


Running With Poles to Increase Training Efficiency and Reduce Injuries

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ABSTRACT

Running makes significant demands on the musculoskeletal system, which is heavily strained as it absorbs up to three times the runner's body weight each time the foot strikes the ground. This strain often leads to injuries that compromise an athlete's training. The authors propose running with poles or Nordic Running, a means they tested on themselves, as a way to reduce orthopaedic strain and increase training efficiency. They start by comparing Nordic Running to cross-country skiing and Nordic Walking. This is followed by a report on an experiment showing that when running with poles the average maximum force on the feet is approximately 5% less and the pressure is redistributed to the front part of the foot compared to normal running, confirming the author's central claim. They then outline the case for including Nordic Running in the training programmes of athletes and make recommendations for the groups of athletes that could benefit from the practice. Also included are a description of the technique of running with poles and a brief presentation of ancillary exercises that can be done with the running poles.

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Introduction

Running is the basis of athletics and a number of other sports. As it involves many of the body's muscles, it is a highly effective training activity that is suitable for almost anyone – both performance-oriented sportsmen/sportswomen and individuals with recreational or fitness motivations.

Running does, however, make significant demands on the musculoskeletal system, which is heavily strained as it amortises the gravity at the moment in each stride when the foot strikes the ground (depending on the running speed, the foot must absorb two to three times the runner's body weight with every foot strike and there can be 1000 or more foot strikes per kilometre). It is an unfortunate fact that running-related injuries are common among athletes of all levels and motivations. These include stress fractures as well as various forms of tendon and muscle damage in the lower limbs that can be classified as over-use injuries resulting from the

accumulation of stress linked to the runner's constant interaction with the ground. Any injury can greatly compromise training effectiveness if the athlete must reduce the quantity or quality of his/her running and other training or, worse, must undergo (often lengthy) treatment and rehabilitation.

To address this situation, we have proposed the incorporation of a method of running with poles, called Nordic Running, into the training activities of athletes and other sportsmen and sportswomen. Based on our subjective experiences of using this method regularly for more than two years, we have found that running with poles increases the physiological challenge and energy consumption of running. This means more work can be done in a shorter period of time and, therefore, the number of foot strikes the body is subjected to can be reduced with no reduction in training effect. More importantly, we feel that, with the proper technique, running with poles reduces the force impact and pressure changes on the feet during the support phase of the running stride. This, in turn, diminishes the stress on the lower limbs and can help to lessen the orthopaedic risks associated with running. Finally, running with poles can help remove some errors in running style and thus improve it, which could be of great interest for recreation/fitness-oriented athletes.

The general contribution of Nordic Running can be seen as a widening of the range of training methods currently used in all athletics disciplines as well as recreational or fitness training. Indeed, in the Czech Republic, a number of top coaches, including national head coach Tomas Dvorak, as well as top athletes like javelin throwers Barbora Sportakova and Vitezslav Vesely, have already incorporated Nordic Running into their programmes. We have created a website (www.nordicrunning.eu) that explores all aspects and possibilities of this method.

An obvious analogy to Nordic Running can be found with the increasingly popular fitness activity of Nordic Walking, which developed as a summer training means for cross-country skiing. Here the use of poles provides greater support and stability as well as a reduction

of the stress on the musculoskeletal system, which are similar aims to those of running with poles. However, unlike Nordic Walking and cross-country skiing, which have both been studied from the methodological, training and medical points of view and developed into industries, none of these aspects of Nordic Running has been properly examined.

Our aim in this article is to explore the concept of Nordic Running. We will first compare running with poles to cross-country skiing and Nordic Walking. Then we will report on an experiment to test our central claim that running with poles reduces the impact and strain on the runner's feet. We will also describe the technique of Nordic Running and discuss ancillary exercises that can be done with the running poles. As a conclusion, we will present our case and recommendations for including running with poles in the training of performance-oriented and recreation/fitness-oriented athletes.

Comparisons

Both classical cross-country skiing and Nordic Walking are widely practiced activities that have been scientifically analysed and bear certain resemblances to Nordic Running. However, there are considerable differences between the three that should be understood from the outset.

Like running, the main training advantage of classic style cross-country skiing is its relatively high intensity. Both activities lead to a high consumption of energy, which makes them good for both sport training goals and body-fat reduction. As for running, there is the disadvantage of the high impact on the musculoskeletal system. Classic style cross-country skiing, which can be considered as a very convenient training or cross-training method during the winter season, does not overstrain the main joints so much. However, this activity requires prepared trails, which can often be very limiting (most runners and other active people are not lucky enough to live just next to a skiing trail or track).

