CANADIAN MASTERS CROSS-COUNTRY SKI ASSOCIATION
L'ASSOCIATION CANADIENNE DES MAITRES EN SKI DE FOND

Newsletter Winter 2008

From news that has filtered in from here-and-there, skiers from almost all provinces seem to have experienced an exceptional start to the season. Only Newfoundland seems to have suffered from the December thaw, with the resulting lack of snow hampering training conditions. But Alf. Parsons in Labrador City claims they have plenty of snow, so we can expect him to be in top form for the World Masters in McCall in March.

It appears that most of our members were able to start training on snow by mid-November, and have been able to ski continually through to the present. In Québec our first outing on skis was on 6 November at the Forêt Montmorency and we have continued without interruption. And the first race in our masters circuit, a 10k free-style, was held on 7 December at the Forêt Montmorency under excellent conditions. For several years now this ski centre has attracted many skiers and teams for early autumn training on snow.

Because there have been few recent developments, this news letter will be short. A lengthier one will follow in spring with fresh news on several events..

By the time you receive this newsletter it will already be too late to register for the World Cup in McCall. Nevertheless registration has progressed well, and at the time of writing 156 skiers are on the list.

World Cup, McCall, USA 28 Feb. to 8 March.

It seems that snow conditions at McCall are already excellent and the organizers are ready to welcome us.

As mentioned above, many inscriptions have been received and the Canadian contingent can look forward to a busy schedule. **The Canadian championships will take place at the same time as the World Cup. This means that the two first World Cup races also count for the Canadian championships. The first three Canadians (both men and women) in each two first races(Classic & Free) will receive a Canadian medal.**

We have organized a « 5 to 7 » (a Happy Hour) during which the Canadian medals will be awarded. This will take place on 3 March at 7:30 PM. at the MCcall gulf course Club. Refreshments will be available as well as beverages – both alcoholic and non-alcoholic (for those who fear that booze might hinder their performance).

We will also take advantage of this reception to organize the relay teams, for the relay races to be held on 5 March **to participate to the relay you have to be present**. Only the

first race will be taken into consideration for participation. The relay races are also by categories, with 4 participants per team: two classic style racers and two free-style racers. The starting member will be a classical skier who will pass the relay to the second classical skier, who will in turn pass the relay to the first free-style skier … The same system applies to women, except that age categories are by 10-year groups, rather than the 5-year groups for men (this difference is imposed by the smaller number of female participants).

To participate in the relays, one must have come out first or second Canadian in his or her category during the first race. However, the relays are not obligatory; if a qualified racer does not wish to participate, he or she can be replaced by the skier that placed third… A relay team can also be completed by an athlete from an older age category.

For those participants who have not already done so, I would appreciate obtaining your address at McCall **as soon as possible,** so that I can pass on any last minute changes regarding the competitions. Addresse : jybabin @videotron.ca

Annual General Assembly of the Canadian Masters Cross-country Ski Association

The annual meeting of the Canadian association will be held at McCall on Tuesday 4 March at 4:30PM at a location that has yet to be announced. On that occasion, Wendy Greater from Ontario will table a submission for the Canadian Championships for 2009.

Web Site

The new web site for the Canadian Association is : www.canadian-masters-xc-ski.ca and will be updated from 10 February.

Biomechanics in cross-country skiing: implications for training

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I have recently consulted a number of publications, dating from 2000 to 2006, that synthesize studies on biomechanics in cross-country skiing over the past few decades. A list of these studies is provided at the end of this report. This research is of considerable interest because it emphasizes the importance of muscular qualities such as force, endurance, and muscular power in basic physical training.

Table 1 illustrates the relative duration of the propulsive phases of the different techniques of both classical and free-style skiing. The duration is expressed as a percentage of the total cycle. For example, in the alternate stride the total cycle could be

considered as the time elapsed between two successive « plantings » of the left ski pole; in the two pole stride, the time between two successive plantings of both poles. The duration of propulsion by the legs or arms is, therefore, the active phase, or that in which the force is applied either to the skis or to the poles. The average speed, shown in the left-hand column, documents the speed at which the the skiers were moving at the time the data were recorded.

