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What Kind of Leisure Sports is Suitable for Adults with Congenital Heart Diseases?

Welcher Freizeitsport ist für Erwachsene mit angeborenem Herzfehler geeignet?

REVIEW

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Summary

› **Most patients** with congenital heart diseases profit from physical activity and physical exercise training. Physical activity improves exercise capacity and, therefore, reduces the risk of suffering from cardiovascular and chronic diseases. Patients with former congenital heart diseases have reduced physical capacity compared to the healthy population despite having no hemodynamic sequelae. They should be encouraged to do physical activities to improve quality of life and to prevent acquired cardiovascular disease. Nevertheless, precautions have to be taken in some patients and recommendations have to be made according the individual residual findings in order to minimize risks of cardiac events.

› **This article** summarizes the recent sport recommendations for adults with congenital heart diseases in consideration of the diagnostic findings, medication and patient's requests and expectations. As sport eligibility notably correlates with the recent findings, it is more useful to focus on hemodynamic function than on the type of defect.

› **The majority of sport activities** can be recommended for most patients. Fundamentally, annual medical surveillance needs to be conducted to reassess the sport recommendations considering recent diagnostic findings. Specific restrictions should only be addressed in case of medical issues. These restrictions should be discussed individually with the patient, taking any diagnostic findings and the patient's requests as well as their expectations into account.

KEY WORDS:
Congenital Heart Disease, Recommendation, Restriction, Residual Findings

Zusammenfassung

› **Die Mehrzahl aller Patienten** mit angeborenem Herzfehler profitiert von körperlicher Aktivität und gezieltem Training. Die körperliche Aktivität verbessert die Leistungsfähigkeit und damit die Lebensqualität sowie die soziale Einbindung in das Freizeit- und Berufsleben. Erwachsene mit angeborenem Herzfehler weisen trotz derselben hämodynamischen Situation, verglichen mit der gesunden Population, eine reduzierte physische Kapazität auf. Nur selten müssen Vorsichtsmaßnahmen zur Risikominimierung kardialer Events getroffen werden.

› **Dieser Artikel** fasst die aktuellen Sportempfehlungen für Erwachsene mit angeborenem Herzfehler unter Berücksichtigung der Befunde, der Medikation sowie der Wünsche und Erwartungen der Patienten zusammen. Da unerwünschte Ereignisse beim Sport stark mit den aktuellen Rest-Befunden zusammenhängen, ist es unerlässlich, die hämodynamische und elektrophysiologische Funktion in den Vordergrund zu stellen, und nicht den Vitiumtyp.

› **Bei der Mehrheit der Patienten** können nahezu alle Sportarten empfohlen werden. Grundsätzlich sollten jährliche Kontrolluntersuchungen durchgeführt werden, um die Sportempfehlungen an die aktuellen Befunde anzupassen. Spezifische Restriktionen sollten ausschließlich im Falle von medizinischen Risiken ausgesprochen werden. Diese Restriktionen sollten mit jedem Patienten individuell, unter Berücksichtigung der aktuellen Befunde, Wünsche und Erwartungen des jeweiligen Patienten, besprochen werden.

SCHLÜSSELWÖRTER:
Angeborene Herzfehler, Empfehlung, Einschränkung, Restbefund

Introduction

Physical activity is defined as any body movement executed by muscle contraction, leading to an additional energy consumption exceeding the basal metabolic rate. The American Heart Association emphasizes the importance of physically active lifestyles for the wellbeing and health of adults with congenital heart diseases (1, 5, 6, 18-20, 29, 30, 32). Several studies have shown an increase of the physical activity and health benefits due to physical exercise training as a part of the congenital heart disease management (9). Furthermore, the improvement of exercise performance and promotion of physical activity is the aim of strategies dedicated to preventing the development or progression of heart diseases and to decreasing further risks in cardiovascular events. Even in patients with congenital heart diseases, ›

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Table 1

Cardiological Assessment to Define Sport Eligibility in Patients with Congenital Heart Disease; modified from (19) with permission (copyright ©2007 Deutsches Ärzteblatt).

