PREVENTION OF RUNNING INJURIES

By Blaise Dubois, B.Sc., P.T., RCAMT, SPD
DEAR RUNNER,

This short informative book will provide you with answers to certain common questions. Whether you run regularly or plan to begin, you have clearly made the decision to take charge of your health. What you have yet to discover, perhaps, is the extent of the benefits of this decision; your risk of developing a serious disease (cancer, diabetes, heart disease...) will decrease by more than 60%. Imagine... a 'super-drug' to prevent and treat all these diseases at the same time! Indeed, no drug offers as great a promise of health as a program of regular physical activity...

Let’s run!

DEAR HEALTH PROFESSIONAL,

This short informative book may not be designed for you, as certain affirmations contradict some of your current knowledge and may come as a shock. A special three-day course will allow you to study the concepts in detail and discover the scientific evidence that supports the facts included in this book.

Let’s debate!

DEAR SCIENTIST,

This short, popularized book is designed to inform and guide runners. Waiting on the publication of evidence-based data often slows the complex process of knowledge transfer, or even halts it completely. Developing an expert- and evidence-based clinical guide is a colossal task...

If you’re interested, contact me!

DEAR SHOE COMPANY,

This short, simplified book is merely the tip of the iceberg. You will probably not appreciate the discussion about shoes since the points raised contradict the majority of the ideas your industry conveys. Remember, however, that everything is subject to change, as long as a rigorous and transparent scientific process free of commercial bias inspires clinically applicable changes...

I look forward to a debate with your scientists!

All rights reserved © The running clinic, 2010. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the author.
## TABLE OF CONTENTS

### INTRODUCTION  (PAGE 1)

### BIOMECHANICS  (PAGE 3)
- Biomechanical Behaviors
- Useful Tips (How to Become a Safe and Efficient Runner)
- Pronation

### TOP TEN RUNNING MYTHS  (PAGE 6)
1. Cause of Running Injuries  (PAGE 7)
2. Frequency of Training Sessions per Week  (PAGE 8)
3. Shoes  (PAGE 10)
4. Surfaces  (PAGE 11)
5. Anatomy and Pathologies  (PAGE 12)
6. Orthoses  (PAGE 16)
7. Flexibility  (PAGE 14)
8. Arthrosis  (PAGE 17)
9. Anti-inflammatories  (PAGE 18)
10. Hydration

### CHOOSING A SPORTS SHOE  (PAGE 19)
- Choosing a Sports Shoe
- Buying a Sports Shoe (Ten Useful Tips)
- Minimalist Shoes
- Minimalist Shoes and Science

### CONCLUSION  (PAGE 25)

### APPENDIX: The Runner's Essential Tools

- Ten Golden Rules
- Quantification of Mechanical Stress
- Rules of Progression to Avoid Injury
- Preparing for Training
- Interval Program (Level I)
- Interval Program (Levels II and III)
- Core Strengthening
- Knee Strengthening
- Achilles Tendon Strengthening
- Foot Strengthening
- Flexibility Exercises
BIOMECHANICS

Certain anthropologists are convinced that man has survived through time because of his qualities as a long-distance runner. These researchers even suggest that the human body, in its evolution, developed physical characteristics suited to running. With his shortened arms, prominent buttocks, lengthened Achilles tendons, short and parallel toes, in addition to foot arches that flex for weight bearing and become rigid for propulsion, have made Homo erectus a biomechanical wonder. Whether these characteristics are a cause or an effect of running, one can observe a close link between function and adaptation. The human body continues to adapt to its environment, which has changed rapidly over the last decades: regular surfaces and ‘interfering’ shoes on one side, and a sedentary lifestyle on the other. The sedentary lifestyle has multiple consequences, such as a weakening of our tissues due to a lack of stimulation, as well as a gestural incompetence resulting from the lack of variety in mechanical patterns.

BIOMECHANICAL BEHAVIORS

The majority of studies on the biomechanics of running have been conducted in the last thirty years. Almost all have analyzed recreational runners, on treadmills, wearing standard training shoes. It comes as no surprise that 80% of the runners thus analyzed ran with a heel strike. And no more proof was required for the ‘rear-foot striker’ to become the standard in running pattern. It is interesting, however, to note that barefoot runners and a great number of high-level runners do not strike heel first. In fact, some biomechanical characteristics are constantly seen in effective runners, who unconsciously seek to be more energy-efficient. High cadence, minimal vertical displacement, shortened contact time with the ground, little or no braking phase and energy-efficient movements define the international-level runner. In contrast, the occasional jogger places his foot in front of the center of gravity, attacking heel first, thereby increasing the braking phase, the impact force, and contact time with the ground. These mechanics diminish the stride rate and, therefore, ground-level dynamics. There is no longer adequate function in the elastic response of the anti-gravity system of muscles and tendons*, including the Achilles tendon which normally acts as a spring. This results in an important loss of energy during the prolonged contact phase, incurring a greater muscular effort during the propulsion phase.

A question then arises: why does modern man run so poorly? The first of two main reasons is the modern shoe with its elevated heel and its cushioning. The slope of the shoe, which elevates the heel by several millimeters in relation to the forefoot, causes an unconscious first contact with the heel. The cushioning and comfort of the shoe act on the neurophysiology responsible for mechanisms of protection. The ‘protected’ foot no longer needs to worry about painful stimuli brought on by heel-first contact, and the ideal mechanics of the bare foot are thus disrupted.

The second reason is the human being himself. As soon as our ancestors were able to stand, they

*Muscles that prevent the body from collapsing to the ground
ran and walked barefoot daily, logging many hours per week. This repetition of a movement brings biomechanical refinements that make us more efficient. This explains in part why individuals who have been running for a long time are more efficient and economical runners. Through inactivity, however, modern man has lost his running skills and some members of the modern human race have never even acquired them. Such individuals will have to learn proper running movements in much the same way that one has to learn the proper movements of any other sport or skill.

It is possible to transform the running movements of the modern man into safe and efficient biomechanics in two ways. First, several gurus in the field of running biomechanics propose the integration of a new running style through structured and well-defined stages of intentional learning. The most popular techniques are ‘Pose Tech’, ‘Evolution Running’ and ‘Chi Running’, which correct the position of body segments through exercises. Such corrections, initially static, then dynamic and, finally, integrated into running mechanics can be hopefully maintained in the long term. However, this sometimes laborious process, relatively costly and often more philosophical than scientific, does not always succeed.

The second method of acquiring safe and efficient biomechanics is the indirect and unconscious method. By minimizing shoe interface and increasing stride frequency, one automatically reduces heel contact, contact time with the ground, vertical displacement and impact force. My recommendation for over 90% of runners is therefore simple: run in minimalist shoes at an average stride rate of 3 steps per second!

### USEFUL TIPS

**HOW TO BECOME A SAFE AND EFFICIENT RUNNER**

- Run in minimalist shoes.
- Maintain a pace of about 180 strides a minute (170-190).
- Run at least 4 times a week.
- Gradually integrate a few minutes per day of forefoot jumping (ex. jumping rope).
- Choose firm irregular surfaces such as cross-country trails.

**NB** Any change must be gradual so that the body has time to adapt!
The human body has developed and adapted biomechanically, allowing it to maintain its stability, minimize the impact of stress, and maximize energy efficiency when in motion. The barefoot racer Abebe Bikila successfully incorporated these biomechanical and neurophysiological changes. (In 1960, in Rome, Abebe Bikila ran the marathon barefoot and won the Olympic gold medal.)

