THE ATHLETE WITH SPINAL CORD INJURY

– Written by Jan Lexell, Sweden

Physical activity, exercise and sport are important components of chronic disease prevention and health maintenance[1]. They are well-known to be associated with health benefits and to reduce the risk of several chronic diseases, such as osteoporosis, cardio-vascular diseases, metabolic syndrome and cancer.

For people with physical disabilities such as spinal cord injury (SCI), it is equally important to be physically active to improve and maintain health[2]. The positive effects of physical activity, exercise and sport for people with disabilities extends to physical, as well as mental health, while also influencing a person's self-concept, self-esteem, self-perceived physical appearance, global self-worth and ultimately their life satisfaction.

Physical activity, exercise and sport have, over the past century, engaged people with a variety of disabilities. Historically, people with SCI have been part of the evolution of sports for people with disabilites and the Paralympic Movement[3]. Thus, people with SCI are central to our understanding of the impact of physical activity (i.e. any movements of the body that require energy) and exercise (i.e. planned, structured, repetitive movements designed to improve fitness) for people with physical disabilities, as well as how to engage this population in such health maintenance activties, the importance of organised sport and last but not least, their involvement in elite sport[4].

THE IMPACT OF SPINAL CORD INJURY

Every year between 250,000 and 500,000 people globally acquire a traumatic SCI[5]. This corresponds to approximately 40 per million individuals in North America and 16 per million individuals in Western Europe, where reliable statistics are available. The most common causes of SCI are traffic accidents and falls.

As a result of an SCI, there is a complete or partial loss of motor and sensory function below the lesion, accompanied by short-term and long-term effects on bowel, bladder and sexual function, as well as the potential for neuropathic pain, spasticity, autonomic dysfunction, altered body composition and secondary health conditions such as osteoporosis, type 2-diabetes and cardiovascular disease. Many of these remaining impairments affect the person's ability to engage in daily life and also influence community participation in general and more specifically in physical activity, exercise and sport.

Advances in acute treatment, care and rehabilitation over the past decades have improved survival after SCI and increased longevity. Yet, life expectancy is lower than in the non-injured population, due to higher mortality rates among people with severe SCI and those injured at older ages. In this context, however, it is important to note that living with an SCI does not preclude good health and social inclusion. By ensuring medical and rehabilitative care and long-term follow-up, adequate community services, prescription of mobility aids and accessible environments, persons with SCI can reach and maintain a relatively high level of physical independence and are generally satisfied with their lives, regardless of gender, age or time since injury[5].

Figure 1: Wheelchair basketball involves many athletes with a spinal cord injury Photo: Martin Nauclér.

PHYSICAL ACTIVITY FOR PEOPLE WITH SCI

With regard to physical activity, people with SCI are among the most inactive in society[6]. This is particularly evident among older adults with long-term SCI, where many do not reach the amount or intensity needed to achieve fitness benefits[7]. Therefore, engaging this population, young and old, in physical activity and exercise can improve many aspects of health and quality of life. Indeed there is considerable evidence that physical activity can improve physical capacity in people with SCI.

Leisure time physical activity (LTPA) is the form of physical activity mainly associated with health and fitness benefits in this population. LTPA includes activities performed during free time, such as sports, recreational activities, walking and wheeling and is distinguished from activities of daily living. Accordingly, habitual LTPA is often recommended in health interventions for people with SCI.

In 2011, a Canadian team led by Professor Kathleen Martin Ginis was the first to present SCI-specific physical activity guidelines[8]. These guidelines[9] apply to all healthy adults with chronic spinal cord injury, traumatic or non-traumatic and inclusive of both tetraplegia and paraplegia. They are available in 13 different languages and have been distributed and taken up internationally. Importantly, the guidelines are the only evidence-based, SCI-specific physical activity guidelines that have been developed using a rigorous and systematic process.

During this process, researchers and clinicians, as well as people with SCI were engaged, resulting in the following overall guideline: "For important fitness benefits, adults with a spinal cord injury should engage in at least 20 min of moderate to vigorous intensity aerobic activity two times per week and strength training exercises two times per week[9]."