Compared to standard walking, Nordic Walking - by involving the poles and arms - relieves a part of the impact put on the main leg joints (ankle, knee, hip). Nevertheless, by using standard poles for this activity, the higher intensity, which is necessary for reaching training goals in the athletics training effectively, is not guaranteed.

Nordic Running is different from above-mentioned activities in key movement phases and equipment. It requires a longer stride (not an ultra-endurance stride) than walking or Nordic Walking. Compared to classic style cross-country skiing, the take-off phase of the stride in running with poles is shorter, both in time and space. The take-off phase of the stride in running with poles can be compared to the middle phase for the cross-country skiing

stride (i.e. without moving the arms considerably in front of or behind the body). See the box on page 53 for a description.

With regard to the poles used, the key consideration is the length of the pole. Those used for Nordic Running should reach just below the shoulder and therefore are approximately 10cm shorter than classic style cross-country ski poles (which should come to just above the shoulders). The grip and correct stroke movement require a narrow profile and smooth surface of the handle, which allows the hand to slide gently – similar to the poles used for cross-country skiing. The lower part of running poles are similar to Nordic Walking poles in that a longer tip allows penetration into the ground or rubber endings can be used on roads or other hard surfaces.



Figure 1: Olympic javelin champion Barbora Sportakova

Box 1

THE TECHNIQUE OF RUNNING WITH POLES

1 The mid-stance, as well as the other parts of the stance phase, is characterised by a slight forward lean of the body. At this moment, when the foot is in contact with the ground and is situated under the body centre of mass, the pole support is the greatest, significantly reducing the load of the foot. Similarly to running, the angle in the elbow is approximately 90° at this moment. Pole support effectively eliminates potential hyper-pronation and prevents overloading of the musculoskeletal system.

2-4 In the later parts of the stance phase, the body center of mass is moving forward and so is the knee of the swinging leg. During this period the elbow extension is associated with the pole support. Reduction of the load exerted on the feet depends on the power with which the runner consciously sticks the pole in the ground with (the greater the force, the greater the load reduction).

5 During the take-off phase when running slowly, the supporting leg is not fully stretched in all three joints (ankle, knee and hip). At this moment, the pole/arm take-off is not finished yet, but it terminates during the swing phase.

6-8 The pole support continues during the swing phase. Unlike in ordinary running, the runner using the poles accelerates during this phase! The supporting arm is not getting behind the trunk with the elbow flexed to 90° as in ordinary running, but terminates take-off next to hip with elbow slightly flexed. When the swing phase is longer (longer stride) the arm-pole push off is longer too, which allows the runner to fully extend the elbow. In the second part of the swing phase the lower leg is swinging forward and is getting ready for foot strike.

9 Here we see the foot strike with an active pull is taking place just in front of the trunk with the knee slightly flexed. At this moment, the opposite lower leg is positioned in parallel with the ground and, in more active and faster running closer to the buttock. The pole is placed into the ground just under the centre of mass and starts to cooperate on the absorption of the impact.

10 When the runner is getting to mid-stance the pole support is increasing, which should prevent the runner from lowering his or her body - "sitting down", and eliminates excessive knee flexion which often causes injury problems.

11 The runner is getting to mid stance again and the entire stride cycle repeats while arms and legs are being switched.

Note: When running uphill, the body is leaned slightly forward, the pace is lighter and shorter (rebounding more from the tiptoe) and the pole planting is more dynamic.



Running with poles on the flat ground

Videos and further information and available at www.nordicrunning.eu.

The Experiment

Objectives and hypotheses

The objectives of our experiment were 1) to compare the force impact and pressure changes in the feet during the support phase of running and running with poles and 2) to evaluate potential changes in foot pressure distribution and its affect on the rest of the musculoskeletal system.

Hypothesis A: When running with poles at the same velocity as normal running, the impact on the foot, and the musculoskeletal system, is diminished.

Hypothesis B: When running with poles, the pressure distribution across the sole of the food is changed.

Methods

The measurements were made on one test subject, a male athlete-runner (weight: 74kg, height: 180cm). An analysis of the foot pressure distribution onto the sole of the foot was conducted during support phase of stride while running and again while running with special poles. The measurement was conducted on a grass surface, a track of 100m, which was repetitively run through by the test subject, at the same pace of 4:20 min/km. The analysis is based on the average result of the measured parameters for 30 strides.

