



THE VALUE OF SPORT FOR CHILDREN WITH CEREBRAL PALSY: BEYOND THE "MOST ADAPTABLE" ACTIVITIES

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ABSTRACT

Cerebral palsy is a group of permanent disorders impacting movement and posture caused by abnormal development of the brain or damage to the developing brain. While cerebral palsy can present in a variety of ways, the disorder is commonly classified by the following movement disorders: stiff muscles (spasticity), uncontrollable movements (dyskinesia) and poor balance and coordination (ataxia). As the most common motor disability in childhood, cerebral palsy significantly impacts how a child is able to engage in recreational activities and sports. This review examines four adapted sports including: wheelchair fencing, cycling, alpine skiing, and archery, in addition to two sports originally created for individuals with cerebral palsy: boccia and frame running, to consider the value in providing unique opportunities to engage in physical activity to children with cerebral palsy. In this review, there was evidence in support of these less-discussed and less common adaptive sports in their ability to increase the physical activity options available to individuals with cerebral palsy, to contribute to one's physical therapy goals, provide opportunity to work alongside one's peers and to increase the overall mobility of individuals.

INTRODUCTION

Cerebral palsy is a group of permanent movement disorders caused by abnormal development of the brain or damage to the developing brain before birth, during birth or within the first few years of a child's life (1). Cerebral palsy impacts a child's ability to control their muscles and is the most common motor disability in childhood, with a reported prevalence estimate of 1 to 4 cerebral palsy cases per 1,000 children (1,2). The

The symptoms of cerebral palsy can vary between individuals, and are classified by the following movement disorders: stiff muscles (spasticity), uncontrollable movements (dyskinesia) and poor balance and coordination (ataxia) (1). While cerebral palsy is developed in early childhood, it is a permanent, non-progressive disorder (3). Adults with cerebral palsy experience similar symptoms, as well as premature aging due to increased levels of energy strain (3). Comorbidities can include intellectual disability, seizures, problems with vision, speech or hearing, and scoliosis (1).

In 2020, the World Health Organization (WHO) updated the physical activity guidelines for children to an average of 60 minutes per day of moderate to rigorous exercise (4). This update included sections tailored to various populations, such as individuals with chronic conditions and disabilities (4). As a whole, physical activity can promote social inclusion, improve mental health, optimize physical functioning and enhance overall well-being (5). Children with cerebral palsy experience varying levels of impaired movement, which can present unique challenges to participating in physical activity independently and with peers. Compounded by the lack of encouragement and limited opportunities to engage in competitive sport, or more generally, exercise, children with cerebral palsy are more likely to engage in sedentary activities—leading to a higher prevalence of obesity and social isolation (6). To compare, children with disabilities are 40% more likely to be obese than typically developing children, often comorbid with adverse cardiovascular diseases such as hypertension and stroke (6).

The benefit of engaging in sport and physical activity has been established in the literature, however, in the efforts to make sports accessible to children with physical disabilities, there remains barriers that prevent participation. Some barriers are common to a larger

population, disabled and not, such as perceived limited time to dedicate to sport participation. Other barriers selectively impact individuals with physical disabilities based on individual, social, or environmental factors (7). At the individual level, barriers to participation can include: pain or fear of pain or lack of knowledge regarding what activities can be adapted to their unique needs (7). Social level barriers include lack of parental support, lack of opportunity, transportation, lack of friends, and social stigma (8). Environmental barriers include lack of space and accessibility concerns (ramps, auditory signals) (7). While investigating these factors in depth is beyond the scope of this article, it is important to remember that these factors do not exist in isolation and shape one's attitudes surrounding sports for children and individuals with physical disabilities (7). In this review, a select number of sports will be considered for the purpose of identifying the ways in which sports are adapted, how they serve individuals with cerebral palsy in childhood and advancing in age into adulthood. To accomplish this, adapted versions of common sports in addition to sports specifically designed for individuals with cerebral palsy and other physical impairments will be discussed—including background information of the sport, how it is played, what relevant equipment there is, and what benefits and risks are associated with the sport in the context of cerebral palsy.