EXAMINATION	PURPOSE
Medical history	Current symptoms, health history, dispositions, living conditions, etc.
Physical examination	Age-appropriate development of cardiopulmonary status, palpitation, auscultation and blood pressure behavior
Electrocardiography	Arrhythmia, time intervals, depolarisation, repolarisation, abnormalities
Echocardiography	Cardiac functionality and hemodynamic and significance of residual findings
Cardiopulmonary exercise testing	Cardiac Rhythm and blood pressure behavior during exercise and peak cardiopulmonary exercise capacity
Cardiac magnetic resonance, computed tomography (in certain patients)	Anatomical and functional details

structured exercise-based rehabilitation programs are an effective possibility in ensuring the greatest safety and optimal efficacy in decreasing the mortality and morbidity rate in patients with known cardiovascular diseases (3).

Physical capacity is one of the most robust predictors of survival and health outcome of healthy people in general and cardiac patients, including those with congenital heart diseases (3, 28). Poor physical capacity is associated with a higher risk for hospitalization or death (7, 8, 11, 23). These facts are alarming since studies have shown reduced physical capacity in patients with congenital heart diseases, regardless of symptoms (7, 28). Several studies demonstrate the improvement in the objective and subjective physical capacity due to physical activity and sports participation. Apart from this, there was no cumulative occurrence concerning cardiac events like arrhythmias or sudden deaths (24). There is compelling evidence that physical activity improves cardiovascular and health benefits as well as the patient's quality of life (14, 16, 17, 18, 20, 21, 22). Those data also apply to patients with congenital heart diseases. Nevertheless, precautions have to be taken in some cases and recommendations have to be made in order to minimize the risk of cardiac events.

Sport Eligibility Testing

The purpose of sport eligibility testing is a detailed cardiac-specific examination with the aim of identifying residuals with a specific risk for disastrous events during physical activity. Sport eligibility is solely dependent on the patient's risk that acute cardiac problems may occur related to activity or develop in long-term with certain exercise. Therefore, sport eligibility is not solely dependent on the physical capacity and only little on the initial congenital heart disease, but notably on the results of recent examinations (13). Accordingly necessary conditions are the precise knowledge of the heart disease, therapeutic steps and current cardiac situation including all residual findings (13).

Sport eligibility testing consists of medical history (including a sport history), physical examination, electrocardiography (resting ECG, and Holter ECG), echocardiography and cardiopulmonary exercise testing (26) (Tab. 1). In certain patients, an additional cardiac magnetic resonance or a computed tomography scan might be necessary. All these investigations are designed to identify the age-appropriate development of cardiopulmonary status, heart rhythm, physical capacity as well as cardiac functionality and the hemodynamic significance of the residual findings, at rest and in exercise (1, 5, 6, 19, 20, 26, 29, 30, 32). The resting ECG gathers dysrhythmias, ischemia and signs of congenital heart diseases which are related to arrhythmias, like altered QT interval, signs of hypertrophy, repolarization disorders and pre-excitations (13). The evaluation of the individual anatomical situation, residual findings and the cardiac function can be made on the basis of echocardiography. During the cardiopulmonary exercise testing, cardiorespiratory fitness is examined on the basis of the maximal oxygen uptake (VO_2peak) measurement. Cardiorespiratory fitness is one aspect of physical fitness (representing endurance). Also arrhythmia, desaturation, drop in systolic blood pressure, or a circulatory failure on exercise have to be carefully analyzed in order to give an appropriate sport recommendation to the patient. Exercise echocardiography and invasive cardiopulmonary exercise test with pulmonary artery catheter is currently confined to scientific questions.