The test subject wore elastic pressure-measuring insoles (Pedar-X System, Novel GmbH, Munich, Germany) in his running shoes. Cables connect the insoles to a recorder, which is attached to the waist by a belt (Figure 2).

The system also comprises an internal Bluetooth device, a memory unit and software for processing and evaluating of the data. The shoe insoles fully cover the area of the sole of the foot. Each insole's surface is divided into 99 small fields, in which there are force sensors to measure current vertical force at a frequency of 50 Hz. The system is able to detect and assess the pressure changes between the foot and the pad during the support phase of the walking or running stride. Using this system, the pressure

on the pad as well as other time-space characteristics of the foot strike can be recorded and displayed so that changes can be assessed.

For more detailed analysis, the insole surface is divided into seven segments: medial heel area, lateral heel area, middle foot, medial forefoot, lateral forefoot, big toe and other toes. Software enables to assess all the measured constants both for each segment separately and all together. Furthermore, it enables observation of the data immediately on the computer screen or to process and assess the data through the database module Novel database essential.

Results

When running without poles, the average maximum force, measured in Newtons (N), affecting the left foot reached 1616N and 1700N for the right foot (Figure 3a). When using poles, the force was diminished to 1538N and 1610N, respectively (Figure 3b). In the first case, the difference is 78N (4.8%) and in the second it is 90 N (5.3%). There is a similar picture when we look at peak pressure, measured in kilopascals (kPa), as shown in Figure 4a and 4b.



Figure 2: The Pedar-X System

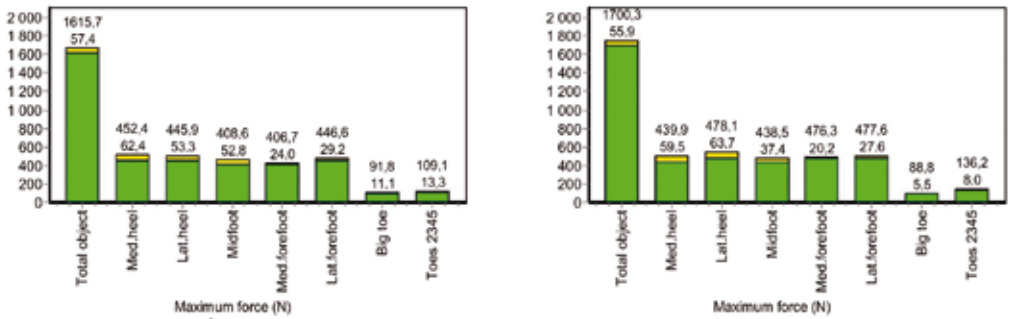


Figure 3a: Maximum force (N) on regions of the feet for one individual running without poles (left foot shown in left graph)

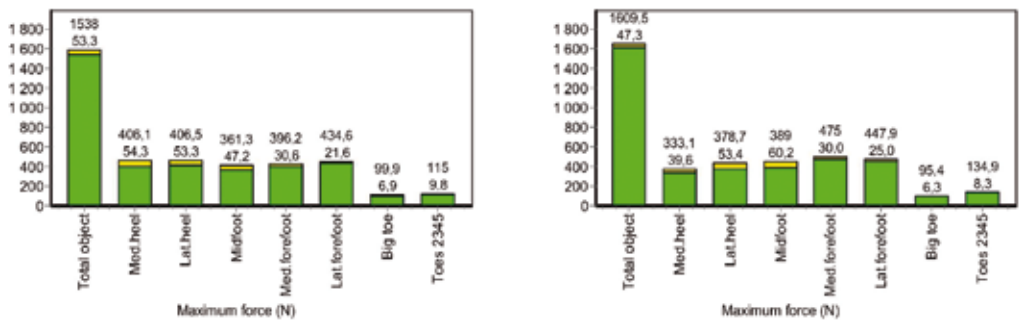


Figure 3b: Maximum force (N) on regions of the feet for one individual running with poles (left foot shown in left graph)

We also found that there are significant functional changes in the distribution of pressure across the feet. When using poles, the pressure centre moves more to the front part of the foot. The average maximal force significantly decreases in the heel and mid-foot area, while the differences in the forefoot are relatively small. Figures 5a,5b, 6a and 6b demonstrate that concerning the pressure redistribution, the area of maximum figures on heels (red colour) is significantly diminished when running with poles.