Pronation, the natural inward roll of the foot as it strikes the ground and flattens out, is a good example of the integration of these adaptive biomechanical behaviors. Pronation plays an essential role in adapting the foot to the ground, but may also increase to improve foot stability or shock absorption. Soft shoes or soft unstable surfaces increase stabilization behavior, while hard surfaces and soles increase impact-moderating behavior.

Impact-moderating behavior intensifies when increased pressure is applied to the metatarsal heads* and to the heel, or when bone vibration increases due to impact. The body contracts certain key muscles in the entire leg, even before the foot strikes the ground, in order to reduce vibration in, and stress on, the joints. In other words, this behavior causes muscles to absorb the shock from the ground, thus reducing stress on, and damage to, the bones.

Stabilization behavior serves to maintain pressure points necessary to the stability of the foot and thus the entire body. Pronation that occurs rapidly after the initial impact with the ground is observed in barefoot runners and has even been identified by some researchers as a factor in the prevention of injury.

* Anatomical region located under the forefoot.
TOP TEN RUNNING MYTHS

MYTH AND REALITY

Many practices and beliefs have persisted over time without any challenge from a process of scientific analysis. This is understandable in that science attempts to demonstrate the already-established principles and interventions of clinicians or coaches in their daily practice. These unfounded theories have been built on clinical experience, often very rich and often communicated by persons of influence. In this context, it is essential to challenge the theories with new knowledge and, on occasion, with new scientific evidence made available through an increasingly abundant literature. Questions and changes in practice often arise from such a challenge, changes which are usually slow and difficult, given the gap of more than a decade that separates science from practice. It takes ten years to prove what we practise, ten years to change an unacceptable practice after scientifically demonstrating it as baseless or revealing the contradictions surrounding it.

1. CAUSE OF RUNNING INJURIES

MYTH

Most running injuries are caused by external factors (shoes, running surfaces, etc.) or intrinsic factors (lack of flexibility, muscle weakness, abnormal biomechanics...).

REALITY

The main cause of running injuries is the amount of stress applied to the tissues. Nearly 80% of running injuries are attributable to an increase in training volume or intensity.

MY OPINION

No matter how worn the shoe, how stiff the calf muscles, or how weak the foot muscles, a runner only incurs injury by running. Internal factors (related to the body itself) and external factors (related to equipment and running surfaces) merely exacerbate tissue overload induced by the mechanical stress of running. The first step in preventing the emergence of overuse injury is to quantify the mechanical stress and then control the progress of this stress (See annex, p.29). The overall mechanical stress applied to the body must never exceed the body’s maximum capacity for adaptation. Otherwise signs such as pain will appear (maladaptation zone) and the tissues, now less tolerant, will tend to weaken if stress is reapplied during the period of recovery. Inactivity or insufficient stress to the tissues (unadaptation zone) will bring on a deconditioning of the tissues, making them more fragile. To adapt, strengthen, or at least maintain tissue, minimal but relatively frequent stress is required.

The runner who trains without provoking pain, through a progressive increase in volume and intensity, trains in the desired adaptation zone. Calculating the amount of training and increasing it by approximately 10% per week is a wise progression. Adding quality training segments such
as intervals represents a significant additional mechanical stress that must also be quantified. Clearly, the stress applied to the Achilles tendon during a 100-meter sprint is much greater than that applied over the same distance while jogging. These principles of adaptation and quantification of mechanical stress are so fundamental that it is not uncommon for runners with a well-planned training program to complete an entire season without injury, despite poor technique or inappropriate footwear.

### 2. FREQUENCY OF TRAINING SESSIONS PER WEEK

**MYTH**

*To avoid injury, it is better to run 2 to 3 times per week and cross-train with cycling or swimming than to run 6 times per week.*

**REALITY**

*With respect to the prevention of running injuries, no study has successfully quantified optimal or ideal frequency of training.*

**MY OPINION**

The majority of running overuse injuries such as the patellofemoral pain syndrome (runner’s knee), Achilles tendinopathy, patellar tendinopathy (jumper’s knee), medial tibial stress syndrome (peristitis, or shin splints), plantar fasciopathy and stress fractures are all weight-bearing pathologies involving low- and medium-metabolism tissues. Contrary to muscle, which is high-metabolism tissue, the former are better adapted to less intense but repeated stress. For this reason, when seeking to prevent injury, it is preferable to run daily instead of distributing the same weekly volume over three days. For the runner accumulating fewer than four training sessions per week, adding two 10- to 20-minute periods of jogging would be a wise progression. Cross-training activities such as cycling and swimming are very interesting from a physiological point of view (cardiovascular), but the mechanical stress of these activities is different and inadequate. Another advantage of frequent running is the unconscious learning of efficient mechanics, synonymous with safe or injury-reduced running.
OFF-SEASON

An annual rest period is sometimes a necessity. The high-performance athlete, injured or physically and psychologically tired from extreme training sessions, allows his body to rest and return to homeostasis. Weight gain and hormonal balances are examples of desirable physiological changes for certain individuals. However, since the adaptation of musculo-skeletal tissues is directly linked to the mechanical stress applied, it would be preferable not to unload these tissues (bone, cartilage, tendons), which are less malleable than those responsible for physiology (heart, lungs, blood vessels). For these reasons, three to six weeks of complete rest without mechanical stress will lead to an unadaptation of tissues, dramatically increasing the risk of injury at the beginning of the new season. Maintaining minimal mechanical stress during a period of rest is an efficient way to prevent these complications. For example, a runner who totals 60 kilometers per week in the regular season may continue to jog 20 minutes three times a week in addition to integrating dynamic drills such as jumping rope for five minutes a day.

3. SHOES

MYTH
A shoe’s cushioning prevents injury by reducing shocks to the runner’s body.

REALITY
Clinical and scientific results do not support the fact that shoe cushioning reduces the incidence of running injuries.

Cushioning does not change the stress on the skeleton (bone and cartilage) since the body adapts its impact-moderating behavior (to absorb more or less of the impact) according to the hardness of the shoe.

MY OPINION
The foot is the organ that connects us to the earth. It informs us about the surface, adapts to the unevenness of the ground, and absorbs the weight of our bodies. The foot, just like the rest of the body, is a biomechanical marvel that fits for better...or worse. The shoe is the interface between the body and the earth. It provides essential protection from the cold and from dangerous surfaces, but constitutes both unnecessary protection in the majority of our daily activities and harmful interference for activities involving neurophysiological mechanisms.

The 1990s brought an explosion in the technological development of the running shoe, based on clinical concepts devoid of scientific evidence: more cushioning to reduce stress on the bones and technologies integrated into the shoes (heel stabilization and anti-pronation systems, arch support) to control the foot deemed abnormal in its biomechanics. These technological advances designed to reduce the incidence of injury have propelled the shoe to an ever-greater weight, size and price. As the shoe has modernized and an exceedingly complex manufacturing process has
become the norm, the foot has lost primary tactile sensations because of the increased thickness of the soles. Like the modern sedentary man, physically unfit and maladapted to mechanical stress, the runner’s foot, now constantly protected, has become lazy. This laziness can be observed not only in foot muscles, but also in the loss of absorption-capacity reflexes responsible for efficient and protective mechanics. The shoe is now the leading cause of altered running biomechanics! As for injury prevention, it is disheartening to note that runners incur more injuries than before and that runners who wear shoes are injured more often than those who run barefoot. In addition, a higher-priced shoe (of better quality and with more technological features) does not reduce the incidence of injury.