ADVANCEMENTS IN ADAPTIVE SPORT

In the following subsections, we highlight major advancements in adaptive sport through the lens of impact on children with cerebral palsy. The term *adaptive sport* refers to any competitive or recreational sport designed or suitable for persons of varying disabilities. Wheelchair fencing, cycling, skiing, and archery were selected for this review based on the availability of information in the peer-reviewed literature, the differences in types of movement and how the sports could be suitable to persons of different mobility levels (as to have considerations for persons with different types of cerebral palsy), and the opportunity to participate in the sport recreationally and also competitively (as this is a significant aspect of sports participation and following in broader society and influenced the amount of available information).

Wheelchair sports are one type of adaptive sport that has been developed out of a need to provide persons with disabilities opportunities to improve their physical fitness, and evidence has continuously supported that they enable children and other individuals to increase their cardiovascular fitness (9). Despite this, there is a paucity of research considering the implications and potential health benefits for children with disabilities engaging in power wheelchair sports, especially for individuals with cerebral palsy. Considering the potential benefits and risks of these select sports is important to be able to provide disabled persons with the necessary information to navigate their options for sports and

physical activities generally. Furthermore, since the number of children with cerebral palsy estimated to use wheelchairs or walkers is 31–41%, and 50% for adults with the condition, there is a significant need to discuss wheelchair based sports. This discussion needs to include not only one's physical ability but also their desired therapeutic goals, personal preferences, and enjoyment of the sport (10,11).

I. Wheelchair Fencing

The number of sports that have been adapted for the use of walkers and wheelchairs is extensive, however only some have been developed enough to reach professional levels of competition including basketball, rugby, tennis, curling, and fencing. Fencing is one of such sports that has gone on to reach professional levels of play. It is a combative sport involving sword fighting, has an extensive history with the sport having been refined by the Italians in the 16th century and further defined by the French in the 17th century. Today, the sport has three different weapons each having their own style of offense, defense, and associated rules.

The adapted version of the sport, known as wheelchair fencing, remains an energetic and fast-paced sport. First introduced at the International Stoke Mandeville Games in 1954 for athletes with amputations, spinal cord injuries, and cerebral palsy, wheelchair fencing maintains the challenge of mastering technique and accuracy, power, speed, strength, and coordination whilst the competitors remain largely seated (at most, one buttock is allowed to be lifted during play) (12). While movement of the arm in fencing remains the same for the three styles in this adapted version, there is greater focus on attacks, counter-attacks, and defensive movement with the weapon hand—meaning that athletes with significant impairments in the legs are able to fence from the seated position. In wheelchair fencing there exists specific rules to ensure fairness in competition such as allowing pauses in play for the competitors to fix their positioning in their wheelchair or to pause for a moment due to a disability-related event, such as muscle spasms that occur in cases of dyskinetic cerebral palsy causing uncontrollable movement (12). Additionally, the International Wheelchair and Amputee Sports Federation, which governs the rules and regulations of the sport, allows special devices or attachments on weapon handles to improve the functionality for players with mobility challenges of the arm, as is the case for some athletes with cerebral palsy (12).

Wheelchair fencing provides disabled athletes with a unique opportunity to engage with a highly individual sport. The unique value of wheelchair fencing has been expressed in news articles and other personal stories shared online by athletes with cerebral palsy and other physical disabilities. Some common themes found included pride in being able to compete as an individual without another person directly helping them to move during a fencing match, enjoyment of the mental and physical challenge of the sport, and how the allowance

of short breaks suited their individual needs. Ultimately, wheelchair fencing offers greater opportunity for physically disabled athletes to be independent compared to some other adapted sports as athletes are able to wield their blade without someone else facilitating their movement and all parties must follow the same rules of play (with able-bodied fencers also sitting in a wheelchair to fence this adapted style). Wheelchair fencing has the ability to be integrated into some traditional fencing tournaments, provided there is specialized equipment, however, the International Wheelchair and Amputee Sports Federation has a Wheelchair Fencing sub-organization that hosts a variety of tournaments including World Cup tournaments for physically disabled fencers (13). However, there are other considerations with the sport. Fencing trains both able-bodied and disabled athletes in an uneven way, with one arm being largely responsible for all movement and bladework. Upper body functional asymmetry can be an issue for these athletes and consequently additional focus on addressing the range of motion and strengthening the upper body is necessary to avoid injury from repetitive overuse (11).

