

CROSS-COUNTRY SKIING

Cross-country, or Nordic, skiing is rated by many experts as one of the best forms of aerobic conditioning. It promotes overall physical fitness because it requires the use of muscles in both the upper and lower body. This sport is increasing in popularity every year, partly due to the current national focus on fitness and also to the increasing expense of downhill skiing. Cross-country skiing combines an exhilarating winter sport with the breathtaking beauty of ever-changing terrain. It does not require heavy or cumbersome clothing; recent developments in wind-resistant and water-repellent fabrics allow skiers to be out in the coldest weather in lightweight, body-contoured attire.

Unlike some of the other activities included in this section, acquired skill, technique, and good physical fitness are prerequisite to the enjoyment and benefit of trail and cross-country skiing. Navigating various types of terrain in the high altitude of most cross-country ski trails places great demands on the heart and lungs, and on the body as a whole. Muscular strength and endurance are needed to sustain the activity for several hours at a time. People who are not in good physical condition, or beginners who lack skill and technique, will quickly feel the effects of a strenuous workout without traveling very far. These people should start on trails that are flat and tracked, and therefore less strenuous.

Areas designated for cross-country skiing are usually accessible to people with lower limb amputation, as well as other people with disabilities, such as paraplegics who will be using sleds. The old saying,

“There is safety in numbers,” certainly applies to anyone who goes cross-country skiing. No matter how skilled, those who ski in remote areas should always have at least one partner.

COMPENSATING FOR LOWER LIMB LOSS

In cross-country skiing, the legs work in a gliding motion, which can be likened to skating, that is relatively nontraumatizing to the residual limb. The gliding motion takes considerable practice to master and can be particularly challenging for those with lower limb loss. However, forward propulsion is not accomplished strictly by movement of the legs, especially on trails. Effective use of ski poles is needed to gain momentum and maintain balance. This requires upper-body, shoulder, and arm strength, as well as proper technique for coordinating the use of ski poles with the strides of the legs.

A skier who develops good technique with ski poles will be able to compensate for lack of leg strength and for the forward kicking motion that is lost as a result of using a prosthetic foot. According to Janet Penn, an avid cross-country skier, a person with BK amputation loses only about 25 percent of power on the side with the prosthesis.¹ This loss of power can be compensated for by developing upper-body strength and by perfecting techniques. Using the ski poles effectively for speed, additional balance, and push-off can substantially offset the lack of leg strength on the side with the prosthesis.



JON BORK/MAUCH LABS, DAYTON, OH

Greg Mannino enjoys the aerobic benefits of cross-country skiing. He uses the Mauch SNS Knee Unit with a CAT/CAM socket and Endolite prosthesis with the Stabilized StanceFlex (Bouncy) Knee, and Endolite Foot and Multiflex ankle. Mannino was the top Men's Three-Track Skier and was an Olympic Medalist on the U.S. Disabled Downhill Ski Team, 1988 Winter Olympics, Calgary, Canada.

PROSTHETIC ADAPTATIONS

Skiing requires coordination of the body at the ankles, knees, hips, and trunk. Thus, the types of prosthetic adaptations needed will be determined primarily by the level of amputation.

For those with BK amputation, a walking prosthesis is usually adequate but may require modification to allow full range of motion and flexion. Energy-storing feet are helpful. Many competitive skiers use the Flex-Foot, which is effective in achieving the "kick" associated with cross-country skiing, since the keel of the foot is unloaded at toe-off with great force. The Flex-Foot is rigid in the mediolateral plane, which permits the ski to react more effectively when movement is initiated. Unlike a foam-covered foot or multi-axis foot that requires moving past a certain point before the motion is transferred to the ski, the Flex-Foot translates each movement almost directly to the ski.