Discussion

With regards to Hypothesis A, the experiment has shown a decrease of musculoskeletal system strain when running with poles. This could be the result of involving the arms, which provides both relief for the musculoskeletal system and greater stability for the runner.

The decrease of musculoskeletal system strain at given pace (4:20 min/km) within one movement cycle is relatively small (approximately 5% of the overall maximum force). However, we can presume that it will have a significant injury prevention effect with longer runs, where the overall musculoskeletal main joint strain is cumulative from many thousands of foot strikes. According to the distance covered, the resulting figures of decreased strain would be measurable in tons or even tens of tons.

Based on the assumption that vertical forces are also influenced by the runner’s weight and running pace, we can presume there would be bigger differences (higher relief of the musculoskeletal system) for heavier athletes, for example throwers. Bigger differences can also be expected on harder surfaces.

With regard to Hypothesis B, the experiment showed that when using the poles, the whole movement technique changed. The pressure centre of the foot moved forward without significantly increasing the strain on the front area of the foot, as can be observed when running on the front part of the foot. The vertical force decrease is significant mainly during the first support phase. This means that running with poles does not strain the musculoskeletal structure involved in step amortisation (mainly the heel and Achilles tendon) as much as running without poles.

Conclusion

Our finding from this simple experiment is that running with poles makes a small but potentially significant reduction in the load on the runner’s musculoskeletal system demonstrated by the reduction of the maximal force on the foot and the change in the distribution of force across the foot compared to running without poles.

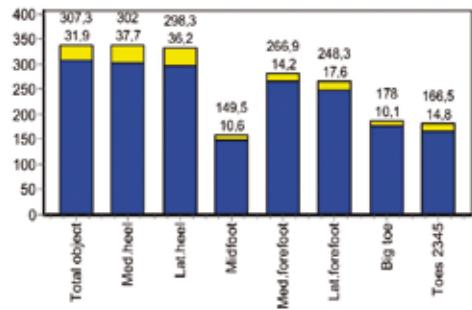
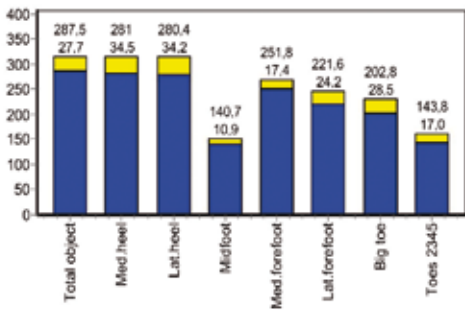


Figure 4a: Peak pressure (kPa) on regions of the feet for one individual running without poles (left foot shown in left graph)

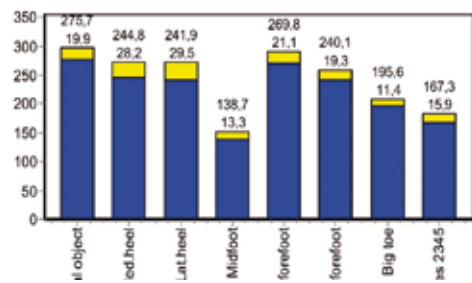
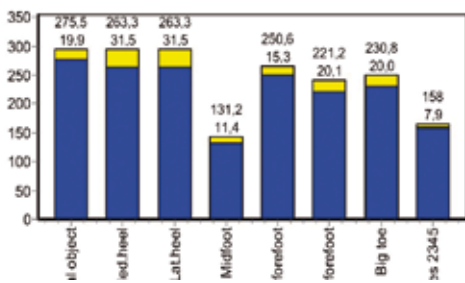


Figure 4b: Peak pressure (kPa) on regions of the feet for one individual running with poles (left foot shown in left graph)

