

Chapter Four

Specific Exercise Programs

*by Stacy Green, CTRS**

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INTRODUCTION

The need for fitness and exercise for the individual with spinal cord injury (SCI) has been established for many reasons. Sedentary people with SCI are more prone to cardiovascular disease than their sedentary nondisabled peers. Many theories exist to explain this, but the overall reason lies in the fact that people with physical disabilities are less active. Individuals with SCI can reap the benefits of regular physical activity. These benefits include increased muscular endurance and strength making functional everyday activities, such as transfers and negotiating architectural barriers, easier. Secondary complications, such as restricted range of motion, stiffness, weight gain, and muscular atrophy can be limited. High blood pressure and cholesterol levels can be more effectively regulated. Increased self-efficacy and self-confidence, reduced depression and anxiety, perceived competence, increased acceptance of disability, and general well-being are cited psychological benefits as a result of athletic participation (1). Studies have revealed fewer skin sores and related hospitalizations for people involved in wheelchair sports programs versus those not involved in regular sports activities. The inability to exercise is rarely due solely to physical limitations. Inaccessible facilities/equipment

and limited information on exercise techniques contribute greatly to the lack of exercise for people with SCI.

General health and wellness lay the foundation for fitness. To fully benefit from a fitness/exercise program, individuals must take the responsibility of knowing about their disability and associated medical complications and how to prevent/control them. Good health habits (i.e., diet and nutrition, self care, and personal hygiene) are important in achieving full fitness potential. While taking responsibility for the client's health is not the role of the doctor, therapist, nurse, coach, and so forth, it is the role of the medical professional to be aware of, and make clients cognizant of, these basic concepts. Clients are taught, early on in their rehabilitation, to do push-ups during the course of the day in order to prevent pressure sores (which could develop into serious decubitus ulcers) from forming on the buttocks (**Figure 1**).

Following is a review of the components of a well-balanced fitness program and of exercise principles and techniques. Specific wheelchair sports will be discussed as well as equipment and/or adaptations and exercise considerations. A bibliography for additional/ongoing information appears on page 96.

COMPONENTS OF FITNESS

There are four basic components of fitness: muscular strength and endurance, cardiorespiratory endurance, body composition, and flexibility. All components need attention in developing an exercise program.

Muscular Strength and Endurance

Muscular strength refers to the maximal force that can be generated by a specific muscle or muscle group (2). Muscular endurance is the ability of a muscle group to execute repeated contractions over a period of sufficient time duration to cause muscular fatigue (2).



Figure 2.
Passive stretching.



Figure 3a.
Passive stretching.

Cardiorespiratory Endurance

Cardiorespiratory endurance is defined as the ability to perform large-muscle, dynamic, moderate-to-high-intensity exercise for prolonged periods (2). This is of particular importance because of health implications. Higher levels of cardiorespiratory fitness are associated with decreased risks of heart disease and higher levels of habitual physical activity (2).

Body Composition

This component of fitness refers to the percentage of body weight that is fat. Measurement is based on the assumption that body weight is broken down into lean body weight and fat weight (2).

Currently, there is no efficient, accurate method for calculating body fat for individuals with SCI. Bone density, atrophied muscles, muscle tone, and so forth, make tables/standards of nondisabled athletes inaccurate. Hydrostatic weighing is most often cited in research studies of wheelchair athletes. However, there does not seem to be a consensus of opinion as to the method the health professional, coach, or trainer should use.

Flexibility

By definition, flexibility is the maximum ability to move a joint through a range of motion (2). Wheelchair

athletes must be concerned with developing flexibility and including a stretching program (**Figure 2**) in their routine in order to prevent injuries and improve mechanical efficiency (3). Lack of flexibility contributes to the majority of injuries occurring in the soft tissue of the shoulders, elbows, wrists, and hands. The lack of flexibility can even preclude an individual from participating in a sport (i.e., wheelchair racing which requires flexibility in the anterior muscles of the chest and shoulders).

It is vital that adequate time be given to stretching before and after a workout regardless of the sport in which they are training. The closer the flexibility program is to the actual skills performed, the more effective the flexibility program. Stretching is most effective after a mild warm-up (**Figure 3a**) and should be repeated at the conclusion of the workout (**Figure 3b**). The mild warm-up prior to stretching increases the



Figure 3b.
Passive stretching.



Figure 4.
Active stretching.

muscle's extensibility, which results in greater gains in flexibility (3). To minimize soreness and relax muscles, stretching should be done following a workout (**Figure 4**).

Performing passive stretching routines with a partner is an effective stretching technique. The broomstick stretch is another technique. This stretch utilizes a stick and allows the athlete to stretch the trunk, shoulder, elbow, and wrist in a self-directed program (3).

RECOMMENDED PRE-SPORT EXERCISE AND/OR TRAINING

Exercise for sports participation not only prepares a person for optimal performances, it also reduces the likelihood of injuries. Exercise programs for people with SCI who use wheelchairs must follow general exercise principles. Psychological training is an important element for both persons with disabilities and for the nondisabled. Sport psychology and interventions are not discussed in this chapter, but a study done in 1984 by Henschen, et al., which observed that elite male wheelchair athletes displayed mood state profiles similar to world class nondisabled athletes is worth citing (4). It has been reported that the wheelchair athlete has more in common psychologically with the nondisabled athlete than with nonathletes with disabilities (5).

The following is a review of some basic exercise principles; how each is applied varies according to the sport, the nature of the event (i.e., aerobic vs. anaerobic), the skill level of the participant, and his or her performance goals.

Overload

The overload principle is used in strength and endurance development. It implies that an activity must be upgraded to a consistently higher level through maximum or near-maximum stimulation. In order for overload to be effective, the amount of work should be increased as the body adapts to the growing demands being placed upon the system. Although overload is important in exercising, the stress must not be too great in order to avoid injury.

Specific Adaptation of Imposed Demands (SAID)

The SAID principle states that over time the body will adapt metabolically and physiologically to the

specific type of stress that is brought about through exercise (6).

Specificity

An exercise program must be specific to the sport with regard to the muscles used and the required energy system(s). Two of the things to be considered are the type of strength required and the direction/motion requirements of the sport (6). Specificity also relates to upcoming events (i.e., exercising for a marathon will emphasize mileage vs. a 10K event). In addition to event distance, specificity exercising for road racing includes conditioning for the race course, such as hills, flat roads, and turns.

Reversibility

Reversibility is the concept of detraining (no exercise). Muscles atrophy from disuse and will detrain if they are not consistently trained toward a set goal. Two weeks of detraining can significantly reduce work capacity (6).

Individual Difference

Individual difference implies the need for individualized exercise programs. There is no recipe for success. Because individuals respond differently to exercise regimes, adjustments must be made to achieve optimal exercise effects. Heredity, maturity, nutrition, rest and sleep, environment, and motivation are all contributors to individuality (6).

Progressive Resistive Exercise (PRE)

Exercise should be progressive. Programs should go from simple to complex, from easy to hard, and from quantity to quality (6).

Intensity, Duration, Frequency, and Type

Intensity refers to the degree of energy or work expended by the individual in a given unit of time. This should not be confused with longer workouts. Duration is the length of time spent exercising. This varies with the specific sport and the objective of the workout. Frequency is how often the individual exercises. This also varies, according to the sport in which the individual plans to participate. Type refers to the type of workout, such as, concentration on anaerobic versus aerobic systems and power vs. endurance (6).

Periodization

This principle refers to the concept of dividing the exercise plan into smaller segments, phases, or cycles. Periodization helps to decrease the potential for overexercising by varying exercises, intensity, volume, and load.

Competition Sports

In competition sports, a yearly training cycle can be divided into three or four phases, depending on the sport (7). An example of a three-phase exercise cycle might consist of phase 1) preseason or preparatory phase; phase 2) in season/competitive phase; and phase 3) postseason. The four-phase cycle consists of all of the above with a *transition phase* occurring just before and after the competition phase.

Phase 1: The preparatory phase consists of high-volume, low-intensity workouts focusing on proper exercise technique to provide a foundation for more advanced exercise. This phase can be 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 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.

Warm-Up/Cool-Down

Warm-up increases body temperature and 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.

OVEREXERCISING

Overexercising is an imbalance: too much exercise and not enough recovery for a given level of conditioning (8). 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. Being able to recognize overexercising is important in preventing overuse injuries (see Chapter 5). The response of a typical individual to poor performance is to increase exercise time. If overexercising is the potential cause of the less than optimal performance, the individual may be adding to the problem. Keeping a log book and recording the workout, how he/she felt before/during/after the workout, medications being taken, resting heart rates, etc., can help the exerciser.

COMPETITIVE AND NONCOMPETITIVE WHEELCHAIR SPORTS

The following is a review of wheelchair sports options for individuals with spinal cord injury. Not all sports options are represented, because of the extensive nature of such a listing.

This review of athletic events will include exercise considerations, equipment, sports organizations, and classification systems. Classification systems vary for each activity and are designed to “equalize” competition and compensate for the varying levels of disability. Classification systems include a medical history and muscle test, as well as an examination of the functional

skills of each participant. In the observation of functional ability, the classifier watches the individual perform the sport either in a practice setting or in competition. Using the muscle test and observations, the classifier places the individual in a class so that he or she will be competing against other participants with similar limitations. Classification of individuals can be highly controversial due to the amount of subjectivity; especially when it involves persons with low-level quadriplegia, persons with high-level paraplegia, and persons with incomplete spinal injuries.

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.

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 lbs.

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 (**Figure 5**).

The paraplegic-backhand and the quadriplegic-backhand techniques are characterized by contact between the pushrim 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 (9). The quadriplegic backhand was originally developed by a Swedish athlete, Sten Westermarck, as a result of a wrist injury (10). The first American athlete to use the backhand-stroke (John Brewer) improved his marathon time from 3:19 to 2:30 (10). As in the paraplegic-backhand stroke, the quadriplegic-backhand requires specially made gloves with rubber covering the back of the glove (**Figure 6**).

