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The evolution of champion cross-country skier training: from lumberjacks to professional athletes

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***Abstract***

Competitive cross-country (XC) skiing has traditions extending back to the mid-19th century, and was included as a men’s event in the first Winter Games in 1924. Since then, tremendous improvements in equipment, track preparation, and knowledge about training have prompted greater increases in XC skiing speeds than in any other Olympic sport. In response, this commentary focuses on how the training of successful XC skiers has evolved, with interviews and training data from surviving Norwegian world and Olympic XC champions as primary sources. Before 1970, most men champion XC skiers were lumberjacks who ran or skied long distances to and from felling areas while working long days in the woods. In addition, they trained as much as possible, with increased intensity during the autumn, while less work but more ski-specific training and competitions was done during the winter. Until the 1970s, few XC skiers were women, whom coaches believed tolerated less training than men. Today’s XC skiers are less physically active, but the influence of both science and the systematic approaches of former athletes and coaches have gradually taught XC skiers to adopt smarter, more goal-oriented training practices. Although the very high VO2max of world-class XC skiers has remained the same since the 1960s, new events in modern XC skiing have additionally required superior upper-body power, high-speed techniques, and tactical flexibility. These elements also emerge in the training of today’s best skiers, and especially women’s physiological capacities and training routines seem to have improved dramatically.

**Keywords:** cross-country skiing, endurance training, maximal oxygen uptake, physical activity, speed and strength.

***Introduction***

Competitive cross-country (XC) skiing has traditions dating back to the mid-19th century and was included as a men’s event at the first Winter Olympic Games in 1924 in Chamonix, France. Amid societal changes in the last century, tremendous improvements in equipment, track preparation, and knowledge about training have prompted greater increases in XC skiing speeds than in any other Olympic event.[1](#_ENREF_1) In response, this commentary focuses on how the training of successful XC skiers has evolved, with interviews and training data from surviving Norwegian world and Olympic XC champions as primary sources.[2](#_ENREF_2)

***The evolution of champion cross-country skier training***

*Preparing for the first competitions*

A 5-km race in Tromsø in northern Norway on March 30, 1843, is considered to be the world’s first official XC race. In the years that followed, XC skiers raced 2 or 3 km through fields and meadows in publicly attended events, and turns and small jumps were included in competitions to test skiers’ all-round skiing ability. In January 1884, when Trondheim Ski Association announced a 12-km race, skeptics called the long course into question and wondered whether skiers could endure such a distance. Some even predicted death by exhaustion. Fortunately, however, every skier survived.

Although we know little about how 19th-century XC skiers trained—in general, training for improved fitness was an unfamiliar concept—fear of overexertion was common. Observers believed that training caused harm and generally prioritized conserving energy instead of wasting it on sports. Indeed, sports were thought to wear down the body’s physical reserves and cause premature burnout. Doctors even averred that intense training and competition during adolescence harmed the heart and lungs, and the Norwegian Ski Federation did not allow people less than 20 years of age to compete until 1945.

However, young people, especially those living in the Norwegian countryside, were used to hard physical work. Splitting wood was the responsibility of young boys, who by age 10 had already helped with haymaking and constructing hayracks. Long days in hayfields wielding scythes, potato picking, and performing other harvesting tasks developed endurance, without any mention of the word *training*. Distances trekked to school—5 km was the average, though some schools were 10 km away—also simulated the physical activity of training. Girls and women, especially those living on farms, were also physically active, although the common belief was that women tolerated physical strain less than men.

*The beginning of systematic training*

In 1923, *The Sports Book, Volume 3* exemplified how 19 of Norway’s best XC and Nordic skiers trained and executed different skiing techniques. Never before had any text provided so much information about XC ski training, with progress planned and evaluated, which the book indicates that skiers were conscious about their training also 100 years ago. However, much of the book’s advice does not coincide with the ways in which skiers train today. For example, the text argues that XC skiers should not perform too much intensive training during the summer, but instead go for long walks in the woods, row, swim, or cycle at a slow pace, in addition to performing daily work.

Since most early Norwegian men XC skiers were farmers and lumberjacks, there was a natural progression in how they worked, and the type of that work changed with the seasons. In the spring and early summer, early XC skiers typically performed physical work on the farm until the more intense work in the woods started up in the autumn. Such a schedule allowed them to progressively build up strength and stamina. Beginning in December, most XC skiers received permission to work less in order to focus on training and competitions instead.