The guidelines also provide examples of ways to reach these goals. With regard to aerobic capacity, upper body exercises can include wheeling, arm cycling and various sports activities. Lower body exercises for those with an incomplete SCI and partial function in the lower limbs can include body weight supported treadmill walking, cycling and water exercises. With regard to strength training, the goals can be reached by using free weights, elastic resistance bands, cable pulleys and weight machines. As a safe progression towards meeting the guidelines it is appropriate to start with smaller amounts of physical activity and gradually increase how long, how often and how hard the person engages in physical activity.

A limitation, however, is that the current guidelines only provide recommendations for the amount of physical activity needed to obtain fitness benefits, such as increased VO_2 max and improved muscle strength. Given the considerable increase in SCI research over the past 5 years, evidence is now emerging regarding the effects of physical activity on body composition, cardiovascular risk and bone health in people with SCI[10]. Therefore, the evidence-based, SCI-specific physical activity guidelines are being updated and will emerge later this year. However, further research is needed to understand the impact on mental health and different SCI-related secondary health conditions in detail and thereby allow further developments of the evidence-based guidelines.

Figure 2: Alpine skiing for people is an example of adapted sports for athletes with a spinal cord injury. Photo: Karl Nilsson.

ORGANISED SPORTS FOR PEOPLE WITH SCI

Participation in competitive and non-competitive organised sport, regular as well as adapted sport, is one way for people with SCI to engage in regular physical activity and exercise (Figure 1). A recent narrative review summarised current evidence regarding the impact of organised sports on activity, participation and quality of life in people with neurological disabilities of all ages and discussed facilitators of and barriers to participation in sports for this population[11]. Interestingly, almost all reviewed studies, regardless of age, were on individuals with SCI. Thus, much of what we surmise regarding the impact of organised sport on individuals with diasbilities more broadly comes from studies of people with SCI. The reviewed studies consistently described that children and adolescents with SCI who engaged in organised sport reported self-concept scores close to those of able-bodied athletes, as well as higher levels of physical activity. Adults with SCI who participated in organised sports reported decreased depression and anxiety and increased life satisfaction, compared to non-athletic individuals with disabilities.

One study is of particular interest. Blauwet et al[12] investigated the association between sports participation and employment using a self-authored questionnaire. The study included as many as 149 participants, who were both military veterans and non-veterans with SCI. The authors reported that participation in organised sport was significantly associated with a higher rate of employment, even when adjusting for demographic factors. This implies that sports participation is more important from a personal and societal perspective than just participation in physical exercise and is another incentitive to encourage participation in organised sport among people with SCI.

Another qualitative study of seven individuals with SCI[13] described the benefits of organised sport from an insider's perspective of the persons themselves. The participants described facilitators through sport, such as socialisation, acquisition of knowledge from others, development of greater awareness of health and well-being issues, weight maintenance, functional development and independence. Some participants also expressed that they gained motivation by observing other individuals with SCI who participated in sport and had higher functional independence than themselves. Another important factor was the ability to show ones competence through sports participation and thereby provide purpose by redefining oneself.

Thus, it is clear that organised sport can serve as an effective complement to traditional SCI mangement and general healthcare. Participation in organised sport is thought to be fun and inviting, providing comradeship and social fellowship. It is therefore important to further strengthen the development of sports for people with SCI.

THE ELITE PARA ATHLETE WITH SCI

The Paralympic Movement

Organised sport for people with physical disabilities is closely linked to the post-war era at the Stoke Mandeville Hospital in Great Britain3. At the end of World War II, Ludwig Guttmann, a German-born neurosurgeon became the Director of the National Spinal Injuries Centre at Stoke Mandeville. Doctor Guttmann was a firm believer that participation in sport could improve patients' physical and psychological wellness. He coined the following phrase: "sport is the most natural form of remedial exercise, restoring physical fitness, strength, co-ordination, speed, endurance and overcoming fatigue". He also stated: "sport has a psychological impact of restoring pleasure in life and contributing to social reintegration". Although Paralympic sport has evolved from a tool for rehabilitation to now being considered elite sport, these principles still apply when considering the broad impact of the movement.