Clinical Considerations Relevant to Physical Activity

Correction of congenital heart diseases is thought to be achievable in the majority of the patients. However, residual findings are not rare. Some complex heart malformations, called functionally univentricular hearts, can only be palliated with a type of Fontan procedure that needs special consideration for sport counselling. At the time of sport eligibility testing, most of the heart defects are "corrected" and show more or less severe residual findings (27). The initial congenital heart disease, its sequence of therapeutic interventions as well as the extent of the residual findings and the evaluation of the functions determine not only the patient's physical capacity but also the patient's individual risk (26). In the vast majority of former international recommendations, sport eligibility was categorized exclusively on the basis of the underlying congenital heart disease. Since assigning a certain physical capacity to individual types of congenital heart disease has not turned out to be sensible, it is more useful to focus on the hemodynamic function and to consider the unique clinical status than focusing on the type of defect (18, 26) (Tab. 2). There are no restrictions for patients with an atrial or ventricular septal defect, patent ductus arteriosus, patent foramen ovale as well as an aortic isthmus stenosis, if no residuals are present. Those patients are allowed to participate in both in leisure sports and in competitive sports. Nevertheless, for example ventricular dysfunction, aortic abnormalities, syncope, hypoxia, anticoagulation and device implantation are morbidities that may influence sport eligibility (18). Additionally, there are no restrictions in minor defects that do not need to be corrected and do not implicate complications. Furthermore, the following facts should be considered:

Ventricular Dysfunction

Patients with significant ventricular dysfunction are allowed to perform a wide range of leisure sports at low to moderate dynamic level, while these patients should be discouraged from performing competitive sports. However, static sport activities inducing an increase in blood pressure should be omitted. Thus, disciplines such as bowling, walking, baseball, golf, cricket or tai chi are recommended. Patients who are also suffering from arrhythmia should follow the recommendations for physical activity published by the Heart Rhythm Society (18).

Aortic Abnormalities

Aortic dilations are most notably in bicuspid aortic valves, aortic coarctation as well as in conotruncal defects which can occur in various forms of congenital heart diseases. The risk of dissection is largely related to the size of the aorta and its

Table 2

Restrictions Depending on Residual Findings (9).

CLINICAL CONSIDERATIONS	RESTRICTIONS
Ventricular Dysfunction	
	No participation in competition. Sport permission can be expressed for leisure sports activities, however it should be restricted to low to moderate dynamic and static activities.
Arrhythmia	
Supraventricular ectopy and tachycardia	No participation in competition until success of treatment is proven in symptomatic supraventricular tachycardia. None, if the tachycardia is rare, short in duration and self-limiting without any hemodynamic impairment.
Ventricular ectopy and tachycardia	None, if patients with ectopy are asymptomatic, the extrasystoles are monomorphic and the number is decreasing with exercise. Patients with ideoventricular rhythm or idiopathic monomorphic ventricular tachycardia can exercise if they are not symptomatic, short and non-sustained. No exercise until diagnostic workup is complete.
Ion Channel Diseases	
	Leisure sports activities might be performed according the genetic variants, EKG findings, and success of treatment.
Cardiomyopathy	
	Sport permission can be expressed for leisure sports activities depending on the findings and, in individual cases, additionally low-intense physical exercises might be allowed.
Syncope	
Syncope	No exercise until clarification of the syncope reasons. No activities where they put oneself or companions in danger in the case of syncope.
Reflex Syncope	No exercise until clarification of the syncope reasons. No restrictions in reflex syncopes.
Cyanosis	
	None, as long as the patient is subjectively completely asymptomatic and is allowed to determine his/her own activity intensity.
Pulmonary Hypertension	
	None for patients with pulmonary hypertension and a right-left-shunt, as long as the patient is free of symptoms and is allowed to determine his/her own activity intensity. Patients having no shunt are restricted to leisure sports with low dynamic and low static activities.
Medical Devices	
Pacemaker	Sport permission can be expressed for low-intensity and moderate-intensity sport disciplines unless device and leads are endangered by expected collisions and impacts, high pressure load (diving depending on manufacturer specifications), or frequent and intensive upper limb movements. Exercise prohibition of sport disciplines where sudden presyncopes or syncopes correlate with an increased risk for the patient or accompanying persons.
ICD	Sport permission is according to the underlying disease. Exercise prohibition of sport disciplines where collisions and impacts are expected, diving (depending on manufacturer specifications) and sport disciplines with frequent and intensive movement of the upper limbs. Exercise prohibition of sport disciplines where sudden presyncopes or syncopes correlate with an increased risk for the patient three months after ICD-implantation or shock.
Other Devices	No exercise prohibition for patients with artificial heart valves, stents, conduits or other devices unless direct impact on the device is expected.
Aortic Abnormalities	
Aortic Dilatation	Exercise prohibition of high-intensity dynamic and any static exercise, as well as disciplines with a risk of thorax compression. Exercise prohibition has to be extended in patients with connective tissue diseases with aortic involvement depending on the individual findings.
Aortic Dissection	Sport permission can only be expressed for low-intensity dynamic and static leisure sports activities for patients with a dissection of the descended aorta which does not need any surgery, depending on the pathology, findings and the inclination of the progression.
Anticoagulation	
	Exercise prohibition of all contact sport disciplines.
After Procedures	
After Surgery	Supervised rehabilitation can start immediately according to the clinical condition. Full sport permission can be expressed six weeks after a sternotomy even for static sports activities and contact sports unless other restrictions are present.
After Cardiac Catheter	Full sport permission can be expressed at least one or two weeks afterwards, unless complications or residues occurred.