Daily work in the woods during autumn and early winter was critical preparation for competitive XC skiers. In the morning, with equipment on their backs, the skiers walked or skied many kilometers to felling areas, where sawing timber alone or with partners involved maintaining ski-like rhythms in bent-over positions. They used axes to lop off twigs, saws to chop up tree trunks, and bark spades to strip away bark, all in poling movements that exercised the entire body, although especially the shoulders, trunk, and leg muscles. In doing so, it was important to change hands and strip on both sides of trees so that both sides of the body received an equal workout. To top it all off, they felled, moved, and stacked timber. All tasks were regarded to be ski-specific exercises that developed strength and endurance in relevant muscle groups in intervals for hours on end. While working, skiers achieved heart rates at around 60–70% of the maximum, although briefer periods of work encouraged rates closer to 70–80%. Beginning in the 1950s, instructors even traveled around to teach skiers how to optimize work positions and rhythms in order to develop their XC skiing capacities. Reinforced by earnings that increased with effort, lumberjacks thought along the same lines as athletes and worked themselves to the limit. When the workday ended, they walked or skied home, often with increased intensity.

XC skiers worked less in the winter to instead focus on more ski-specific training. To condition themselves, XC skiers regularly skied up to 3 h, while to improve their pacing, they engaged short, intense training sessions—for example, with different types of high-intensity intervals or continuous effort for 15–30 min as quickly as possible from start to finish. High-intensity training combined with long-lasting endurance training at lower intensity produced results, which ideally involved striking the right balance between moderate and high-intensity effort. Later, skiers began to work with so-called expanders—elastic metal cords fastened to a wall—that developed upper-body strength and endurance. In the 1960s, some skiers began to use roller skis, albeit not to a large extent.

*The last lumberjacks*

In the 1960s, elite men XC skiers were still mostly from the forestry workers’ milieu. Champion skiers ran or skied long distances to and from felling areas, preferably in wellingtons, yet also trained more often than in previous generations. XC skiers ran or skied more than 10 h/week, engaged weekly strength and speed training, and continued to perform manual labor (Tables 1 and 2), which was a combination that proved to generate good results. The foundation of training was established in the summer, when routines included lots of long distances (2–3 h) in combination with relevant work. For example, the tradition of doing a 3-hour run in in moory or mountainous areas each Sunday morning started during this period. Previously, all work and training on Sundays had been limited. During the autumn, training involved more varied intensity, as well as systematic intervals, and training camps were done once per month. Camps were followed by 2-3 easier days, without any training in addition to work. However, as seen in Table 1, the load from work was still high and probably did not allow for optimal recovery. Once the snow arrived, high-intensity training and competitions took priority, and time spent at work was limited. Men athletes competed in as many as 50 or more races each season (Figure 1), and successful skiers at the time achieved VO2max values as high as today’s best skiers (i.e., for men, >80 mL/kg/min).[3](#_ENREF_3) The annual ski-specific training of a Norwegian XC champion leading up to the 1966 World Championship appears in Figure 2A.

Since 1963, Norwegian girls aged 12 years or more have been permitted to perform XC skiing competitions. However, coaches continued to believe that girls and women tolerated far less training than men, likely with reference to the fact that girls’ and women’s everyday work lives involved less physically demanding tasks. Interestingly, the tradition differed in countries such as the Soviet Union and East Germany, and the first Norwegian women to compete against skiers from those cultures drew upon childhoods with physical activity comparable to that described above for boys. On top of that, they trained more often and more intensely than recommended for women at the time.

*The first professional XC skiers*

As progress continued into the 1970s, methods of so-called Lydiard training that revolutionized track and field in the 1960s were applied successfully in XC skiing. Training in increased quantities at relatively low intensity was the recipe, which meant plenty of low- intensity preseason training.In the same decade, Norway’s College of Physical Education was established, which afforded Norway a modern, academic institution for educating coaches and athletic instructors. As skiing came to be analyzed in greater depth, though it was sometimes difficult to transfer scientific knowledge to skiing practitioners, much new knowledge about XC training emerged.

