

# Sports and Disability

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**Abstract:** Participation in recreational and competitive sports at an early age has long been touted as a positive influence on growth and development, and for fostering lifelong healthy lifestyles. The benefits of an active lifestyle include not only fitness, but the promotion of a sense of inclusion and improved self-esteem. These benefits are well documented in all populations, and their importance has been summarized in the recent Healthy People 2010 guidelines. The American Academy of Pediatrics has recently produced a summary statement on the benefits of activity for disabled children. They note that children with disabilities tend to have an overall lower level of fitness and an increased level of obesity. For this population, developing a lifelong desire to be active can be a simple means for limiting illness and much of the morbidity associated with sedentary lifestyles often associated with disability. For disabled youth, participation in disabled sports programs available nationally and internationally can be an effective means to promote such precepts. The goal of this focused review is to improve the learner's knowledge of the positive impact that active lifestyles can have on overall health in the disabled youth population and, as a result, modify their practice by incorporating recreational and competitive sport activities as part of improving overall patient care.

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## INTRODUCTION

In examining the impact that sports and recreation can have on habilitation and rehabilitation, consider a very talented young athlete who woke up one morning unable to move her lower extremities. She was diagnosed with transverse myelitis and was devastated by the impact this diagnosis would have on her life. During the day she was upbeat, but at night the reality of her situation was apparent. Her body and spirit were devastated, and hope for her previous life was stripped away. Interestingly, however, during the rehabilitation process, she was able to recapture part of her old self.

One of the crucial elements in this rebirth was her reintroduction to sports and recreational activity. It gave her the strength and courage to move forward with a new image. Clinicians need to understand the power that sports and recreation can have on those with disabilities. This is extremely important for adults who have been injured and perhaps even more so to children born with a disability [1, 2]. Sports, recreation, and play activities are what ground young athletes and expose them to a different aspect of their lives.

## THE ROOT OF DISABLED SPORTS

Before the 20th century, individuals with disabilities often were viewed as nonproductive members of society and often left to fend for themselves. The concept of survival of the fittest was used to justify infanticide and neglect. The large numbers of survivors of regional and worldwide conflict appear to be a major impetus for the social reform necessary to foster the creation of organized disabled sports as a concept. Formal programs for those with disabilities can be traced back to 1888, when the first sports programs for the deaf were started in Berlin. The actual deaf Olympics were formed in 1922. Sports for those with physical disabilities were introduced during World War II by Dr. Ludwig Guttmann in England, a neurosurgeon and director of a spinal cord injury program at Stoke Mandeville Hospital. The clinicians in this program used physical activity as part of the recovery process, which evolved into competition among those in their rehabilitation programs [3].

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By 1948, as the Olympics were opening in London, Dr. Guttman introduced the first Stoke Mandeville Games. The games developed an international flavor when the Dutch sent a team to compete in 1952 and, thus, the birth of the International Stoke Mandeville games. These games are still held today. In recognition of the need for an international competitive venue for disabled athletes, the Olympic-style events termed the Paralympics were first held in Rome in 1960 [4]. Four hundred athletes with paralysis, from 23 countries, were present and competed in 8 sports.

The need to include multiple groups with disabilities became apparent and the International Sports Organization for the Disabled was formed in 1964 to include not only athletes with spinal cord injuries (SCIs), but athletes who were blind, who were amputees, and those with movement disorders. The Olympic games in 1976 were the first official games that merged multiple disabilities into a single competitive event. This is also the year during which the first winter Paralympic events were held in Sweden.

The Paralympics have always been held in the same city as the Olympics, but not until Seoul 1988 and Albertville 1992 were they included in the same venues. During the last several decades, the Paralympics have evolved into an elite level of competition. In the most recent games in Beijing (2008), 4000 athletes from 147 countries participated [5]. During the 12 days of competition, 279 world records were set by these highly trained athletes. The next Paralympic events will be held in London, and a large group of participants are expected to come from those young adults injured in recent years in military actions.