progression. Wall stress on the aorta depends on the rise of blood pressure during exercise. In general, dynamic activities of low to moderate intensity can be recommended to patients with a dilation of more than 2s (13, 18). Static activities should be avoided due to the rise in blood pressure. Furthermore, sport disciplines associated with the risk of chest compression, as well as competitions invariably have to be avoided to prevent aortic dissection, especially at the insertion of the aortic ligament. In addition, the restrictions for patients with connective tissue diseases with aortic involvement like Marfan syndrome, Loeys Dietz syndrome or Ehlers Danlos syndrome might have to be extended depending on the individual medical findings (13).

Syncope

If syncope occurs during exercise, physical activities should be avoided until the cause has been identified (13). Even if there is no cardiac reason for syncope, patients at risk for syncope should not perform activities where they put themselves or companions in danger in the case of syncope. Those patients should participate in activities like soccer, walking, baseball, dancing, table tennis, bowling, yoga and tai chi. Sports like gymnastics, horseback riding, diving and rock climbing should only be performed under supervision, if syncope episodes are common. If the patient suffers from cardiac syncope, sport eligibility is determined by the underlying congenital heart disease (12).

Cyanosis

In some patients with congenital heart diseases, intracardiac shunting is diagnosed. In those patients physical activity can cause or increase cyanosis. Since increasing cyanosis usually limits exercise to an appropriate extent, medical activity restrictions do not need to be defined. Concerned patients should be encouraged to do sports within comfortable limits, even if the hypoxia increases related to exertion. In cyanotic patients, discomfort during exercise might be a first sign of cerebral hypoxia, therefore the current activity should be interrupted (13). The precondition for being active is to ensure the opportunity for the patients to determine the activity intensity on their own (18). ›

Pulmonary Hypertension

The same recommendations as for cyanosis can be made for patients with pulmonary hypertension and a right-left-shunt. Syncope and circulatory collapse might occur during exercise in patients with solely pulmonary hypertension and no shunt. Those patients are restricted to low dynamic and low static activities which should not be under performance pressure. If syncope is recorded in the medical history, physical exercises without medical monitoring have to be confined to the minimum (13). Patients suffering from severe pulmonary hypertension should be allowed to perform leisure sports activities, however a specialized rehabilitation program is recommended at the beginning (2, 10).

