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ROLE OF PHYSIOTHERAPY IN ADAPTIVE SPORTS IN PEOPLE WITH SPINAL CORD INJURY

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Abstract:

Introduction: According to the statistics, from a modest 400 athletes representing 23 countries at first Paralympic games in Rome (1960), the modern Paralympic games now boats 4,000 athletes from 150 nations and ever increasing global television audience. There are currently 10 Paralympic sports (summer & winter) that involve competition in the form of wheelchair. This review article provides an overview of the evidence that links exercise and sports participation to physical and psychological well-being among people with spinal cord injury. **Aim of the Study:** To encourage exercise and sports participation to promote health and well-being among people living with spinal cord injury. **Method:** A literature study was conducted using PUBMED search. Out of 65,178 papers identified relating to spinal cord injury out of which 999 papers were related to Wheelchair sports and 404 articles on Paralympic sports. **Conclusion:** In discovering the potential of individuals with SCI for getting involved in Physical exercises showed improvement in health parameters including- HDL Cholesterol, Physical Functioning & Independence, overcoming shoulder pain, Respiratory function and Psychological well-being. Hence, sport group should be an inherit part of the rehabilitation process. Also, individual not having access to Physical exercise should be given opportunity to participate in wheelchair mobility training. This may improve the adherence to Physical exercises of individuals with SCI in post-clinical settings.

Keywords: SCI, wheelchair sports, physical exercise, Paralympic games

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1. Introduction

Each year thousands of men and women become disabled due to an accident or illness suffers from Traumatic Spinal Cord Injury, and thereafter uses a wheelchair for locomotion. In 1984, Sir Ludwig Guttman, a neurologist who was working with world war II veterans with spinal cord injuries at Stroke Mandeville Hospital, Aylesbury, UK, began using sport as a part of rehabilitation programmes for his patients and organized the first international sport competition. Since that time, participation in wheelchair sport has grown beyond a method to improve wheelchair user's physical capacity.

Wheelchair sports can increase confidence and self-esteem, and it may provide people with a positive outlook on life. There is a wheelchair sport for almost everyone who wants to participate and for any level of expertise, from novice through Paralympic competition.

Wheelchair athletes need sporting opportunities that nurture, recruit, and develop them through to the national level. They need access to sporting facilities and the community, as well as effective disability sports organizations. Access and support are just some of the challenges that wheelchair athletes and nondisabled athletes do not share.

Due to advancement in wheelchair production/modification, understanding of the classification system, training methods, pushing techniques and psychological aspects of wheelchair sport should help people with disabilities to achieve their sporting dreams at the highest level. Wheelchair sport bridges the gap between sporting excellence to wheelchair sport at a grassroots level.

What began as a rehabilitation exercise has now evolved as one of the largest multisports events- The Paralympic Games.

From a modest 400 athletes representing 23 countries at first Paralympic games in Rome (1960), the modern Paralympic games now boats 4,000 athletes from 150 nations and ever increasing global television audience.

Currently there are 10 Paralympic sports (summer & winter) that involve competition in the form of wheelchair. These range from individual and team sports involving propulsion, such as wheelchair racing and wheelchair basketball, to non-propulsion wheelchair sport, such as fencing and shooting. Some sports have even developed equivalent to wheelchairs that is used for travelling on ice and snow, such as in sit skiing and ice sledge hockey whereby the wheels of the chair are replaced with skies or blades.

2. Sport Classification

Wheelchair sport classification includes a number of disabilities that cause problems with the spinal cord. These include paraplegia, quadriplegia and spina bifida

In general,

- Spinal cord injuries and Wheelchair sport is overseen by IWAS.

- IPC (International Paralympic Committee) handles sports such as athletics, alpine skiing, biathlon, cross country skiing, ice sledge hockey, powerlifting, shooting, swimming, and wheelchair dance.
- International Wheelchair Rugby Federation (since 2010) overseas Wheelchair Rugby.
- Lawns bowls is handled by International Bowls for the Disabled.
- Wheelchair fencing is governed by IWAS Wheelchair Fencing (IWF).

2.1 Three steps of Classification

Athletes are classified by classifiers, who work together in a classification panel of two or three. They are trained and certified by the International Federation. When evaluating an athlete, the classification panels always consider three questions, which are answered through the process of athlete evaluation:

- Does the athlete have an eligible impairment for this sport?
- Does the athlete's eligible impairment meet the minimum disability criteria of the sport?
- Which sport class describes the athlete's activity limitation most accurately?

2.2 Eligible Impairment

The first step in disability sport classification is to determine if the athlete has an eligible impairment. The Paralympic Movement offers sport opportunities for athletes that have an impairment that belongs to one of the ten eligible impairment types identified in the "Policy on Eligible Impairments in the Paralympic Movement."

2.2.1 Impairment types: Explanation

Impaired muscle power: Reduced force generated by muscles or muscle groups, such as muscles of one limb or the lower half of the body, as caused, for example, by spinal cord injuries, spina bifida or polio

Impaired passive range of movement: Range of movement in one or more joints is reduced permanently, for example due to arthrogryposis. Hypermobility of joints, joint instability, and acute conditions, such as arthritis, are not considered eligible impairments.

Limb deficiency: Total or partial absence of bones or joints as a consequence of trauma (e.g. car accident), illness (e.g. bone cancer) or congenital limb deficiency (e.g. dysmelia).

Leg length difference: Bone shortening in one leg due to congenital deficiency or trauma.

Short stature: Reduced standing height due to abnormal dimensions of bones of upper and lower limbs or trunk, for example due to achondroplasia or growth hormone dysfunction.

Hypertonia: Abnormal increase in muscle tension and a reduced ability of a muscle to stretch, due to a neurological condition, such as cerebral palsy, brain injury or multiple sclerosis.

Ataxia: Lack of co-ordination of muscle movements due to a neurological condition, such as cerebral palsy, brain injury or multiple sclerosis.
Athetosis: Generally characterized by unbalanced, involuntary movements and a difficulty in maintaining a symmetrical posture, due to a neurological condition, such as cerebral palsy, brain injury or multiple sclerosis.
Visual impairment: Vision is impacted by either an impairment of the eye structure, optical nerves or optical pathways, or the visual cortex.
Intellectual Impairment: A limitation in intellectual functioning and adaptive behavior as expressed in conceptual, social and practical adaptive skills, which originates before the age of 18.

The presence and permanency of one of the sport's eligible impairments is a prerequisite to participate, but not the sole criterion.

2. Minimum disability criteria

Each sport's Paralympic classification rules describe how severe an eligible impairment must be for an athlete to be considered eligible. These criteria are referred to as minimum disability criteria. Example: maximum height for short stature, or a level of amputation for athletes with limb deficiency.

As a consequence, an athlete may meet the criteria in one sport, but may not meet the criteria in another.

3. Sport class

Once it has been determined that an athlete is eligible, he/she is assessed and placed into a class. A higher number indicates higher functioning (eg., 2-point player is more functional than 1-point player, & so on).This assessment is carried out by a team of members which includes doctors, physiotherapists, sports scientists, coaches, or ex-athletes.

It means that, if different impairments cause similar activity limitation, athletes with these impairments are allowed to compete together. Example, in athletics wheelchair racing events, you will see athletes with paraplegia and leg amputations racing together.

Note: Due to the progressive nature of some impairments and their impact on certain activities, athletes are sometimes classified a number of times throughout their career. Also, when the medical condition of an athlete changes, athletes need to inform the sport and ask for re-assessment.

3.1 Functional classification

Since the 1990s, there has been a move away from many of these sport specific disability type classifications and into a more functional classification system that allows sportspeople with different types of disabilities to compete fairly against each other. This classification system tends to use a number of measures to classify sportspeople

including muscle strength, range of joint movement (ROM), co-ordination, amputation, body height and balance. The importance of these various measures then changes based on sport specific needs.