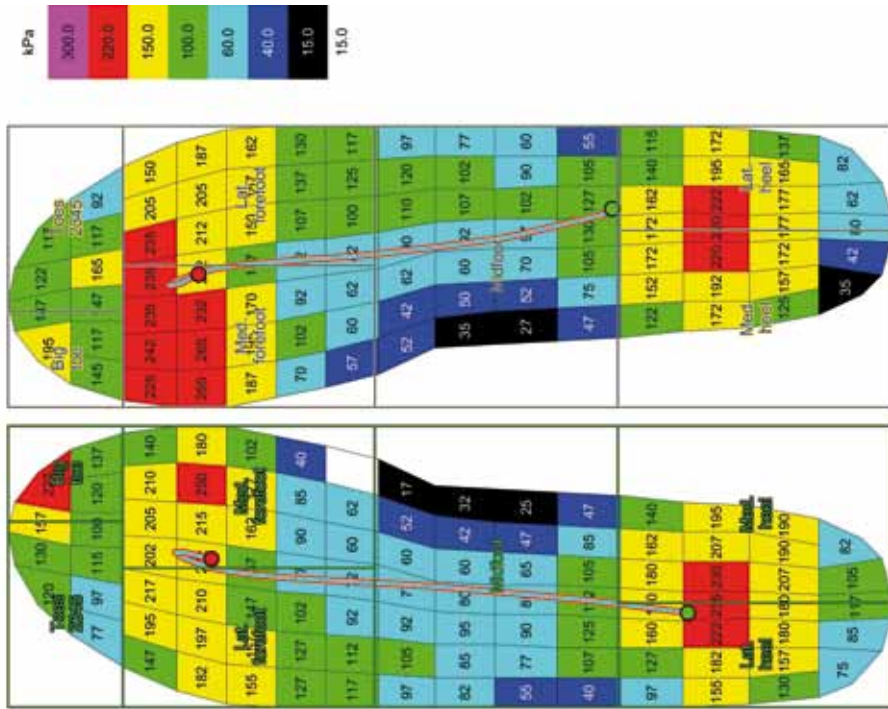


Figure 5a: Averaged maximum pressure across the foot for one individual running without poles

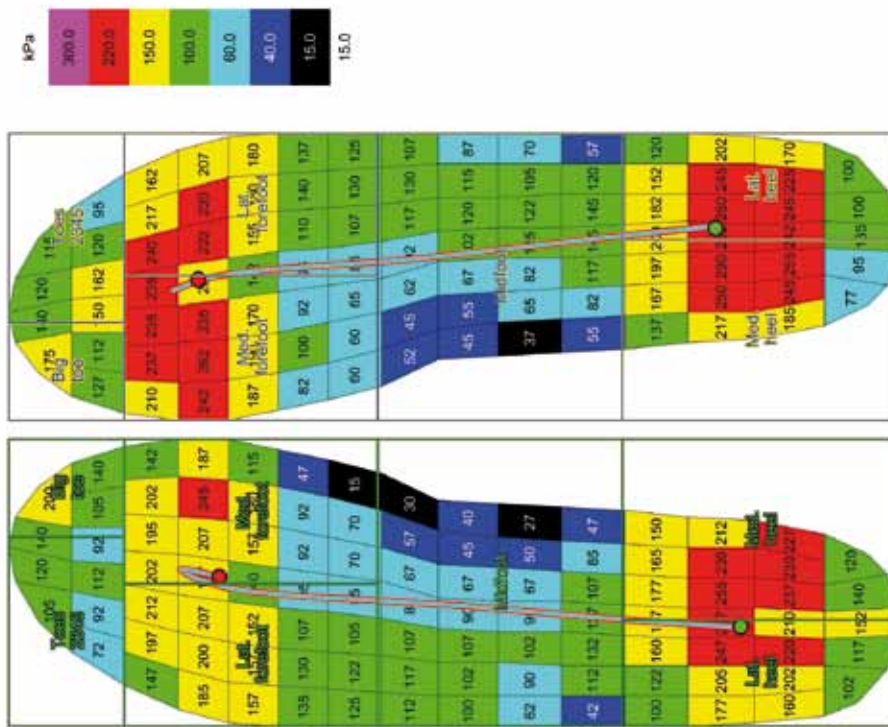


Figure 5b: Averaged maximum pressure across the foot for one individual running with poles