Arrhythmia

In case of supraventricular ectopy, no restrictions are necessary, unless there is high-grade arrhythmia. By contrast, ventricular ectopy could be a first sign for myocarditis, hypertrophic cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy or other structural cardiac diseases associated with a higher risk of sudden death. In these instances, long-term electrocardiography, echocardiography and cardiopulmonary exercise testing should be implemented. Patients can perform any activities without any restrictions if they are free of symptoms and have an unremarkable echocardiography, normal PQ-time and monomorphic ectopy in the Holter ECG which disappears during exercise. Indeed, annual follow-ups should be performed to adjust the recommendations to the current cardiac situation (13).

Patients with rare supraventricular tachycardia lasting for a few seconds and without any haemodynamic impairments are allowed to do sports. The same applies to patients with a structurally anomalous heart after a successful catheter ablation. No restrictions have to be set in this group (13). A detailed rhythmological diagnostic investigation is warranted in case of ventricular tachycardia. Any exhausting physical activity has to be avoided until completion of the diagnosis (13).

Ion Channel Diseases

Ion channel diseases are associated with a higher risk of sudden death. The most frequent ion channel diseases are short QT syndrome, Brugada syndrome, long QT syndrome and catecholaminergic polymorphic ventricular tachycardia. There is evidence that particularly the last two diseases cause life-threatening arrhythmia under stress and during physical exercises. Under certain circumstances, leisure sports can be performed if sudden load peaks, long workloads and performing sports in extreme heat or humidity are avoided (13).

Cardiomyopathy

Cardiomyopathy is the most common cause of death in competitive sports. In individual cases, training schedules providing low workloads and designed according to the individual findings can be shaped. Currently there is no consistent recommendation for patients with non-compaction cardiomyopathy. Recommendations for those patients seem to depend on the dilative components. Patients with arrhythmogenic right ventricular cardiomyopathy showing clinical symptoms are not allowed to perform any sports due to the risk of ventricular tachycardia (13).

After Procedures

Supervised sport activities can be initiated a few days after procedures. Strenuous exercise should be delayed for approximately 1-2 weeks after catheter or 3-6 weeks after surgery, unless complications or residues occurred. Patients with a Fontan circulation are limited in their physical capacity, and confine themselves accordingly. These patients are allowed to take part in most of the leisure sport activities. In case of myocardial dysfunction, strength training should not be performed (20). A Valsalva maneuver has to be avoided because of blocking the circulation in the lungs, as a consequence diving is not permissible (13). Nevertheless these patients should be physically active. The opportunity to interrupt the exercise at any time should be given (13). Furthermore, restrictions of ventricular dysfunction apply for Fontan patients.

Medical Drug Treatment

Taking anticoagulants poses a higher risk of bleeding during performing exercises which are associated with a higher risk for impact. The risk of undergoing impacts, especially those leading to intracranial hemorrhage, is increased for patients from the age of 14 playing more competitively (20). Patients with anticoagulation should be admonished to participate in sports in which "impacts may occur" and discouraged to participate in sports where "impacts are expected" (20). In sport disciplines implying an increased risk of blunt head traumas (such as martial arts), antiplatelet treatment should also be considered (13). For more detailed information about performing exercise with oral anticoagulation, the readers are referred to the article "Atrial Fibrillation: Sports and Oral Anticoagulation" being published in issue 6/2017 by Laszlo R et al.

Device Implantation and other Implants

For pacemaker patients, engaging in physical exercises and activities is possible to a limited scope (32). It is essential to participate only in sports consistent with the limitations of the underlying heart disease as well as the current cardiac situation (13, 15) . Sport disciplines like martial arts, football, rugby, hockey and boxing should be avoided under all circumstances due to unavoidable bodily collision. In these sports, there is a high risk of trauma such as direct blows to the chest damaging the pacemaker system or the risk of skin perforation which may occur after trauma (15, 32). In order to avoid fractures in pacemaker leads, exercises with direct compression of the chest or excessive movement of the upper limbs as well as disciplines where overhead strokes are performed (e.g. volleyball) should also be prohibited (32). Depending on the type of sports and the patient's arm dominance, the pacemaker should be implanted on the right or left side (15). For example, the pacemaker should be implanted on the left side in a right-handed badminton player (15).