Bench Test for Disability Sports Classification						
		Full Range of	Paralysis Muscle Test		Range of Movement Dysfunction	
Joint	Movement	Movement	Right	Left	Right	Left
Shoulder	Flexion					
	Extension					
	Abduction					
	External rotation					
	Internation rotation					
Elbow	Flexion					
	Extension					
	Pronation					
	Supination					
Wrist	Flexion					
	Extension					
	Ulnar flexion					
	Radial flexion					
Fingers	Flexion					
	Extension					
	Abduction					
	Abduction					
Trunk	Flexion upper					
	Flexion lower					
	Extension upper					
	Extension lower					
	Lateral flexion					
	Rotation					
Hip	Flexion					
	Extension					
	Abduction					
	Abduction					
Knee	Flexion					
	Extension					
Ankle	Plantar flexion					

Table1: Muscle strength, range of joint movement (ROM) chart

Note: A standard bench press form used for functional classification for wheelchair sportspeople.

3.2 Interpretations of Bench Test

Using the Adapted Research Council (MRC) measurements, muscle strength is tested using the bench press for a variety of spinal cord related injuries with a muscle being assessed on a scale of 0 to 5.

0. no muscle contraction;
1. flicker or trace of contraction in a muscle;
2. active movement in a muscle with gravity eliminated;
3. movement against gravity;
4. active movement against gravity with some resistance;
5. normal muscle movement.

3.3 The NWAA Classification System Based on the Level of Injury

Table 2: National Wheelchair Athletic Association (Nwaa) Classifications & Muscle Movements

Class	Neurological Level	Key Available Muscles/ Movements
1 A	C4-6 (Cervical Spine)	Diaphragm; Trapezius, Levator Scapulae; Rhomboids, Serratus Anterior; Rotator Cuff; Deltoid, Biceps ; Latissimus Dorsi; Supinator, Pronator; Wrist Extension (Partial To Complete)
1B	C7	Triceps (Partial To Complete); Wrist Flexion (Partial); Finger & Thumb Extension
1C	C8	Triceps (Complete); Finger & Thumb Flexion; Finger Abduction/ Adduction
2	T1-5 (Thoracic Spine)	Intrinsic Hand Function; Upper Back Extensors
3	T6-T10	Upper Abdominals; Middle Back Extensors; Trunk Rotation (Partial)
4	T11-L4 (Low Thoracic &Upper Lumbar Spine)	Abdominals (Complete); Trunk Rotation (Complete); Quadratus Lumborum (Hip Hiker); Ilipsoas(Hip Flexion); Hip Adduction; Quadriceps(Knee Extension); Ankle Dorsiflexion (May Be Partial)
5	L5-S5 (Low Lumbar &Sacral Spine)	Gluteus Maximus(Hip Extension);Gluteus Medius (Hip Abduction); Hamstrings (Knee Flexion); Ankle Dorsiflexion (Heel Walking);Ankle Plantaflexion (Toe Walking);Bowel & Bladder Control

4. Sports for Wheelchair Athletes (In Paralympic Games)

A. Summer Sports:

- Basketball
- Rugby
- Tennis
- Softball
- Wheelchair Racing
- Fencing
- Archery
- Athletics
- Broccia
- Cycling
- Equestrian
- Football- 7-a side
- Paracanoe
- Paratriathlon
- Power Lifting
- Rowing
- Sailing
- Shooting
- Swimming
- Table Tennis
- Volleyball

B. Winter Sports

- Alpine skiing program (Alpine skiing & Para-snowboarding)
- Ice sledge Hockey
- Nordic skiing (Biathlon & Cross-country skiing)
- Wheelchair curling

C. Games Other Than Paralympics

- Billiards
- Weight lifting
- Bowling
- Air rifle & Pistol

5. Training Programs for Spinal Cord Injured Athletes

- **Strength (resistance) training:** The importance of resistance training in SCI athletes cannot be overemphasized. The training program should be designed specifically for the individual athlete's sporting event and the progress should be monitored at regular intervals. Specific muscle groups should be trained in movement patterns that simulate those required in competition.
- **Aerobic training:** Aerobic training methods such as arm cranking and wheelchair exercise induce significant gains in peak aerobic fitness and the anaerobic threshold. Optimum training intensity appears to be 60% to 80% of peak heart rate, for duration of 20-30 minutes of continuous activity, 3 to 4 times per week.
- **Anaerobic training:** This area had not been well researched in the SCI population. SCI athletes follow the same principles as those used by able-bodied athletes. Typically exercise :rest intervals of 1:1 to 1:3with work durations between 10 secs to 30 secs will stress the anaerobic system and induce adaptations in this type of fitness.
- **Flexibility:** In the SCI population, muscle spasticity can adversely impact flexibility and thereby influence performance. It is important , therefore, that flexibility training be incorporated into the normal training regimen of SCI athletes. Coaches and trainers should assist the athletes in completing the flexibility exercises of the pertinent muscle groups throughout the entire range of motion.
- **Respiratory Muscle training:** Individuals with SCI, particularly quadriplegics, have compromised lung function. As a result, they have an inefficient breathing pattern during exercise; ie. a high rate of breathing with only small amounts of air exchanged on each breath. Specialized breathing equipment is designed to exercise the breathing muscles. Example, use of breathing bag at a specified frequency for several minutes while remaining seated and hence progressing by giving resistance. Sport performance would indeed improve as a result of respiratory muscle training in the SCI population.

5.1 New developments

Functional Electrical Stimulation (FES) of muscles is a relatively new training technique, in which computer-controlled electrical stimuli enable paralyzed large muscles of the lower limb to contract and relax in such a way so that they can operate exercise equipment such as a cycle or rowing ergometer. Using the larger muscles of the body puts more activity-induced load on the heart, and potentially contributes to improvements in aerobic fitness. This training modality also increases the capacity of the paralyzed muscles to utilize oxygen. It also slows down the rate of bone loss in the paralyzed limbs which occurs over time.

Table 3: Physiological Effects of Aerobic & Strength Training

System or Organ	Effects of Disuse (Physiological)	Effects of Exercise (Physiological Change)	Effects on Performance
Cardiovascular System	• Higher Resting Hr • Lower Cardiac Output • Decreased Circulation	• Increased Absolute Left Ventricular Wall Thickness And Left Ventricular Mass. • Decreased Resting Hr. • Greater Absolute Stroke Volume • More Efficient Cardiac Output & Pulmonary Ventilation • Increased Oxygen Extraction & Delivery To Muscles • Increased Circulation	• Heart Is More Efficient (Pumps Same Output With Lower Beats)
Nervous System	• Suboptimal Coordination • Decreased Emotional State, Possible Depression, & Lethargy	• Increased Activation Of Motor Units In Prime Movers • Increased Emg Responses • Increased Appropriate Activation Of Synergists And Antagonists	• Increased Coordination & Skill Of Movement • Increased Accuracy, Precision, & Balance • Smooth, Flowing Movements • Improved Self-Esteem.
Muscle	• Decreased Muscle Mass (Atrophy) & Strength • Early Onset Of Fatigue	• Increased Muscle Mass (Hypertrophy) • Increased Muscle Endurance • Improved Ability To Generate Muscle Tension (Strength)	• Easier Performance Of Daily Activities • Increased Ability For Wheelchair Propulsion On Varied Surfaces
Connective Tissue/ Bone	• Bone Demineralization (Osteoporosis) • Decreased Pliability Of Tendons & Ligaments • Contractures • Pressure Sores	• Increased Bone Density • Increased Tensile Strength In Tendons And Ligaments • Increased Skin Elasticity	• Decreased Or Elimination Of Pressure Sores • Decreased Incidence Of Injury From Overuse Activities

			• Stabilize & Protect Joints (Ligaments)
Body Composition	• Increased % Body Fat	• Decreased % Body Fat & Increase In Lean Tissue	• Decreased Risk Of Cardiovascular Disease.