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

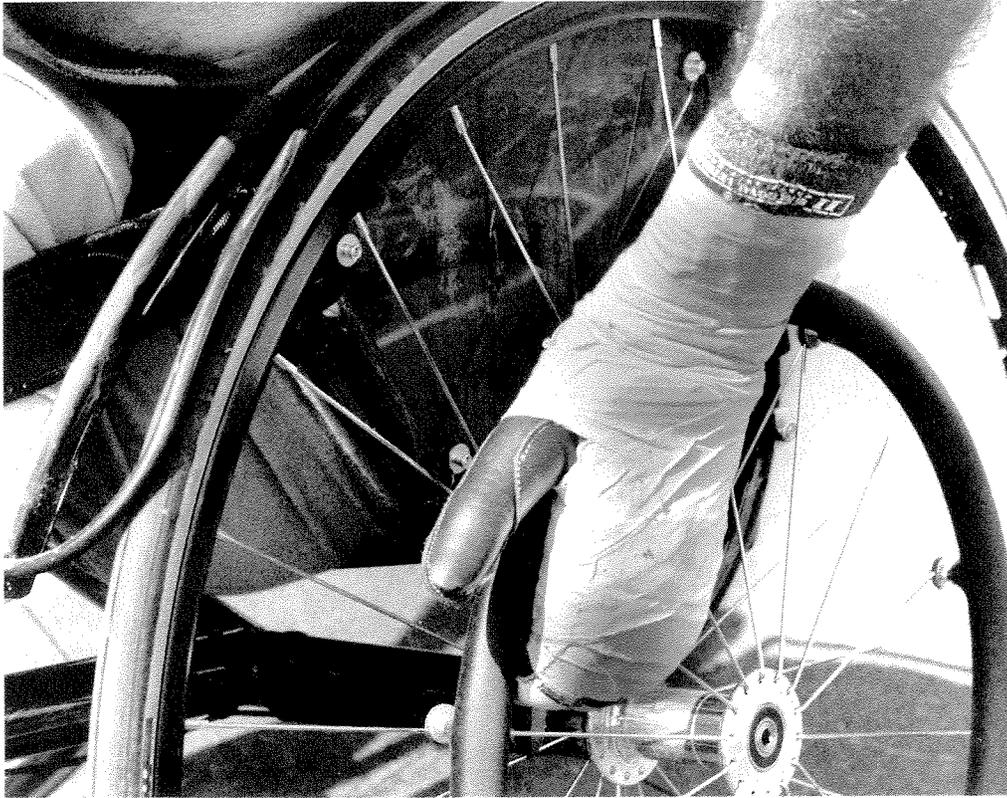


Figure 5.
Personally customized taping of hands.



Figure 6.
Commercially available glove.

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 (11). 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 mirror when training on rollers, the person can see problems more easily and correct them.

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.

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 is 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.



Figure 7.
Tennis is a sport popular with wheelchair users.

TENNIS

Wheelchair tennis was introduced to the public in 1976 (Figure 7) when two persons with disabilities held



Figure 8a.
A lightweight wheelchair with cambered wheels is used.

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 (12). In 1976, the National Foundation of Wheelchair Tennis was founded as the sports governing body. In 1989, the International Wheelchair Tennis Federation was formed to organize and promote tennis on an international level (12).

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.

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 (Figures 8a and b).

Tennis players with quadriplegia may use ace athletic bandages, tape, or cuffs to assist in gripping the racquet.

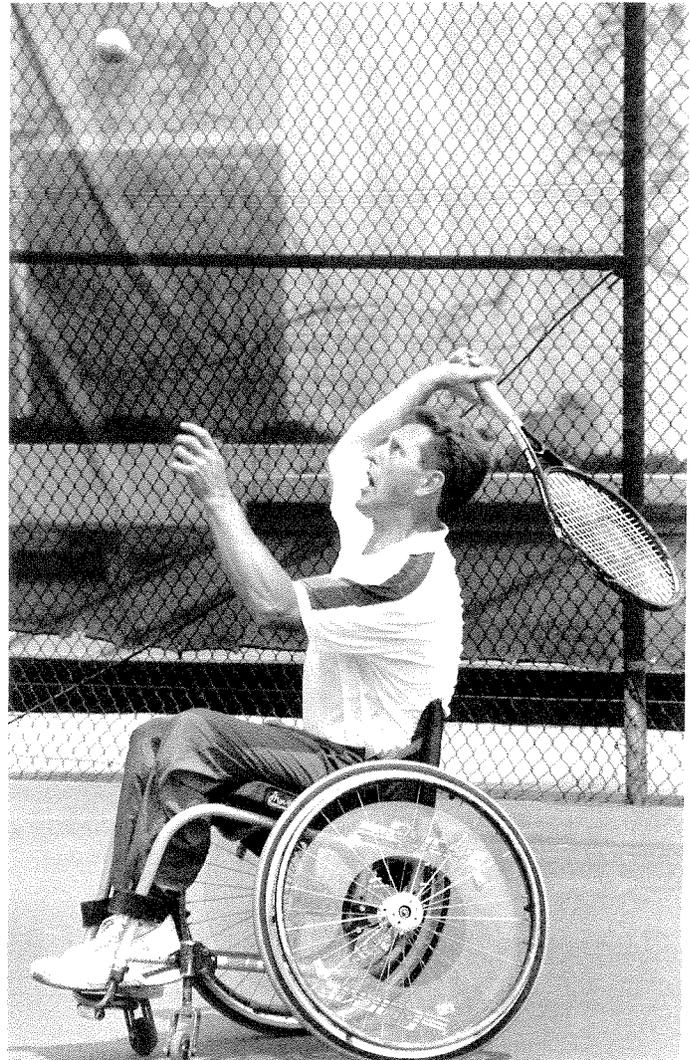


Figure 8b.
The same racquet is used as that used by a nondisabled player.



Figure 9a.
A tennis serve from a wheelchair.

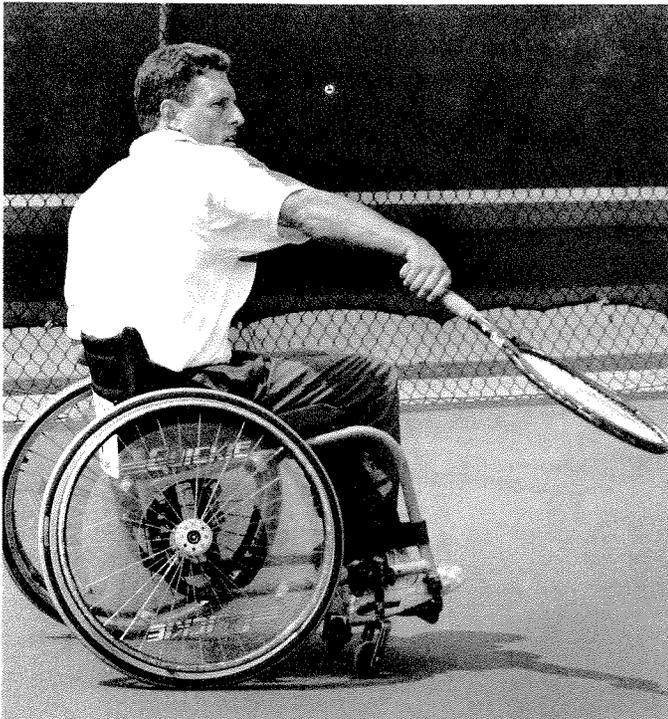


Figure 9b.
A tennis return from a wheelchair.

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 Division B.

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 (Figures 9a and 9b). When the season is in full swing, playing the games is enjoyable and healthy (Figure 10).