In terms of performance, the runner is unconsciously converted to a heel-strike position, as the shoe protects him from the impact of the ground. This rear-foot cushioning and the relative elevation of the heel in relation to the forefoot have completely disrupted the runner’s biomechanics which now include an ineffective, and possibly harmful, braking phase.

The protective aspect of footwear has always been valued. Since the beginning of time, leather has acted as a shell against sharp rocks, the cold and snow. The day that manufacturing technologies improved and new materials were discovered, engineers, influenced by the marketing departments, took off with catchy designs. Running shoes have evolved as much in the past twenty years as in the previous four thousand.

USEFUL TIPS

• Walk barefoot when possible.
• Choose a dress shoe that is simple in style with a heel as low as the forefoot.
• Opt for a not-too-tight shoe without arch support in which the foot retains freedom of movement.
• The perfect running shoe should protect the skin from lacerations and the cold, while minimizing the ‘interface’ between the foot and the ground. Wear running shoes that are low, simple, and flexible, which allow you to perceive contact with the ground (such as a ‘racer’s flat’), and very gradually run barefoot whenever possible.
• Change your shoe gradually, over a period of 3 or 4 weeks, when it becomes a factor in the exacerbation of a biomechanical vice (deformation or wear).

NB Any change must be gradual so that the body has time to adapt!
4. SURFACES

MYTH
Hard surfaces and hills increase the risk of running injury.

REALITY
No surface has been clearly identified as more likely to cause injury.

MY OPINION
All surfaces present the same risk for the appropriately adapted runner. Only when a runner makes a rapid change in surface without allowing the body time to adapt does he expose himself to the risk of injury. Each type of surface produces different biomechanics. Hard surfaces such as asphalt and concrete increase impact-moderating behavior, while soft surfaces such as sand and grass help increase stabilization behavior. Each of these behaviors leads to a specific mechanical response and, therefore, heightens mechanical stress on certain anatomical structures such as muscles, tendons, or joints. A second factor to consider in the regularity of surface is its implication in overuse injuries. The repetition of a new and asymmetrical movement, such as always running on the same side of the street, will put stress on certain specific tissues, exposing them to a greater risk of injury. Regular surfaces such as a treadmill, track, and road have the same effect on the mechanical regularity of the runner. If running mechanics are deformed through irregular wear on the shoe (change in an external factor) or a recent change of an internal factor, the body will once again suffers. For these reasons, uneven surfaces, varied and fairly firm, allow the runner to minimize the risk of overuse injuries while improving proprioception and internal absorption mechanisms, stimulated by such surfaces. A third related aspect of surfaces is hill training. Running uphill increases the force of propulsion and, therefore, the stress on the posterior chain (Achilles tendon, plantar fascia, etc.). Running downhill increases impact and the braking phase, thus increasing stress on the heel, the IT band and patella. Again, it is a question of adaptation. Gradually including hills in training leads to tissue adaptation, which in turn protects the runner from related pathologies.

In conclusion, a runner should be gradual and cautious when changing surfaces. Moreover, he should select a variety of irregular and relatively firm surfaces (cross-country) to complete the volume of specific performance training (track or road).
5. ANATOMY AND PATHOLOGIES

MYTH
Flat feet and other anatomical ‘abnormalities’ of the lower limbs make people more vulnerable to injury.

REALITY
Inherent anatomical and biomechanical peculiarities (high arches or flat feet; knee, forefoot, and heel valgus or varus; pronation or supination; increased Q-angle; etc.) are not predictors of running injury.

MY OPINION
Flat feet have long been regarded as a significant risk factor for running injury. However, the majority of certain populations, such as Africans, have flat feet. Recently, some studies have suggested the opposite; that high arches pose a risk whereas flat feet are a protective factor against injury to the lower limbs. How could a unique anatomical feature, which has been carried by an entire population over many generations, be the cause of any overuse injury? A critical and global view of the literature is required to rule on the matter.

Pronation, often cited as a risk factor for running injury, is a good example of the importance of having a broad view of what is written. Some studies indicate that pronation (the natural inward roll of the foot as it strikes the ground and flattens out) is a risk factor in conditions such as Achilles tendinopathy, patellofemoral syndrome or maybe plantar fasciitis. At the same time, several other authors have published contrary views. The most credible explanation for the difference in the results observed emerges from the population studied. Each unique anatomical or biomechanical characteristic is a risk factor if the body is not adapted to it or, in other words, if this feature is new. For example, a recent excessive pronation caused by a weakness in the muscles of the foot, in turn caused by a radiculopathy*, becomes a risk factor for several injuries. The infamous plantar fasciitis** could even result from these tissues having to support a new and excessive stress.

Even though science is divided on this issue, recent publications tend to deny the link between atypical biomechanics of a runner’s foot and the risk of running injuries! “Pronation” having lost its luster, scientific literature has taken on another topic: the control and strength of glute muscles in the prevention of certain pathologies of the knee. This very fashionable topic is at the center of several clinical studies that offer increasingly promising conclusions. Rigorously studied and clear recommendations have yet to be presented. In the interim, however, some clinical guidelines can still be applied; the functional strengthening of the gluteus medius and maximus should be integrated into treatment programs and in the prevention of both patellofemoral and ilio-tibial band syndromes. (See annex, page 35.)

* Compressed nerve in the lower back
** Irritation of the fascia located beneath the foot
A PRACTICAL GUIDE TO PROGRESSION

• An increase in volume should not exceed 10% per week.
• In training, combine minutes of walking with running to reduce the incidence of injury.
• The weekly long run should not exceed the longest run of the previous week by more than 10 to 15 minutes.
• In big training weeks, boost volume by adding a cross-training activity such as cycling or aqua-jogging, both mechanically less stressful.
• The increase in weekly volume of intensity should not exceed 3% of the total volume.
• Be cautious and gradual when running on a new surface, such as after the first snowfall, at the beginning of the cross-country season, on the integration of the track, etc.
• Quantify hill training by counting the number and length of hills, and progress cautiously.

6. PLANTAR ORTHOSES

MYTH
Orthoses prevent and treat overuse injuries to the lower limbs by correcting ‘abnormal’ biomechanics.

REALITY
The absence of serious studies does not allow a clear demonstration of the effect of orthoses in the treatment and prevention of lower-limb injuries in runners...except in the short-term treatment of certain foot pathologies.

The biomechanical changes made by ‘corrective’ orthoses are limited and unsystematic.

MY OPINION
Biomechanical orthoses* should not be used as an initial course of treatment. First, this intervention in the treatment of common running injuries finds no consensus among scientists. Second, clinical results are modest and often confused with other treatment methods. It is important to note that the results observed are by professionals who prescribe orthoses as one element of a treatment plan, making it difficult to establish a direct cause-and-effect relationship.

The exception is support plantar orthoses** which aim to reduce pressure on a specific painful area of the foot. Their effect can be fast-acting, as pain usually disappears in a few days or, at most, a few weeks. Foot pathologies that respond well to unload plantar orthoses include metatarsalgia, sesamoiditis, certain stress fractures and talalgia.

* Biomechanical plantar orthoses: Plantar orthoses designed to correct a biomechanical aspect considered abnormal or excessive, with the goal of preventing or dealing with musculoskeletal pathologies of the lower limbs.