Note: Adapted From National Wheelchair Athletic Association, (1990)

Table 4: The Four Phases of Periodization

	Volume (Reps/Sets)	Intensity (Load)	Rest (Minutes)	Frequency (Days/Week)
Muscle Endurance (Hypertrophy)	10+/3-5High	Low	0-2	3-4
Strength	5/3-5Moderate	High	3-4	3-5
Strength-Power	2-3/3-5	Very High	3-4	4-6
Peaking-Maintenance	2-3/1-3	Very High	3-4	1-5
Active Rest (3-4 Weeks After Peaking)	Low	Very Low		2-4 Days Off

Note: Adapted from Kraemer (1984/1985, 1990a) & Stone etal.(1982)

Table 5: Autonomic Nervous System Responses

Organ	Parasympathetic	Sympathetic
Sweat Glands (Thermoregulation)	No Connections	Secretion
Smooth Muscle In Skin	No Connections	Constriction
Blood Vessels In Skin	No Connections	Constriction
Blood Vessels In Skeletal Muscle Of Arm	No Connections	Relaxation
Blood Vessels Of Abdomen	Vasodilation (Increases Blood Flow)	Vasoconstriction (Decreases Blood Flow)
Colon Wall	Peristaltic Contraction	Relaxation
Bladder	Contraction (Emptying)	Relaxation
Sphincter Muscles	Relaxation (Emptying)	Contraction
Heart	Slow Heart Rate & Decreases Metabolism	Increases Heart Rate, Vigor Of Contraction & Metabolism

6. Training Cycle in Competition Sports

In competition sports, a yearly training cycle can be divided into phases, depending on the sport.

- Phase 1: The Preparatory Phase (Preseason) consists of high volume, low-intensity workouts focusing on proper exercise technique to provide a foundation for more advanced exercise. Divided into generalized and specialized phases. Strength and endurance building exercises are introduced in the generalized phase. Intensity and volume are increased with the use of exercises more closely duplicating actual competition skills in the specialized phases. If the sport is primarily anaerobic, power and strength workouts are started in the second half of the preparatory/preseason phase (first transition in the four-phase model).

- Phase 2: The Competitive Phase (In-season) focuses on technique during an event, bringing performance to a peak. The time devoted to strength exercise may be reduced with exercises being limited specifically to the event/sport . The goal of this phase is to maintain the level of strength that has been acquired to prevent regression without leading to overexercising. Quality not quantity is emphasized.
- Phase 3: The Postseason, or Transition Phase, begins at the end of the competitive season. This period is one of active rest with the athlete participating in a variety of enjoyable recreational activities; thus providing a psychological, as well as physiological, break from competition.

6.1 Warm-Up/Cool-Down

Warm-up increases body temperature, respiration, and heart rate, and guards against muscle, tendon, and ligament strain. It consists of stretching and gradually increasing exercise intensity. Abrupt cessation of vigorous activity leads to pooling and slow removal of waste products. It may also contribute to cramping and soreness. The cool-down process helps the removal of metabolic wastes, lowers the body temperature, and gradually slows heart rate.

6.2 Overexercising

Overexercising is an imbalance: too much exercise and not enough recovery for a given level of conditioning. Overexercising is a plateau or decrease in performance that results in the inability to tolerate, or adapt to, an exercise load. It occurs as a result of too much exercise, inadequate nutrition, or in following a monotonous exercise program. Symptoms of overexercising include increased heart rate and recovery heart rate, weight loss with decreased appetite, chronic muscle soreness, depression and irritability, loss of motivation, insomnia, urinary tract infections, and skin breakdowns.

7. Nutrition and Body Composition of an Athlete with Spinal Cord Injury

The competitive nature of sport demands that athletes optimise training and performance strategies (including nutrition) to attain competition goals. The basic nutritional requirements of an athlete with SCI are thought to be similar to that of an able-bodied athlete.

- **Energy requirements**
  SCI is associated with significant body composition changes, which often include decreased muscle mass and increased adiposity. Overall energy requirements are generally less in athletes with SCI compared with their able-bodied counterparts due to the lower muscle mass and therefore a reduced basal metabolic rate. The higher the injury on the spinal cord, the lower the metabolic rate, and the lower the caloric requirement. Energy intakes in SCI population range from approximately 1,500 to 2,200 kcal/day, with 46-53% of energy from carbohydrate, 15-20% from protein, and 28-37% from fat (24-26).

- **Vitamins and Minerals**
  Intakes of several vitamins and minerals including calcium, vitamin D, folate, zinc and iron were found to be below recommendations for non-athletes with SCI. Similarly, more than 25% of male athletes with SCI in a Canadian study were reported to have intakes below the estimated average requirement (EAR) for calcium, magnesium, zinc, riboflavin, folate, vitamin B12, and vitamin D . In the same study, more than 25% of female athletes with SCI had intakes below the EAR for calcium, magnesium, folate and vitamin D. This data suggest that athletes with SCI need to consume a nutrient dense diet to ensure micronutrient requirements are met even with a lower total energy intake.
- **Medical considerations**
  SCI athletes often have medical considerations and secondary health complications associated with their disability that must be accounted for when planning for optimal performance. For example, individuals sitting in a wheelchair have high risks of pressure sores and infections. Existing medical conditions need to be well managed for optimal adaptation to training and for performance benefits during competition.
- **Bladder/bowel control**
  Poor bladder/bowel control is a common experience for people with a SCI . Athletes with SCI may have problems with incontinence and constipation or may require ileostomies/colostomies. Therefore, routine, consistent eating and exercise patterns are important to ensure the athlete can perform without bowel/bladder hindrances. Fiber type and amount, fluid intake and eating times must be well managed and planned ahead.
- **Hydration**
  Fluid intake is important for all athletes. Individuals with SCIs have an impaired capacity for thermoregulation due to neurological interruption within the spinal cord which diminishes their sweating response. Thus, they generally have lower fluid requirements than their able-bodied counterparts. Though the reduced fluid loss from sweat would appear to reduce the risk of dehydration, it significantly impairs the thermoregulatory capacity of the individual and increases the risk of hyperthermia and hyponatremia. Fluid requirements can be estimated from sweat rates. Athletes with SCI also need to consider access to toilet and water facilities, and the potential use of urine collection bags.

8. Psychological and Social Aspects of Wheelchair Sports

People who experience disability for the first time undergo stress; cope with life transitions, value changes, and experience disability issues across their life spans. From a sociological perspective, people who experience disability for the first time also have to deal with the role of family, cross-cultural issues and adjustments, the consequences of negative demeanor's towards people with disabilities as a whole, and the roles of professionals who work to assist them with adjusting. Their system of life and living

has changed in many different ways, meaning they must endure a process of adjustment and self-evaluation.

8.1 Stages of Adjusting to a New Form of Disability

- **Shock**

Shock involves a state of both emotional and physical numbness that can last from a few hours to several days.

- **Denial**

Denial may last anywhere from three weeks to two months and is a defense mechanism that allows the implications of the new disability the person has experienced to be gradually introduced. Denial only becomes an issue when it interferes with the person's life, forms of treatment, or rehabilitation efforts.

- **Anger/Depression**

Anger and depression are reactions to loss and the person's change in social treatment and status. The person may experience a number of different emotions during this stage and grieve for the changes in their body image, function, loss of future expectations, or former satisfaction based upon any function that has been lost.

- **Adjustment/Acceptance**

The stage of adjustment and acceptance does not necessarily mean the person is happy about the disability they now experience, although it does allow for the relinquishment of any false hopes, as well as the successful adaptation of new roles based upon realistic potentials and limitations. The person might benefit from interactions with others who experience forms of disabilities, and becomes comfortable with who they are.

Sociological gains include new experiences, new friendships, and a countering of stigmatization. Perceived health is improved, and in a more long-term perspective there is a reduced risk of many chronic diseases. Finally, there is a greater likelihood of employment, with less absenteeism and enhanced productivity.

8.2 Athlete Medical Form

An athlete medical form should be completed before beginning an exercise program to detect the presence of disease, identify exercise restrictions, and help direct your program.

