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# EXEC SUMMARY

## BAREFOOT SCIENCE – THE FACTS.

Humans have been covering their feet to protect against climate and terrain since, well, since we became humans.

Today however, footwear has very little to do with protection from climate and terrain and a lot to do with fashion, marketing and misguided science (which is really just another plot of marketing dark arts).

The result?

Modern, western-influenced feet are at risk of pain, dysfunction and deformation from modern footwear.

What might come as more of a surprise is that the problem with shoes has been researched and documented for quite some time.

And yet we continue to stuff our – and, more worryingly, our children's – feet into narrow, pointed, stiff, heeled and cushioned shoes for both everyday and sports' wear.

This document presents all the vast array of scientific study there is out there on BAREFOOT: from historical studies presenting the problem, to more recent ones which show the effect on our gait, movement and injuries. It also delves into all the science which shows how walking, running, just being barefoot – or wearing minimalist footwear – is beneficial. Not just beneficial to growing kids and adults alike, but as a means to prevent injury, to be strong and physically fit and healthy for longer. There is even evidence to show how being as barefoot as possible is better for balance, coordination and better for kids' academic performance at school.

We get it, you get it, now we just need to make sure EVERYONE gets it.

The barefoot revolution has begun.



# CHAPTER

1



# CHAPTER 1:

# THE NEGATIVE IMPACT OF CONVENTIONAL SHOES

## SUMMARY:

Conventional shoes wreck our feet, inhibiting foot function and deforming feet.

This chapter reviews how this happens, from Big Toe getting pushed out of alignment, to how conventional footwear affects foot stability and upstream knee motion is affected: ankles roll in

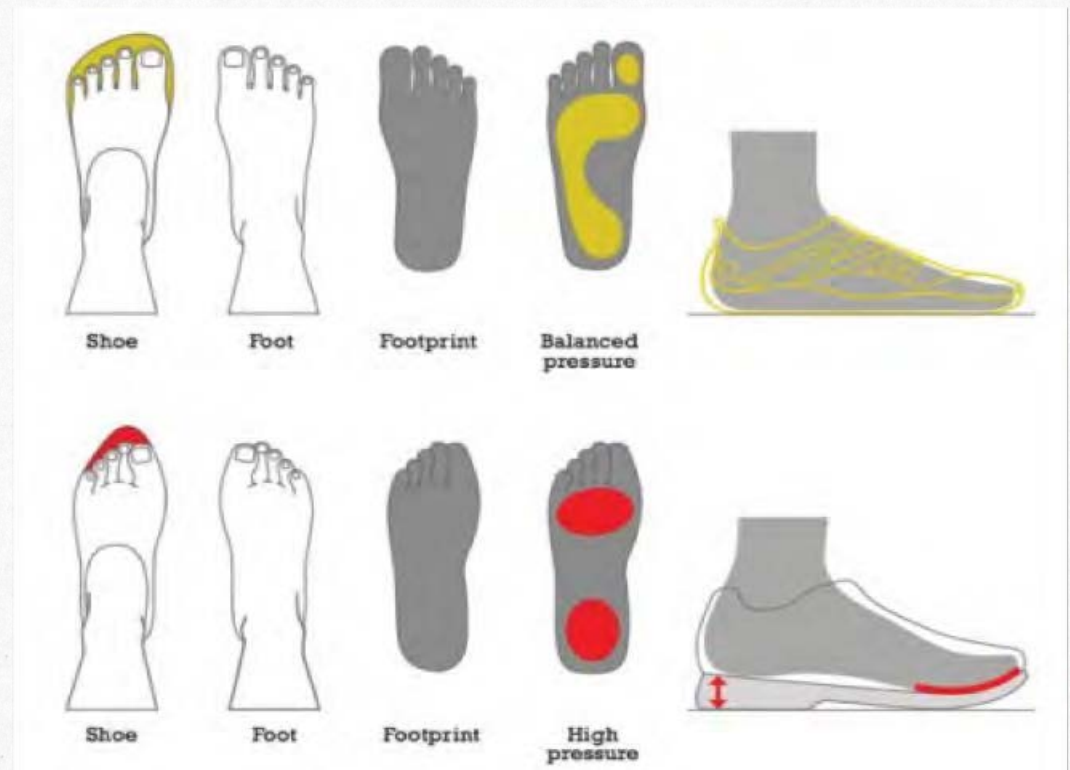
and knees collapse.

Padded, maximalist shoes also encourage longer strides and more knee loading, which means an increased chance of injury. Normal conventional footwear isn't just damaging to feet - the effects of conventional shoes are felt upstream.