Before 1984, junior-age athletes could only compete in adult venues, which often placed them at a significant disadvantage. During this same year, however, the first US junior wheelchair sports meet was held in Delaware as a means to provide young disabled athletes a venue at which they could truly compete with their peers. The event has since been held yearly, and to meet the needs of all disabilities, it has evolved into a multidisabled event analogous to the Paralympic movement. Disability groups include not only wheelchair athletes, but children/adolescents with amputations, cerebral

palsy (CP), visual impairments, and les autre (a mixture of other disabilities). Athletes are not only classified by disability but also by age. Opportunities for disabled children/adolescents to compete in sports have grown as several sport governing bodies around the world have developed youth programs. Basketball now has youth as well as college-level tournaments.

A move toward disabled athlete inclusion in all age groups has been adopted by several sports organizations. Today, sports such as fencing, archery, shooting, and table tennis all include disabled groups/categories within their competitions so that able-bodied and disabled athlete alike can be a part of the event. Practical considerations, however, may limit the adoption of this philosophy because of time and facility considerations when large numbers of athletes compete across many classifications.

As one reviews the history of sports for those with disabilities, it is interesting to reflect on individuals who had disabilities and participated and succeeded in sports against non-disabled athletes. Table 1 lists a few key individuals who have crossed these barriers.

## ORGANIZATIONAL STRUCTURE OF DISABLED SPORTS

There have been many changes to the governing bodies of disabled sports during the years. The current organization of grassroots and elite sports is under the doctrine of the International Paralympic Committee, which develops policy and supervises the conduct of summer and winter events. Groups who impact decision-making policy include the national Paralympic committees, international sports federations, and the 4 disability groups under the direction of International Sports Organization for the Disabled:

- Cerebral Palsy International Sports and Recreation Association;
- International Blind Sports Federation;

**Table 1.** Prominent individuals with disabilities breaking barriers in sports

Athlete	Sport	Disability
George Eyser	Gymnastics: Olympics 1904 and won 6 medals	Amputee competed with a prosthesis
Peter Gray	Baseball: St. Louis Browns 1945	Upper extremity amputee
Liz Hartel	Dressage: Olympics 1952, silver medal winner in a combined male female division	Polio
Wilma Rudolf	Track: Olympics 1956 and 1960, 3 gold medals, 1 bronze	Polio
Eddie Gadeal	Baseball (St. Louis): 1959 he played one game	Short stature (3 feet, 7 inches)
Tom Dempsey	Football: field goal kicker set record 63 yard which stood from 1970-2007 until it was equaled by Elam	Partial foot amputee
Neroli Fairhall	Archery: Olympics 1984, first paraplegic in the Olympics	Spinal cord injury
Marla Runyon	Track: Olympics 2000 1500 meters	Visually impaired
John Curtis Pride	Baseball: LA outfielder 2008	Hearing impaired
Natalie du Toit	Swimmer: Olympics 2008 10,000 meters open	Amputee

- International Federation for Sport for Persons with an Intellectual Disability; and
- International Wheelchair and Amputee Federation

## CLASSIFICATION FOR DISABLED SPORTS

Classification is a method to place individuals with similar disabilities in a group that will provide for equitable competition. Classification systems have evolved and can be somewhat controversial. Different disability and sports groups have different classification strategies. Originally classification was on the basis of a medical/anatomic model, but a shift in philosophy has emerged on the basis of a functional strategy. This strategy combines different disabilities that may have similar athletic performance. The athlete is analyzed as to his or her capacity to compete in a particular event. The classifier has to define what an athlete is capable of performing, not just what he or she is demonstrating. The process includes both bench testing and athletic performance. Swimming is an example of a fully integrated sport that uses 3 different steps to properly place an athlete in a class [6]. These include a bench test, a water test, and sports competition.