Athlete Medical Form
(To be completed by the Athlete)

Date received by **facility name**:…….
Team affiliations: …….
Name……..Phone……
……
Address
……
……
City……State……..Zip…
…….
Date of Birth……../……/…… / Health Insurance……Policy #.....
Emergency
contact……Relationship……..Phone……
Diagnosis……
…….
Cause: …..Congenital (present at birth) or .....Acquired
(if acquired, please complete the following)
Date of onset/ injury: …….
Head injury due to (type of accident): …….
Amputation level: …….....cause: ……
Stroke : cause: …….
Spinal Cord Injury: ….. complete ….incomplete, level …….cause……..
Other (specify disability and cause)…….....
List all surgeries (procedure and date): ……..
Date of last tetanus shot: ……
Medications you are currently taking (prescription and over the counter) ……
……
Allergies and specifics of reaction: ……
Medical history:
Seizures No Yes Type……
Number in the past 12 months…….. Date of most recent seizure……..
Diabetes No Yes
Insulin dependent No Yes Explain……..

Hypertension (High BP) No Yes
Heart disease No Yes Specify……
Lung disease/ asthma No Yes Specify……
Heat-related problem No Yes Specify……
Injury affecting sports participation No Yes Specify……
Other
(specify)…… …….
Are you currently involved in any out-patient therapies? No Yes Explain…… ……..
Sports classification: Track……. Field…… Swimming…….Basketball……
Quad rugby……. Other…….
For purpose of competitive/ recreational participation in the following sports/ activities (check all that apply)
……swimming …… bocce ……. W/C basketball ……. Quad rugby ….. amb. Soccer …….. field ….. target shooting …… W/C team handball …. Equestrian ….. bowling …. Track ….. archery … slalom ..... cycling … table tennis ……. Powerlifting …. Strength & conditioning ….. tennis …….cross country ……..
Permission is given to **facility name**, ……... its representative, a representative of the local team, or local competition organizing committee to seek medical care in case of an emergency for the above person.

_____ _____

Signature of participant or parent/guardian if under 18 Date

(To be completed by Physician)

Athletes
name……..
Diagnosis (list all): ……
Impairments (e.g., hemiparesis, etc)……
Height :……. Weight: …… Pulse:…… BP: …… Sex:……
Physical exam Normal Abnormal Explanation of abnormalities
Head /neck ……. ……. ……..
Eyes /vision ……. …… ……..
Ears /hearing ……. …….. ……..
Heart /lung ……. ……. ……..
GU ……. ……. ……..
CNS ……. ……. ……..

Skin ……. ……. ……..

Orthopedic exam:

ROM loss/ contractures: …….

Joint laxity/ instability: ……

Other :……

……

Date of hospitalization over last 2 years with admitting diagnosis: ……..

Significant "abnormal test" (EKG/ X-ray/lab): ……..

Approval for participation …… Yes ……..No

Comments /restrictions: …….

Physicians signature ……..

Date……

Print name……Phone……

…….

Address……

……..

City ……..State…….Zip……

……

8.3 SCI Exercise Precautions

- With an injury to the spinal cord, be aware of restrictions because of surgically placed rods or spinal fusion. In these cases, forced flexion and rotation of the spine with exercise are contraindicated.
- To preserve tenodesis in the hand, do not stretch out finger flexors.
- In conditions of quadriplegia with limited hand function, be careful not to hyperextend the wrist with strap-on weights or adaptive wrist cuffs.
- If an athlete has thrombophlebitis or deep vein thrombosis in an extremity, exercise with the uninvolved extremities, but keep the affected extremity immobilized until cleared by doctor. Take care not to put pressure on or place straps over the involved area.
- If an athlete has heterotrophic ossification, a contracture, or osteoporosis in an extremity, understands medical restrictions for stretching and strengthening exercises.
- When strapping for positioning or to control lower extremity spasticity, use padded straps at least 2 in. wide. Be sure to observe skin for any reddened areas and identify areas prone to skin breakdown. Be aware of skin colour changes, swelling, or decreased sensation in a strapped extremity; this could indicate that the strap is placed over a blood vessel or nerve.
- Exercise hypotension is exhibited by a drop in BP, which may cause fainting episode or even pass out. Get assistance to recline in chair or lay on back to relieve symptoms by elevating BP.
- Empty leg bag before exercise to avoid over distending the bladder, as athlete may drink water with exercise.

9. Suggested Exercise Program for Athletes with SCI

Table 6: Upper Extremity Exercises

Exercises	**Class 1A (C4-C6)**	**Class 1b (C7,C8)** (Partial Triceps)	**Class 1c (C7,C8)** (Complete Triceps)	**Class 2 (T1-T5)**	**Class 3 (T6-T10)**	**Class 4 (T11-L4)**	**Class 5 (L5-S5)**
Shoulder Depressors	✓	✓	✓				
Lateral Shoulder Raise	✓						
Shoulder Overhead Press		✓	✓	✓	✓	✓	✓
Shoulder External Rotation	✓	✓					
Lateral Pull Downs	✓	✓	✓	✓	✓	✓	✓
Straight- Arm							

Back Raise	✓	✓	✓	✓	✓	✓	✓
Dips				✓	✓	✓	✓
Bench Press			✓	✓	✓	✓	✓
Upright Rows	✓	✓	✓	✓	✓	✓	✓
Bent Over Rows		✓	✓	✓	✓	✓	✓
Biceps Curls	✓						
Triceps Extension		✓					
Wrist Flexion/ Extension			✓	✓			

Table 7: Lower Extremity / Trunk Exercises

Exercises	**Class 4 (T11-L4)**	**Class 5 (L5-S5)**
Straight Leg Raise	✓	
Knee Extension	✓	✓
Posterior Pelvic Tilt	✓	✓
Upper Abdominals #1	✓	✓
Lateral Abdominal Crunch	✓	✓
Upper Back Extension#1	✓	✓
Upper Trunk Rotation		✓
Knee to Chest		✓
Leg Back Raise		✓
Leg Side Raise		✓
Leg Curls		✓
Heel Raises		✓
Ankle Curls		✓

.

9.1 Upper Extremity Exercises

- **Upper Extremity Multi joint**
  - Shoulder Overhead Press;
  - Upright Rows;
  - Dips (With Rickshaw);
  - Bent-Over Rows;
  - Bench Press;
  - Lateral Pull-Downs.
- **Upper Extremity Single Joint**
  - Lateral Shoulder Raise;
  - Shoulder Depressors;
  - Shoulder External Rotation;
  - Straight- Arm Back Raise;
  - Triceps Extensions;
  - Biceps Curl;
  - Wrist Flexion (Curls);
  - Wrist Extension (Reverse Curls).
- **Abdominal And Trunk Exercises**
  - Posterior Pelvic Tilt-Hook Lying;
  - Upper Abdominals- Abdominal Crunches;
  - Lateral Abdominal Crunch;
  - Upper Back Extension;
  - Upper Trunk Rotation.

9.2 Lower Extremity Exercises

- Leg Curls;
- Straight Leg Raise and Knee To Chest;
- Leg Side Raises;
- Leg Back Raises;
- Knee Extensions;
- Ankle Curls;
- Heel Raises.

10. Wheelchair Basketball

Wheelchair basketball began in 1946 as a result of World War II veterans surviving catastrophic injuries. In 1949, the National Wheelchair Basketball Association was established and serves as the national governing body.There are currently 19 conferences representing over 100 teams in addition to independent teams.

Wheelchair basketball has become a very popular recreational sport for persons with SCI. It is played in accordance with NCAA rules with very few exceptions, which include contact, time limits, dribble, loss of the ball, out-of-bounds, physical advantage foul, and falling. The dribble and physical advantage foul are of particular significance. A player in possession of the ball may not push more than twice in succession, with one or both hands in either direction, without again tapping the ball to the floor.