# THE NEGATIVE IMPACT OF CONVENTIONAL SHOES

## DO YOU WEAR YOUR SHOES IN OR DO THEY WEAR YOUR FEET OUT?

Studies at the Northumbria University into how conventional shoes inhibit foot function and deform feet also looked at: the influence of foot shape on running (bio)mechanics footwear and running injuries. The untapped power of Big Toe. Comparing with maximalist shoes(thick, underfoot padding) to show how these increase knee joint loading and subsequent knee injuries.



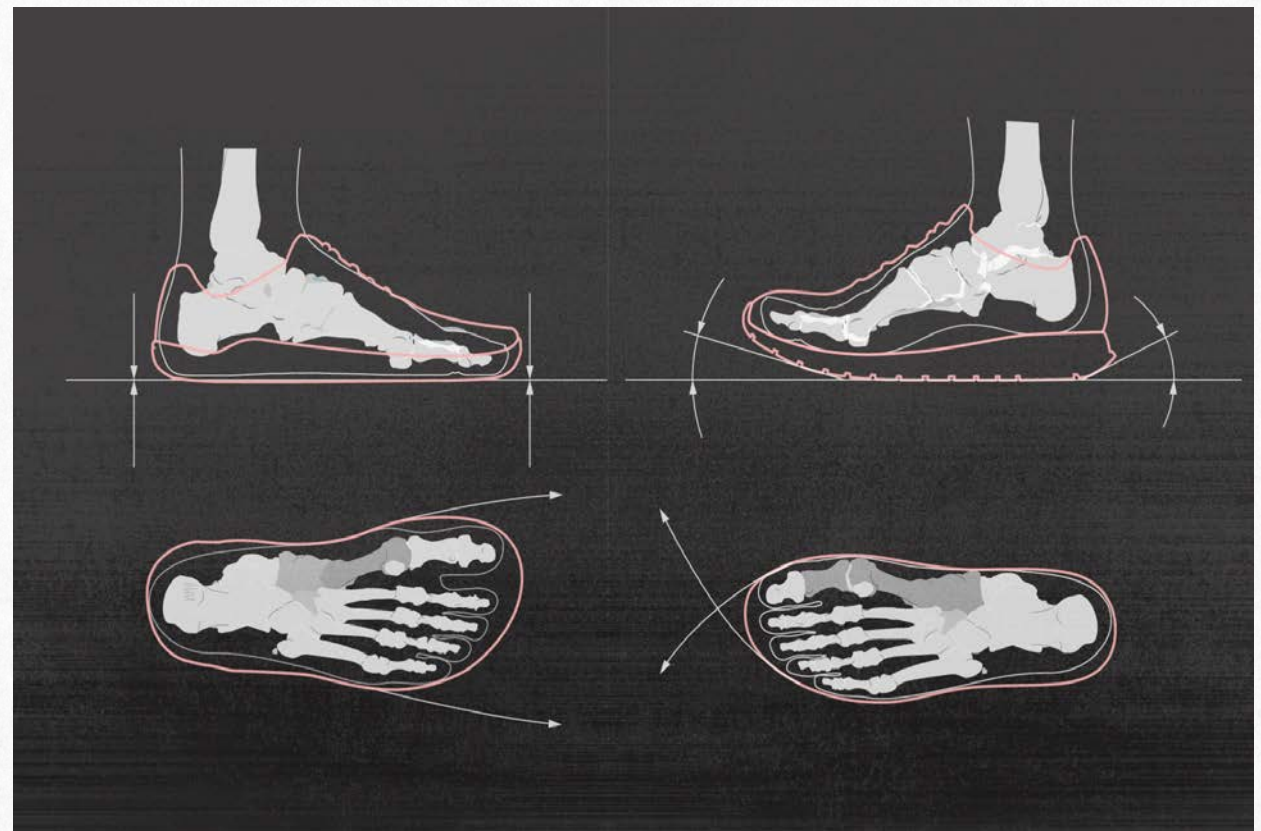


# THE NEGATIVE IMPACT OF CONVENTIONAL SHOES

## THE FORM OF OUR FEET DETERMINES THEIR FUNCTION

What we cover our feet with everyday really does matter. Footwear not only determines foot structure, but this structure then determines foot function, which itself determines movement skill and balance.

Our thinking on this can start with Big Toe: if it's not in the right place, how can it do its job? (As pivot and balance for posture and movement)





# FEET AND FOOTWEAR: MISMATCH THEORY

## THE FORM OF OUR FEET DETERMINES THEIR FUNCTION

Humans are 'born to run' – we are adapted for endurance running (and walking), but today, injury rates are also very high.

A mounting body of evidence suggests that the design features of modern footwear can actually deform our foot structure and impair foot function.

Chronic use of conventional footwear and associated maladaptation could be irreversible or take years to undo.