In sport disciplines such as baseball, basketball and soccer, collisions are possible but less likely. Taking protective measures such as wearing a protective vest is recommended. When diving, the pacemaker system will be exposed to water pressure which can lead to penetration of fluid implicating a functional loss. The maximal diving depth is dependent on the implanted model and the manufacturer's data have to be taken into account (13). Moreover, sports associated with a higher risk for the patient or the companion in the case of sudden presyncope or syncope should not be performed by pacemaker patients who recently had syncope. Those types of sports include rock climbing, skiing, motorsports, watersports and bicycle racing (13).

The same recommendations apply for patients wearing an ICD. The essential prerequisite for risk-free sport is a precise ICD programming which depends on the kind of tachycardia and the individual peak heart rate achieved in exercise. Inappropriate shocks triggered by exercise-induced sinus tachycardia

or arrhythmia have to be avoided (25). In general, there are no reasons not to resume sporting activities six weeks after pacemaker or primary ICD implantation. After secondary ICD implantation or intervention with a shock or antitachycardiac pacing, sport activities should be deferred for 3-6 months (25).

In general, there are no restrictions for patients with mechanical valves, stents, conduits, vascular closure devices or closure devices for atrial or ventricular septal defects unless there is verification of ventricular dysfunction, arrhythmia and other clinical considerations which are relevant to physical activity. There is no evidence for direct mechanical impairment of these implants due to any physical exercise (13).

How to Plan Exercise Training

One cornerstone of physical activity is exercise training which is planned, structured, repeated and targeted to improve physical fitness (4). In patients with congenital heart disease, the type and severity of the heart disease have to be considered. Moreover, the patient's exercise training should be adjusted and structured individually on the basis of a risk evaluation. In addition, personal characteristics like sex, age, previous physical inactivity and exercise experiences, preferences, skills, motivation and training goals need to be taken into account (26). Based on this information an individual recommendation, containing the training Frequency, exercise Intensity, workout Time as well as the Type of exercise (FITT principle) should be determined for every patient. Furthermore training method, type of training and the training goal should also be defined. Individual training schedules should be designed in a team of physiotherapists and cardiologists specializing in congenital heart diseases (17).

The training frequency and the workout time should include the duration of the whole training schedule and of every single training session. The exercise intensity can be determined for endurance training by the heart rate and derived from a certain level of oxygen uptake or lactate accumulation. The heart rate can be supervised by the patient during exercise. It is recommended to consider the patient's individual physical capacity as well as the specific conditions, to start at low level and to increase the exercise intensity, training frequency and workout time slowly but steadily (26).

In general, High Intensity Training (HIT) and High Intensity Interval Training (HIIT) represent forms of training with the aim of performing at the highest possible intensity at maximum heart rate. Stress phases are followed by given recovery phases in which activities are performed at low intensities. These training sessions are exclusively recommended for a short time and especially under supervision as acute side effects may occur (31).

Furthermore, exercise can be performed in a dynamic and static way. The main difference between dynamic and static exercise is that high pressure load is verified by static exercise whereas a volume load can be evidenced during dynamic exercises (20). Predominantly dynamic exercises are associated with a protective effect on the cardiovascular system caused by the reduction in left ventricular afterload in long-term (26). They are the preferred mode of training from a cardiologists' point of view when dealing mainly with left heart failure caused by coronary artery disease (14). Predominantly static exercise (maximal strength training) induces muscle growth and is the favorite training modality to increase strength and body shaping. During static exercise, however, high pressure loads on the systemic circulation can extremely influence the hemodynamic situation in patients with previous left heart damage. Metabolic and mechanical afferents in skeletal muscle induce large persistent changes in blood pressure (20, 26). In contrast to maximal strength training, where hypertrophy has priority, dynamic strength training is characterized as strength endurance training. Training with submaximal intensity and a higher number of repetitions leads to a mid-term reduction in arterial blood pressure (31). The intensity of static and dynamic exercises is commonly divided into three different levels: low, medium and high. The classification refers to the exercise intensity which is performed during competition, since in training different intensities might occur.