Taking more than two successive pushes constitutes a traveling violation. However, a player can dribble and push the wheelchair simultaneously, much as a nondisabled player runs and dribbles. The physical advantage foul is called when a player does not keep firmly seated in the wheelchair at all times. Legs are not allowed to be used as physical advantage (i.e., braking, jump balls, rebounds). This rule is strictly enforced and two such fouls in a game disqualifies a player from playing in that game. In addition, if a player falls out of his/her chair during play, the officials immediately suspend play if there is chance of danger to the fallen player. If there is no danger, play continues until the particular play in progress is completed.

10.1 Classification

There are three classes for wheelchair basketball. Class I includes those with complete motor loss at or above T7. Class II players have no useful motor power below L2. Class III represents all those with lower limb paralysis or paresis originating at or below L3 (13). Each class is given a point value corresponding to the class (i.e., Class I has 1 value point). At no time in a game shall a team have players participating with total value points greater than 12 or have more than three Class III players on the floor at one time.

10.2 Equipment

Wheelchairs used in basketball are much like tennis chairs in that they too are lightweight, have cambered wheels, and are set up to turn on a dime. Brakes and anti-tip bars are usually removed from the chair. The court and basket height remain the same as for NCAA basketball.

10.3 Recommended Pre-sport Exercise and/or Training

Pushing around the block or doing laps around a track builds endurance. Weight exercise to develop upper body strength and medicine ball exercises that develop dynamic muscular strength needed for the stops/starts in basketball are also recommended.

Exercises should emphasize strength, ball handling skills, shooting skills, and speed. Time in the weight room focuses on building upper body strength, which in turn

will contribute to muscular endurance. Pre-season exercises focus on strength development of specific muscle groups, actions, and energy systems. During the playing season, maintenance is in the form of muscle strengthening. Shooting practice, dribbling and passing skills, defensive and offensive plays, etc., are emphasized in the practice season.

11. Rugby for the Person with Quadriplegia

Rugby for the person with quadriplegia, or "Quad Rugby" (QR) was developed in the 1970s by two sportsmen with quadriplegia who came from Winnipeg, Manitoba and a professor of architecture at Manitoba University. It was developed as an alternative to wheelchair basketball because most individuals with T1 spinal lesions and above either lack the functional capacity to play basketball or, if on a team spend most of their time on the bench. In 1981, the first US team was formed and in 1988, the United States Quad Rugby Association was founded. QR developed from wheelchair basketball and is a mix of basketball, ice-hockey, and American football. A basketball court is used for play, with cones set up at either end to identify goal lines. A goal is scored when an offensive player crosses the opponent's goal line while in clear possession of the ball. Ball handlers may take an unrestricted number of pushes, but must bounce or pass the ball within 10 seconds. A penalty box is utilized for personal fouls when defensive team members commit violations, such as illegal physical contact with another player.

11.1 Equipment

A volleyball is used instead of the heavier basketball. The chair is a lightweight sports chair with cambered wheels; typically, it has spoken guards to prolong the life of the wheels and to protect the players' fingers. Wide elastic bands are used by many players to help compensate for their lack of balance. Gloves serve as protection and help the limited-functioning hand of a person with quadriplegia make contact with the push rim.

11.2 Classification

The classification system used in QR is functionally oriented and uses a player profile based on the accumulation of points. Each hand/arm is assessed and assigned a point value (0 .5 to 1 .5 points). The trunk is assessed for function and assigned points of 0.0, 0.5, or 1.0. A player can accumulate from 1 to 3.5 points. If the player accumulates more than 3.5 points, he/she does not meet the minimum disability requirement of this sport. The combined classification score of the four players on the court may not exceed eight points.

11.3 Recommended Pre-sport Exercise and/or Training

Strength exercise using light weights, pulleys, or bands to build the upper body strength and endurance are essential. Because QR, as well as basketball, requires stopping and starting the wheelchair, medicine ball exercises can develop the needed

upper body strength/endurance for the sport. Exercise is much like that for basketball. Strength and endurance are the basic needed components that can be worked on year-round. Sport-specific skills such as passing, picking up the ball, catching, and wheelchair mobility can be developed using drills, and are focused on as the playing season nears. Both offensive and defensive plays are developed and practiced at team practices.

12. Track and Road Racing

Track event/wheelchair racing distances range from 100 meter sprints to endurance events up to the 10K race. The season for track competition begins with regional competitions (Regionals) in early spring.

12.1 Equipment

Equipment needed by the wheelchair racer includes a racing chair, helmet, gloves, spare tires/tubes, and miscellaneous items, such as a tire pump and tools. Sports racing chairs are commercially available and must be measured carefully to the person, using hip and chest measurements of the individual. The chairs weigh about 14 tbs. Wheelchair racers wear gloves to protect their hands and for more efficient contact with the handrim. The impact of the hand hitting the pushrim is great and can result in blisters, skin irritation, and even broken bones. Gloves serve their purpose the way running shoes do for runners: they are specific to the pushing style of the individual and the more broken in they are the better. Some athletes put hours into the development of their gloves, using athletic tape, rubber/foam padding, elastoplast tape, glue, and so forth

The paraplegic-backhand and the quadriplegic-back hand techniques are characterized by contact between the push rim and the backside of the hand and/or fingers. The hands are locked in the closed position, not the open hand of the conventional technique. It is believed that the paraplegic-backhand technique results in fewer impact injuries to the hand. The quadriplegic backhand was originally developed by a Swedish athlete, StenWestermark, as a result of a wrist injury. The first American athlete to use the backhandstroke (John Brewer) improved his marathon time from 3:19 to 2:30. As in the paraplegic-backhand stroke, the quadriplegic-backhand requires specially made gloves with rubber covering the back of the glove.

12.2 Exercise

Exercise is dependent on the distance of the race being trained for, the athletic ability of the individual, and the time of year (if following the periodization exercise principle). Weight exercise is important in developing power, which is needed in sprints and hill climbing. Flexibility is especially important in order to utilize the full range of motion of the shoulder, elbow, and wrist. Fartlek and interval methods develop the anaerobic system, and long-distance pushes improve the person's aerobic conditioning. Both short- and long-distance elements should be incorporated to provide a well-rounded

program. A survey of training practices among elite racers showed a wide variety of training styles: mileage averaged 63 miles per week, 78 percent of the athletes incorporated weight training into their programs, and very few people included regular stretching and goal setting. Stationary roller systems are available and enable athletes to train year-round regardless of the weather. Rollers are also useful when developing pushing technique and analyzing body position and stroke technique. By using a milTOr when training on rollers, the person can see problems more easily and correct them.

12.3 Classification

Classification of wheelchair racers includes two classes for persons with quadriplegia—T1 and T2. T1 participants are neurologically impaired at C6 or above. The T2 participants are broken down into two subclasses based on neurological and functional levels. T2A people are typically impaired at C7 and T2B at C8. Persons with paraplegia are classed into two groups: T3 (neurological impairment between T1 and T7) and T4 (T8-S2).

Note: The wheelchair and specialized equipment discussed here are primarily for the professional racing athletes. However, commercial racing wheelchairs are available for those who race for the exercise and recreational fun.

12.4 Recommended Pre-sport Exercise and/or Training

Weight and strength training exercises: using free weights, progressive resistance exercises (PRE) that target triceps, biceps, shoulders, upper and middle back, chest, forearm, and wrists. For example, shoulder overhead press with barbell or dumbbell will strengthen shoulders, back, and triceps. Dips, using a rickshaw, parallel walking bars, or any custom-made apparatus are an excellent exercise for developing upper limb and back strength. In addition, pulley and/or band exercises are good because the "pushing" motion can be imitated with the shoulders and elbows completing the full range of motion.