This is why the orthotics industry is worth 3.5\$US. But maybe that industry is a problem in itself – not a solution.

**Loss of structure and function in the foot, caused by the design features of modern footwear, could explain many common running (*movement*) injuries**



Feet and Footwear: Applying Biological design and mismatch theory to running injuries. 2018 Wilkinson

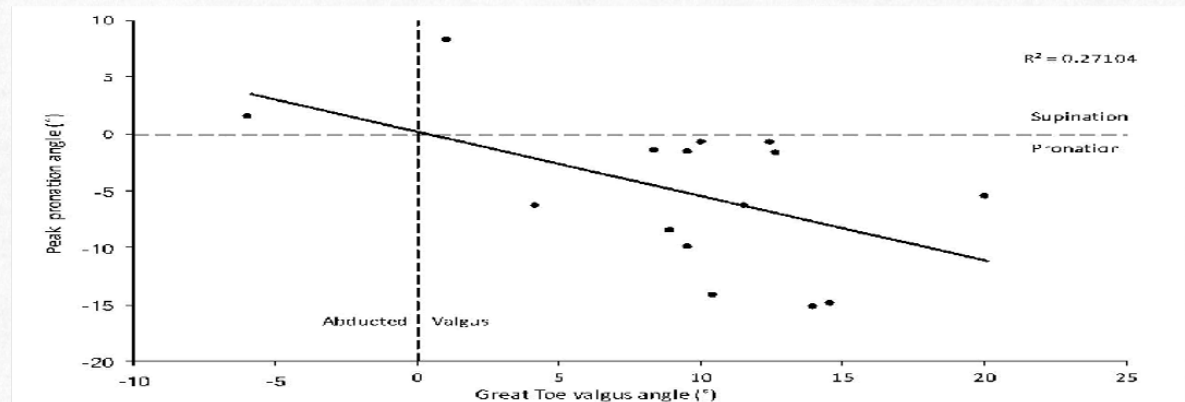
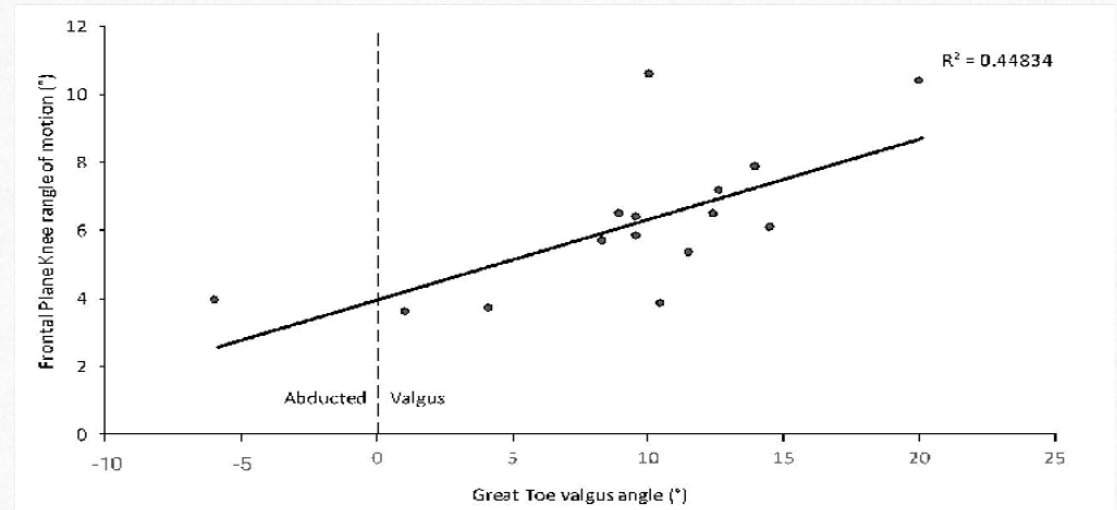


# LET'S START WITH THE ALIGNMENT OF BIG TOE

Conventional footwear deforms Big Toe, pushing it towards the other toes and lifting it up and off the ground.

The results of the study opposite suggest great toe position plays an important role in overall foot stability and upstream knee motion.

The more deformed big toes are, the more ankles roll in and knees collapse, leading to dysfunction, discomfort and possibly injury.



The influence of great toe valgus on pronation and frontal plane knee motion during running: Wilkinson, 2020



# VIVOBAREFOOT REDUCES KNEE JOINT LOADING

## (COMPARED TO MAXIMALIST SHOES)

The data in our latest study suggests there is a reduction both in stride length and knee loading through innate adjustment according to footwear condition. This means running in maximalist shoes naturally increases stride length and thus loading at the knee joint.