Table 3

Sports according to Risk of Impact and Age; modified from (14) with permission.

	COMPETITIVE SPORTS	LEISURE SPORTS
Impact expected	American football	American football
	Ice hockey	Ice hockey
	Lacrosse	Lacrosse
	Wrestling	Wrestling
	Karate / Judo	Karate / Judo
	Fencing	Fencing
	Boxing	Boxing
	Downhill skiing	
	Squash	
	Basketball	
	Soccer	
Impact may occur	Field hockey	Field hockey
	Equestrian	Equestrian
	Cycling	Cycling
	Gymnastics	Downhill skiing
	Baseball / Softball	Squash
	Figure skating	Basketball
		Soccer
Impact not expected	Cricket	Cricket
	Golf	Golf
	Riflery	Riflery
	Volleyball	Volleyball
	Swimming	Swimming
	Track and field	Track and field
	Tennis	Tennis
	Cross-country skiing	Cross-country skiing
	Rowing	Rowing
	Sailing	Sailing
	Archery	Archery
	Weightlifting	Weightlifting
	Badminton	Badminton
		Gymnastics
		Baseball / Softball
		Figure skating

A detailed classification of sports according their degree of impact is given in (Tab. 3) for adolescent athletes. When the occurrence of sudden syncopal events poses risks to the athletes or others in certain sport types, these risks are classified as well. This classification is based on the distribution by Maron, who associated the types of sports with the educational background (Junior High School vs. High School / College). The older the athletes, the higher the risk that impact may occur. With advancing age, muscular strength increases and movements are more powerful. Furthermore, the will to win is more pronounced. Thus, there is a higher probability of getting injured. Maybe the same classification could also be applied to ›

leisure versus competitive sport activities. This classification is a useful tool for making recommendations concerning sport eligibility and guiding practitioners. Nevertheless, it should be noted that this scheme is just a rough and simple guidance for orientation. For instance, different positions on the court causing different cardiovascular loads have not been taken into account. It is indispensable that the individual patient as well as the way of performance and the playing position be considered to enable a reliable recommendation (20).

There are no data that the general training principles are different in patients with congenital heart disease. All training activities train the components that are used in the training. Aerobic training improves aerobic capacity, strength training improves strength, and flexibility training improves flexibility. The usual thresholds from sport physiology can be used to set up a training plan; however the individual thresholds have to be tested and must not be substituted by various normative data or rules of the thumb.

Practical Advices for Cardiologists

Findings from several studies indicate that neither advices in routine consultations nor intensive interventions render persistent increase in patient's physical activity (17, 21). In order to increase patient's daily activity and their exercise activity sustainably, the following issues should be heeded:

In general, all rehabilitation and leisure sport activities can be recommended for most patients. These patients should be allowed to do sports as physically possible and reasonable. Fundamentally, annual follow-ups need to be conducted to reassess the sport recommendations considering recent diagnostic findings (25, 32). Specific restrictions should only be addressed in case of medical issues (26). These restrictions should be discussed individually with the patient, taking any diagnostic findings and the patient's requests as well as their expectations into account. In any case of uncertainty on the part of patients or cardiologists, further experts (e.g. exercise physiologists) should be called in for additional examinations or additional advice. Specific sports groups for patients with congenital heart diseases may give a first insight on the patients' capability in sports and alleviate any baseless fears. Nevertheless, in long-term, most patients can join regular sport clubs with no risks.

In general, recommendations for increasing physical activity need to be adjusted to every patient's daily routine, as individualized interventions are more successful (17). Physical activities should be manifold to motivate the patients, provide pleasure, and promote social cohesion. Having fun is one of the main reasons for many patients to remain physically active. Risk-free physical activity can be integrated in the patient's daily life solely by tailored recommendations considering recent diagnostic findings, medication, and considering patient's requests and expectations.

Conflict of Interest
The authors have no conflict of interest.

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