFA), may be used. This procedure involves creating small, controlled lesions ("burning") in the left atrium to isolate the origin of the arrhythmia. A slow heart rate causes symptoms such as fainting and dizziness and is treated with a pacemaker. Severe pump dysfunction following a blood clot in the heart significantly increases the risk of cardiac arrest. This risk can be mitigated by an implantable cardioverter defibrillator (ICD), a special pacemaker that delivers an internal electric shock to restore normal sinus rhythm during cardiac arrest caused by ventricular fibrillation.

Valve defects
Heart valve defects, such as narrowing (stenosis) or leaks (insufficiency), are often degenerative and age-related: examples include aortic stenosis. However, they can also be congenital or result from conditions such as valve inflammation (endocarditis). Symptoms often include shortness of breath, pressure in the chest, exertion-induced fainting, and possibly heart failure. Diagnosis is typically made using echocardiography, and severe valve defects are often treated with valve replacement surgery. Some patients, however, may undergo less invasive treatments such as transcatheter aortic valve implantation (TAVI). Mechanical valve prostheses require lifelong anticoagulant (AC) therapy, whereas biological valve prostheses typically require only three to six months of treatment.

Stroke (apoplexy)
A stroke (apoplexy) occurs when a blood clot or haemorrhage in the brain interrupts the oxygen supply to a specific brain area, causing the affected cells to begin dying immediately. Identifying whether a stroke is due to a blood clot or haemorrhage requires a brain scan. If a significant brain area is involved and the patient presents soon after the onset of symptoms, treatments such as thrombolysis (clot-busting drugs) or catheter-based interventions may be necessary. Typical stroke symptoms include paralysis of the face or one side of the body and disruptions in speech, vision, coordination or balance, depending on the affected region of the brain.

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