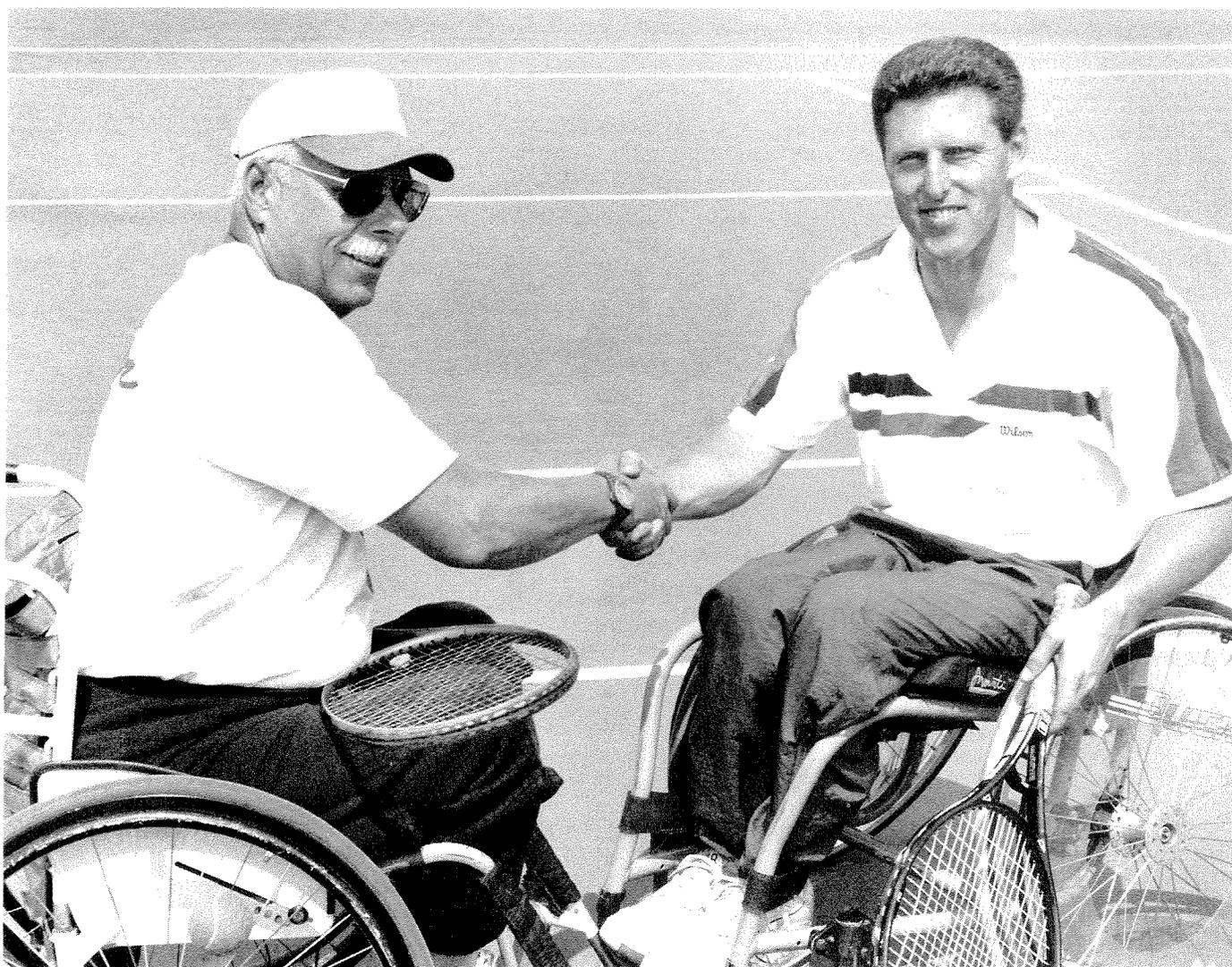


Figure 10.
The end of an enjoyable tennis match.

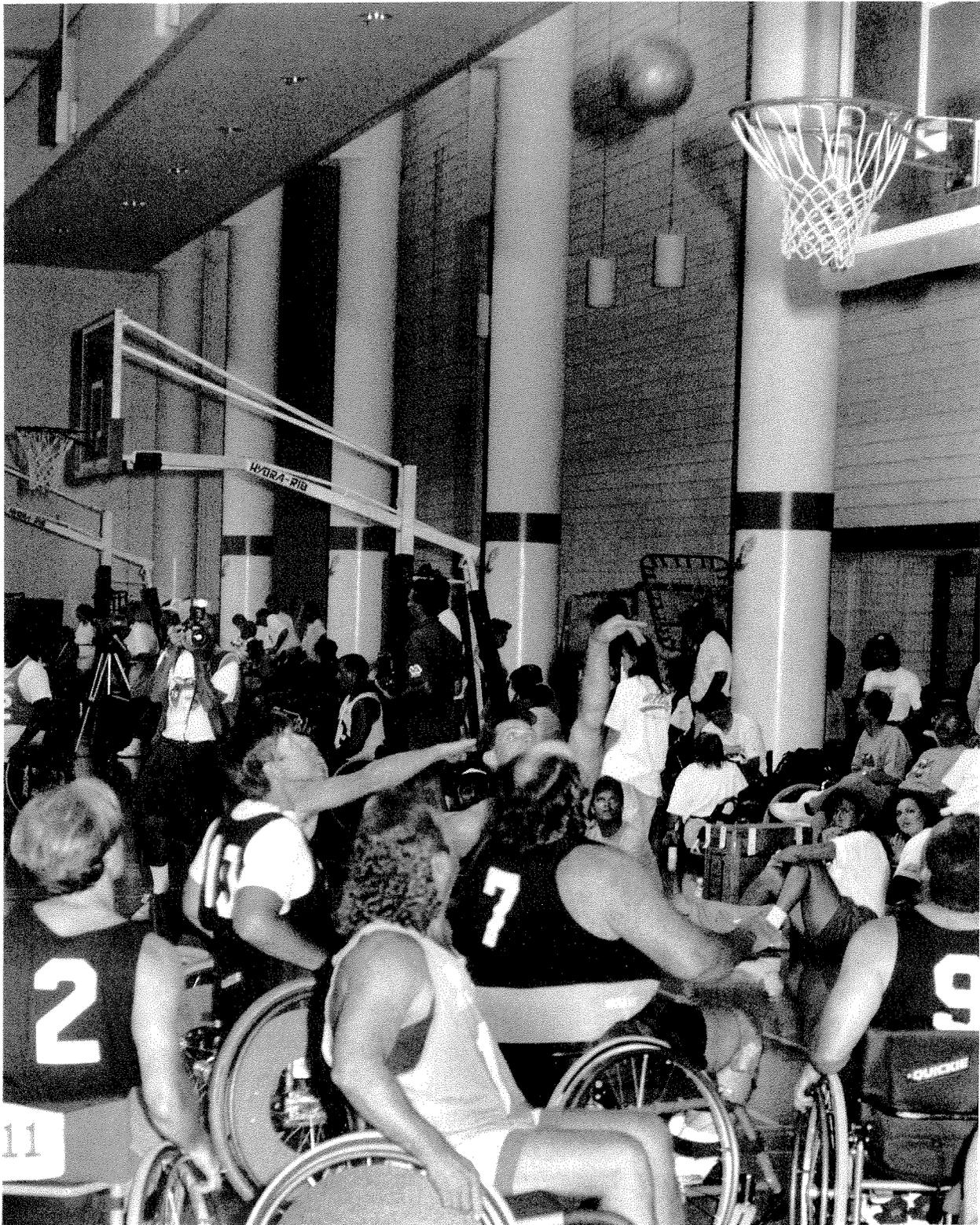


Figure 11.
Wheelchair basketball.

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 (Figures 11,12, and 13).

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 (Figure 14), 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.

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



Figure 12.
A tight play in wheelchair basketball.



Figure 13a.
Blocking in wheelchair basketball.

value points greater than 12 or have more than three Class III players on the floor at one time.

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.

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 (**Figure 15**).



Figure 13b.
Wheelchair basketball is a fast-moving sport.



Figure 14.
A player falls from his wheelchair during a basketball game.



Figure 15a.
Wheelchair basketball defense/
passing skill.

Figure 15b.
Wheelchair basketball
defensive maneuver.

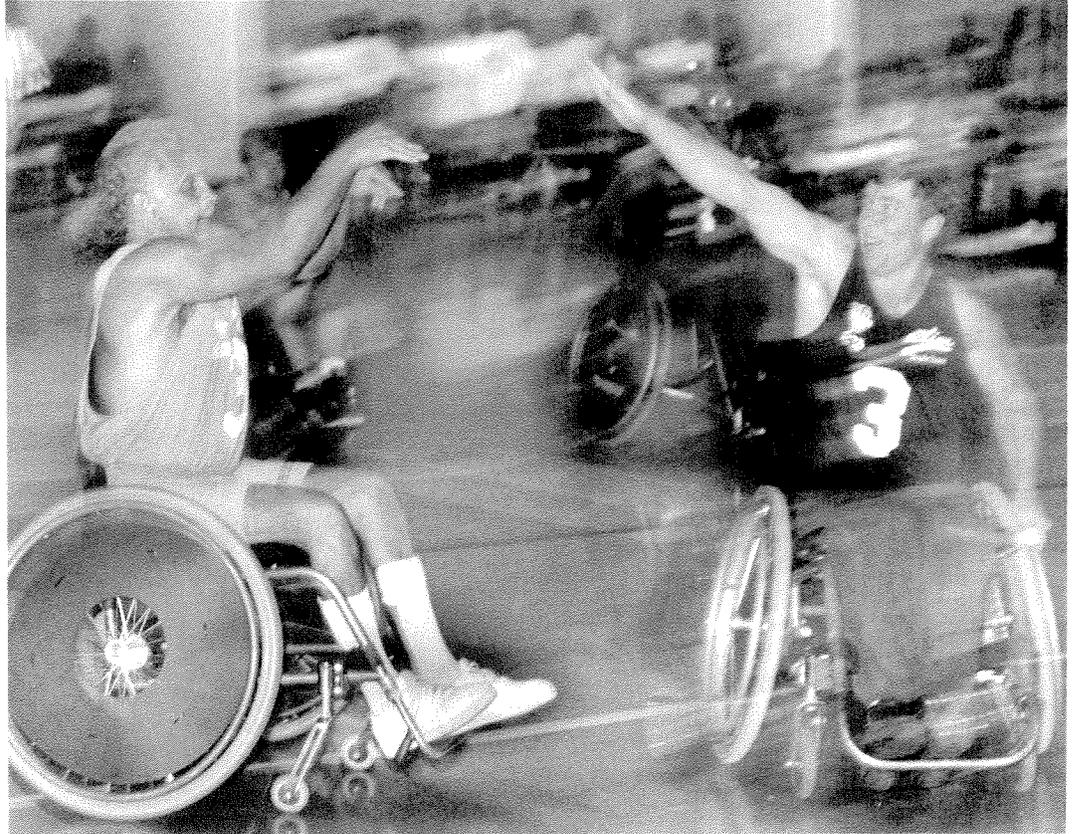


Figure 15c.
Wheelchair basketball,
shooting skill.