It is noteworthy that in the classical style the relative duration of the propulsive phase of the arms is greater than that of the legs. This is explained by the greater possible articular amplitude of the arms, particulary at the shoulder level; the action of the trunk during the tecniques of double-poling or double-pole-one-stride, and the effects of the poles amplifies the levering action and lengthens the duration of the propulsive force. The reduced amplitude of leg movement explains the shorter duration of propulsion by the lower limbs.

In free-style events, two of the four techniques result in a more-or-less equivalent duration of the legs and arms. Nevertheless, the legs make a relatively greater contribution in free-style than in classical techniques. The movements involved in free-style allow a greater articular amplitude in the legs than in classical style where the movement is restricted to a single plane. Also, in free-style, the application of the propulsive force can continue while the ski is gliding over the snow, whereas in the alternate stride the ski comes to a brief halt at the time of impulsion.Table1 Duration of the propulsive phases of classical and free-style techniques..

Classical techniques	Speed, km/h	Propulsive duration, legs,%	Propulsive duration, arms,%
Alternate stride, level	16	13	35
Alt stride, climb 5º à 11º	12,5	18	42
Double pole	16	-	100
Dbl pole, 1 stride	20	13?	42
Free styles			
V2, level	20	29	27
Two skate	20	19	33
Offset, climb 5º	16	25	35
One skate, climb 5º	16	37	36

Table 2 illustrates the propulsive force produced by the legs or by the arms through the action of the poles. Typically, in biomechanical research, the propulsive force is expressed as a multiple of body weight. For example, during the alternate stride the maximal force exerted on the ski is equivalent to approximately twice the weight of the skier. In running, somewhat higher values are generally recorded.

The standard unit for measuring force is the Newton. Traditionally we express our body weight in kilograms, for example 70 kg. This value is, however, a measure of your body mass. Theoretically we should say that our weight was roughly 700 Newtons, but because we are frightened by large values, we prefer to hide the truth by using kilos.

Coming back to the skier, we are talking about a resulting maximal force of about 1400 Newtons, or roughly twice his body weight. Note that we are talking about a maximal force. Also, the propulsive phase of the legs is of very short duration, i.e. in the order of a few tenths of a second. This is a very brief interval to produce such an impulsion, and it is only then that it reaches its maximal value. If you are curious to explore this further you should consult the second reference below to examine the graphs showing the forces acting through cycles of alternate stride and free-style.

Note that the average or mean value of this force during those few tenths of a second is only half of the maximal value. This average value is the mean of all the forces registered on the curve of force itself. As will be seen further on, it is important in our physical training to ensure that our muscular force is compatible with the optimal demands of our expected objective.

Regardless of the technique employed, the maximal force produced by the propulsive phase of the legs is a multiple of 1.5 to 2 times of body weight. The mean force is about one times the body weight or slightly more.

The force transfered to the ground by the poles can vary from 15 to 50% of body weight, depending on the technique being used and the topography of the terrain. The relative contribution of the arms increases substantially while climbing hills , regardless of the quality of waxing.

About 25 years ago, I myself conducted some experiments along these lines involving classical techniques for both arm and leg propulsion, using of course less sophisticated methods than are available today. Although the results must be considered as anecdotal by present standards, they were remarkably similar to those obtained in recent research..

The choice of a particular technique can have a strong influence on the energy expended. One recent study showed that, at a comparable speed and on an appropriate terrain, double-poling was the least demanding energetically, followed by one skate (12% greater) and alternate stride (32% greater). In double-poling a higher proportion of the propulsive force of the arms is oriented horizontally, the skier is in a better aerodynamic posture, his weight is distributed equally on both skis, and the coefficient of friction with the snow is reduced. All of these factors contribute to a reduction of energy expenditure during double-poling..