** support plantar orthoses: orthoses designed to support the foot, distribute load or relieve pressure from a specific area of the foot.
In the long term, a runner will gain little advantage from orthoses. First, the extra weight, at the end of a limb in motion, significantly increases oxygen consumption. In addition, some authors maintain that the continuous contact of the orthoses over the entire plantar surface could contribute to the alteration of the neuro-physiological mechanisms of absorption and propulsion. In other words, orthoses offer no benefit to running performance and may even increase the incidence of certain injuries associated with a disruption of natural mechanisms of absorption.

LEG LENGTH DISCREPANCY

Too often diagnosed as a cause of pain requiring medical attention, a difference in leg length is generally found in more than 90% of the population and measures 5.2 millimeters on average, according to some authors. Clinical tests (tape measure) and para-clinical tests (X-rays) both contain a significant margin of error. Therefore, when the difference measured does not exceed 15 millimetres, it is impossible to establish the existence of a real discrepancy. Moreover, following a review of the scientific literature on the effect of leg length discrepancy on pain, function, and biomechanics, two authors have concluded that it is inappropriate to correct a difference of less than 20 millimetres. A very small percentage of the population exhibits such a discrepancy, with the exception of people having suffered fractures that incur significant bone shrinkage. For these reasons, the correction of leg length discrepancy should be the exception rather than the rule in a clientele consisting primarily of runners.
7. FLEXIBILITY

MYTH
Stretching decreases the incidence of injury and exercise-induced muscle pain (DOMS*) while improving performance and post-run recovery.

REALITY
Stretching before physical activity does not reduce the incidence of injury and may even increase it.

Stretching has no influence on post-run pain or recovery.

Pre-run stretching has a negative impact on speed and endurance, while regular stretching, done in separate sessions, appears to improve speed.

MY OPINION
The practice of stretching has followed trends dictated by the experience of influential professionals and by questionable scientific studies. Pre- or post-run stretching, whether static or dynamic, includes techniques such as PNF (Proprioceptive Neuromuscular Facilitation), ART (Active Release Technique), and AIS (Active Isolated Stretching) ... all of which have, in turn, been recommended or proscribed!

Once again, the body adapts. The flexibility of the fetus, which increases in utero, is lost in the first few months of the baby's life. Flexibility quickly returns, however, with the variety of newly acquired movements of the young child. What follows, as with what preceded, depends on functional demands, independently of genetic influence. A ballerina develops a flexibility which allows her to do splits, while the modern sedentary man, working seated all day, develops stiffness.

Stretching exercises should be customized, taking into account the functional requirements of the sport as well as the individual's acquired stiffness. Running is a flexibility exercise per se, especially when speed and, therefore, amplitude increase. The most effective way to increase amplitude seems to be by stretching in the evening when the body is not warmed up, and separately from training runs in order to decrease the risk of injury. This approach is effective provided the individual does not return to the postural vices which limited flexibility in the first place. Indeed, there is little point in stretching the hip flexors (ex. iliopsoas) for 3 x 30 seconds if one sits for more than 10 hours per day?

* DOMS: delayed onset muscle soreness
PREPARING FOR INTERVAL TRAINING*

To prepare for training and minimize injury, it is necessary to prepare the body for the demands of training in terms of biomechanics (range of motion), neurophysiology (motor coordination) and physiology (energy systems).

This preparation is optimized in three easy steps:

STEP 1
A gradual 15- to 20- minute jog to increase your body temperature.

STEP 2
Progressive functional ballistic stretching combined with neurophysiological awakening: dynamic drills at progressive speeds and amplitudes, for example, ABCDs (high knee drills, heel kick drills, etc.) and progressive accelerations, over 30 m and up to 110% of your training speed.

STEP 3
One or two tempo runs of 100 to 200m to experience a slight physiological discomfort stimulated by speed in interval training.

STRETCHING SESSIONS**

Static pre-run stretching can increase the risk of muscle strain. It should be done only when muscle muscle length imbalance influence biomechanics to the point of creating a specific pathology or reducing mechanical efficiency. A customized program can be developed and taught to certain runners, following evaluation by a qualified professional. For runners who tend to be very stiff, flexibility is a good way to reduce the incidence of injury. A runner may normalize his muscle retractions by performing 1 to 5 sets of 30 seconds of static stretching for each group of retracted muscles. These stretches should be slow and progressive, and performed without warm-up each and every evening.

* Additional information can be found on page 31.
** Additional information can be found on page 38.
8. ARTHROSIS

MYTH
Running increases arthrosis of the knee because, over time, the significant and repeated impact with the ground causes irreversible damage to the cartilage.

REALITY
Several studies have shown that arthrosis is no more common in runners than in non-runners.

MY OPINION
The cartilage in a runner’s knee is thicker and stronger than that of a sedentary person. This can be explained by the simple fact that the tissue has adapted to mechanical stress. As long as the stress is applied gradually and does not exceed the tissue’s capacity to adapt, positive tissue remodeling will occur. In other words, cartilage, a living tissue, will rebuild more than it will deteriorate.

Because excessive impact forces may influence the level of stress on cartilage and cause it to degenerate, it is important to develop intrinsic mechanisms that play a critical role in decreasing impact force. Running softly is one such mechanism. However, contrary to popular belief, a cushioned shoe or a soft running surface will not diminish stress to the bones.

Traumatically injured cartilage has a very limited potential for healing. This explains the higher incidence of arthrosis in certain sports where traumatic lesions are more common as a result of frequent physical contact.
9. ANTI-INFLAMMATORIES

MYTH
Anti-inflammatories help the injured runner control excessive inflammation and hasten his return to regular activity more quickly, with no negative impact on tissue.

REALITY
Inflammation is a natural and necessary response to all tissue damage induced by trauma or over-use. Anti-inflammatory drugs prevent proper healing of tissues, making them more vulnerable in the medium term.

MY OPINION
Except for use in top athletes during performance, anti-inflammatory drugs (over-the-counter or prescription) should be avoided as much as possible. In response to tissue damage, the body triggers a cascade of complex chemical reactions called the ‘inflammatory process’. This process first calls upon the ‘cleaner’ cells that engulf the debris of the injury. Next, ‘reconstruction cells’ take over to repair damaged tissue. In this complex cascade, each cell and molecule plays a specific role in repairing the injured tissue. Nature thought of everything! Inhibiting part of this process results in the alteration of the cascade and, consequently, a lower quality of repair and of tissue quality. Several studies have demonstrated both delayed healing and secondary tissular fragility in bones as well as muscles and tendons following the use of anti-inflammatory drugs.
10. HYDRATION

MYTH
To avoid hyperthermia* during an endurance activity, it is important to drink often even when not thirsty.

REALITY
One of the main causes of serious complications in endurance sports is hyponatremia.** Many reported cases are caused by an excessive intake of fluid.

No solid scientific evidence supports the idea that it is important to drink before feeling thirsty in order to prevent hyperthermia.