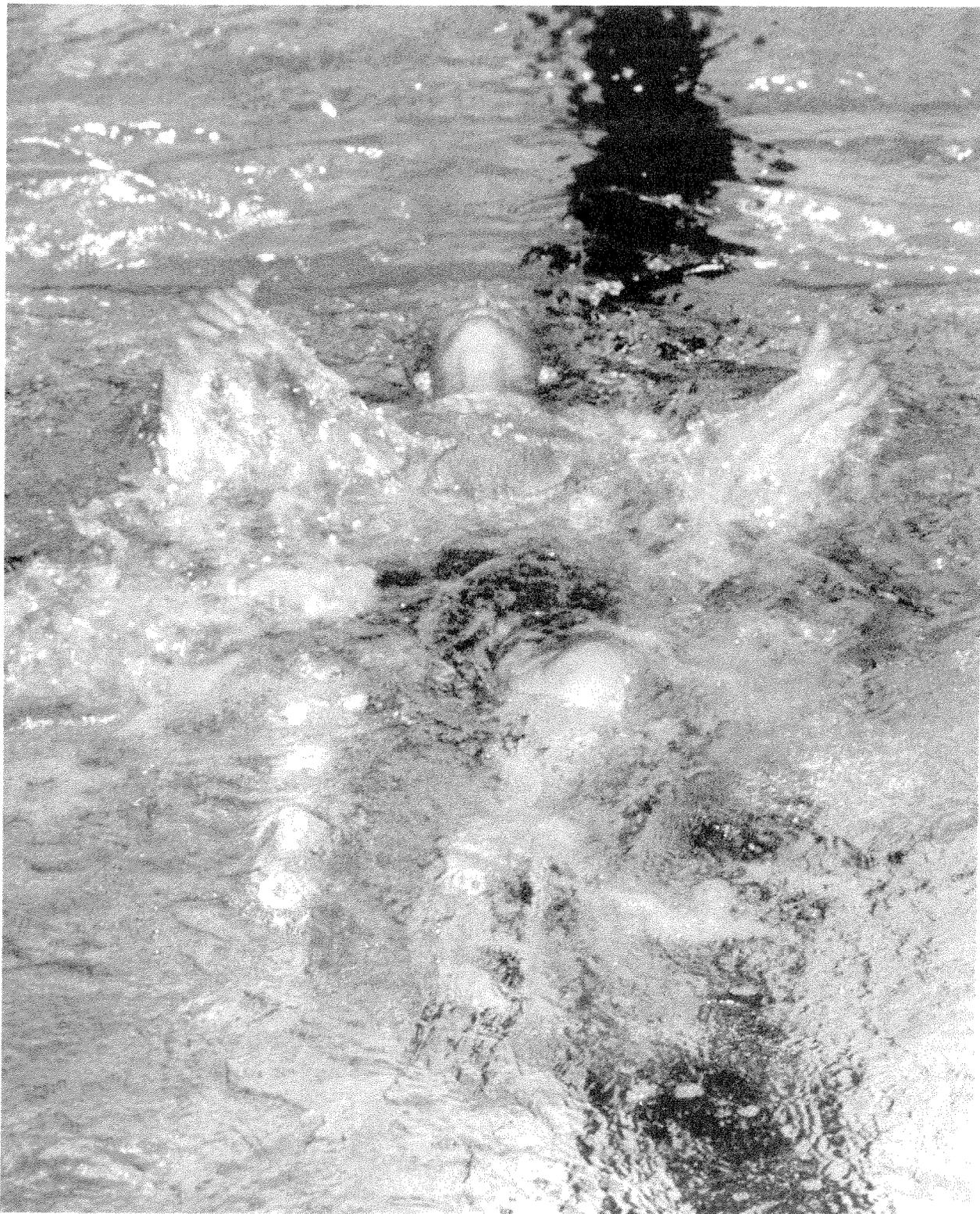


Figure 16.
Recreational swimming.

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 (Figures 16,17,18 and 19).

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 S1–S10 with S1 being severe quadriplegia and S10 swimmers having minimal limitations of

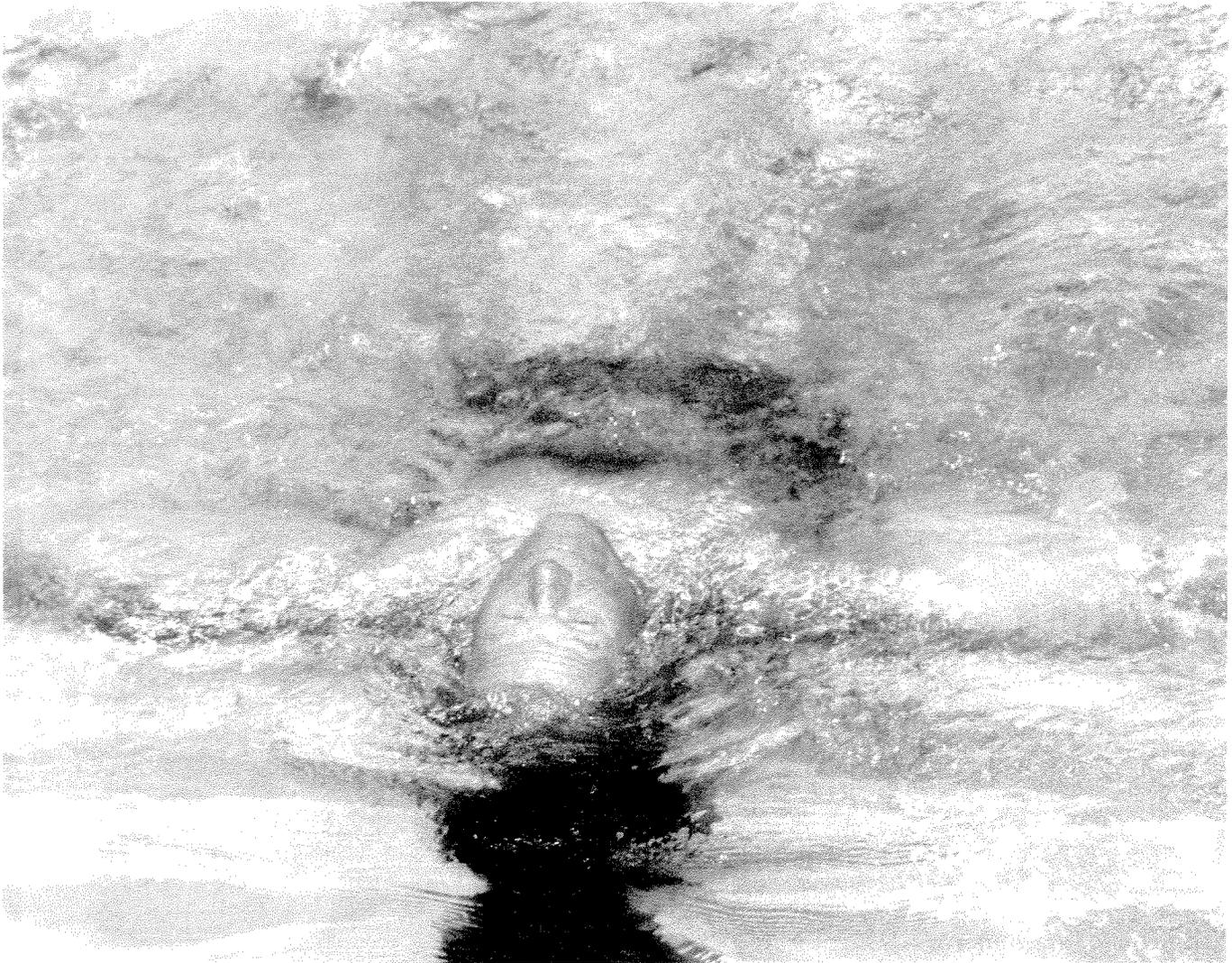


Figure 17.
Swimming using the backstroke.