Table 2 Propulsive forces expressed in multiples and percentages of body weight (BW)

Classical techniques	Max resulting force, legs	Max resulting force, arms
Alternate stride, level	2BW	15 - 25%BW
Double-pole	-	20 - 25%BW
One step-double-pole	1,5 – 2BW	25%BW
Alter. stride, climb 5º	2	25 - 30%
Free-style techniques		
Offset, level	1,6 – 2BW	50%BW
One skate, level	1,5 – 2BW	25%BW

In a recent study (reference # 4, below) the influence and specific effects of rollerbroard training as a means of increasing muscular strength was examined. In this study, the propulsive force of the arms was calculated during double-poling on roller skis. The maximal force was the equivalent of 50% of the body weight of the skier, the mean force of 25%, and the duration of application of the force was 0.5 seconds. The authors recommended that rollerboard training should emphasize high resistance (heavy weight and/or steep incline), an explosive movement, and that the number of possible repetitions be about 10 to 12. They also suggested avoidance of light resistance or too many repetitions. In effect, this exercise is aimed at developing muscular power through a dynamic movement reflecting the product of strength and speed.

Although I do not want to discourage the reader, it must be pointed out that the process of aging can not be avoided. Studies on this subject show that between the ages of 40 and 70 the speed of a runner on a 10km course declines by nearly 30% in both males and females. Compared to younger people, the strength of those over 60 experience a decline of 28%. The muscular mass of 70 year-old men is 22% less than in younger men at their peak. For both men and women the number of slow and rapid muscular fibres decreases by about 50% between the ages of 40 and 70. A decline also occurs in motor units, dropping by 20% between 45 et 75. But everything is not negative! Over the age of 70, muscular training with isometric exercises, weight training or gymnastics, carried out over a period as brief as three weeks, is sufficient to increase muscular strength by almost 40% over the initial condition.

What can be concluded from the above discussion on these biomechanical concepts? What are the implications regarding physical preparation, more specifically in terms of training for muscular quality? The resulting force produced by the legs represents about twice the body weight in alternate stride, and a little less in free-style. But it must be remembered that this force is produced in a very short period. It is the result of the rapid acceleration of your body weight, driven by the action of the muscles in the thigh, the

knee, and the ankle. It is therefore a reflection of your **strength** and your **muscular power,** the latter being the product of strength and rapidity of contraction (force x speed).

The force produced by the arms is transfered to the ground by the poles, and this can reflect as little as 15-25% of body weight in the alternate stride and as much as 50% in double-poling while climbing and during free-style events. The seasons of spring, summer and fall are ideal for undertaking a program of muscular training. This should emphasize exercises aimed at developing strength and muscular endurance of the legs and arms. Muscular strength is developed by exercises involving high resistance in series of about 6 to 8 repetitions each, whereas muscular endurance is built up by series of 12 to 15 repetitions. Whenever possible, select muscular exercises that imitate the movements used in cross-country skiing in order to sollicit the same muscle groups. Exercises that simulate the movements of the alternate stride or free-style (ski-skating) , *ski walking, ski running,* or those that imitate double-poling, *rollerboard,* are all well suited to improving muscular strength. Exercises of the type plyometric are also of interest but more likely to bring on injury because of muscular degeneration among older athletes. Your training program should reflect a good balance between developing strength, endurance and power. Good physical conditioning centres usually have qualified professionals to guide athletes in their choice of exercises and training protocols. As a result, the greater your strength, your endurance and your power, the greater will be the dynamics of your propulsion by your legs and arms, allowing you to ski with ease and efficiency.

References:

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3. Cross-Country Skiing: Technique, Equipment and Environmental Factors Affecting. Performance by G.A. Smith, *in* Biomechanics in Sport, 2000.
4. Biomechanical Validation of a Specific Upper Body Training and Testing in Cross-Country
   Skiing, by T. Stöggl; S. Lindinger; E. Müller, *in* Sports Biomechanics, Vol 5(1) 23-46, 2006.
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Death of Heinz Niederhauser

I will close this newsletter with the sad news of the death of Heinz Niederhauser which occurred while skiing on 5 January 2008. In the name of all members of our association, I offer my sincere sympathy to the Niederhauser family. Heinz was well known to many of us through his devotion to the cause of developing and promoting cross-country skiing in Canada.

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