MY OPINION
Some elite runners do not drink during a long run or a marathon. Their well-adapted bodies minimize sweating and signal thirst appropriately. This adaptive capacity was no doubt present in our ancestors who ran because they had to. But what approach should a marathoner adopt when running a 4-hour race, in a new and hot environment? He could compensate for his excessive sweating through regular intake of isotonic drinks (containing electrolytes). A wiser approach would be to determine fluid requirements in advance of the race by weighing himself before and after his long runs. This allows the runner to measure how much fluid he loses through sweat in varying temperature and humidity levels. A slight weight loss (around 3% of one’s body weight) determines the amount of fluid intake required to replenish fluid loss. One thing is certain: a runner must be careful not to exceed 800 ml of liquid per hour during a race, in order to minimize the risk of hyponatremia.**

* Also called ‘heat stroke’
** Decrease in the level of sodium in the blood, often caused by an excessive intake of water and one of the most frequent and serious complications during marathons.
Sports Shoes

Shoes have long protected feet from dangerous surfaces and the cold. Over time, they have also become fashion accessories and indicators of group membership or social status. This phenomenon applies equally to sports shoes, where since the 1970s, look and fashion have directed designers seeking to respond to the consumer’s constant quest for style. The last twenty years have been particularly effervescent. Hoping or claiming to reduce injury, companies have designed and integrated increasingly complex technologies of cushioning, support and stability. These technologies, combined with eye-catching designs, achieved the essential goal of selling product. Despite the millions of dollars that multinationals invest each year in the promotion of new and supposedly ‘protective’ technologies, very few published studies and no solid evidence confirms these technological advances. For example, the cushioning of a running shoe has no impact on stress applied to the bones, despite clever attempts by individual companies to integrate such features into increasingly elaborate products (Ethylene Vinyl Acetate, Polyurethane, Gel, Air, Adiprene, Wave System, Shox, etc.). Not only has cushioning failed to prove its usefulness in the prevention of injury, it has been shown to perturb the natural dynamics and proprioception of the foot due to the interference it creates. In an attempt to decrease the incidence of injury, shoe companies have contributed to an ever-increasing weight, size and price in shoes. Today, many researchers believe that these changes can even be held responsible for pathologies such as bunions and Achilles tendinitis, which are much less frequent in barefoot populations. Briefly stated, despite the modernization of shoes and their increasingly complicated production, runners continue to incur injury. Given such observations, it becomes imperative to question the accuracy of information used to promote these lucrative technologies (shoe manufacturers, specialized magazines and boutiques, etc.).

Choosing a Sports Shoe

There is a considerable lack of consensus and of scientific data concerning which criteria a professional should use to recommend any given shoe. We therefore rely on two fundamental principles to guide our choices:

1. The Right Fit
The size, width, and shape of the shoe must respect the shape of the foot and not cause pressure points or deformation of the toes. The shoe should feel comfortable as soon as you put it on, especially if it will be worn for long periods.

2. Simplicity and Specificity
The shoe should interfere as little as possible with the natural protective biomechanics of the foot. The runner would do well to choose a simple and low shoe that allows him to better perceive contact with the ground; a shoe exempt of extravagant technology, and specifically designed for his sport.
Sport-specific criteria may also guide an athlete in an appropriate choice of shoe.

**Grip**

According to your needs, the grip can be maximized by the design and material used for the outsole or by the addition of spikes under the shoe. (Ex: the type of rubber used in the outsole and the gym floor; the type and length of spikes in outdoor soccer shoes and the type of pitch; spiked sprinting shoes and the track; hiking boots with crampons for winter surfaces, etc.).

**Stability and Side-Step Sports**

Shoes that adequately support the foot within the shoe afford lateral stability of the ankle and foot in high-speed side-step sports (soccer, basketball, tennis, aerobics, etc.). Various features that contribute to stability are straps on the instep or the upper, lateral reinforcements of the quarter (high cuts), optimal lacing systems, wider soles or heel stiffeners. The most important criteria, however, is the height of the sole; the shoe should be as low as possible to decrease the lever effect and the secondary risk of a sprained ankle.

**Lightness and Endurance Sports**

The weight of a shoe has an important effect on oxygen consumption. Several studies have shown that a 1% increase in the weight of a shoe can cause a 3% increase in oxygen consumption. In other words, for all sports where performance is influenced by an ‘endurance’ factor, i.e. sports such as running, soccer, boxing or basketball, shoes must be lightweight in order to reduce cardiovascular requirements and consequently improve physiological performance.

**Flexibility and Certain Specific Sports**

A flexible shoe that does not interfere with the foot’s natural dynamics is recommended for long-distance running whereas a shoe with a very rigid sole could improve performances in sprinters and jumpers, according to certain authors. Shoes required for dance, rock-climbing or gymnastics, however, must be flexible to allow certain specific dynamics for performance.

**Antipronators and Running Shoes**

Despite the absence of clear scientific support of their usefulness, antipronators in running shoes (the denser and darker-colored section of the midsole) are promoted in an attempt to reduce overpronation. In other words, runners and walkers whose arches fall abnormally during the strike phase might wish to purchase shoes with antipronation features. It is important to note, however, that high-quality studies on the role of anti-pronators in the prevention of running injuries have pointed out that choosing a shoe according to foot type (flat, normal, or high-arched) is inappropriate!

**Other Criteria**

In addition to the requirements of a sport, certain secondary criteria can influence our choice of shoe. Breathability of the sole and upper in a shoe for use in hot weather can help reduce perspiration, a waterproof upper is useful in hiking shoes and for use in rainy or damp weather, light reflectors on running shoes make the runner visible at night, the rigidity and snug adjustment of alpine skiing boots support the ankle and foot to allow immediate and optimal response, padding...
in cross-country ski boots keeps feet warm in cold weather, etc. The look and color of a shoe remain superficial criteria and should never influence our choice.

**SPECIAL SHOES AND NEW TECHNOLOGIES**
Based on the assumptions that the foot has what it takes to protect itself against injury and that barefoot dynamics are the benchmark of correct walking and running biomechanics, an impressive number of new shoes have appeared on the market to tackle the obvious paradox: Biom, Five Fingers Vibram, Nike Free, BMT shoes, Newton shoes, Kigo, Feelmax, VivoBarefoot, etc. Even though their design is inspired by interesting theories, it is important to exercise judgment when faced with new trends and marketing techniques. It is equally important to progress gradually when changing shoes, especially if the change involves a significant biomechanical modification such as a substantial difference in the thickness of the sole of the shoe.

**SPECIFIC POPULATIONS**
Diabetics suffering from peripheral neuropathies (loss of sensitivity in the extremities) should pay particular attention to the comfort of their feet. The fit and comfort of a shoe must be of utmost consideration in order to minimize the risk of skin lesions due to irritation. Cushioning and plantar orthoses could be essential features of appropriate shoes.
The shoe’s capacity to protect from uncomfortable surfaces and the cold has always been a much-desired feature. The moccasin’s simple design of a thin layer of leather offered sufficient protection for over 5000 years. In the last thirty years, with the evolution of shoe technology, this feature of protection has come to create enormous interference, to the point of perturbing running biomechanics and potentially increasing the risk of injury.

---

**BUYING A SPORTS SHOE**

*(TEN USEFUL TIPS)*

1. Shop for shoes late in the day, after activity. (The foot swells slightly with activity.)

2. Choose a store that offers a wide choice of sport-specific shoes with recommended features.

3. Try on both shoes in the store. Wear sports socks and lace the shoes securely.

4. Practice some dynamic moves such as running or jumping.

5. Make sure the shoes feel comfortable as soon as you put them on. (Good fit, no pressure points, heel doesn’t slip, etc.)

6. Leave a centimeter between the toes and the end of the shoe. (Toes should be able to wiggle freely in the toe-box...except for certain types of shoes for dance, rock-climbing, etc.)

7. The price of a shoe is not an indication of quality and definitely not one of protection from injury.

8. Shoes have a limited lifespan. However, contrary to popular belief, you need to monitor the wear of the shoe and any deformations that can affect the incidence of injury, rather than monitor the cushioning.