13. Tennis

Wheelchair tennis was introduced to the public in 1976 when two persons with disabilities held a series of exhibitions and clinics. In 1977, the first tournament was held in Los Angeles and attracted 30 participants. Today, more than 10,000 people in 30 nations actively participate in the sport. In 1976, the National Foundation of Wheelchair Tennis was founded as the sport's governing body. In 1989, the International Wheelchair Tennis Federation was formed to organize and promote tennis on an international level. Events the season starts in early spring and lasts through fall. Events include singles and doubles matches. Rules for wheelchair tennis vary from tennis for the nondisabled only in that in wheelchair tennis, the ball may bounce twice before being returned.

13.1 Equipment

The wheelchair used by tennis players is lightweight, easy to turn, and has a variety of positions for the feet, based on the athlete's preference. Wheels of the tennis wheelchair are cambered to enhance the turning ability and the quick directional changes for the sport. The racquet used by wheelchair athletes is the same as that used by nondisabled tennis players. Tennis players with quadriplegia may use ace athletic bandages, tape, or cuffs to assist in gripping the racquet.

13.2 Classification

Wheelchair tennis does not classify SCI according to neurological impairment. Instead, the players are divided according to skill level. The elite and most highly skilled participants are in the Open Division. Divisions A, B, C, and D represent the rest of the players, with D representing beginners. Players with quadriplegia compete against other players with quadriplegia, with the most skilled players competing in the Open Division and the beginners playing in D**iv**ision B.

13.3 Recommended Pre-sport Exercise and/or Training

Lower and upper pulley and/or band exercises and resistance using light weights that, emphasize the chest, upper and lower back, upper arm (biceps and triceps), and shoulders and internal and external rotation. Overhead, cross chest, rows, and shoulder raises are exercises that can be done with pulleys/bands that are good for developing tennis skills. During winter and early spring, exercise should consist of working with weights, and tennis-skill development drills and play. Some athletes participate in one-bounce league play to work on speed and agility. Pushing to build/maintain cardiovascular endurance is important as well. As the season nears, weight exercise tapers off, and the focus becomes more skill specific, such as, the forehand and backhand development and serve and return techniques. When the season is in full swing, playing the games is enjoyable and healthy.

14. Swimming

Swimming is a popular sport for the SCI at all levels of injury. The same rules are followed as those for nondisabled swimmers, with additional rules being made to accommodate SCI levels (i.e., turns, water entry, starts, and stroke modifications). The sport is governed by Wheelchair Sports USA with regional competitions beginning in the early spring, nationals in mid/late summer, and international competition concluding the season in late summer to early fall. Events range from the 25 m freestyle to the 200 m individual medley. Strokes include the freestyle, breast stroke, butterfly, and backstroke.

14.1 Classification

The classification system in swimming is complex due to the variety of levels of impairment and the number of strokes. A manual muscle test by a physical therapist is

used to establish muscular function, followed by a functional classification when the classifier, a recreation therapist, watches the swimmer perform. Classifications for the freestyle, backstroke, and butterfly range from S I–S 10 with S I being severe quadriplegia and S10 swimmers having minimal limitations of the lower limbs. Classes SB I–SB 10 are breaststroke swimmers and SM1–SM10 make up the classifications for the individual medley.

14.2 Recommended Pre-sport Exercise and/or Training

Stretching is a vital component of a swimmer's program. Because the water is a medium that reduces gravity, stretching can be done most easily in the water. Body positioning, stroke mechanics, starts, turns, and finishes are areas that need special attention. Tools, such as hand paddles, pull-buoys, flotation belts, and kick boards, are utilized to develop these areas. Because swimming is dependent on the pulling action for propulsion, strengthening exercises are highly recommended. In swimming, there are two alternatives for strength exercises: dry land and in-water resistance exercise using hand paddles, aqua web gloves, or wrist weights. Tethered swimming is a unique type of resistive exercise. Wearing a belt attached to surgical tubing around the waist, the swimmer pulls the tubing to its maximum stretch point and maintains that resistance. If the resistance is not maintained, forward motion is lost. Overhead, back, front, and lower pulley exercises for shoulders, arms, upper back, and forearms are an excellent way to prepare for swimming. Using this exercise, range of motion can be maintained while developing strength.

15. Field Events

Field events for people in wheelchairs include the discus, shot put, javelin, and the club. The club event is performed by persons with class F1 quadriplegia (C6 level of injury) and may be substituted for the javelin event. Rules in field events are the same as rules for the nondisabled with the addition of a few rules dealing with disability related areas. In classes F1-F6, at least one part of the upper leg or buttock must remain in contact with the cushion or seat until the implement is released. If "lifting" takes place during an event for persons classed as F7 or F8, the participant must keep one foot in contact with the ground inside the circle and any part of the chair used for leverage must remain inside the vertical plane of the circle. No gloves or devices of any kind are allowed that would assist a participant when making a throw. Players may, however, use substances directly on their hands to obtain a better grip. F1–F3 participants may use strapping on the non-throwing hand to anchor their hand to their chair.

15.1 Equipment

Equipment consists of field implements and field chairs. In the standing class for field athletes, there is no need for the field chair (which is not necessarily a wheelchair). Wheels are not usually a component of the field chair unless when used to make the transport of the usually heavy chair easier to manage. The only rules limiting the

throwing chair are a seat height restriction of 75 cm and a rule against footrest(s) not being rotated in or out to permit abnormal placing of one or both feet if the footrest protrudes outside the throwing circle. All parts of the chair must remain within the throwing circle. While competing, the player is held in place by means of a holding device, which is anchored to the ground and uses straps to keep the chair stable during the action of the throw.

15.2 Classification

There are eight classes of field athletes. Participants with quadriplegia are divided into three classes according to neurological impairment and functional ability: F1, F2, and F3. Those in the F1 class do not compete in the shot put event, and F1 players are the only class allowed to use the club. Participants in the F1 class are impaired at C6 level and above. F2 class competitors are impaired at C7 and F3 at C8. F4–F8 are classifications for persons impaired from T1 to S2.

15.3 Recommended Pre-sport Exercise and/or Training

The focus of exercise for field athletes is power and strength. Hence, the field athlete spends time in the weight room every day. Flexibility cannot be overlooked as the competitor needs full shoulder, elbow, wrist, and hand range of motion to make throws efficient. The rest of the exercise time is spent on the field practicing throwing technique.

16. Table Tennis

Table tennis for wheelchair competitors is played according to rules published by the International Table Tennis Federation (ITTF) and the International Table Tennis Committee for the Disabled (ITTC). The service rule is an exception to the ITTF rules. It states that a let is called on a service if, in service, the ball a) leaves the table by either of the receiver's side lines; b) on bouncing on the receiver's side, returns in the direction of the net; or c) comes to rest on the receiver's side of the playing surface.

16.1 Equipment

Equipment for wheelchair table tennis is the same as for table tennis for the nondisabled. The rubber on the racket may be the same colors on both sides if all characteristics are identical. Otherwise, it must be covered with bright red and black rubber on opposite sides. In addition to a racket and balls, the player lacking adequate muscle function to grip a racket, may use bandages, tape, cuffs, or other adaptive devices to aid in gripping the racket. The table must allow access to wheelchairs without obstructing player's legs and allow for doubles matches.

16.2 Classification

A functional classification system is used for this sport as is used in track, field, and quad rugby. Five classes are used for wheelchair table tennis competition:

- Classes 1 and 2 represent the player with quadriplegia, with Class 1 players being impaired at C6;
- Class 2 players level of injury occur around C7;
- Class 3 represents C8-T7 with no sitting balance or trunk rotation;
- Class 4 consists of T8-L1;
- Class 5 athletes are impaired from L2-S2.

16.3 Recommended Pre-sport Exercise and/or Training

Strengthening exercises for the wrists, forearms, and shoulders are needed for table tennis. Wrist curls and wrist extensions with a light dumbbell strengthen the wrist and forearm. Pulley and band exercises provide dynamic strengthening while developing/ maintaining range of motion. Balance can be a factor in table tennis and pulleys/bands can help improve balance.