In 1948, the hospital organised the first Stoke Mandeville Games (archery competition) for 16 British war veterans, many of them with SCI. Four years later, the games became international and thereafter competitions for athletes with disabilities grew rapidly and the first Paralympic Games took place in Rome, Italy in 1960. At the beginning, athletes with SCI participated. During the 1976 Paralympic games in Toronto, amputee and vision-impaired athletes also took part. Since 1988, the Summer and Winter Paralympic Games have been held in the same city and immediately after the Olympic Games. Today, the Paralympic Games is the third largest athletic event worldwide and during the most recent games in Rio de Janeiro, Brazil, 4350 athletes from more than 160 countries competed.

Figure 3: Wheelchair rugby is a sport specifically created for people with impairments of the upper and lower extremities, thereby being suited for athletes with a cervical spinal cord injury. Photo: Martin Nauclér.

Different type of sports engaging people with SCI

Many of the 22 different sports that are currently part of the Paralympic Games were originally created for people with SCI and still involve many athletes with SCI. Sports like basketball (Figure 1), fencing, curling, tennis, shooting and athletics are performed in a wheelchair, using basically the same rules as for non-disabled athletes. Other sports, such as cross-country skiing and alpine skiing (Figure 2), are performed with specific equipment tailored for people with SCI. There are also sports that have been created for athletes with disabilities, among them those with SCI. Two such sports are wheelchair rugby (Figure 3) and sledge hockey, which engage both athletes with SCI as well other disabilities.

Medical issues in athletes with SCI

Athletes with SCI may experience medical issues that can interfere with their sports participation. It is therefore important that these issues are well-known to the team physician and accompanying entourage, allowing for preventative measures to be built into the athlete's sports preparations and medical care before, during and after any games.

> ***Adults with SCI who participated in organised sports reported decreased depression and anxiety and increased life satisfaction, compared to non-athletic individuals with disabilities***

One specific medical and physiological issue is autonomic dysreflexia (AD). This is an acute attack of uncontrolled sympathetic nervous activity that is characterised by a sudden rise in blood pressure, headache, flushing and sweating. It can occur in individuals with a lesion above the sixth thoracic spinal cord level and is caused by a noxious stimulus below the lesion, for example a full bladder or skin wound. Autonomic dysreflexia can be life-thretening given the accompanying acute rise in blood pressure with a risk for hypertensive emergency.

Autonomic dysreflexia has also been recognised in Paralympic sports given its potential for performance enhancement. In wheelchair sports, it has been reported that an athlete may intentially induce AD, for example by stimulating a full bladder, with a resultant increase in blood pressure, stroke volume and peak heart rate. This, in turn, may result in a 10% improvement in physical performance. This effect, referred to as 'boosting', is forbidden and strictly banned by the International Paralympic Committe (IPC). Since 2008, the IPC Medical

> ***Athletes with SCI who compete in wheelchair sports that involve throwing or repetitive wheelchair propulsion are at risk for shoulder injury. Athletes with a high cervical lesion, which affects their upper body muscle function, are particularly at risk.***

Committee has therefore been recording blood pressure in athletes susceptible to AD prior to events in certain sports. Ongoing work by the IPC Medical Committe and data recorded during this boosting monitoring programme provides information regarding how to detect athletes who may be at risk of developing AD and thereby work towards the prevention of boosting in Paralympic sports.

Other medical factors to take into consideration include hydration for training, competition and recovery, and the impact of multi-time zone travel. Athletes with SCI, particularly those with a cervical injury, may have an impaired ability to sweat below their injury level, putting them at risk for impaired thermoregulation. In addition, they also have an impaired sensitivity to cold, leading to a loss of thermal autoregulation. This in turn can cause poikilothermia, where people with SCI can have increased core body temperatures in warm climates and lowered in cold environments. It is therefore important to implement proper cooling and heating strategies during athletic events in hot and cold climates.

Long-distance travel, including getting on and off an aircraft and time spent en route, can affect athletes with SCI. The risk of pressure ulcers increases, and lower-estremity swelling and the risk of deep venous trombosis requires specific attention. Also, athletes with a neurogenic bladder who normally use clean intermittent catherisation need to plan for their bladder emtying during long-distance flights, noting that assistance may be required to get to and from the toilet in-flight.