Different disability groups continue to have separate classification and competition in the majority of events. In some sports, the classification system and rules allow athletes with a given disability to compete either in one class or another (but not both) as long as their abilities do not provide a distinct advantage. For example, lower extremity amputee

track athletes could compete as ambulatory runners, but because of issues with their stump/prostheses, opt to compete in the wheelchair division (ie, crossover to another competitive division). Their functional abilities would be reevaluated as appropriate to their wheelchair class. The crossover athlete would then be competing against individuals with different disabilities (eg, SCI) but overall with similar functional limitations. There is no perfect classification system, but the essential elements in any ideal system would provide for fair and equitable competition, only measure functional limitations caused by the physical disability, be user-friendly so that they can be applied in a consistent way in every participating country, and be sports specific [7]. The natural talents of athletes, training effects, and body habitus should not be factored into the process.

## CURRENT PARALYMPIC SPORTS

The scope of sports options available for elite-caliber athletes has increased during the last few decades. Originally there were 8 sports (fencing, track, field, snooker, basketball, archery, table tennis, and pentathlon). It was not until 1972 that those with quadriplegia and visual impairments were included in competition. As with the Olympics, Paralympic sports are added and removed on the basis of competition and trends of the population. Table 2 contains a list of current winter and summer events and what disability group can officially participate [8].

**Table 2.** Disability competition for Paralympic sports (summer and winter) (8)

Paralympic Event	Wheelchair	Amputee	Cerebral Palsy	Les Autre	Blind/Visual Impairment
Archery	x	x	x	x	
Athletics	x	x	x	x	x
Boccia			x	x	
Cycling	x	x	x	x	x
Equestrian		x	x	x	x
Fencing	x	x	x	x	
Football, 5 vs 5					x
Football, 7 vs 7			x		
Goal ball					x
Judo					x
Power Lifting	x	x	x	x	
Rowing	x	x	x	x	
Sailing	x	x	x	x	x
Shooting	x	x	x	x	x
Sitting volleyball	x	x	x	x	
Swimming	x	x	x	x	x
Table tennis	x	x	x	x	
Wheelchair basketball	x	x	x	x	
Wheelchair rugby	x		x	x	
Wheelchair tennis	x	x	x	x	
Alpine skiing	x	x	x	x	x
Ice sledge hockey	x	x	x	x	
Nordic skiing	x	x	x	x	x
Wheelchair curling	x	x	x	x	

## TECHNOLOGY AND DISABLED SPORTS

Technology has been used as an “enabling” force for individuals with disabilities ever since the first use of a cane. Indeed, developing enabling technologies has grown into its own field, Assistive Technology. Wheelchairs, prosthetic limbs, and other assistive devices such as crutches and walkers all have seen significant advancement during the years. It is not surprising therefore that such changes have played a major role in the advancement of disabled sports. A few examples are discussed in this section that demonstrate how technology has had an impact on disabled athletes.

### Wheelchairs

Perhaps the most obvious disabled sports technology is the development of the racing wheelchair. Its history can be traced back to the early days of wheelchair racing in England at the “Stoke Mandeville” games. These games were created for veterans of World War II who had been hospitalized and were seeking a way to satisfy their competitive desires as well as recreate. The standard “hospital wheelchair” soon gave way to modifications that lessened the weight and stabilized the chair. Such changes became “the competitive advantage,” and change has been going on ever since. In the United States, the first wheelchair patent was granted in 1869, and mass production commenced in the 1930s under a patent granted to Herbert Everest and Harry Jennings [9, 10]. The story goes that Everest, an engineer, built the first folding tubular steel wheelchair for his disabled friend, Jennings. Many will recognize the “E&J” moniker seen on wheelchairs around the world today. E&J, as well as many other companies, now mass produce not only standardized, efficient everyday chairs but also sport and recreation wheelchairs for the masses.

An analogy for the evolution of wheelchair racing technology can be found in cycling. Because cyclists continually seek advantages to improve their speed, new materials (eg, carbon fiber and titanium) and innovative design provide the athlete with aerodynamic design and efficient transmission of power. There are now an estimated 20 manufacturers developing wheelchairs uniquely adapted for each sport. Tennis chairs provide quick turning and enhance agility on the court, and wheelchairs for basketball and rugby also must be agile but are much more strongly built to withstand the collisions inherent to the sport. Disabled athletes have their own sports magazine, *Sports n’ Spokes*, which details athletic competition and covers the latest wheelchair technology with their annual reviews.