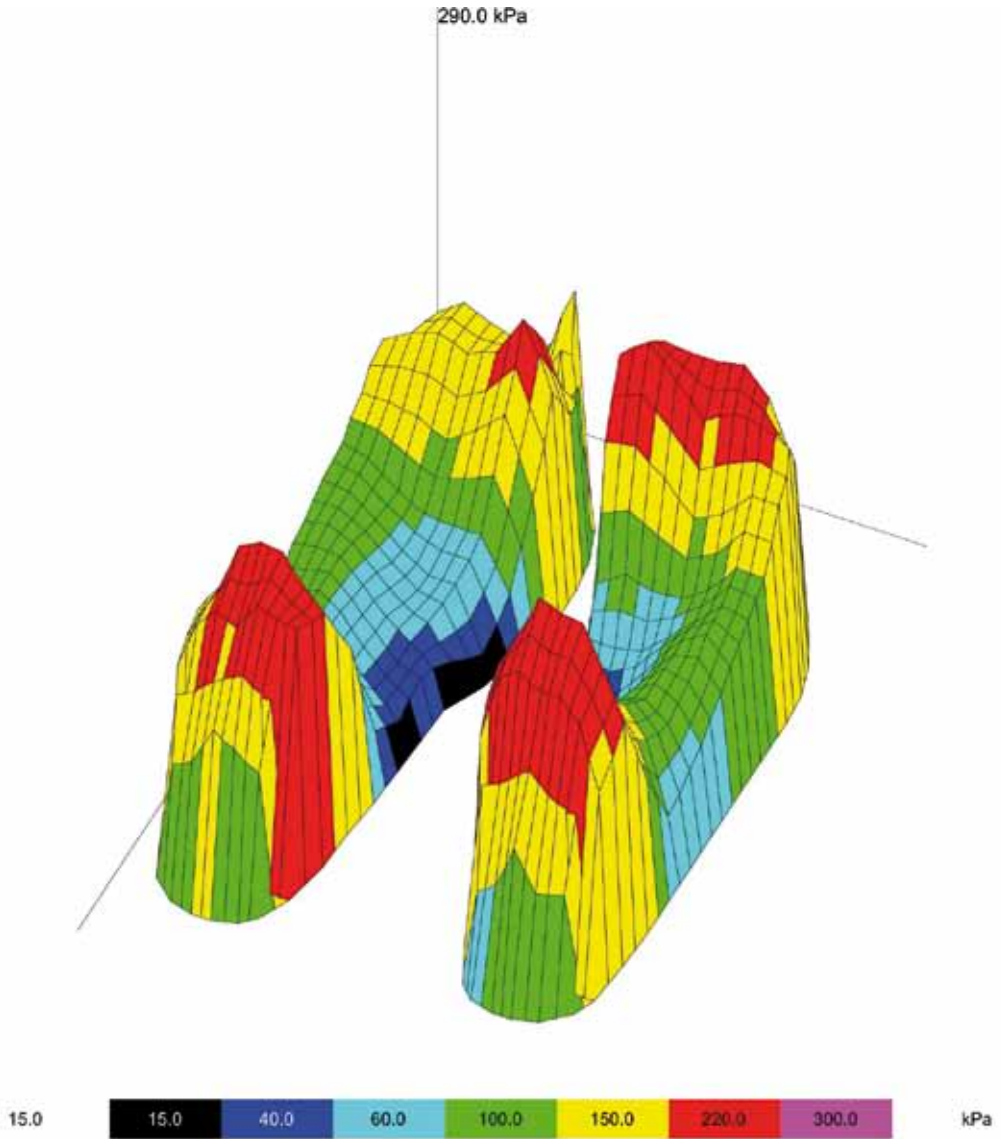


Figure 6a: 3-D picture of averaged pressure across the foot for one individual running without poles