In the training diaries commonly kept at the time, most skiers counted hours instead of kilometers skied. As these diaries show, some athletes trained up to 120 h/month during the preseason preparatory periods of the 1970s, with priority given to running and classical skiing on the snow. For elite skiers, XC skiing became a year-round sport, and every month of the year included either skiing or roller-skiing. Never before had so many hours been logged, but unlike the woodsmen of previous decades, the athletes were full-time skiers or students, and their recovery periods were correspondingly longer. At the same time, their training was directed more toward XC skiing and its unique movements, in which the high VO2max of XC could be utilized in the various skiing techniques on snow.[4](#_ENREF_4) During those years, some women began to train as often and intensely as men and tolerated it. Indeed, world champion Berit Aunli was the first Norwegian woman to train up to 100 h/month in the preparation phase.

*21st-century XC skiers*

In the mid-1980s, the race format of XC skiing contained freestyle events, followed by several other major changes in the racing format, including sprint skiing, mass start races, and pursuits in which the outcome is often decided in a final sprint (Figure 1).[1](#_ENREF_1) Correspondingly, the competitive demands have become extensively examined,[5-11](#_ENREF_5) and today’s best XC skiers train in a more goal-oriented fashion to meet specific demands based on scientized approaches (Tables 1 and 2). Nevertheless, cross-training, including running in moory or mountainous areas, and basic strength exercises in the gym were used to enable XC skiers to tolerate the high quantities of ski-specific training free of injury.[12](#_ENREF_12) Figure 2B shows the annual ski-specific training of a Norwegian XC champion preceding the 2015 World Championship. In addition, today’s XC skiers have the possibility to do more sophisticated periodization of their training, and can thereby optimize the way they “push their limits” and recover.

As society changed, technology superseded manual labor. For instance, the use of school buses has meant that children no longer walk, cycle, or ski to school, and extended use of cars has contributed to decreased physical activity in our daily lives. Nevertheless, the background of most of today’s good skiers belongs to the old school, with large amounts of physical activity at a young age. Most of these are recruited from rural districts, which means that they are used to physical activity from play, sports, and work during childhood. Skiers coming from cities have also had an active childhood, with families spending most of their leisure time as physical activity. In general, anyone whose adolescence is characterized by all-round physical activity has a commanding advantage as a top athlete.

***Perspectives***

Although less time is spent on intense physical work and activity today than it was 100 or even 50 years ago, today’s skiers perform twice as much sport-specific training than skiers did in the 1960s (Tables 1 and 2; Figure 2). The bulk of that increase relates to more low-intensity endurance and strength or speed training, whereas the amount of moderate- and high-intensity training has remained the same. In addition, the professionalism of XC skiers together with the influences of science and the systematic approaches of former athletes and coaches have gradually taught XC skiers to engage in more goal-oriented training, do more sophisticated periodization and use more effective recovery strategies. Although the exceptionally high VO2max of world-class XC skiers has remained the same since the 1960s,[3](#_ENREF_3),[10](#_ENREF_10),[12-15](#_ENREF_12) skiing speeds have nearly doubled and new events in modern XC skiing additionally require superior upper-body power, high-speed techniques, and “tactical flexibility.”[1](#_ENREF_1),[13](#_ENREF_13) Although we do not know how much of the performance changes that come from athlete versus technology, these new elements emerge in the training of today’s best skiers, and especially women’s physiological capacities and training routines seem to have improved dramatically.[12](#_ENREF_12) Although less running and classical skiing is performed today, more training involves roller skis, often on special roller ski tracks on competition-specific terrain and techniques. At the same time, more emphasis is placed on training the upper-body, and skiers systematically incorporate strength, power, and speed training.[12](#_ENREF_12) Nevertheless, skiers need to compensate less everyday physical activity with variation in their training and include injury prevention strategies to tolerate and respond to such training.

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***Figure legends***

**Figure 1**. Cross-country skiing in the 1960s and the 21st century.

**Figure 2**. The annual ski-specific training of Norwegian cross-country skiing champions preceding the 1966 and 2015 World Championships, with training hours based on individual training logs and using the session goal approach.

1966: Time for warm-up and cool down before and after competitions are estimated, with additional work and physical activity excluded; see Table 1 for details.