Of recent note has been the development of the “hand cycle.” Hand cycles, 3-wheeled devices propelled by use of the arms, are different from the current 3-wheeled “racing chair” in that they incorporate the advantages of gearing, which has been adapted from cycling. Not only is hand cycling competition found around the world, this technology

is readily available to the recreational, weekend athlete who merely wants to go for a ride with friends and family, supporting an “active lifestyle.” In a way, the hand cycle is merely an adaptation of the “recumbent” cycle more commonly seen nowadays for able-bodied riders.

The snow-skiing community has long fostered the inclusion of disabilities in their sport. The most recognizable disabilities on the slopes are the amputee skiers and wheelchair users. For single-amputee skiers, the prosthetic limb is typically left in the locker, and they ski “3-track” by using crutches with ski tips on the bottom called outriggers. This limited technology gives the skier amazing grace and speed on the mountain. For competition each skier modifies his or her outriggers and tinkers with bindings and wax just like any other competitive skier.

The CP athlete and the double-amputee athlete may have 2 options: (1) ski upright (ie, 4-track) with the use of 2 skis and 2 outriggers (the amputee would need to use his or her prosthetic limbs in this case); or (2) use a sitting skiing device called a “sitski.” The sitski comes in 2 basic forms, the monoski and biski. Both use a frame made from aluminum/steel hybrids, carbon fiber, and/or titanium. A seat is provided that can enable the skier to “fit” snugly so that upper body movement can weight and set ski edges as needed. In addition, a shock absorber adapted from motorcycle racing is attached to the frame and the seat to absorb shock in much the same way that knees function. The skis have either a single ski attached or 2 if balance is more of a concern and more adaptations to the biomechanics of skiing need to be provided. In skiing there is huge overlap with ski design, and additional technology functions to adapt the skiers given functional limitations to the biomechanics of skiing that all skiers use.

### Prosthetics

Another area of technological innovation has been in limb prosthetics. Amputees have sought more lightweight and efficient limbs to make their daily lives easier and provide an aesthetic sense to make the missing limb less recognizable. Today, however, sports limbs are high-tech, engineering marvels designed for maximizing function rather than striving for natural-like appearance. Now, prosthetics often are flaunted by the wearer rather than hidden by coverings painted to look like flesh.

Advances in biomechanics and materials engineering have provided the athlete with very sports-specific advantages. The characteristics of materials such as titanium, carbon fiber, and other “space-age” developments provide the engineer with the capability to create a limb/joint with the flexibility and energy storage/release characteristics specifically designed for a given sport (eg, running, high jumping, snow skiing). In 2008, double amputee Oscar Pistorius from South Africa petitioned the International Amateur Athletic Federa-

tion to allow him to compete in the able-bodied Olympics (not Paralympics), attempting to fight an earlier ruling indicating that his carbon fiber prosthetics provided an unfair advantage. It was posited that his “flexfoot” prosthesis had such energy storing and releasing characteristics that it provided him with an advantage. He won his petition and now will attempt to meet the elite qualifying standard in the 400 meters for the 2012 Olympics [11, 12]. He did compete and win a gold medal in the 2008 Beijing Paralympics. It is ironic that technological development has gone from enabling people to participate in normal everyday activities to being considered too much of an advantage in competition against able-bodied competitors.

### Sports Wear

Swimming is one sport that seems to be a great equalizer when it comes to the ability of technology to provide an athletic advantage. One of the technological marvels touted at both the able-bodied Olympics and Paralympics in 2000 and 2008 was the prevalence of “fish scale” swimming suits codeveloped with NASA. Improvement in race times seemed to be available to those athletes wearing these low-drag marvels. The suits feature a lycra fabric with a herringbone/fishscale texture plus innovative coatings that limit water saturation and enhance shedding and buoyancy. Research [13] has estimated that this technology has produced an average racetime improvement of at least 1%.