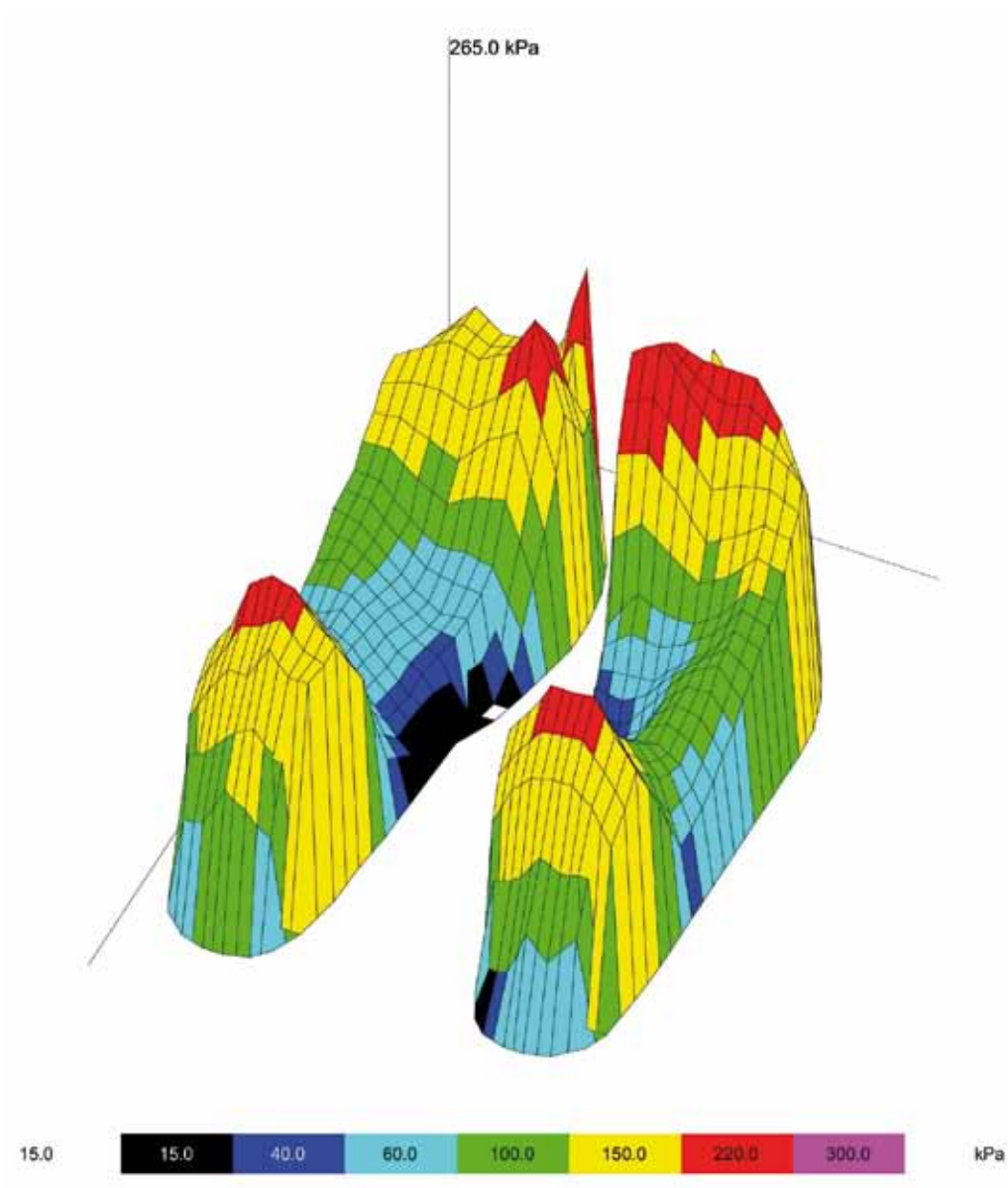


Figure 6b: 3-D picture of averaged pressure across the foot for one individual running with poles

The Case for Nordic Running

Based on our subjective experience and the results of the experiment described above, we believe Nordic Running should be incorporated into the training of all different types of athlete as a supplement to normal running. To start with, the method is universal (it can be used by any athlete at all performance levels or age groups) and it is inexpensive. The four main arguments for running with poles are outlined below:

Injury prevention

In addition to the above confirmation our hypotheses about reducing the impact load and strain on the musculoskeletal system, our experience has let us to the feeling that there is better stability when running with poles. The poles help the runner to remain upright and steady, even on soft uneven terrain (parks, grass, fields, forest paths etc.) or on the snow in winter, thus reducing slipping and straining. We believe that these two factors could significantly decrease the risk of injuries. Moreover, runners who already have some injuries could use of poles to make a faster return to full training.

Empirical statement: after two years of regularly practising Nordic Running, one of the co-authors can report that he has completely avoided injuries (contrary to previous years) and that the positive effect of the running with poles manifested itself by strengthening of the heel- and calf tendons and muscles (which helps further to prevent injuries).

Training efficiency

Concerning our other subjective experience of Nordic Running, we have to point out the increased training effect. Running with poles is much more physically demanding than ordinary running. We can say that there are actually two runs in one: “up” (body, arms, shoulders), where we are doing classic cross-country skiing technique, and “down” (legs) we are run-

ning. With poles the chest muscles, shoulders and arms are more involved than without poles and the breathing is more intense. A runner using poles has to move more muscles more vigorously and therefore has significantly higher energy consumption than when only running. When running with poles the runner naturally strengthens the muscles of the upper limbs, chest and abdomen. And, contrary to cross-country skiing, when the arms relax while going downhill and legs relax while double poling on a flat surface, when running with poles, neither arms nor legs relax at any time.