9. Your weight should not determine the size or the cushioning of the shoe, but only the quality of the shoe’s upper, which should be a little more sturdy.

10. Give your feet time to adjust. Wear your new shoes very gradually so that the
MINIMALIST SHOES

In my discussion of the prevention of running injury, I recommend running in minimalist shoes (also called performance shoes, racers, flats...in other words, simple, low shoes that allow the runner to better perceive contact with the ground.) The question that inevitably follows is: Why not continue running in my big, cushioned, technological shoes with so-called protective features?

My answer is that there is no proof that modern shoes with their technologies of motion control, stability, and cushioning actually prevent injury (Systematic review by Richards in 2008) which, in turn, provokes the response that neither does any proof exist for the affirmation that minimalist shoes prevent injury or that modern shoes with all their technology cause running injury. I must then concede that both points of view are valid.

In the absence of high-quality studies that analyze the incidence of injury in both groups of runners i.e. a study conducted over a two- to three-year period with one group in elaborate modern shoes and the other in minimalist shoes, we must depend on indirect scientific evidence.

SCIENCE AND THE MINIMALIST SHOE

The following current evidence directs my reasoning to recommend running in minimalist shoes.

1. Thirty years of technological evolution in running shoes is incomparably shorter than two million years of evolution in the human foot. Are we so much more intelligent than our own evolution as to subject our feet to the vagaries of unproven technologies?
2. There is no scientific basis for technological developments in cushioning, motion control, and stability (systematic review by Richards 2008), and high-quality studies that sought to decrease the risk of injury through an appropriate choice of such shoes did not achieve the anticipated results. (Studies by Knapik in 2009 and 2010 involving 5000 military personnel)

3. It remains clear, however, that the modern shoe has important repercussions on the body and running mechanics.


   b. Modern shoes significantly decrease stride pace. (Literature review- Dubois, 2010; Squadrone, 2009)

   c. Modern shoes alter the ‘natural’ sequence of muscle contractions in the legs and back. (Systematic review of the effect of shoes on the EMG of lower limbs – Murley, 2008)

   d. Modern shoes and their cushioning do not reduce stress on the bones and may even increase it. (Liebermann, 2010; Squadrone, 2009; Divert, 2005; Laughton, 2003; Ekenman, 2002; Milgrom, 1998)

My response therefore to the initial question is this: in the absence of scientific proof of the protective aspect of modern shoes and in light of the indirect evidence of their probable detrimental effect, entrust your body to what nature intended and run barefoot. If weather, running surfaces, or the social environment prevents you from doing so, opt for the minimalist approach!

**NB**
Any change in your training program, if too significant, entails the risk of overloading tissues and therefore causing injury. A change in shoe must be done as gradually as a change in volume of training. To ensure this progression and for proper tips, consult a competent professional: http://www.therunningclinic.ca/en/specialists-in-my-area/

For an informed choice in your next shoe purchase, visit the ‘Recommended Shoes’ section of the running clinic’s website: http://www.therunningclinic.ca/en/recommended-shoes/
The prevention of running injury is made possible in three easy steps. First, quantify the stress of each training session to ensure slow progression, and exercise caution when integrating new stimuli. Next, through progressive practice, incorporate a stride pace of close to 180 strides per minute. Finally, buy a simple, low and flexible shoe, which allows you to perceive contact with the ground, and integrate it very gradually over a few weeks. This shoe will facilitate the already-practiced biomechanical changes, as well as restore dormant neurophysiological mechanisms. A fourth stage - more expensive, painstaking and sometimes even superfluous - is an individual personalized analysis in which your running pattern, flexibility, muscle weakness and history of sports injury can be analyzed in detail by an avant-garde and experienced specialist.

ENJOY THE RUN!

**Blaise Dubois** graduated from Université Laval in 1998, with a degree in physiotherapy from the Faculty of Medicine, where he was awarded the prize for excellence in musculoskeletal studies. He immediately specialized in sports physiotherapy and received his diploma as well as a resident title from the Canadian Academy of Manipulative Therapy.

A speaker, ardent runner, and co-owner of the PCN sports physiotherapy clinics, Blaise considers himself primarily a clinician specializing in the prevention and treatment of running injuries. He also acts as a consultant to the Canadian National Track and Field team whom he has accompanied to numerous international events.

APPENDIX
THE RUNNER’S ESSENTIAL TOOLS

TEN GOLDEN RULES (page 28)

Ten essential tips for the prevention of running injuries

QUANTIFICATION OF MECHANICAL STRESS (page 29)

Applying the correct amount of mechanical stress to your tissues is the key to success in avoiding non-traumatic injury. You can quantify this stress by calculating the total volume of each of your activities, of varying degrees of stress, and integrating them into your training plan. Such an approach allows a gradual progression and an adequate adaptation of the tissues.

RULES OF PROGRESSION TO AVOID INJURY (page 30)

An increase in the volume of training or intensity, or even a change in shoe, should be carried out with respect for certain rules of progression. In other words, every change in habit should be incorporated gradually.

PREPARING FOR TRAINING (page 31)

We now know that pre-run stretching is rarely necessary. Here is a suggestion for preparing for a classic session of interval training.

INTERVAL PROGRAM (LEVEL I) (page 32)

After an injury, return to running in a progressive and measured fashion. Personalize the suggested program, considering your condition and any pain, and progress more or less quickly through the stages.

INTERVAL PROGRAM (LEVELS II AND III) (page 33)

A return to running after the ‘off season’ requires a measured approach. Even the high-level athlete, after 2 or more weeks of rest, should return to training progressively (ex: level III).
**CORE STRENGTHENING** *(page 34)*

Core strengthening is included in exercise programs for the prevention of pelvic and lower back problems in runners, and may even help prevent knee problems!

**KNEE STRENGTHENING** *(page 35)*

The following knee problems are very frequent in long-distance runners: ‘runner’s knee’ (patellofemoral knee pain), IT band syndrome (iliotibial band friction syndrome), and ‘jumper’s knee’ (patellar tendinopathy). One of the best ways to prevent these pathologies is to strengthen your knees with the ‘step down’ exercise.

**ACHILLES STRENGTHENING** *(page 36)*

Achilles tendon problems and shin splints are very common in mid-distance runners. One of the best ways to prevent these pathologies is to reinforce your tendons with the ‘drop down’ exercise.

**FOOT STRENGTHENING** *(page 37)*

Runner with fallen arches or runners weaning themselves off plantar orthoses can perform foot-strengthening exercises.

**STRETCHING** *(page 38)*

Stretching can help ‘stiff’ runners gain greater range of movement and sometimes even improve performance, if not done just before running.

**Acknowledgements**

The author wishes to thank Shane Lakins for his expertise in running biomechanics and for his contribution to the understanding of concepts related to stride frequency.

The author wishes to thank Sean Cannon and Isabelle Dumais for their contributions to this eBook.
10 GOLDEN RULES

1. Surround yourself with the right people

Proper medical and coaching supervision for all runners, whether high performance athletes or joggers, must be done by qualified, competent and understanding professionals. For this reason, a runner must never accept final recommendations from a professional (physiotherapist, chiropractor, MD, …) that is not a runner himself.

2. Keep it simple

Be careful not to complicate or “over-medicalise” your condition. Avoid repeated treatment without progress. Avoid surgery. Do not choose plantar orthoses as a first option. Use a simple running shoe… very flat, allowing for sensations from the ground.