However, these suits may be particularly advantageous to those Paralympic athletes, whose disability inherently increases drag or whose generalized weakness makes it difficult to move through the water. For example, the SCI athlete often has difficulty efficiently moving through the water because denervated limbs drop down below the surface, increasing drag. With these new low-drag suits, however, some race time may be reclaimed. Here the technology seems to provide universal assistance; however, the advantage may be more useful to those in the pool whose disability inherently increases drag. These types of suits may also be of benefit outside the competitive arena in recreational water sports but, at this time, cost is a prohibitive factor.

These limited examples are only a few that show how technology has had an impact on disabled sports. In the future, innovative minds and new technology will undoubtedly make new advances. An athlete with a need to accommodate to a given sport will undoubtedly be able to adapt useful technologies found throughout science and industry. For instance, metallurgy of the space/aircraft industry will undoubtedly continue to provide the disabled athlete with lighter and stronger racing chairs. As our understanding of the biomechanics of sport-specific movement improves and our understanding of the etiology of the physiological limitations of individual disabilities grows, adaptations in training technology also will have an impact on disabled sports performance.

### SPORTS FOR CHILDREN WITH DISABILITIES

Sports and recreation are important for all children, disabled or not. Sports help children to develop skills, exercise, and learn team play and how to get along with others. The benefits of exercise are well documented. When considering sports programs, one needs to examine sports readiness. In disabled children, this not only includes development but also motor skills and coordination. Children with different disabilities may achieve these milestones at different time intervals, and modifications need to be used (Table 3) [14].

Children who have a cognitive component may develop slower, and modifications to instruction may need to be different. Children with spina bifida and CP are known to have nonverbal learning disorders, which will need to be incorporated into a sports plan. Disabilities with underlying coordination problems require repetition to learn specific motor activities. Children who have muscle weakness need a very structured program to improve performance but not breakdown muscle. Each disability group needs to be assessed on the basis of the physical needs of the sport activity and the physical limitations of the individual.

### PARTICIPATION IN HIGH SCHOOL TEAM SPORTS

High school sports programs for students with disabilities vary from state to state. Title 9 legislation entitled female students to be included in sports activities open to male students, but no national legislation mandates inclusion for those with disabilities. Individual education plans may provide for adaptive physical activity, but some students are still being excluded from school-based athletic programs. An illustrative case is that of Tatyana McFadden, a Paralympic-caliber wheelchair athlete with spina bifida who just wanted to “run” on her high school team as a fully included member [15]. She was forced to compete alone and could not score points as a team member. In fact, she was a token athlete who could compete, but not with her able-bodied peers. Through much legal discussion, she was eventually allowed to run during the same events and was given proportioned team points [15]. There are now several states that have resolved this dilemma with an equitable plan for full inclusion.

### SPORTS AND THE PERSON WITH A SEVERE DISABILITY

There is very little information available on sports for those persons with very severe disabilities. This group includes CP, high-level SCIs, and *les autres* (neuromuscular disorders). Historically, this population has been excluded from available activities because of resources and education of providers. So what sports are available for this group of unique individuals to participate in competitively?

**Table 3.** *Developmental considerations for children with disabilities*

Developmental Age (14)	Typical Children (14)	Goals for Children With Disabilities	Sports Considerations
2-5 years	<ul style="list-style-type: none"> <li>• Introductory skills</li> <li>• Short attention span</li> <li>• Limited motor skills</li> <li>• Limited ability to understand sports</li> </ul>	<ul style="list-style-type: none"> <li>• Work on mobility skills, wheelchair and walking.</li> <li>• Work on motor control and fundamental skills such as kicking, pushing, and throwing.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction of variable sports skills</li> <li>• Emphasize fun and participation not competition</li> </ul>
6-9 years	<ul style="list-style-type: none"> <li>• Learning more fundamental skills</li> <li>• Improving understanding of game</li> <li>• Body control improving balance and reaction time</li> </ul>	<ul style="list-style-type: none"> <li>• Work on sports fundamentals.</li> <li>• Continue to work on adapted mobility skills and rules modification.</li> <li>• Endurance</li> </ul>	<ul style="list-style-type: none"> <li>• Emphasis on all sports and exposure concepts including track, field, swimming, basketball, skiing, table tennis etc</li> <li>• Introduction to individual and team sports.</li> </ul>
10-12 years	<ul style="list-style-type: none"> <li>• Skills acquisition is improved</li> <li>• Better motor skills</li> <li>• Better understanding of game</li> </ul>	<ul style="list-style-type: none"> <li>• More focused skills development.</li> <li>• Endurance</li> <li>• Understanding game</li> <li>• Advancing mobility skills</li> </ul>	<ul style="list-style-type: none"> <li>• Entry-level team and individual sports</li> </ul>
13-15 years	<ul style="list-style-type: none"> <li>• Has fundamental and advanced skills</li> <li>• Team sport</li> <li>• Competitive sports</li> </ul>	<ul style="list-style-type: none"> <li>• Sports-specific activities can be emphasized such as basketball, tennis, swimming.</li> </ul>	<ul style="list-style-type: none"> <li>• Ready for team sports and more intense work out</li> <li>• Competitive sports</li> </ul>