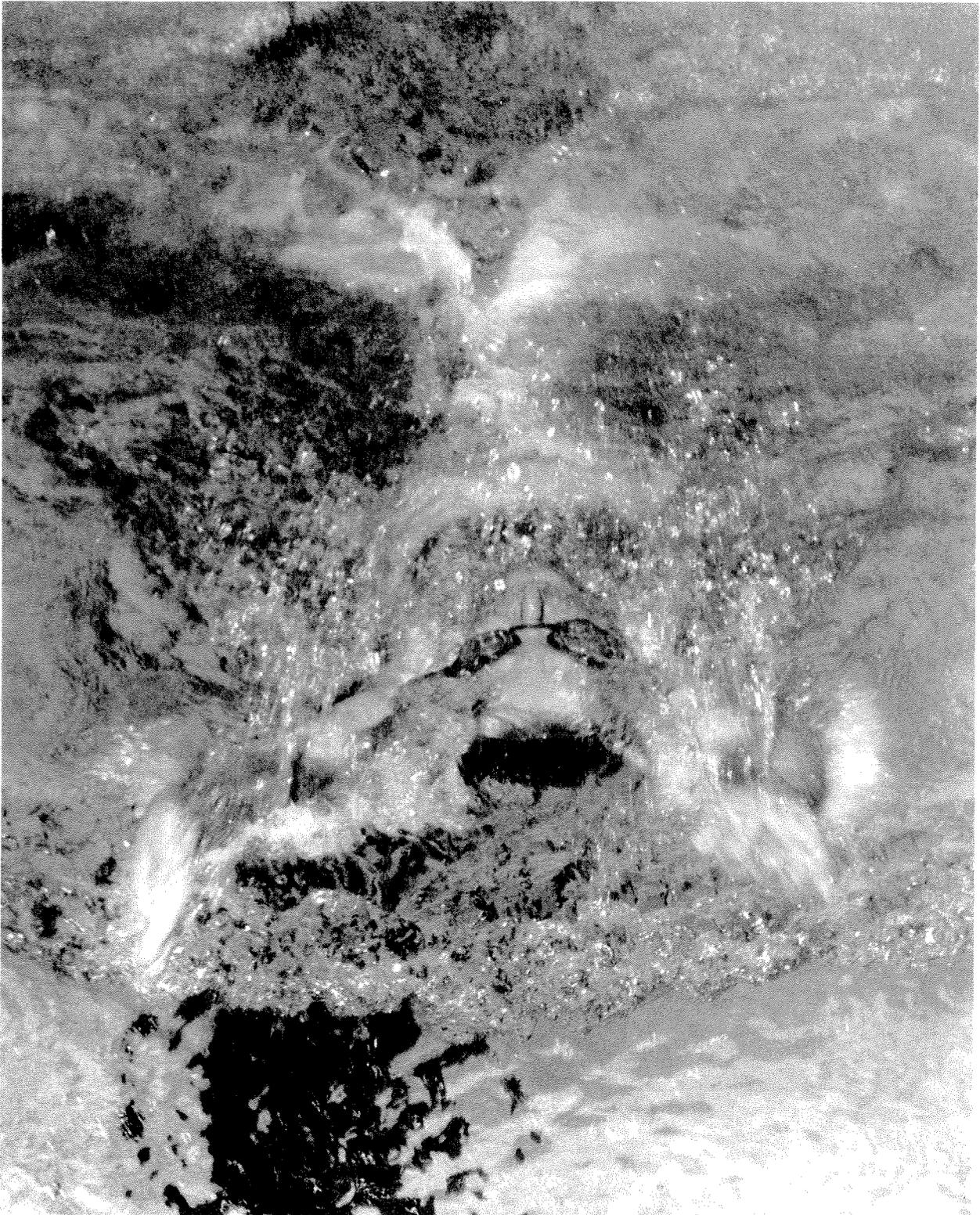


Figure 18.
Swimming. Water is a medium that reduces gravity.

the lower limbs. Classes SB1–SB10 are breaststroke swimmers and SM1–SM10 make up the classifications for the individual medley.

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 recom-

mended. 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 (14). 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 (14).

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.

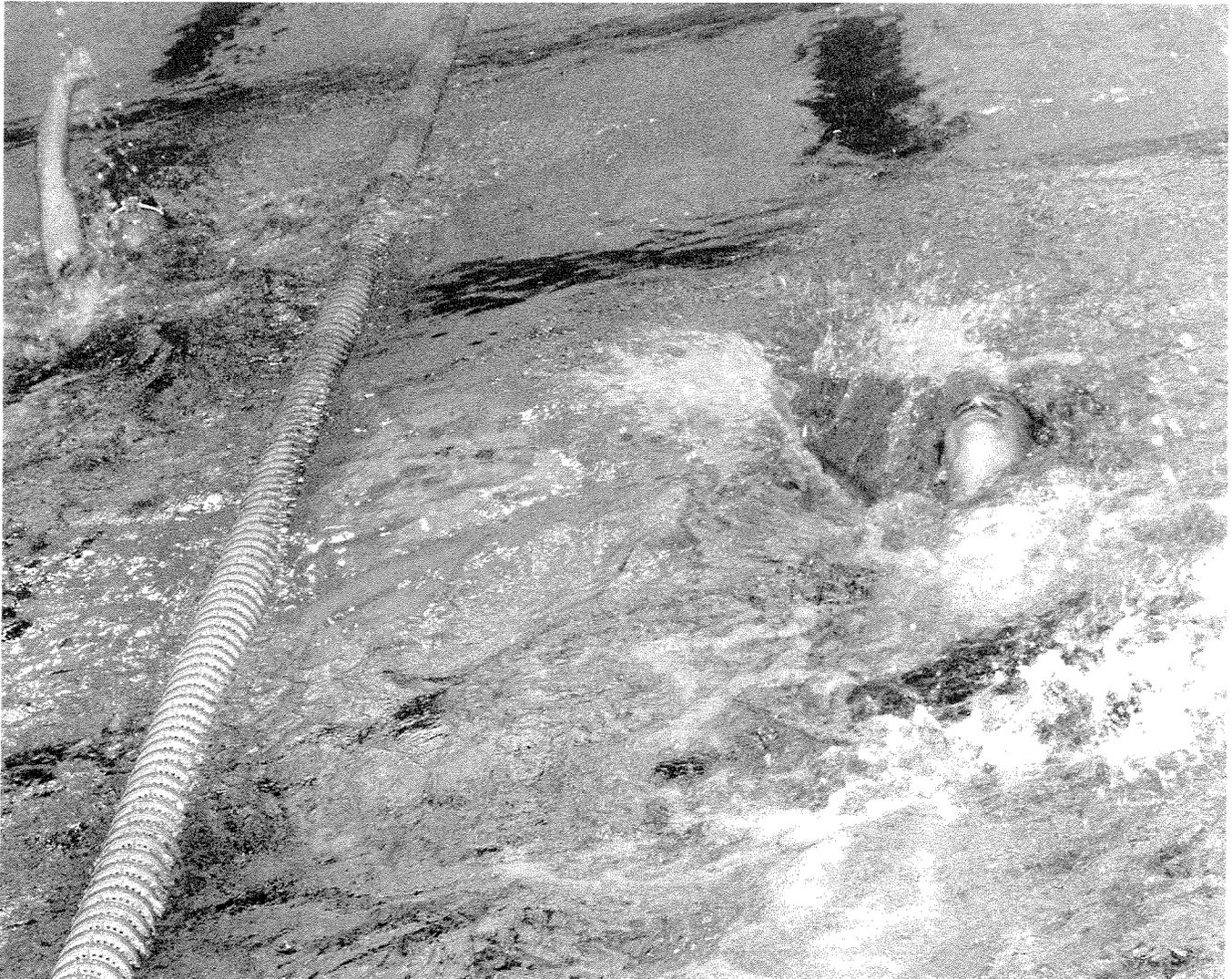


Figure 19.

Stretching can be done more easily in water.



Figure 20a.
“Quad Rugby.”

RUGBY FOR THE PERSON WITH QUADRIPLÉGIA

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 (15).

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 (15).

Equipment

A volleyball is used instead of the heavier basketball. The chair is a lightweight sports chair with cambered wheels; typically it has spoke guards to prolong the life of the wheels and to protect the players' fingers. Wide elastic bands are used by many players to



Figure 20b.

A volleyball is used in "Quad Rugby."



Figure 20c.
“Quad Rugby,” an alternative to wheelchair basketball.



Figure 20d.
The player on the left is wearing gloves for protection and better contact with pushrim.

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 pushrim.

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 (15). The combined classification score of the four players on the court may not exceed eight points.

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 (**Figures 20a–e**).



Figure 20e.
“Quad Rugby” player with severe limitations demonstrates his ability to participate.



Figure 21.
Field event: Discus thrower.

FIELD EVENTS

Field events for people in wheelchairs include the discus (**Figure 21**), shot put (**Figures 22 and 23**), javelin (**Figure 24**), and the club. The club resembles a bowling pin but is weighted with lead at the distal end. 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.

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



Figure 22a.
Field event: Shot Put.



Figure 22b.
Field event: Shot Put.



Figure 23.
Field event: Shot Put. The chair is kept stable during the throw.

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.

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.

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.



Figure 24.
Field event: Javelin.



Figure 25.
A table tennis match.

TABLE TENNIS

Table tennis for wheelchair competitors (**Figures 25 and 26**) 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.

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 (**Figure 27**). The table must allow access to wheelchairs without obstructing player's legs and allow for doubles matches.

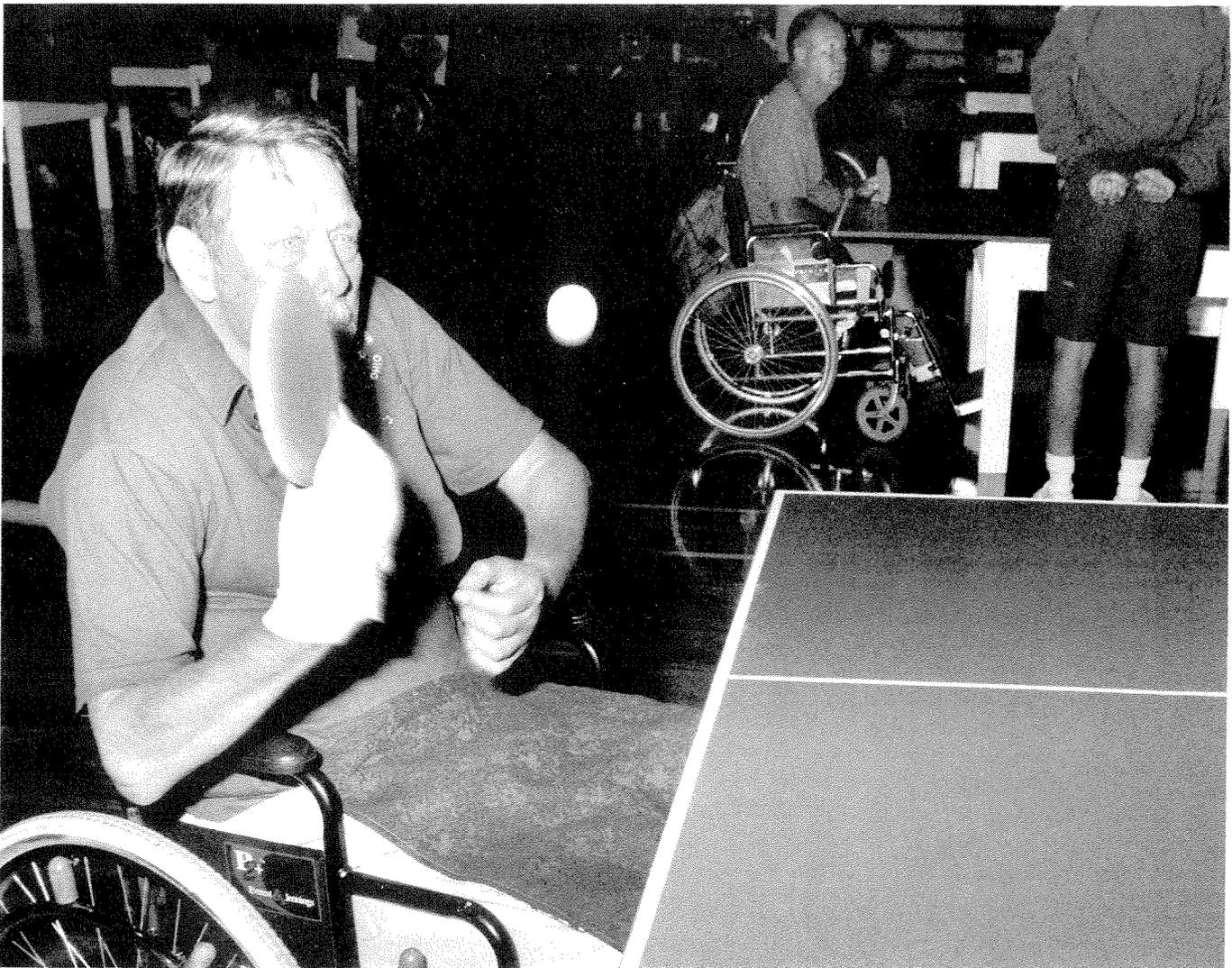


Figure 26a.
Player using a bandage to help grip the racket.



