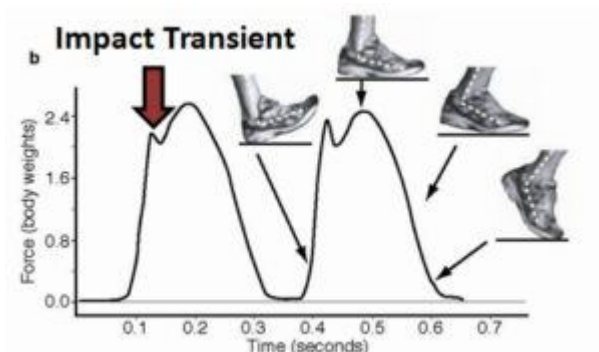


Ground Reaction Forces (GRF) and Running

Originally published 10 June 2020 · fatchfitness.com



I wanted to write about this topic based on my recent experience purchasing a pair of running shoes. What was interesting about the experience is that the sales person spent their entire time discussing the latest in shock absorption heel technology and how this was the difference between a \$100 pair of shoes and a \$250 pair of shoes.

It had me thinking about running technique and how the more shock absorption we apply to shoes, the more our running technique diverges from how we originally evolved to run (quite successfully if you review the history of Human running evolution, well covered in an entertaining read "Born to Run" by Christopher McDougall).

I didn't want to rehash the vast amount of content online about this topic but did want to highlight a couple of factors that people may not be totally aware when pounding the pavement...

Firstly, a couple of definitions:

1. Ground Reaction Force (GRF) – This is based on the Newtonian 3rd Law, for every action, there is an equal and opposite reaction. What this means in a practical sense is that however much force is applied to the ground when your foot hits, the same amount of force is pushed back up the body to be absorbed by the skeletal system, muscles, ligaments, tendons, joints (and now running shoes!).



2. Joint Levers – Every joint in the body is a lever – there are three main Classes (Class 1, 2, 3). The main lever to be found in the Human body is Class 3 (designed for speed) whilst there is only a single Class 2 lever (designed for strength) and this is the ankle joint.

Every time your foot hits the ground, there is an equal force that pushes back up your leg. If you have poor running mechanics, then this force can quickly exacerbate any weakness and often presents itself as pain in the ankles, shins, knees, hips or lower back.

There has been plenty of research to show that when heel first running, the forces experienced can be as high as 3 times body weight (for the purpose of this article let's discuss this in terms of mass (kg) and a 70kg person would be experiencing as much as 210kg of GRF with each ground contact).

Two factors increase the potential damage that this loading can cause:



1. The best joint to deal with these large forces is the ankle joint (being a Class 2 lever) BUT as we have moved from a midfoot or forefoot strike to a heel strike, we have totally disabled the capacity of this lever to handle any of this repeated impact!

All the impact at ground contact is directed up the tibia/femur to the pelvis/lumbar spine.

Because of this type of running shoe and associated running technique, the incidence of knee/hip/lower back injuries rapidly increased and in turn, instead of dealing with the incorrect running technique issue, shoe companies instead spent more and more of their research & development dollars on improving the shock absorption qualities of their shoes (and in turn giving them a reason to increase the shoe price!).

2. As shoe shock absorption qualities improved, this gave runners false confidence in that they could reach out even further with each stride thinking they were now safe from the longer term effects of large GRF's running up their body with each stride. Today there is still the belief that an increased stride length will make you run faster – the reality is that the more in front of your Centre of Gravity (COG) you place your foot, the greater the braking forces that will be applied (further exacerbating the GRF loads being placed upon your lower body).

As an example:

If you are a 70kg runner with a 3x body weight GRF – you are experiencing 210kg of force up your legs at each impact (this is when we evaluate a vertical GRF). As a heel striker, you will automatically reach out with your heel and as you impact the ground, forces are distributed depending on the angle of impact.

If your heel hit the ground ~30cm in front of your COG – this increases the horizontal braking force by ~30kg (~15% of GRF). If you try to reach out even further (40cm) in front of your COG, then your braking forces are ~27%-28% of your body weight as a force that is pushing against your forward movement...

So apart from wearing out your precious joints you have also added a resistive force to each step (this would be the equivalent of you dragging a 20kg+ weight with you on every run)!!

If you look at some of the tribes that are great distance runners (the Tarahumara from Mexico being a great example), they run with a short stride, midfoot placement and upright posture (minimising feet forward of their COG). Many of these runners run with nothing more than a piece of rubber strapped to their feet but they are some of the greatest distance runners in the world.

WHAT TO DO?

As an older fitness enthusiast, it is too late for me to start over by strengthening my feet by running with minimal support or bare feet (my old plantar fascia's would protest and go on strike!). I have certainly tried to do my bit, I purchased a pair of Merrell barefoot shoes (no support) and wore them during every day activities. It took the best part of 6-months for my feet to stop aching as they weren't used to having to deal with the forces that had traditionally been absorbed by the surrounding shoe. In the end my feet are stronger for the effort, but I have not been able to extend this to running, the increased forces are too great for my old ankles to absorb but hopefully the above approach has still extended the functional life of my feet?

Since writing this article in early June I have been continuing to increase my running efforts as a part of a regular 7km walk I try to complete daily. I was having issues with my calves and every time I attempted a standard running session I would pull a calf muscle at the musculotendonis junction (mid calf) and that would be the end for several weeks. No matter what I did to try to strengthen my calves they continued to pull whenever I went for a run.

I had all but given up hope of being able to run but during the COVID19 lockdown I had the opportunity to apply a very small incremental progressive overload on my calves and achieved this by only running uphill.

The reasoning for uphill only is that my injuries were happening at the point of ground contact (as outlined above, there are very high ground reaction forces going through your calves each contact). So I reasoned that if I only ran uphill, as I was not falling back to the ground at the same distance, rate or force (as I was running up a slope), I would ultimately reduce the load going through my calves each step.

Interestingly, I pulled a Popliteal muscle behind one of my knees early on (this is a typical uphill running injury) but was able to manage this issue whilst I very slowly increased the time and distance running up each hill I came to. I focused on not reaching out too much with each step (this is what aggravated my popliteal in the first place) and was really just shuffling up each hill.

Fast forward to early August (2 months later) and I am now able to run the full length of each hill I come to, I have started completing these sessions and not feeling any discomfort in my lower legs at all and have even started adding some flat sections to my runs.

So after many years of not being controlled enough take small steps to increase the volume/intensity of my running, I have now been able to achieve this and believe that I am on my way to getting back to full running.

FEET STRENGTH

For those of you who are keen to ensure your children or young charges are developing the most appropriate biomechanics and physiology for a functional future, then training with minimal footwear is such a fantastic way of developing a lower limb robustness that is largely missing in today's modern society.



I spent time in the Solomon Islands and was always amazed at the most impressive feet of the locals who had spent up until recently a lifetime walking, running, & climbing with no shoes. Their skeletal and ligament development was something to behold – their feet looked indestructible. Sadly, many of the Solomon youth of today have been negatively influenced by TV and now wear shoes all the time without realising the long term limitations that this fashion will bring.

Also what was very evident was the width of the forefoot in most of the locals I encountered, it certainly doesn't seem to be coincidental that with today's shoes restricting foot width that we have so many feet problems.

SUMMARY:

1. Highly shock absorptive shoes exacerbate poor running technique and increase joint wear and tear.
2. Spend as much time barefoot as possible – give your feet a chance to get strong.

Reference:

[Ground Reaction Forces in Distance Running.](#)