3. Your body WILL adapt!

The human body will adapt as long as the applied load is not greater that the body’s capacity to adapt. Overuse injuries are caused by an overload of the body’s anatomical structures (bones, tendons, muscles). Every new stimulus must be integrated progressively (hills, volume, intensity, surfaces, shoes…).

4. Rhythm is the key!

To minimise ground reaction force, energy loss and injuries while maximising stride efficiency, it is preferable to keep your stride rate over 170 strides/min. Quality workouts (intervals, race pacing) should be done between 180 and 185 strides/min.

5. The Kenyan surface

Flat surfaces (road, track, treadmill) are very regular and make every stride mechanically identical to the last. On these surfaces, a biomechanical flaw will be repeated over and over increasing the chances of overuse injuries. The best surface is cross-country or trail running. Firm and irregular; these surfaces allow for a wide variety of movements and therefore a mechanical load that is properly distributed on the lower body.

6. Warm-up: a well kept secret

To get ready for a workout, you must increase your body temperature by a progressive jog (15 to 20 minutes) followed by progressive functional ballistic stretches.

7. Stretching: yes and no!

Pre-workout static stretching should be done ONLY IF running biomechanics are sufficiently altered by shortened muscle groups to either increase the risk of injury or decrease mechanical efficiency.

8. Naturally strong

Barefoot running or walking as often as possible is an excellent way to solidify muscles and tendons that are responsible for the body’s natural absorption mechanisms. Specific stabilisation, proprioception and strengthening programs are also good ways to prevent injury.

9. Cross-training

When injured, complete rest is rarely the best treatment. A cross-training activity is recommended as soon as possible. A cardio-vascular activity that is not painful will decrease recovery time.

10. We are what we eat / Body and mind

We are what we eat… literally! Quality, variety and balance are the most important words when speaking of an athlete’s diet. Having fun, having a positive attitude and having healthy life habits all have direct influences on the body and on injuries.

www.therunningclinic.ca
The body will adapt itself as long as the applied stress is not greater than the body’s capacity to adapt. Daily quantification of the applied mechanical stress is the best way to avoid injury.

Over-stepping your maximum capacity to adapt will result in:
1. Pain during your effort
2. Pain after
3. Morning stiffness

100% Max. adaptation capacity
Minimum load required to create adaptations
Individual stress (activities)
0% No mechanical stress

Rest area
No stress = No adaptation!

Adaptation area
Work inside this zone will increase the body’s capacity to accept more mechanical stress
ADAPTATION

The human body will adapt as long as the applied load is not greater that the body’s capacity to adapt. Overuse injuries are caused by an overload of the body’s anatomical structures (bones, tendons, muscles). Every new stimulus must be integrated progressively (hills, volume, intensity, surfaces, shoes...).

**Volume**
- No more than a 10% increase/week.
- Weekly long run: 10 min. (5’ to 15’) increase/week.
- Break down your workouts into intervals with a 1 min. walk between runs (9’/1’... 14’/1’) as needed.
- In big volume weeks, add a cross-training activity (bike, aqua-jogging), which is mechanically less stressful (up to 35% of total volume for that week).

**Intensity**
- 3% (of total volume) more/week.

**Surfaces**
- Varied as much as possible.
- It will be easier to increase training volume on firm and irregular surfaces (cross-country without hills) than on the road or on a track.

**Hills**
- Be progressive: calculate the distance and the number of hills that you run.

**Shoes**
- Walk at home for 2 days.
- Short jogs (First week)
- Intervals (Second week)
- Longer jogs (Third week)
- Weekly long run (Fourth week)

Running shoes should be changed progressively when they become an exacerbating factor for a biomechanical flaw (deformed sole, overuse...). The perfect running shoe should protect the skin from lacerations and from the cold while minimising the interface between the foot and the ground. Most running shoe technology designed for stability and absorption is superfluous and all is without scientific foundation.

www.therunningclinic.ca
WARM-UP

To warm-up and minimise the risk of injury we must prepare the body for the biomechanical (range of motion), neurophysiological (coordination), and physiological (energy systems) demands of the workout.

**Step 1**
*Increase body temperature by a 15 to 20 min. progressive jog.*

**Step 2**
*Progressive functional ballistic stretches associated with a neurophysiological awakening.*
1. *Functional drills progressing both range of motion and speed.*
   * (ABCD, …)
2. *Progressive accelerations.*
   * (30m, up to 110% of workout speed)

**Step 3**
*Increase the length of the accelerations to reach the desired energy systems (once or twice)*

Static stretching before a workout increases the risk of muscle strain during the workout. Pre-workout static stretching should be done ONLY IF running biomechanics are sufficiently altered by shortened muscle groups to either increase the risk of injury or decrease mechanical efficiency. A personalised stretching program after an evaluation by a qualified professional can be helpful to certain runners.

For some runners, stretching remains a good way to decrease the incidence of injury. After an evaluation by a qualified professional it is possible to normalise one's own muscle imbalances using slow, progressive static stretches, in the evening, on a daily basis including PNF (proprioceptive neuromuscular facilitation).
### INTERVAL PROGRAM (I)

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>5’W + 3x (1’R / 1’W) + 5’W</td>
<td>10x (2’R / 1’W)</td>
</tr>
<tr>
<td>4x (1’R / 1’W)</td>
<td>3x (3’R / 1’W)</td>
</tr>
<tr>
<td>5x (1’R / 1’W)</td>
<td>4x (3’R / 1’W)</td>
</tr>
<tr>
<td>6x (1’R / 1’W)</td>
<td>5x (3’R / 1’W)</td>
</tr>
<tr>
<td>7x (1’R / 1’W)</td>
<td>6x (3’R / 1’W)</td>
</tr>
<tr>
<td><strong>Week 2</strong></td>
<td><strong>Week 6</strong></td>
</tr>
<tr>
<td>8x (1’R / 1’W)</td>
<td>7x (3’R / 1’W)</td>
</tr>
<tr>
<td>9x (1’R / 1’W)</td>
<td>8x (3’R / 1’W)</td>
</tr>
<tr>
<td>10x (1’R / 1’W)</td>
<td>2x (4’R / 1’W)</td>
</tr>
<tr>
<td>11x (1’R / 1’W)</td>
<td>3x (4’R / 1’W)</td>
</tr>
<tr>
<td>12x (1’R / 1’W)</td>
<td>4x (4’R / 1’W)</td>
</tr>
<tr>
<td><strong>Week 3</strong></td>
<td><strong>Week 7</strong></td>
</tr>
<tr>
<td>13x (1’R / 1’W)</td>
<td>5x (4’R / 1’W)</td>
</tr>
<tr>
<td>14x (1’R / 1’W)</td>
<td>6x (4’R / 1’W)</td>
</tr>
<tr>
<td>15x (1’R / 1’W)</td>
<td>1x (9’R / 1’W)</td>
</tr>
<tr>
<td>3x (2’R / 1’W)</td>
<td>2x (9’R / 1’W)</td>
</tr>
<tr>
<td>4x (2’R / 1’W)</td>
<td>3x (9’R / 1’W)</td>
</tr>
<tr>
<td><strong>Week 4</strong></td>
<td><strong>Week 8</strong></td>
</tr>
<tr>
<td>5x (2’R / 1’W)</td>
<td>1x (14’R / 1’W)</td>
</tr>
<tr>
<td>6x (2’R / 1’W)</td>
<td>2x (14’R / 1’W)</td>
</tr>
<tr>
<td>7x (2’R / 1’W)</td>
<td>1x 20’R</td>
</tr>
<tr>
<td>8x (2’R / 1’W)</td>
<td>1x 25’R</td>
</tr>
<tr>
<td>9x (2’R / 1’W)</td>
<td>1x 30’R</td>
</tr>
</tbody>
</table>