Figure 26b.
Returning a serve.

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.

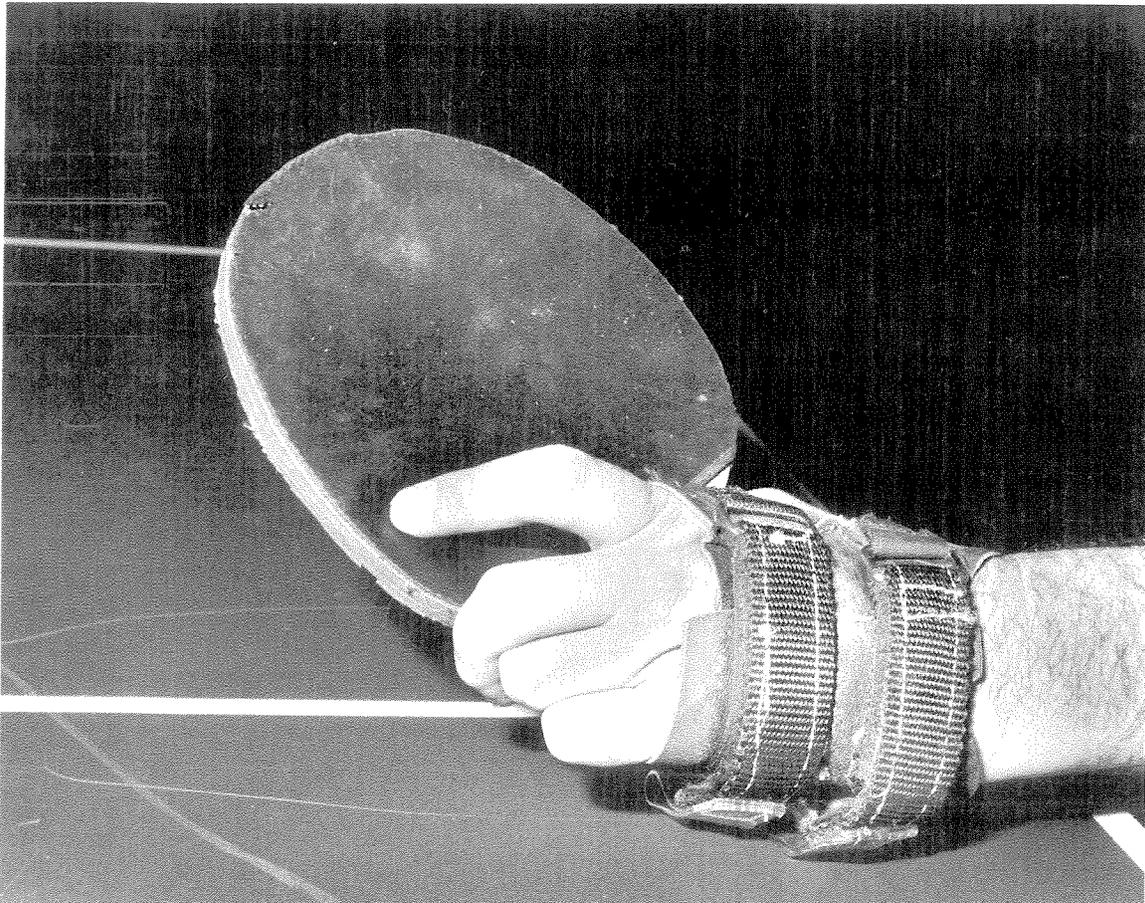


Figure 27.

Wrist support device to facilitate grasp for a person with weak or absent hand musculature.

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 (**Figure 28**).



Figure 28.

The end of an enjoyable table tennis match.

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.

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.

Equipment

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

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.



Stretching for flexibility.



Figure 29.
Air rifle, using a table for support.

AIR RIFLE AND PISTOL

Air rifle competition is one of several sports in which wheelchair users can compete side by side with the nondisabled. Because of this, wheelchair occupants do not have to be limited to wheelchair-sanctioned events, and additional opportunities to compete can be found.

There are three positions in air rifle competition: prone, standing, and kneeling. In the prone and kneeling positions, the sportsman may use a table or board for support (**Figure 29**); in the standing position, no support is allowed. Armrests are not allowed to be used as support during competition. In fact, no strapping that may increase trunk stability is allowed.

Classification

There are four divisions for both men and women in the rifle and pistol competitions. SH I is a standing class for incomplete SCI and similar disabilities. SH II is for persons with paraplegia; SH III is basically for persons with quadriplegia; and SH IV is for more significantly impaired persons with quadriplegia (assistance allowed for loading and unloading, cocking the gun, and exchanging the target). Assistive devices, such as sip and puff, may be used to activate the trigger (**Figure 30**).

Equipment

An air rifle and/or air pistol are weapons used in competition. In addition, a shooting jacket, ammunition, targets, and a shooting table are needed.



Figure 30.
Air rifle assistive device: using a sip and puff device to activate the trigger.



Figure 31.
Rifle shooting practice.



Figure 32a.
Breath control is important.

Recommended Pre-sport Exercise and/or Training

Exercises that develop upper body strength (curls, bench press, overhead press, and pull-downs) could be included in a weight exercise program for the developing air rifle sports person. Activities that build aerobic capacity (pushing around a track, mall, or neighborhood) can help the person keep the gun steady by decreasing heart rate and blood pressure.

Shooting practice (Figures 31 and 32) takes up the majority of time for this sport. *Breath control* is important in order to be competitive. Being able to time one's breathing when pulling the trigger is a learned skill that is needed to minimize interference. Basic strengthening and conditioning can help the person attain better scores by providing the strength needed to hold weapons for extended lengths of time).



Figure 32b.
Shooting practice: keeping the rifle steady.



Figure 32c.
Shooting practice: a board may be used for support.



Figure 33.
An archer and his equipment.

ARCHERY

Archery joins the ranks of sports in which persons with disabilities can compete with the nondisabled



Figure 34.
Finger release shooter using compound bow without target sights.

(**Figures 33, 34, 35 and 36**). FITA (Federation of Internationale de Tir a l'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 (see **Figures 37 and 38**). In fact, there have been disabled archers on the US Olympic Team.

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 (**Figure 39**).
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, USA-sanctioned events, in order to encourage these athletes to compete with nondisabled athletes.



Figure 35.
Archer using compound bow with target sights.



Figure 36.
Archer preparing to shoot.

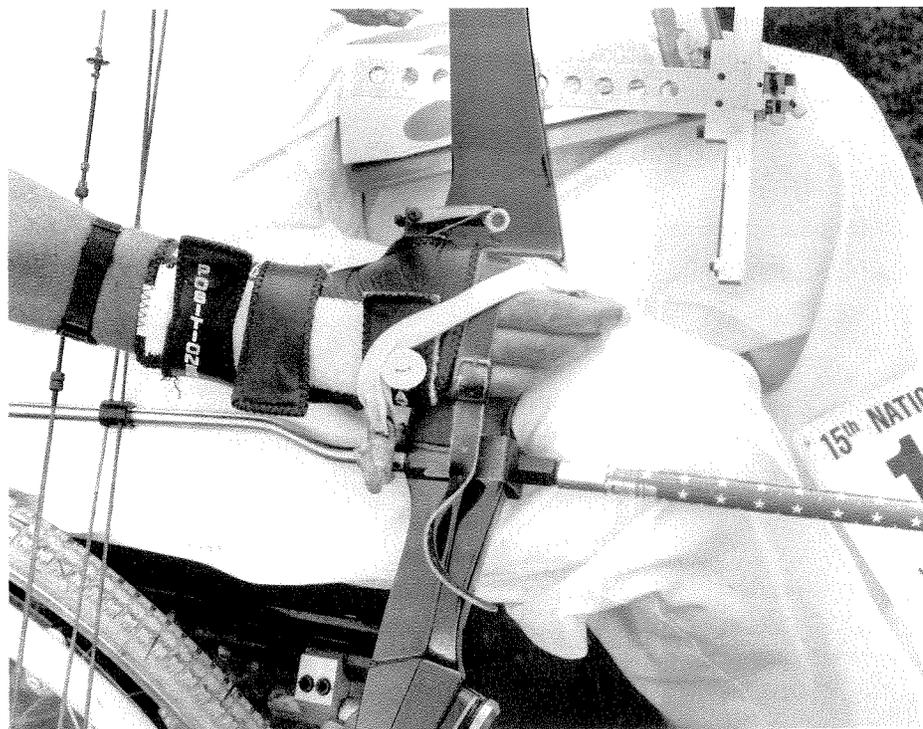


Figure 37.
Archer using adaptive equipment.