People with SCI may have specific medications to treat SCI-related secondary health conditions. It is therefore important to know which medications that are prohibited under the World-Anti-Doping Agency (WADA) Code and the IPC Anti-Doping Code, which may require a Therapeutic Use Exemption (TUE). Examples of such medications are desmopressine (antidiuretic hormone), glucocortocoids and beta-agonsists (anti-asthma medication). Of specific concern are beta-blockers used for the treatment of hypertension, which are prohibited in precision sports such as archery and shooting. In essence, few, if any athletes with SCI can obtain a TUE for this medication when competing in archery and shooting.

Injuries and illnesses in Paralympic sports

The growth in size of the Paralympic Games has been accompanied by a dramatic rise in the level of competition. Athletes are training more intensely than ever before. This has led to an increase in injuries and illnesses14, which, in turn, has increased our awareness of the potentially detrimental and long-lasting effects of elite sports for people with disabilities. Over the past decade, the IPC Medical Committee has successfully implemented an epidemiological surveillance system during the Paralympic Games15,16. This has led to an increased understanding of specific patterns of injuries and illnesses in various sports and among athletes with different types of disabilities.

For athletes with SCI, we can identify a pattern of injuries and illnesses based on the epidemiological studies from the recent Paralympic Games[15,16]. Typical non-sports-related illnesses include those related to skin and subcutaneous tissue (e.g. pressure ulcers) and infectious diseases (e.g. urinary tract infections). Reasons for the higher incidence are prolonged immobility and seating combined with reduced or lack of cutaneous sensation. Athletes with SCI acquire pressure ulcers as a result of ischaemia from capillary bed occlusion, in particular over the bony areas that are exposed to long-term pressure, for example the buttocks. Using tightly-fitting sports equipment in combination with sweating when the skin becomes moist can put athletes with SCI at a particular risk. Adequate skin care, together with appropriate positioning and seating support in wheelchairs and optimal skin hygiene where the athlete is attentive to skin breakdown, can reduce the incidence of pressure ulcers.

With regard to urinary tract infections, data from the London 2012 Paralympic Games[15] show that more than 75% of these infections occurred in athletes with SCI. It is very well known that people with SCI are much more prone to urinary tract infections as a result of their neurogenic bladder and catheter use. Today, many people have access to sterile, clean disposable catheters, which reduce the risk for urinary tract infections when used under normal circumstances. However, travelling, being in new environments and having difficulties with hygiene, put an athlete with SCI at increased risk of urinary tract infection. One should also remember that during large sporting events, not every athlete might have access to modern sterile, clean

disposable catheters and instead reuse their disposable catheters – increasing the risk of infection.

The most common musculoskeletal injury in athletes with SCI is to the shoulder. Athletes with SCI who compete in wheelchair sports that involve throwing or repetitive wheelchair propulsion are at risk for shoulder injury. Athletes with a high cervical lesion, which affects their upper body muscle function, are particularly at risk. For these athletes, sports activities added to their daily routines can place them at a particularly high risk for upper extremity overuse injuries. Thus, to plan for a successful sports career for these athletes, specific shoulder prevention programmes based on knowledge of their SCI, their sports activities and all their other daily activities are essential.

CONCLUSION

Physical activity, exercise and sport have played an important role for people with SCI over several decades. Current knowledge indicates important benefits of regular physical activity, with improved cardiovascular and musculoskeletal health. Engaging people with SCI in organised sport can have additional positive effects and thereby serve as an effective complement to traditional SCI mangement. With the development of the Paralympic Movement, athletes with SCI are at the forefront of elite para sport. Thus, for the healthcare sector, as well as society in general, it is important to organise physical activity, exercise and sport in such a way that the barriers experienced by people with SCI can be reduced and that we are attentive of facilitators that will increase their participation.

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Jan Lexell M.D., Ph.D.

Professor of Rehabilitation Medicine, Senior Consultant

Department of Health Sciences, Lund University

Department of Rehabilitation Medicine, Skåne University Hospital

Lund, Sweden

Department of Health Sciences, Luleå University of Technology

Department of Rehabilitation Medicine, Sunderby Hospital

Luleå, Sweden

International Paralympic Committee Medical Committee

Contact: jan.lexell@med.lu.se