Swimming can be performed by almost any disability group on both a recreational and competitive basis. Severely disabled individuals with spastic quadriplegia, high-level tetraplegia, and other significantly disabled athletes (termed “les autres” in the older CP classification system) compete in the lowest swimming classes.

Boccia can be played at a recreational or competitive level. The game itself is based on getting your balls as close to a target, “the Jack,” as possible. The boccia balls can be thrown or rolled, and adaptive equipment such as ramps and chutes can be used. Athletes with severe CP class 1 and 2, along with other severe disabilities, are eligible for Paralympic competition. This is an ideal sport for not only CP athletes, but those with muscle disease and high SCI, including those on ventilators.

Power soccer was first developed in 1982 as an option for a team sport for those players who use power wheelchairs. It is played on a basketball court, and the rules are simple: scoring is accomplished by getting the 22-inch ball over the goal line. Basically anyone in a power wheelchair is eligible to play, and it is an upcoming sport.

## LEGISLATION AND DISABLED SPORTS

Several key legislative directives have improved the climate of sports for the disabled. The 1973 Rehabilitation Act stated that anyone receiving federal funds could not exclude persons from programs or activities and that programs should be accessible. Then, in 1978, the Amateur Sports Act and in 1998 the Olympic and Amateur Athletic Act both identified and supported athletes with disability as part of the Olympic movement. The Steven Amendment mandated more inclusion of disabled athletes into high-level sports.

## SPORTS MEDICINE FOR CHILDREN WITH DISABILITIES

Participation in recreational and competitive sports activities has inherent risks. People with have disabilities compound these risks with a unique set of conditions specific to the disability. [Table 4](#) lists conditions and relevant considerations for sports participation [16-21].

## EXERCISE AND ACTIVE LIFESTYLES FOR PEOPLE WITH DISABILITIES

The benefits of an active lifestyle for both adults and children are myriad, ranging from regulation of blood sugar and moderation or prevention of diabetes to improvements in cardiovascular health. Immune enhancement and improvements in psychological health (eg, depression, self-confidence) also have been well documented in the literature [2, 23-28]. Older adults appear to reap major benefits from having an active lifestyle [29], including the following: (1) regular activity delays loss of independence; (2) evidence indicates a reduction in fall-related injuries; (3) activity may reduce pain associated with arthritis; (4) activity may improve sleep; (5) activity reduces symptoms of depression; and (6) activity may help reduce age-related cognitive decline.

The benefits of instituting a physically active program of exercise at an early age are more difficult to empirically document. Long-term studies necessary to test such hypotheses require very lengthy follow-up, making them difficult to implement. There is, however, a significant amount of indirect evidence that supports this concept. In studying multiple groups across varying age ranges, Bouchard [22] found evi-