II. Cycling

Cycling is a sport that offers a wealth of health benefits including improved cardiovascular health, coordination, balance, joint motion, and core strength (14). The pursuit of these benefits has contributed to the increasing demand for adapted cycling in therapeutic and recreational settings for children with cerebral palsy (14). In addition to facilitating exercise, biking allows children to engage in social adventures with family and friends, fostering a sense of inclusion, independence, and confidence (15). For some cultures, it is even considered to be a rite of passage in childhood.

The use of adaptive equipment is a major consideration when facilitating participation in sports for children with cerebral palsy (15). Adaptive bikes are highly customizable for the individuals and their specific mobility needs, a primary consideration for children with cerebral palsy. The main types of adaptive bikes include tricycles, handcycles, recumbent bikes, and tandem bikes (16). Tricycles, having one front wheel and two at the back of the bike, can offer extra stability and may include additional accommodations such as self-leveling pedals, modified handlebars, wheelchair-style seating, or wrist straps (16). Handcycles are ideal for children with limited leg mobility, in which they are powered by the arms while still allowing pedal use to encourage lower body movement (16). Recumbent bikes provide support to the rider's buttocks and back by reclining their weight and distributing over a large area to reduce muscle strain (16). Lastly, tandem bikes can allow parents to accompany their child to distribute the responsibilities of pedaling and steering (16). The development of adapted bike programs including services such as free bike maintenance, individualized fitting and adaptations, and "exchange as you grow" opportunities has increased accessibility to the sport substantially (17).

III. Skiing

Adapted alpine skiing was developed as a specialized form of therapy to accommodate the unique needs of children with cerebral palsy. This innovative therapy utilizes modified equipment and techniques to allow children with cerebral palsy to experience the physical, social, and emotional benefits of skiing while being assisted by an aid (18).

Regular skiing requires the use of both upper and lower body strength, as well as balance and coordination. However, children with cerebral palsy may have difficulty meeting these requirements, due to gross motor skill limitations (18). Adapted skiing utilizes specialized equipment, such as sit-ski devices and outriggers, to provide support and stability for children with cerebral palsy. These devices allow children to sit while skiing and use their upper body strength to propel themselves down the mountain, the outriggers are short ski like boards attached to the arms which help stabilize the sitting skier, as they move down the slope. (18). Additionally, instructors are trained to use specific techniques, such as weight shifting and pole use, to help children with cerebral palsy maintain balance and control their speed (18).

Competitive variants of adapted skiing and snowboarding are featured in the Paralympic Games. This provides an avenue for athletes to move into competition from leisure. It is important to note that the therapeutic elements remain, even under more strenuous circumstances. (19). The physical benefits of adapted skiing include improved balance and coordination, muscle tone and strength, and endurance. Adapted skiing programs have also been shown to improve social skills and self-esteem in children with cerebral palsy (20). Social isolation is a common issue for individuals with cerebral palsy, as their physical limitations may make it difficult for them to participate in mainstream activities. Adapted skiing programs provide a safe and supportive environment where children with cerebral palsy can participate in a mainstream activity and interact with their peers. This can lead to improved communication skills, an increase in self-esteem and confidence, and an overall enhancement of their sense of belonging (20). Adapted skiing programs have been found to have a positive impact on the emotional well-being of children with cerebral palsy. Participation in adapted skiing has been found to improve mood and reduce symptoms of depression. This is important as individuals with cerebral palsy may experience emotional challenges due to their physical limitations and social isolation (20).

However, socio-economic factors can restrict access to adapted skiing programs. Adapted skiing programs can be expensive and not all families can afford them. Some children with cerebral palsy may live in areas without accessible ski resorts or adapted skiing programs. Therefore, it's important to consider these factors when discussing the efficacy of adapted skiing for children with cerebral palsy (21).

IV. Archery

Archery is a target sport which focuses on developing hand-eye coordination, strength, and balance (22). Coordination and maintenance of postural control requires integration between the sensory, nervous, and muscular systems which can sometimes be a challenge for children with cerebral palsy (23,24). Strength or resistance training such as drawing the bow in archery has also been shown to counteract muscle weakness, a common symptom of children with cerebral palsy, as well as increase independence in everyday activities (24,25). In addition, active stretching or active-assisted stretching in archery improves flexibility and muscle range of motion, additional goals when it comes to improving the functional ability for an individual with cerebral palsy (24).