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 AR1 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 (**Figure 38**); this allows the archer to pull the bow using biceps and deltoids. The arrow is released by extension of the wrist.

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.

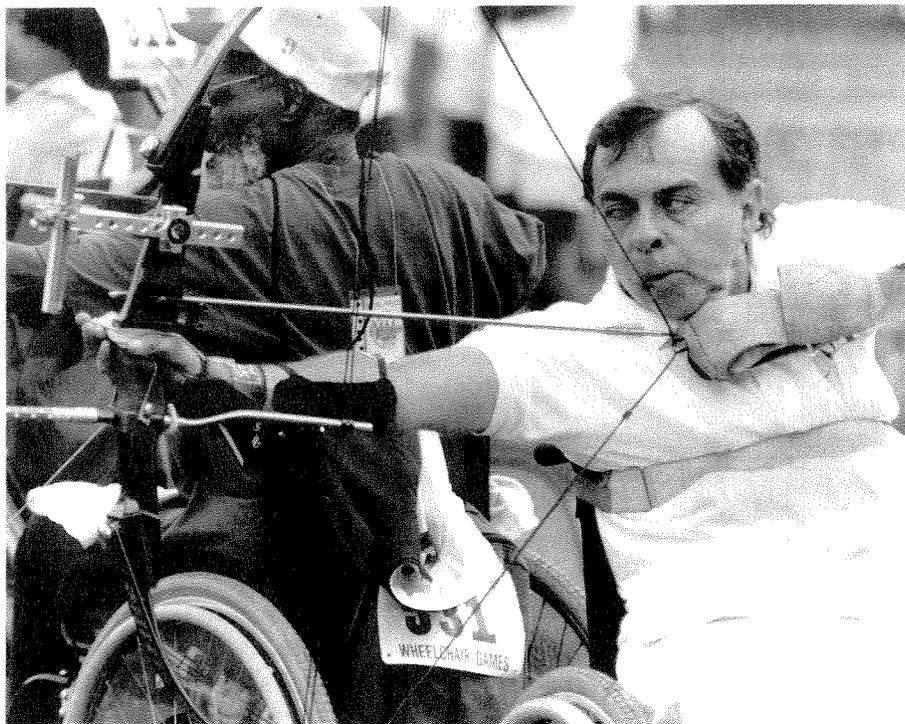


Figure 38.
Archer wearing support strap, using a hook device and adaptive equipment.



Figure 39.
Archer receiving assistance in putting an arrow on the bow.

FENCING

Although popular in Europe since 1948, the US has not been represented in the sport of fencing since 1964. The first wheelchair fencing club was founded in 1994. Wheelchair fencing and fencing for the nondisabled differ only in that the wheelchair fencer is stationary; therefore, persons with disabilities must focus more on complex blade movements than on manipulating the distance between competitors.

Classification

Competitors are placed into one of five classes, based on the function of the fencing arm and sitting balance. Classes 1A and 1B represent individuals with upper limb impairments. Weapons can be fixed with ACE bandages or tape to aid in gripping. Class 2 participants are impaired from T1 to T8 and have no handicap with their fencing arm. Class 3 competitors have good sitting balance and are usually impaired from T9 to L1 and Class 4 participants have good sitting balance and are impaired from L4 down.

Equipment

Weapons consist of an epee, a saber, and a foil. Protective clothing, consisting of a lamé apron, helmet/mask, gloves, padded vest, and jacket, is worn to protect the body. Leg covering, which can be a thick cloth or an apron, is also worn for protection. A score box is

needed for scoring a match. With each “hit,” the scoreboard buzzes and indicates contact between the weapon and the foil lamé.

Perhaps the biggest difference between wheelchair fencing and fencing for the nondisabled is that wheelchair fencers are held stationary by a fencing frame. The frame fixes the wheelchair in one position at an angle and allows for adjustment, depending on which weapon is being used and the length of the fencer’s arm.

The wheelchair used in fencing does not differ from everyday-use wheelchairs.

Recommended Pre-sport Exercise and/or Training

Using pre-sport exercise to increase upper body strength and endurance can help an individual prepare for the sport of fencing. Using light weights and high repetitions can better prepare the arms, shoulders, and wrists for lengthy competitions.

Exercise programs for fencers are skill-based with the most time being spent on skill development. Practice bouts with other fencers and coaching on technique help fencers acquire the needed skills. Although cardiovascular endurance is not an emphasis, upper limb muscular endurance is (due to the amount of time the fencing arm is in action). Therefore, upper arm ergometers; swimming; lightweight, high repetition strengthening programs; and stretching make a well-rounded exercise program for persons participating in the sport of fencing.

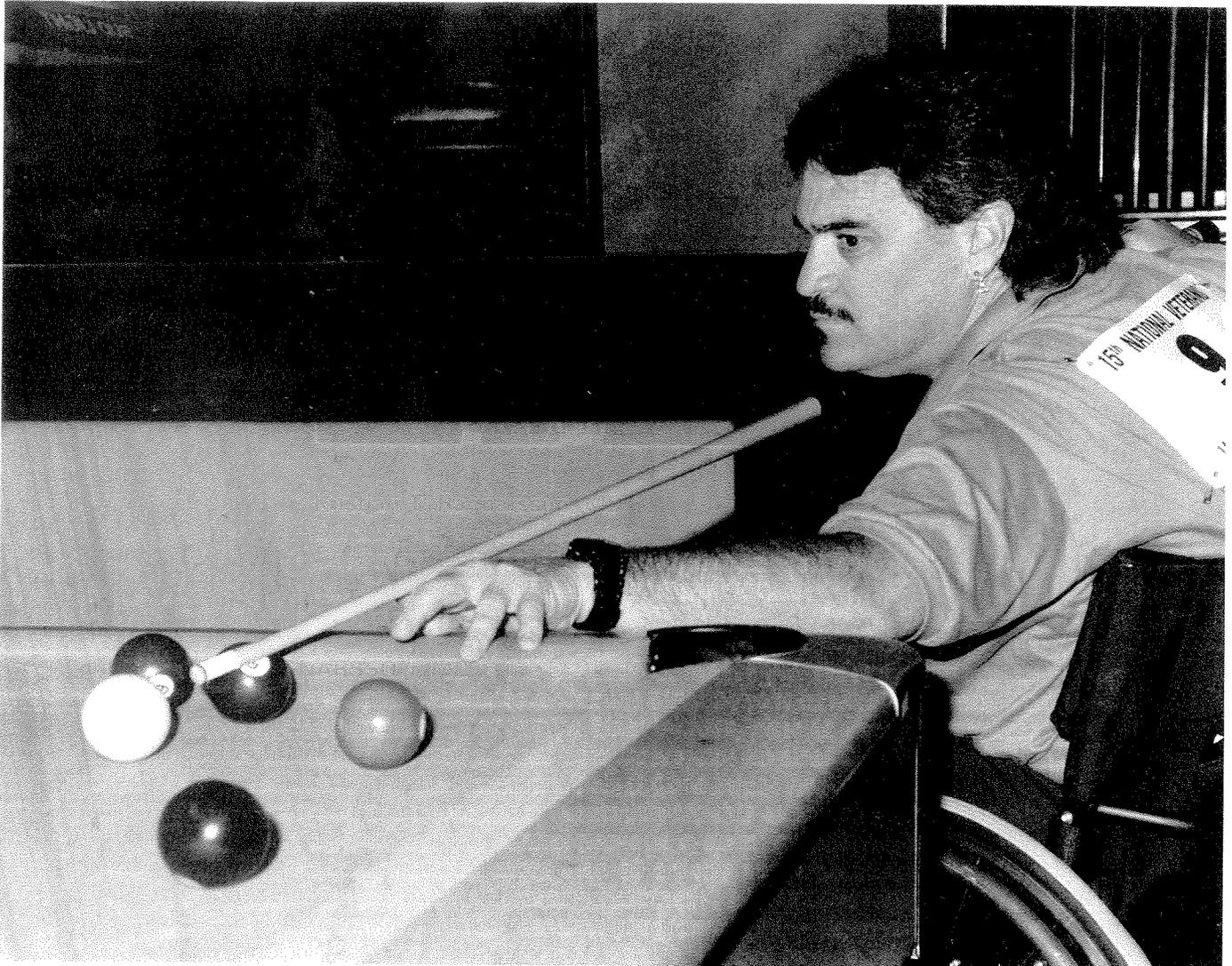


Figure 40.
Billiards; a sport that is accessible and requires minimal adaptations for persons with SCI.

BILLIARDS

Billiards is a popular sport for many reasons. Billiard tables are easily found in most areas, the necessary equipment (cue stick) is easy to carry and is reasonably priced, and the sport is largely accessible with minimal adaptations (**Figure 40**). Pool is easily integrated with nondisabled players; therefore, finding someone with whom to practice or play a game is not usually a problem. The McDermott Wheelchair Billiards Tournament is offered for persons with disabilities who want to compete in this sport. This circuit of tournaments was started in 1995 and is co-sponsored by the PVA. The tour offers prize money and the competition is high. The only rule change is that the player must keep “a cheek in the seat.” Currently, there is no classification system for varying disabilities. For more

information on the tournament, call (214)964-TOUR in Dallas, TX.

Equipment

Equipment for billiards is the same for players with and without disabilities (**Figure 41**). The basic equipment consists of a cue stick, a pool table, and a bridge. There are cuffs available to assist players with quadriplegia in grasping the cue and adapted bridges can be used to aid in the “reach” factor. These cuffs and bridges can be purchased from companies specializing in adapted equipment for recreational activities.

Recommended Pre-sport Exercise and/or Training

Although billiards does not require unusual strength or endurance, skills can be improved by maintaining muscular strength. Light weights with high reps are sufficient to see an improvement in performance.