Therefore Nordic Running can be a great advantage for professional athletes – especially, but not only, during winter season – that the time spent at one training unit with a required energetic intensity can be significantly cut down (the energy consumption is the same in shorter time). There can be no discussion about the value of the time saved, especially with our modern busy daily routines; let alone the fact that the athletes could “invest” this time in rehabilitation and regeneration.

Training variation

Nordic Running and exercises that can be done with poles (see Box 2) add a new set of activities to the programme of the athlete and can create new interest and motivation. The activities can be used as a year-round method of cross training or special training for specific objectives.

Running style

Many athletes - and not just recreational runners - run the wrong way. Nordic Running can help remove some errors in our running style and thus improve it. With poles, the direction of the push-off diagonally backwards forces the runner to take the correct body position (slight tilt). The poles' bouncing when running will automatically ensure the proper working of the arms and the motion of elbows forward and along the body.

Box 2**EXERCISES WITH RUNNING POLES**

If we include running poles in training, it is possible to use them for many other exercises. Here we demonstrate a few ideas that coaches could explore and develop.

One area where the poles could be used is in the warm-up and stretching before or after running itself. The poles allow the runner to bend forward in order to stretch the lower and upper back muscles as well as the calf muscles. Side squats are also possible to help to stretch the hip joints, knees, thigh muscles as well as shoulder girdle muscles (as the athlete leans on the poles).

A second area where the poles could be valuable is with running drills, such as skipping, kick-backs, straight-leg shuffle and jump stride, that are characterized by a greater range of motion. When using the poles, the load of the musculoskeletal system is more complex and balanced compared to exercising without poles (part of the load is shifted from lower extremity to arms and shoulders).



Photo 1: Back Stretch



Photo 2a Side Squat



Photo 2b: Side Squat



Photo 3: Skipping



Photo 4: Kick-backs



Photo 5: Straight-leg shuffle



Photo 6: Jump stride

Videos and further information and available at www.nordicrunning.eu.

Recommendations

We believe there are five main groups of athletes that could profitably make the use of Nordic Running a part of their training programmes. Below we list these groups and outline our reasoning.

Endurance runners

Nordic Running should become one of the regular forms of any middle- or long-distance runner's training. Unlike standard fartlek or free running, it enables the runner to reach desired submaximal running velocities with reduced injury risk especially in difficult terrain or weather conditions (mud, snow etc.). The added training effect of running with poles in any training unit or time period would reduce some of the time required for a high-volume programme. Nordic Running could also liven up the programme and prevent monotony, which is another danger with a high-volume programme.

Sprinters and Jumpers

Endurance development is also a basic physical training element for athletes in other disciplines – sprinters, jumpers and combined event competitors. Nordic Running enables them to combine running exercises with dynamic elements to develop bouncing force and power endurance (e.g. bouncing and steep uphill running). Their training is then extended with very intense outdoor training units, which they would obviously not carry out without poles.

Throwers

Shot putters, javelin, discus and hammer throwers usually have more robust bodies than endurance athletes or sprinters and jumpers, which brings problems with keeping stability during running. Although throwers normally prefer strength training to running out of stadium, endurance running is nevertheless a necessary basic of their general fitness training.

Nordic Running therefore could be convenient for them since it helps increase running stability as well as strengthens the arms and shoulders. It also gives them a more efficient use of the time they do spend running and may even inspire them to spend more time on this type of training than they are currently inclined to do.

Athletes recovering from injuries

A very large target group is, unfortunately, athletes recovering after injuries, trying to regain their pre-injury fitness level, or athletes who have to reduce their training programme due to overstrain. We are convinced that, apart from the advantages of reduced impact and increased stability, the psychological aspect is also very important: a sportsman or sports-woman, used to regular activity, will not be only walking with poles (which could lead to frustration), but will be able, within the realms of possibility, to run with the stable support of the poles. Presumably, the activity would be carried out only on safe and flat tracks.

Health & fitness athletes

We cannot leave out the people, whose current physical condition does not enable them to make a full training effort. Our first thoughts involve mainly overweight people, running beginners and occasional runners who practise only jogging. In all their cases it is possible to incorporate Nordic Running as an activity, which extends simple walking and Nordic walking by its higher intensity and emphasises the injury prevention contributions – mainly relieving of the musculoskeletal system.

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