**Table 4.** Unique disability-associated conditions influencing sports participation

Disability Type	Associated Conditions	Implications/Recommendations
Down syndrome (DS)	Atlantoaxial instability (AAI)	<ul style="list-style-type: none"> <li>All children with DS who participate in sports should have screening cervical spine radiographs (flexion, extension and neutral).</li> <li>Movement of more than 4.5 mm, restriction in sports is advised.</li> <li>It is not required to repeat normal cervical films.</li> <li>Persons with atlantoaxial subluxation or dislocation and neurologic signs should be restricted from contact/collision sport activity</li> <li>Persons with DS who have no evidence of AAI may participate in all sports (13).</li> </ul>
Spina bifida (SB)	Hydrocephalus and VP shunt	<ul style="list-style-type: none"> <li>Variable opinions exist about contact/collision sports activities although reported shunt malfunctions with sports are uncommon</li> <li>Restrictions in football, wrestling and Lacrosse have been suggested (14,15).</li> </ul>
	Latex allergies	<ul style="list-style-type: none"> <li>Common in children with SB.</li> <li>Need to consider equipment that contain latex, eg, basketballs, swim goggles, tires</li> </ul>
	Neurogenic bladder	<ul style="list-style-type: none"> <li>Common in SB and SCI</li> <li>There may be at increased risk for UTI with different positions such as in a track wheelchair.</li> <li>Athletes with indwelling catheter are required to use a collecting device.</li> </ul>
Traumatic brain injury	Permanent neurologic sequelae or parenchymal brain injuries	<ul style="list-style-type: none"> <li>Recommend no contact/collision sport activity</li> </ul>
Spinal cord injury	Temperature regulation	<ul style="list-style-type: none"> <li>Risks of heat or cold injury may occur from the loss of autonomic control.</li> <li>Monitor environmental temperature, hydration, medications, and symptoms (16).</li> </ul>
	Level of injury	<ul style="list-style-type: none"> <li>Impact on responses to exercise and cardiovascular response, cervical injuries cannot increase heart rate to same extent as lower levels.</li> </ul>
	Autonomic dysreflexia	<ul style="list-style-type: none"> <li>Those individuals with spinal lesions above T6 present with hypertension, sweating, skin blotching, and headache. Severity of symptoms may progress leading to death if untreated.</li> <li>Effective treatment includes addressing elevated blood pressure (eg, upright sitting position, sublingual nifedipine) and elimination of nociceptive stimulus.</li> <li>Athletes with higher lesions may use this response to enhance performance (ie, "boosting") (17)</li> </ul>
	Pressure ulcers are common in SB and spinal cord injury because of sensory abnormalities below the level of the lesion.	<ul style="list-style-type: none"> <li>Pressure area common in sports equipment and require appropriate pads.</li> <li>Any open sore has to be covered in any athletic venue.</li> </ul>
Cerebral palsy	Musculoskeletal injuries are common from underlying spasticity, ataxia and motor control issues.	<ul style="list-style-type: none"> <li>Proper training and stretching may reduce injuries.</li> <li>Use of proper equipment.</li> </ul>
	Seizures (applies to any person with seizures)	<ul style="list-style-type: none"> <li>Well-controlled seizures should not restrict participation and contact/collision sports are allowed.</li> <li>High-risk activities such as hand gliding, scuba diving, and free climbing are not recommended.</li> <li>Supervision for swimming, gymnastics, and rock climbing with safety ropes (15,18).</li> </ul>
Amputee	Skin problems, including friction and pressure	<ul style="list-style-type: none"> <li>Prosthetics and interface material should be optimally fit to reduce shear and pressure</li> </ul>
Les autre	Musculoskeletal injuries	<ul style="list-style-type: none"> <li>Abnormal biomechanics can lead to overuse injuries.</li> </ul>
	Multiple disability categories fall into this group	<ul style="list-style-type: none"> <li>A complete understanding of the disorder and its impact on exercise and function should be done to identify potential injuries.</li> </ul>
	Muscular dystrophy	<ul style="list-style-type: none"> <li>Low-intensity exercise</li> </ul>

dence that exercise may reduce morbidity and mortality associated with diseases affecting a variety of organ systems. Among the short-term changes noted were: (1) an improvement in body mass index; (2) lower resting blood pressure; (3) improved lipid profiles; and (4) greater bone mineral density, which may continue into adulthood.