Exercise programs for table tennis are similar to those for many other sports discussed in this chapter. Muscular strength and endurance, speed/agility of the playing arm, and sport-specific skill development make up the optimal exercise program.

17. Weight Lifting

The powerlifting press and the bench press are the two lifts recognized in weight lifting competition for persons with disabilities. The difference between the two lifts is that the bench press is lifted directly off supports at chest height. The powerlifter receives the barbell at arms length and lowers it to the chest ; the lift takes place from the chest and not from supports. Strapping at the ankles and just above the knees is allowed in order to stabilize the weight lifter.

17.1 Classification

There are 10 weight classes for men and women. For adult males, there are 2 divisions in each class: Division One comprises persons with quadriplegia and persons with paraplegia from T1 to T10. Currently, there are no provisions for adapted equipment that would allow persons with quadriplegia who have little or no grip to participate. On a regional level, provisions can be made to include this group of competitors. Division Two consists of all athletes T11 and below.

17.2 Equipment

Equipment consists of a weight lifting barbell, disc weights, and a weight lifting belt. Gloves may be worn, if preferred.

17.3 Recommended Pre-sport Exercise and/or Training

A pre-sport program that uses free weights develops upper body strength, which is essential in weight lifting. Flexibility is hard to regain once it is neglected; therefore, stretching, combined with band exercises, is recommended to develop strength, while

maintaining range of motion. Obviously, the weight lifter spends most of his or her time in the weight room. In that pursuit, performing maximum loads with few repetitions helps to meet the goal of high weight lifts. Nutrition is also important to the participants because body weight is a strong factor in their classification. Flexibility is often lacking in those competing in weight lifting; therefore, flexibility exercises must be incorporated into the exercise program in order to minimize or prevent injuries.

18. Archery

Archery joins the ranks of sports in which persons with disabilities can compete with the nondisabled. FITA (Federation of Internationale de Tir a 1'Arc), founded in 1931, is the international governing body of archery. FITA rules govern archery competition for wheelchair archers as well as for nondisabled competitors. The exception is the provision for shooters with quadriplegia; they are allowed to use adapted equipment. In fact, there have been disabled archers on the US Olympic Team.

18.1 Classification

There are three classifications for wheelchair archery competition:

1. Class AR 1 consists of archers with tetraplegia. If the participants in this class have no functional finger flexors or extensors, they may use a release, compound or recurved bow, strapping, and body support. Archers using mechanical releases may receive assistance in putting arrows on their bows.
2. Class AR 2 is an open class for wheelchair archers. This division is for all other wheelchair competitors. Equipment used is in accordance with FITA rules. Strapping to provide support is not allowed and there are limitations regarding the height of the wheelchair back support (in order to discourage individuals from taking unfair advantage of their wheelchair characteristics).
3. Class AR 3 is the standing division for archers with disabilities. Events for this class are not always offered at Wheelchair Archery, US sanctioned events, in order to encourage these athletes to compete with nondisabled athletes.

18.2 Equipment

The same equipment is used for Class AR2 and AR3 archers as for nondisabled archers. Bows (straight or recurve), arrows, arm guards, field glasses or other visual aides, bracers, bow sling, belt or ground quiver, and tassel are some of the equipment options. Archers in the AR 1 class usually need adapted equipment or assistance in putting the arrow on the bow and in performing the release and draw action of shooting. There are several cuffs available, including a hook device that can be affixed to the palm of the hand; this allows the archer to pull the bow using biceps and deltoids. The arrow is released by extension of the wrist.

18.3 Recommended Pre-sport Exercise and/or Training

Band and/or pulley (front, back, lower, and upper) exercises are excellent because the movement needed for archery can be mimicked. Range of motion is maintained and muscular strength and endurance are developed. Building upper limb strength and endurance is important for the wheelchair archer. During the off-season, time is spent building strength. As the season nears, time spent practicing sport-specific skills increases and weight exercise time drops to a maintenance level of two per week.

19. Every Athlete Has An Incredible Story To Tell… (Athlete Interviews)

19.1 Taylor Graham

Survived a motorcycle accident, adjusted to a spinal cord injury (**Spinal Cord Injury:** C-6, Quadriplegia) and a new life in a wheelchair, picked up the sport of wheelchair tennis. *Moving up the ladder….*He played weekly with others from Madonna at Woods Park. That led to local and national tournaments. Playing recently at the 2016 U.S. Open USTA Wheelchair Championships in St. Louis, he and his partner, Jack Spicer, won the Men's Wheelchair B Doubles category. Graham, ranked sixth nationally, has his eye on tournaments in Tucson, Ariz., and Palm Springs, Calif. Graham is now working towards his goal of the 2020 Paralympics in Tokyo.

19.2 Ernie Johnson

In 1997, Johnson broke his neck and damaged his spinal cord on the football field. In a split second, he went from a 17 year-old in the prime of athleticism to being paralyzed. With the help of friends and family one local quadriplegic man is working towards becoming a professional body builder. He says*: "My goal is not to be inspirational. My goal is to be the best me & instead of looking for reasons not to do it I look for ways to do it. Every day I find a new reason to be better".*

19.3 Malathi Krishnamurthy Holla

This international para-athlete from Bangalore was paralyzed completely at the tender age of one after a high fever. A regular electric shock treatment for two years got the strength of her upper body back, but below the waist, her body remained weak. Holla decided to live life in the best possible way and chose sports to excel in. She won Gold in 200m, shot put, discus and javelin throw at the 1989 World Masters' Games in Denmark. She has over 300 medals in her kitty, and is also the proud recipient of the Arjuna Award and Padma Shri.

20. New Developments in the Field of Spinal Cord Injury

20.1 Epidural Stimulation

Direct electrical stimulation of the spinal cord increases the excitability of spared neuronal connections within the site of injury, thereby enhancing signal transmission and allowing recovery of previously lost volitional function. Recently, epidural

electrical stimulation of the lumbosacral spinal cord in four individuals with spinal cord injury (SCI) has restored motor and autonomic function below the level of injury. So far, study participants, regained voluntary movement with the stimulation, and reported improvements in cardiovascular health, temperature regulation and bowel control, even after the stimulator is turned off.

19.2 Cell Transplantation (OEC)

One currently explored approach to restoring function after spinal cord injury is the transplantation of olfactory ensheathing cells (OECs) into the damaged area.OECs are considered particularly suitable for transplantation because they have been shown to be neuro-protective and to promote neuro-regeneration in different settings, and can be extracted from the patient's own nasal cavity, thereby minimizing the chances of graft rejection and avoiding the need for immunosuppressive drugs. After experimentation, researchers suggest that transplanting OECs into the site of damage does indeed significantly improve locomotor performance in a subject with SCI.

19.3 Functional electrical stimulation (FES)

Dr. Roderic Pettigrew said assistive robotics is one of several emerging solutions to paralysis caused by spinal cord injury. He cited continuing refinements in the field of functional electrical stimulation (FES), in which electrodes from an implanted device deliver small pulses of current to nerves controlling specific muscles. When paralyzed hand muscles are stimulated, for example, a patient is able to grasp and hold objects such as a can of soda. The user controls the stimulation by contracting muscles that are not paralyzed. Stimulating the bladder or diaphragm can also return some bodily functions.

19.4 Stem Cell Therapy

All different types of patients, whether with complete or incomplete injuries and injuries at a variety of spinal regions, have been treated. SCI patients can experience improvements in movement, strength, sensation, control (limb, bowel, and bladder), and even the ability to sweat. Patients have experienced improvements in the expansion and intensity of sensation even while suffering from very severe injuries to the spinal column. Scientists isolated stem cells from umbilical cord blood and then injected them into the damaged part of the spinal cord. The cord blood stem cells, adapt to the injected bodies without triggering a big negative inner reaction, which are common in other transplantations, according to Korean Scientists.