Archery can be played either seated or standing up, allowing participation despite a variety of mobility levels (26). This allows children with cerebral palsy, including those with wheelchairs, to be included in the sport and play alongside others, making it one of the easiest sports to adapt for people with physical disabilities and for the purposes of competitive sports (26). In fact, Para-archery was included in the inaugural Paralympic games (26). Currently, in competitive archery, the sport can be played while seated, in a wheelchair, or standing as well as with various types of bows (26). Being able to play alongside others as in archery offers multiple social-emotional benefits such as a sense of belonging, increased confidence and self-efficacy as well as opportunities to develop meaningful connections with other children (27,28). Archery can be adapted for children with cerebral palsy in different ways depending on the ability and needs of the athlete. Adaptations include assistive devices such as a wheelchair or customized glove or the use of other body parts (ie. feet or mouth) to hold the bow/arrow. These can be beneficial for children with ability limited to one side of their body or decreased functionality of certain limbs.

Additionally, there are various types of bows which also accommodate the athlete such as the longbow, recurve bow, and the compound bow (29). The longbow is a curved bow (C-shaped) strung from both ends (29). This design requires the most force to draw an arrow (29). The recurve bow is similar to the longbow but with slightly curved ends, a design which allows for more powerful shots (30). Thus, the recurve bow is more commonly used in competitions for disabled players with less grip or muscle strength which may be beneficial for certain types of cerebral palsy although many players are also able to play with the longbow, which is more traditionally used (30). Finally, the compound bow includes a series of cables and pulleys to allow the archer to draw the bow with little force. Once the bow is drawn, the arrow is held in place (30). At this point, the archer may focus on the accuracy of the shot (29). Thus, both the use of assistive devices to aid the athlete and the variety of bows to offer benefits to the athlete allow for the adaptability of archery for children with cerebral palsy.

The shared experiences and aspects of identity that are involved in communities centering disability have been able to produce positive changes in relation to emotional regulation and physical functioning, as seen with the countless number of adapted sports and therapies that have been developed. There are two sports now enjoyed by a variety of individuals of different physical abilities that were initially designed for individuals with cerebral palsy: boccia and frame running. Boccia is a paralympic sport that can be enjoyed recreationally and is similar to curling or lawn bowling, where one propels their ball towards a target ball (31). The closest ball to the target ball at each end (of which there are 4 or 6 ends in a game, where each side has 6 balls to throw) ends up scoring a point. Boccia is easily adapted to players of different mobility levels as the balls can be thrown, rolled, kicked or moved with the aid of a ramp. Boccia has been noted to be of particular benefit for children with cerebral palsy, as it requires coordination of the extremities, thought and strategy, teamwork (when working in pairs or a group of three as allowed), and emotional control (32). Since children with cerebral palsy can have difficulty with hand and tension control, throwing a bocce ball allows them to work on improving neuromuscular functions for hand control as an alternative to traditional therapies (32). As the physical act of throwing the ball requires further coordination between hand, wrist, and shoulder and throughout the game, children must also stabilize their torso and work on hand-eye coordination. These specific areas can be beneficial for children with cerebral palsy looking to develop their coordination and balance. While individuals with cerebral palsy may need more time to prepare and throw their balls compared to able-bodied individuals, it remains a sport that is highly suited to their unique mobility needs, can be further adapted, and has benefit for the physical therapy directives for children.

Frame running, previously referred to as Race Running, was invented in 1991 by the occupational therapist, Connie Hansen alongside Mansoor Siddiqi, a para-athlete with cerebral palsy (33). Instead of using a traditional wheelchair, frame running includes the use of a PETRA frame runner, a three-wheeled device that resembles a tricycle without pedals. This device supports the athlete while running and can reduce the physical impact associated with running. While the PETRA device was originally designed as an alternative for individuals with cerebral palsy, it has since been employed in a variety of applications for people with different mobility challenges (34). There has been limited exploration of the adoption of frame running for children with cerebral palsy despite its potential, especially considering that many physical activities and sports in school settings are based around running (35). A study that reviewed a 12-week running

intervention in 43 children with cerebral palsy found significant improvements in running ability and inclusion in physical education—establishing that this sport has potential for further development, research, and implementation for the benefit of children with cerebral palsy (35).