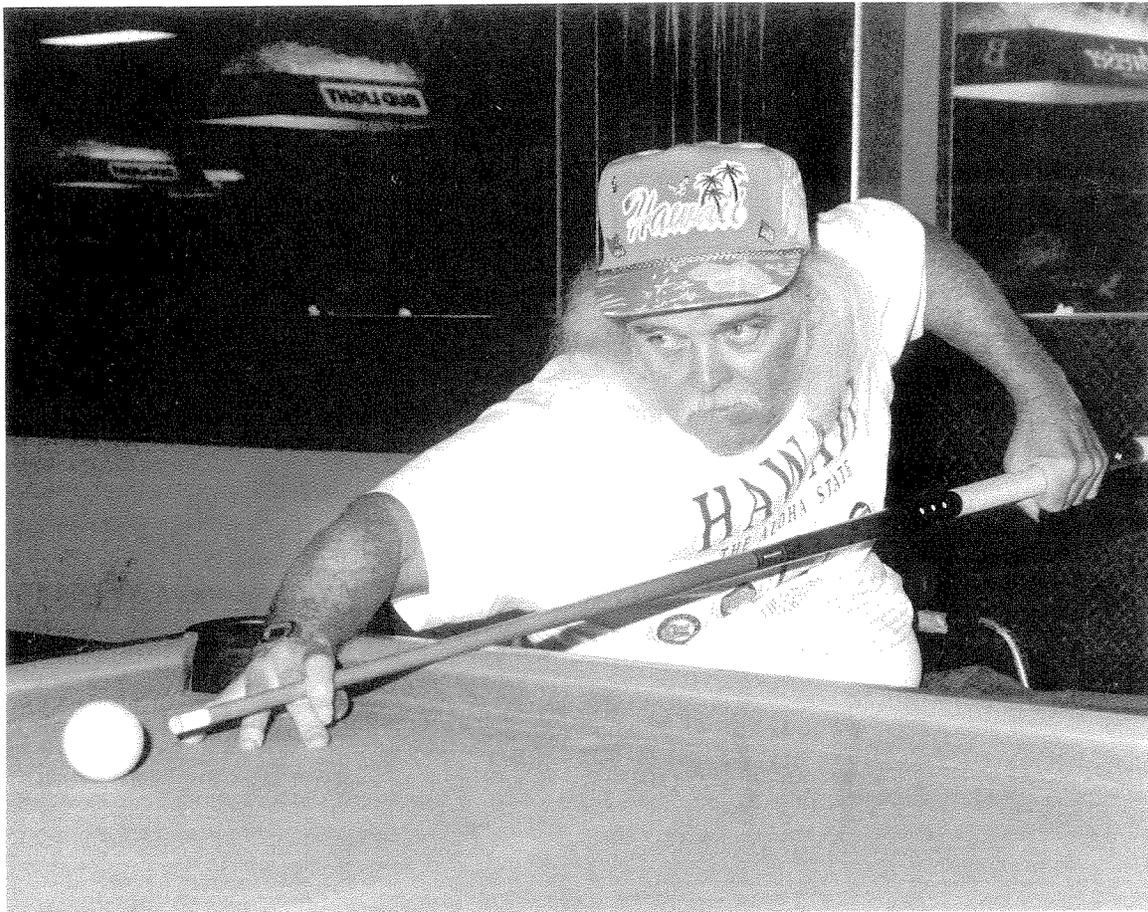


Figure 41.
Equipment is the same for players with and without disabilities.

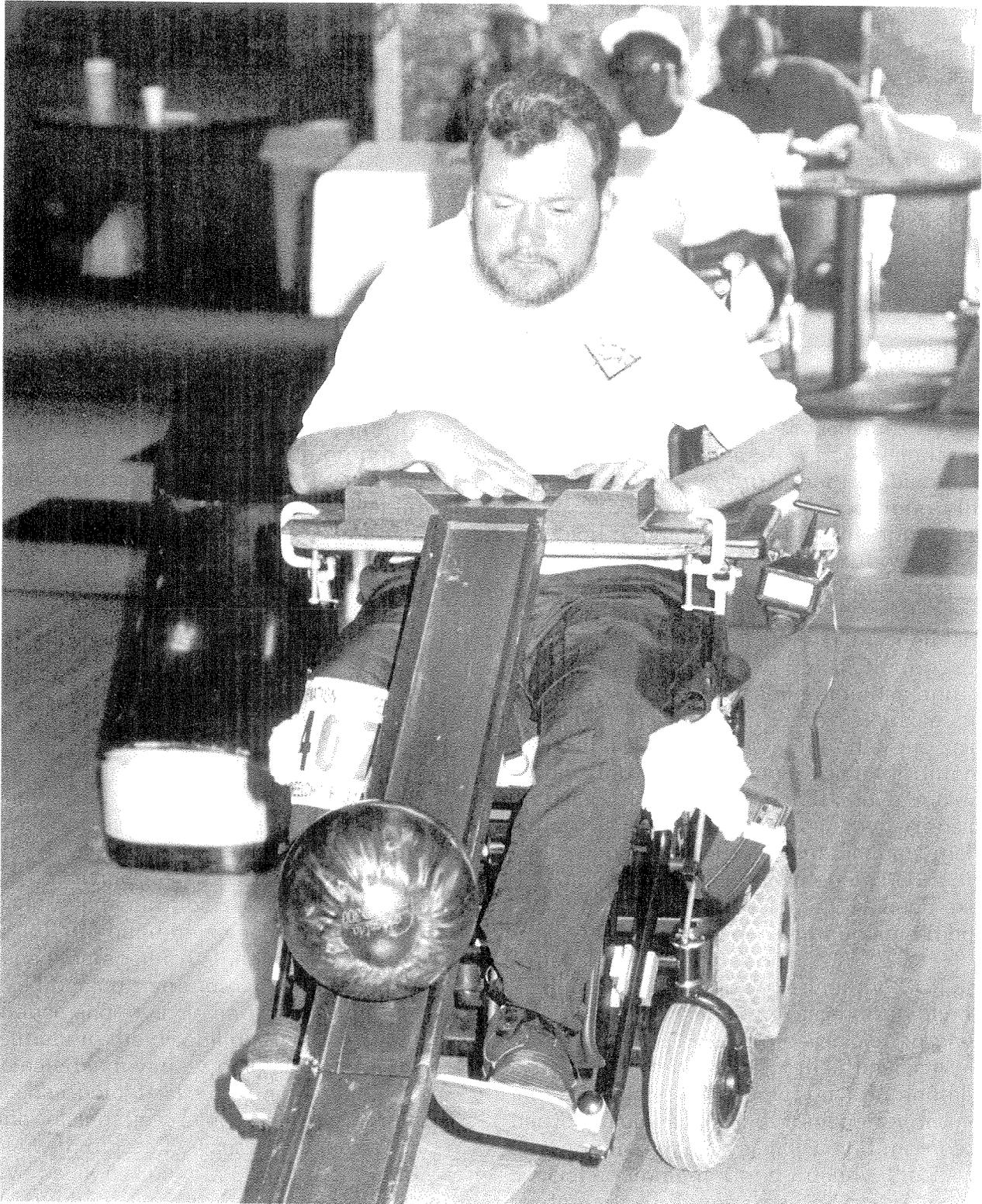


Figure 42.
Bowling.

BOWLING

Persons with disabilities have participated in the sport of bowling for many years (**Figure 42**). Tournaments are held throughout the United States. There is no official classification system for bowling, which can make bowling difficult for people with quadriplegia (**Figures 42 and 43**) if they are bowling against individuals with lower injury levels).

Equipment

Rules and equipment are the same as for those without disabilities. Often, lighter bowling balls are used for beginners. Ramps for ball delivery are available (see **Figures 44 and 45**), as well as adaptations to the ball, such as retractable handles to aid in grasping.



Figure 44.
Straight ahead ramp use.



Figure 43.
A person with quadriplegia bowling.

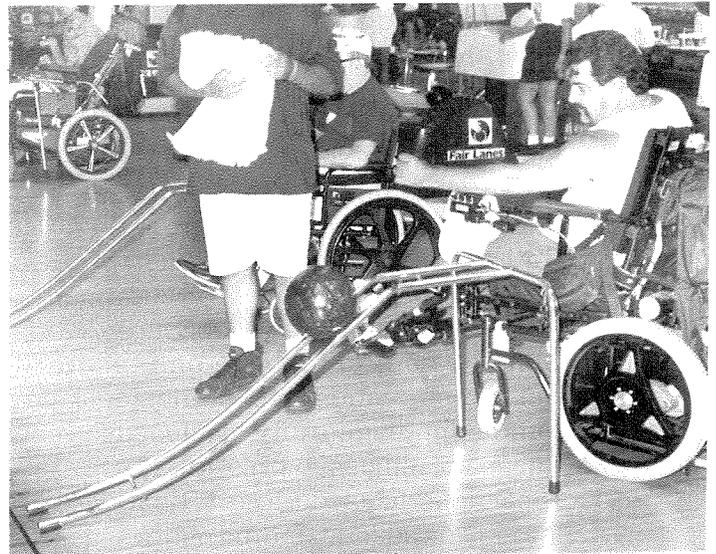


Figure 45.
Sideways ramp use.

Recommended Pre-sport Exercise and/or Training

As with billiards, strength and endurance are not significant factors in bowling. However, a strength exercise program can improve one's game. Light weights with high reps, using dumbbells or free weights, is adequate.

NOTE: Almost all of the sports discussed in this chapter can benefit from the use of overhead pulley systems with weights; many of these are commercially available. A variety of exercises can be performed to strengthen muscles of the upper limbs: vertical bench press, vertical butterfly, overhead press, lateral pull-down, rowing, and so forth.

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