19.5 Rehabilitation Robots (Assisted-Robot Therapy)

Robotic assistance is increasingly used in neurological rehabilitation for enhanced training. Patients often face deficits in motor function. Rehabilitation robots have the potential to provide an interface for objective, sensitive and reliable measurements. These impairments due to SCI lead to a restriction of both independence

and participation in daily life. An intensive rehabilitative intervention can help to improve motor function in SCI patients and, eventually, the patient's quality of life.

Researchers at UC Irvine help a 26-year-old man walk with only a harness to help support his weight. He was able to move using his own brainwaves. Electrodes were attached directly to his muscles so that he could control them, bypassing his injured spinal cord. More

Meanwhile, another man – Mark Pollack – walked with the help of an Ekso exoskeleton. He also gained back some control of and feelings in his legs, thanks to a process known as "transcutaneous spinal cord stimulation."

While the first patent for a wheelchair was granted in the United States in 1869, wheelchairs were mass produced only in the late 1930s. In 1937, a patent was granted to two engineers, Harry Jennings and Herbert Everest, for a wheelchair with an x-brace frame which enabled it to be folded without having to move the drive wheels. This design, which allows the wheelchair to be more easily transported, remains the standard for manual wheelchairs today.

The 1975 Boston Marathon was the first major race to include a wheelchair division. That year Bob Hall completed the race in 2 hours and 58 minutes. Today the course record for women, established in 1994, is held by Jean Driscoll (USA) who completed the race in 1 hour 33 minutes and 22 seconds. Since 2004, Ernst Van Dyck (South Africa) has held the course record for men: 1 hour 18 minutes and 27 seconds. Technology has had a major impact in enabling athletes to achieve these dramatic improvements in performance.

Bibliography

A. Internet References (Reference Websites, Online Journals & Research Papers)

1. Moulds, J. The Nutritional Knowledge and Dietary Practices of Athletes with Spinal Cord Injuries (Thesis, Master of Dietetics). University of Otago.NZ, 2013.
2. Freeman, A. R. The Center and Autonomic Nervous Systems. In E.E. Selkurt (ED.), Basic physiology for the health sciences. Boston: Little, Brown, 1988.
3. Glaser, R.M. Arm Exercise Training for Wheelchair users, Medicine and Science in sports and exercise, 1989 Oct;21.
4. Margaret M. Olle, James M. Pivarnik,William J. Klish, James R. Morrow Jr, Body composition of sedentary and physically active spinal cord injured individuals estimated from total body electrical conductivity. Archives of physical medicine and rehabilitation. July 1993 Volume 74, Issue 7, Pages 706–710.
5. Frederico Ribeiro Neto, Guilherme Henrique Lopes. Body composition modifications in people with chronic spinal cord injury after supervised physical activity. J Spinal Cord Med. 2011 Nov; 34(6): 586–593.
6. Bartosz Molik, James Laskin, Andrzej Kosmol, Natalia Morgulec-Adamowicz. The international wheelchair basketball federation's classification system: The participants' perspective. Kinesiology 49(1):21-22 · June 2017

7. Claudine Sherrill. Adapted Physical Activity, Recreation & Sport: Crossdisciplinary and Lifespan 6th Edition, Journal of Sports Physical Therapy, 1981.
8. de Groot S, Dallmeijer AJ, Post MW, Angenot EL, van den Berg-Emons RJ, van der Woude LH. Prospective analysis of lipid profiles in persons with a spinal cord injury during and 1 year after inpatient rehabilitation. Arch Phys Med Rehabil 2008;89:531-7
9. Jacobs& Nash, Circuit Resistance Training Improves the Atherogenic Lipid Profiles of Persons with Paraplegia. J Spinal Cord Med. 2001 Spring;24(1):2-9.
10. Timo Hinrichs, Veronika Lay & Martin W. G. Brinkhof, Age-related variation in Mobility Independence among Wheelchair Users withn Spinal Cord Injury: A Cross-Sectional Study, J Spinal Cord Med. 2016 Mar; 39(2): 180–189.
11. Fullerton H.D., Borckardt J.J., Alfano A.P., Shoulder Pain: A Comparison of Wheelchair Athletes and Non-Athletic Wheelchair Users, Med Sci Sports Exerc. 2003 Dec;35(12):1958-61.
12. Mark S. Nash, Ingrid van de Ven, Niek van Elk, Brad M. Johnson. Effects of Circuit Resistance Training on Fitness Attributes and Upper-Extremity Pain in Middle-Aged Men With Paraplegia. Archives of physical medicine and rehabilitation. , jan.2007.Volume 88, Issue 1, Pages 70–75
13. Silva A.C., Neder J.A., Chiurciu M.V., Pasqualin D.C., da Silva R.C., Fernandez A.C., Lauro F.A., de Mello M.T., Tufik S., Effect of Aerobic Training on Ventilatory Muscle Endurance Of Spinal Cord Injured Me, Spinal Cord. 1998 Apr;36(4):240-5
14. .Function & O'Doherty L.J., Hickey A., Hardiman O., Measuring Life Quality, Physical Psychological Well- Being in Neurological Illness, Amyotroph Lateral Scler. 2010 Oct;11(5):461-8.
15. Hickes A.L., Martin K.A., Ditor D.S., Latimer A.E., Craven C., Bugaresti J., McCartney N.., Long-term Exercise Training in Persons with Spinal Cord Injury: Effects on Strength, Arm Ergometry Performance and Psychological Well-Being, Spinal Cord. 2003 Jan;41(1):34-43.
16. Emily Churton& Justin WL Keogh, Constrains Influencing Sports Wheelchair Propulsion Performance And Injury Risk, BMC Sports Sci Med Rehabil. 2013; 5: 3.
17. Michael Burton, Franz Konstantin Fuss & Aleksander Subic, Sports Wheelchair Technologies. Sports Technology Volume 3, 2010 - Issue 3
18. Yves C. Vanlandewijck, Joeri Verellen& Sean Tweedy, Towards Evidence-Based Classification in Wheelchair Sports: Impact of seating position on wheelchair acceleration, J Sports Sci. 2011 Jul;29(10):1089-96.
19. www.disabed-world.com (Psychological & social aspects of disability)
20. www.spinalcordinjuryzone.com (Wheelchair Athletes)
21. www.biosciencetechnology.com
22. www.clinicaltrials.gov
23. www.paralympic.org

24. www.canadiansportsforlife.ca

B. Book References

1. Kevin F. Lockette & Ann M. Keyes, Conditioning with Physical Disabilities- –in cooperation with The Rehabilitation Institute of Chicago.1994.
2. Suzanne Tink Martin & Mary Kessler, Neurologic Interventions for Physical Therapy, 3rd Edition, 2015.
3. Vicky Goosey Tolfrey, Wheelchair sports, 2010.
4. Stacy Green, Specific Exercise Programs
5. Smith R. Sport & Physical activity for people with physical disabilities—Park & Recreation, 2004.
6. David P. Swain, Clinton A. Brawner, American College of Sports Medicine--Resource Manual for Guidelines for Exercise Testing & Prescription, 2013.
7. Michael L. Pollock, Jack H. Wilmore, Samuel Samuel Mickle Fox, Exercise in Health & Disease: Evaluation and Prescription for Prevention and Rehabilitation, 1984.
8. American Academy of Orthopedic Surgeons—Athlete Training & Sports Medicine (2nd edition)—Ridge, 1999.
9. Carl E. Klafs, Daniel D. Arnheim, Modern Principles of Athletic Training: The Science of Sports Injury Prevention and Management—(8th ed. Luis Mosby year book, Inc, 1993)
10. Patricia D. Miller, Fitness Programming and Disability-A Publication For Disabled Sports USA, 1995.
11. Susan B. O'Sullivan, Thomas J. Schmitz, George Fulk, Physical Rehabilitation,6 edition 2014.
12. Heyward V. H., Advanced fitness Assessment, 5th edition 2002
13. Claudine Sherrill. Adapted Physical Activity, Recreation & Sport: Crossdisciplinary and Lifespan 6th Edition, Published 1998 by WCBI McGraw Hill,