- W : Regular walk  
- R : Run, regular jogging speed

- **Start and end with a 5 min. walk**
- **Depending on your symptoms:**  
  - Go back one workout  
  - Repeat the same workout  
  - Skip one or two workouts
- **Run minimum 4 x/week... and maximum 6 x/week**
- **Choose a cross-country surface without hills (firm and irregular)**
- **Use a cross-training activity to complete your training regimen (bike, aqua-jogging)**

www.therunningclinic.ca
**INTERVAL PROGRAM (II)**

<table>
<thead>
<tr>
<th>Week 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5’W + 10’ (1’R / 1’W) + 5’W</td>
<td></td>
</tr>
<tr>
<td>15’ (1’R/ 1’W)</td>
<td></td>
</tr>
<tr>
<td>20’ (1’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>25’ (1’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ (1’R / 1’W)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20’ (2’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ (2’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>20’ (3’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ (3’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>20’ (4’R / 1’W)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30’ (4’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>20’ (9’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ (9’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ (14’R / 1’W)</td>
<td></td>
</tr>
<tr>
<td>30’ non-stop</td>
<td></td>
</tr>
</tbody>
</table>

W : Walk  R : Run

- Start and end with a 5 min. walk
- Depending on your symptoms
  - Go back one workout
  - Repeat the same workout
  - Skip one or two workouts
- Run minimum 4 x / week...
  ... and maximum 6 x / week
- Choose a cross-country surface without hills (firm and irregular)
- Use a cross-training activity to complete your training regimen (bike, aqua-jogging)

**INTERVAL PROGRAM (III)**

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5’W + 10’ (1’R / 1’W) + 5’W</td>
<td>35’ (9’R / 1’W)</td>
</tr>
<tr>
<td>rest</td>
<td>rest</td>
</tr>
<tr>
<td>15’ (2’R / 1’W)</td>
<td>45’ (14’R / 1’W)</td>
</tr>
<tr>
<td>20’ (3’R / 1’W)</td>
<td>20’ non-stop</td>
</tr>
<tr>
<td>rest</td>
<td>50’ (9’R / 1’W)</td>
</tr>
<tr>
<td>25’ (4’R / 1’W)</td>
<td>60’ (14’R / 1’W)</td>
</tr>
<tr>
<td>30’ (9’R / 1’W)</td>
<td>rest</td>
</tr>
</tbody>
</table>

www.therunningclinic.ca
**STABILIZATION - PROPRIOCEPTION**  
**(CORE)**

**Inner Unit**

- **Lying on your back**
  - Contract your *inner unit*
  - Let your stomach *tighten*
    (Your navel should simply get closer to your spine)
  - *Breathe* normally
    (While holding your contractions)
  - Hold > 10s

- **Standing** on one leg
  - Same contractions, while
    swinging one leg back and forth

Hips and back should not move.  
Minimal abdominal contraction  
(2cm inside your hip bone)  
DO NOT hold your breath.

**Proprioception**

- **Sitting + kneeling + standing** on a Swiss ball
  - Contract your inner unit + breathe normally
  - Move your arms in a running motion
  - Hold your balance > 10s

Use a level of difficulty that permits you to hold your balance for more than 10 sec. while moving your arms in a running motion.

**Time:** ______ ☐1x/Day ☐2x/Day ☐3x/Day
STRENGTHENING (STEP DOWN)

Start with:

**Warm up**
- Biking (Very little resistance ~ 90 RPM), swimming, walking ...
- 10 minutes or more (until you start to sweat)

**Stretching**
- 1x30 sec, 2x30 sec, 3x30 sec

**Strengthening**

**Step down ON the affected leg**

- Hips stable horizontally
- Patella aligned vertically with the second toe
- Proper arch support

**Total Repetitions:** 3 sets of 20 to 40 reps, 2x/day

**Pain:** Permitted during the exercise but not afterwards

**Progression (according to symptoms and capacity)**

- step height (4” to 12”)
- Vary surface incline and trunk position.
- load (use a back pack or free weights)
- speed (brake just before reaching the ground)
- Horizontal jumps on two legs... Jumps on one leg (further and further)
- Vertical jumps on two legs... Jumps on one leg (higher and higher)
- Use an unsteady surface (SitFit ...)

www.therunningclinic.ca
STRENGTHENING (LOWER LEG)

Start with:

Warm up
- Biking (Very little resistance ~ 90 RPM), swimming, walking ...
- 10 minutes or more (until you start to sweat)

Stretching
- □ 1x30 sec, □ 2x30 sec, □ 3x30 sec

Strengthening

- Descend ON the affected leg (Forefoot on an elevation)
  - Vary the position of your knee (extended, flexed 15°, flexed 30°)
  - Descend slightly lower than horizontal
  - Arch supported, keeping the foot straight

- Total Repetitions: 3 sets of 20 to 40 reps, 2x/day
- Pain: Permitted during the exercise but not afterwards

Progression (according to symptoms and capacity)

- ↑ the Range of movement
- ↑ the load (backpack or dumbbells)
- ↑ the speed (breaking just before the end of the range)
- Horizontal jumps on two legs... Jumps on one leg (further and further)
- Vertical jumps on two legs... Jumps on one leg (higher and higher)
STRENGTHENING
(INTRINSIC MUSCLES OF THE FEET)

Steps

- Place one hand against a wall, weight even on both legs.
- Lift the inside of one foot (inversion).
- Lower the big toe while keeping the arch supported.
- Keep the weight on the metatarsal heads.
- Maintain very little pressure on the toes. (Do not grip the ground.)

Progression

- 100% body weight on one leg
- Ankle dorsiflexion (squat)
- Weight placed on forefoot only
- Knee oscillations at different speeds

To prevent running injuries, a specific program such as this one can solidify the body. However, strengthening the muscles of the feet by slowly removing foot orthotics and running or walking barefoot as often as possible is a good way to solidify the structures that are responsible for natural absorption while stimulating reflex mechanisms that manage muscle control for the lower extremity.
STRETCHES

**IP**
- Rear knee on the ground
- Front knee at a 90° angle
- Elbows on front knee
- Back straight

R: ___ x 30s  
L: ___ x 30s

**Glutes**
- Sitting
- One leg straight
- Other leg bent and crossed over
- Back straight

R: ___ x 30s  
L: ___ x 30s

**ITB**
- Lean against wall, arm extended
- Tuck buttocks in
- Swing hips way from wall
- Cross inner leg behind
- Back straight

R: ___ x 30s  
L: ___ x 30s

**Hamstring**
- Place foot on small bench
- Hips perpendicular to extended leg
- Bend body forward
- Back straight

R: ___ x 30s  
L: ___ x 30s

**Quadriceps**
- Lie on side
- Lower hip and knee flexed forward
- Hold ankle of upper leg
- Pull upper leg back

R: ___ x 30s  
L: ___ x 30s

**Calf**
- Feet lined up straight
- One knee extended
- Move hips forward
- Back straight

R: ___ x 30s  
L: ___ x 30s

☐ before activities  ☐ evening, cold  ☐ 2x/day  ☐ 3x/day

www.therunningclinic.ca