The link between childhood physical activity and that found in adulthood is strongly suggested. Dwyer and others suggest that an early active lifestyle either directly or indirectly improves adult health as active children become active adults, which in turn improves adult health [25, 30]. We do know that sedentary adults are susceptible to more disease and associated morbidity, whereas there is a significant body of evidence indicating that experiences in early childhood are tied to health in adulthood [22, 25]. In recent years the body and mind benefits of not just competitive sport participation, but of recreational activities and moderate exercise like walking or doing chores, have been noted to have a positive impact on health. The key to efficacy appears to be in the regularity of activity.

Such knowledge has had a major impact on the perception of exercise and individuals with disabilities. Indeed, older individuals can benefit from limited levels of exercise without undergoing the stresses of vigorous workouts. It also suggests that disabled individuals with limited ability to participate in really stressful exercise can benefit from regular efforts within their abilities. For those who are capable and inclined, sports training can improve performance even within the limits of one's disability.

Early encouragement of an active lifestyle can thus have a major impact on the quality of life of children with disabilities [31]. They are at increased risk for poor health, obesity, diabetes, cardiovascular disease, and musculoskeletal limitations. The office on Disability, United States Department of Health and Human Services has developed a program that promotes more active lifestyles and inclusion in sports for children with disabilities, analogous to the President Council on Physical Fitness and Sports for able-bodied children [23]. The need for development of programs that promote physical activity for youth with disabilities is perceived to be critical [32].

## Training Options

Sport-specific exercise can improve cardiopulmonary capacities (eg,  $VO_2$  max) and cardiovascular endurance (ie, aerobic and anaerobic capacities) and strengthen even abnormally activated muscle groups as in the CP population [33]. For example, one study of children with CP has shown that weekly training resulted in an increase of 35% in peak aerobic power [34]. Strength and circuit training studies of children with CP have also shown that biweekly training improves muscle imbalances, increases strength 20% to 70%, increases walking speed, and provides long-lasting

results [35]. These results suggest that exercise can have a positive impact on overall function for children with CP. Indeed, studies suggest that the high incidence of osteoporosis in individuals with CP may be lowered by participation in well-defined exercise programs. It is likely that gains made as the result of exercise can be maintained into adulthood by continuing to be involved in physical activity.

Not all disabilities benefit from exercise in the same way or the same degree. For example, several studies have shown that peak heart rates during exercise for children with Down syndrome (DS) are approximately 15% lower than in children who did not have DS but had similar mental disability [36]. Cardiac malformation associated with DS may provide the predominant reason for this. Regardless, limitations in peak heart rate likely limits  $VO_2$  max. Such issues would certainly have an impact on sport performance.

## CONCLUSION

The tenets of sports medicine for children still hold true for those with disabilities. The clinician needs to thoroughly understand how a child's disability alters his or her functional abilities and to realize that access to physical activities such as sports is an important and very accessible modality for improving and maintaining optimal health. Changes in societal attitudes and technology over the decades have greatly improved access to the benefits of sport for the disabled child.

## APPENDIX: LIST OF SPORTS ORGANIZATIONS PERTINENT TO CHILDREN WITH DISABILITIES

- Athletes Helping Athletes
- American Amputee Soccer Association
- America's Athletes With Disabilities, Inc.
- Blaze Sports
- Cerebral Palsy International Sport and Recreation Association (CP-ISRA)
- Disabled Sports, USA
- Easter Seals
- International Amateur Athletic Federation (IAAF)
- International Olympic Committee (IOC)
- International Paralympics Committee (IPC)
- International Swimming Federation (FINA)
- ISMWSF: International Stoke Mandeville Wheelchair Sports Federation
- Lakeshore Foundation
- Mesa Association of Sports for the Disabled
- National Center on Physical Activity and Disability
- National Sports Center for the Disabled
- National Wheelchair Basketball Association
- The Steadward Centre for Personal & Physical Achievement (was Rick Hansen Center)
- United States Adaptive Recreation Center (USARC)



- United States Power Soccer Association
- United States Quad Rugby Association (official)
- Wheelchair Sports, USA
- Winners On Wheels (WOW)

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