Mediolateral knee stability is very important in controlling the prosthesis and ensuring that the ski is responsive to prosthetic forces. Side joints and lacer, or a knee brace, can help maintain mediolateral stability and limit rotation of the residual limb



MODEL AND INSTRUMENT DEVELOPMENT, SEATTLE, WA
 Racing champion Janet Penn pauses for a moment from cross-country skiing. She skis with the Seattle Foot and wears wind-resistant and water-repellent lightweight clothing that barely reveals her prosthetic left leg.

within the socket. However, some people find the side joints and lacer cumbersome, and the added stability may not be worth the added weight and loss of motion. Specially designed BK ski legs, which may include modified trimlines for greater knee flexion as well as alignment variations different from an everyday walking prosthesis, are available for the avid skier.

Skiers with AK amputation will do best using a hydraulic knee prosthesis, such as the Mauch SNS Knee Unit, as well as a multi-axis foot. AK skiers generally use a double-pole and single-kick technique in the tracks. The gliding or skating motion is difficult to achieve with an AK prosthetic leg, but one can become proficient with practice.

OFF-SEASON TRAINING

Many cross-country skiers train during the warm months by using roller-skis, which are skis with an aluminum track and binding. Wheels attached to the underside have a ratchet device that prevents them from rolling backward. This enables the skier to feel the kicking motion used on cross-country trails. The gliding motion can be achieved with roller-skis, and one can practice with ski poles to develop arm-leg coordination.

Using roller-skis on a concrete surface does involve some risks. Falling can be dangerous since concrete is a hard surface, unlike snow-covered ground. Protecting the sound limb is an important consideration, and this activity should be pursued with caution. In fact, some experts recommend the use of roller-skis only after one has learned to ski on snow.²

CROSS-COUNTRY SKIING MACHINES

The indoor version of cross-country skiing is a stationary exercise device that closely simulates the arm and leg movements in skiing. As in actual skiing, the ski-simulator requires practiced technique to be effective. Once skill is developed, skiing machines are excellent for aerobic conditioning as well as for keeping fit for this sport.

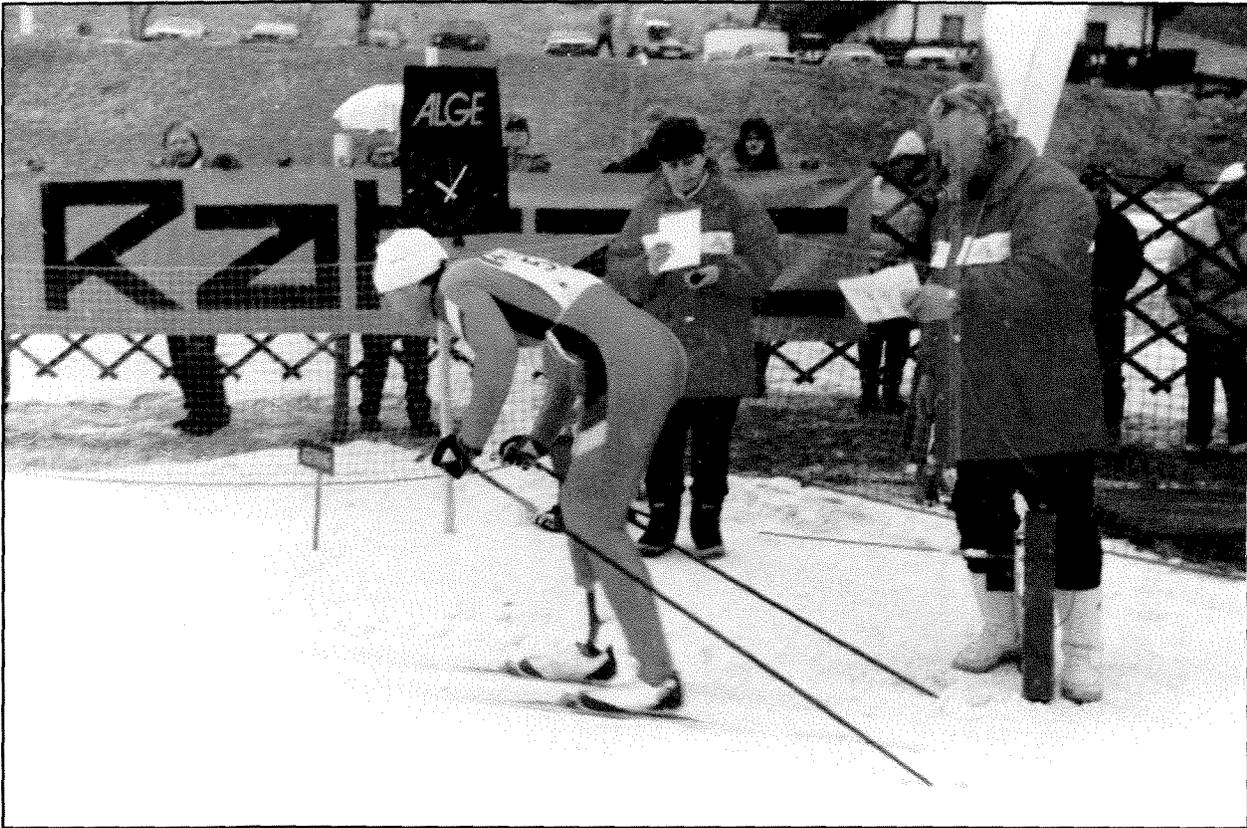
The ski-simulator is equipped with short skis that have slippers to hold the feet in place. The skis rest on rollers. Cables that work against an adjustable resistance device take the place of ski poles. Arm and leg movement can be coordinated in the same way as in cross-country skiing. Resistance should be set low for the beginner and then gradually increased. To gain maximum aerobic benefit using a ski-simulator, one should maintain a target heart rate for 20 to 30 minutes at least 3 or 4 times a week.