DISCUSSION

I. Future Developments of Sport

There have been many developments in recent years that allowed for children with cerebral palsy to become meaningfully involved in sports. For example, in the past, children with physical impairments or cerebral palsy which would prevent them from participating in sport would be given non-active special assignments such as towel boy or water girl which does not actually give them a chance to participate in the sport (36). Sometimes the child would be given the opportunity to play only at the very end, again, preventing them from engaging in the sport alongside their peers (36). As mentioned, there have been competitive adaptations of games for children with cerebral palsy and sports that have also been developed for children with cerebral palsy such as frame running and boccia ball (37). Currently, there are other sports in development such as Wheelchair Slalom, which involves navigating a wheelchair through an obstacle course (38). However, while sports have been adapted and created for people with cerebral palsy there is still a need for greater implementation of these sports in school and community environments to increase awareness, accessibility, and inclusivity of physical activity for disabled persons. Sport is not accessible if it cannot be enjoyed by all, regardless of physical ability and level of competition from professional athletes to those who engage in recreational sports—sport is of benefit to all.

I. Future Developments of Research

The experiences of an athlete partaking in adaptive sports cannot be fully described by using traditional means of research. Studying disability has often taken a medical or social approach. The medical approach seeks to analyze the symptoms and signs of disease, equating health to a lack thereof. The social approach analyzes social determinants of health, and incorporates many environmental elements, such as social factors producing inequities. These approaches are limited by a lack of understanding of the patient's experience of disability. As a result, alternative approaches have been proposed to tackle these issues. One promising approach in this area is the phenomenological approach. Phenomenology, as a qualitative research approach, can be used in conjunction with more traditional data acquisition techniques, such as quantitative methods, to provide a more comprehensive understanding of the experiences of individuals living with cerebral palsy (39). The data acquisition process in phenomenological research also differs from the medical and social approach, as it relies on in-depth interviews,

observations, and personal narratives, and interpretive analysis of the data to understand the meaning and significance of the individual's experiences (39). This research employs a hermeneutic approach, involving interpretive analysis of the data to understand the meaning and significance of the individual's experiences.

One example of how phenomenology can be used in conjunction with quantitative methods is by combining it with surveys or standardized assessments (40). Surveys can provide objective data on the severity of symptoms and functional abilities of individuals with cerebral palsy, while phenomenological interviews can provide in-depth, subjective data on their personal experiences and perceptions of their condition. This approach combines both qualitative and quantitative methods in a single study, allowing for the triangulation of data from multiple sources, which can increase the validity and reliability of the findings (40). Combining this data can provide a more comprehensive understanding of the impact of cerebral palsy on an individual's daily life, including both the objective challenges they face and the subjective ways in which they cope with those challenges (41). Phenomenological research provides valuable insights into the socio-emotional impact of cerebral palsy on individuals by emphasizing the subjective experiences and perspectives of those living with this condition. Additionally, their perceptions of their own bodies, their experiences with medical treatments and therapies, and their interactions with family and friends is a key point of focus (41). Phenomenological research can also explore how cerebral palsy affects an individual's sense of self and identity, including how they perceive their own abilities and limitations and how they deal with the social and emotional challenges of living with a physical disability. This could be exceptionally valuable in the context of sport, where individuals living with cerebral palsy can be pushed to their social, emotional and physical limits.

CONCLUSION

As highlighted in the range of physical activities and sports covered in this article, just as for 'typically' developing children, children with cerebral palsy benefit from having access to a variety of movement-based opportunities. The value of engaging in sports for this population is numerous, as synthesized in this review. Adapted sports can provide more engaging alternatives for physical therapy, allow for increased participation in school and community settings, and serve as a lower-impact option for those with limited mobility. Additionally, adapted sports provide opportunities for youth with cerebral palsy to practice strategic thinking, exercise independence, and interact with others in different contexts. Further investigation into the specific therapeutic benefits of many of these adapted sports is necessary to inform

healthcare professionals and children with cerebral palsy and their parents in choosing which sports to participate in based on their specific needs and goals. This review considered sports that are not able to be performed everywhere or without costly adaptive equipment. Further work to address such barriers to participation in sports is essential to providing kids with physical limitations the same access to play as their able-bodied peers.

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