Maintaining balance and coordination on a ski-simulator, such as the Nordic Track, is often difficult for one who has never skied cross-country, and may be particularly so for a person wearing a lower limb prosthesis. The prosthetic foot may need to be secured at the toe to prevent it from coming out of the slipper, since there is no binding (as on a regular ski) to hold it in place.



AMERICAN ACADEMY OF ORTHOTISTS AND PROSTHETISTS
The Flex-Foot is shown positioned on the roller-ski and in the kicking motion of cross-country skiing.

Most ski-simulators emphasize leg exercise. They do not develop the arms in the same way as in snow skiing because the upper body does not really



RICK RILEY, CP, RENO, NV

Rick Riley in the starting position for the World Championship Skiing competition held in Sweden in 1986.

assist the glide or the movement of the legs. The skis move independently of the arms. This is one reason why training on a ski-simulator is often difficult or impossible for some people with lower limb amputation.

COMPETITIVE PURSUITS

Rick Riley, a certified prosthetist who has a below-knee amputation, was rated tenth in the world among disabled cross-country skiers. He competed in the 1984 Olympic World Winter Games held in Innsbruck, Austria, and in the 1986 World Championship for Skiing in Sweden.

Riley prefers a Flex-Foot prosthesis for skiing because he feels it gives him increased edge control. Modifications to his prosthesis have also helped him achieve his skill. When on skis, his foot is inset slightly more than normal, one-half to one inch in relation to the socket. He says this angle is helpful to him because when a cross-country skier is

“skating,” the weight is being transferred from one side to the other. The angle of inset keeps his foot underneath him as he moves from side to side, and he does not need to overcompensate with shifts in body position to maintain balance and rhythm.

Riley is the only disabled racer at the national level who is also a prosthetist. He feels that most people who have a BK amputation do not need a special leg to enjoy cross-country skiing for fitness and recreation. But, for those who wish to compete, the best alignment possible is needed and a special leg for skiing is helpful.

NOTES

1. Janet Penn, top ranked BK women's Nordic skier, U.S. Disabled Ski Team, National Handicapped Sports and Recreation Association, personal communication with author, August 1988.
2. H.B. Simon and S.R. Levisohn, *The Athlete Within*. Boston: Little, Brown & Company, 1987, p. 229.