This highlights the importance of footwear choice and the potential for a minimalist shoe design to reduce loading at the knee joint, the most commonly injured joint in the runner's lower limbs. Reinforces the importance of Running Coaches for gait retraining to avoid injury when transitioning.

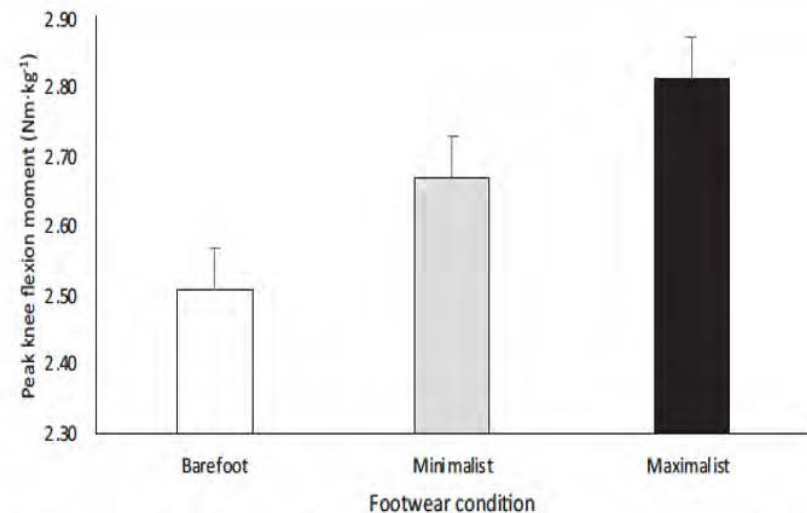


Figure 3. Peak knee flexion moment of 15 recreational runners during running over ground on an indoor runway while barefoot, in minimalist and in maximalist shoes. Columns and error bars are mean and standard error expressed at a common speed of  $2.59 \text{ m}\cdot\text{s}^{-1}$ .

Differences in stride length and lower limb moments of recreational runners during overground running while barefoot, in minimalist and in maximalist running shoes. Wilkinson, 2021



**CHAPTER**

**2**



# CHAPTER 2:

## OUR FEET AND OUR FUTURE

### SUMMARY:

This chapter covers much of the current research into the evolutionary role of our feet, how we use them and treat them today: taking us from the barefoot hunter gatherer to shod pavement pounder.

From the research into effects of cushioning on running mechanics and how this relates to injuries, to detail on how the effects of our physiology and musculoskeletal systems adapt to stress and how this affects our intrinsic foot muscles.

Outlines of research currently underway, including the largest study of its kind to show the effects of footwear and footwear habits on children and adolescent foot structures in Britain and Ireland.

Another study considers the use of footwear for the management of osteoarthritis of the knee, and the role footwear plays in this. The future of our feet starts right here.



# OUR FEET AND OUR FUTURE

Research from the Institute of Technology, Carlow, Ireland, includes:

- Taking the long view from barefoot hunter gatherer to shod pavement pounding – where to for the hum foot and our motion?
- Studying how our footwear habits inform our future habits.
- Studying the impact of footwear on knee osteoarthritis.



Figure 2 Observation of shod (left) and barefoot (right) running at a grass park.



# CUSHIONING REDUCES THE QUALITY OF INFORMATION


- (Cushioned), as in, normal, shoes reduce the quality of information being sent to the brain and spinal cord, which leads to more blunt running mechanics.
- (Cushioned) Shoes allow runners to land with a more upright body position and an extended leg (to over stride), leading to excessive braking forces.
- These running mechanics seem to play a role in some of the most common running injuries.

Open access

Review

BMJ Open Sport & Exercise Medicine

## From barefoot hunter gathering to shod pavement pounding. Where to from here? A narrative review

Peter Francis <sup>1</sup>, Grant Schofield<sup>2</sup>

**To cite:** Francis P, Schofield G. From barefoot hunter gathering to shod pavement pounding. Where to from here? A narrative review. *BMJ Open Sport & Exercise Medicine* 2020;6:e000577. doi:10.1136/bmjsem-2019-000577

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Figure 1

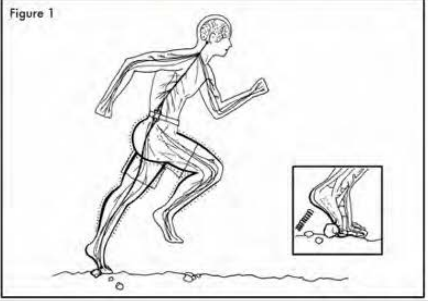


Figure 2



From barefoot hunter gathering to shod pavement pounding where to from here?  
Francis, 2020



# 'USE IT' OR 'LOSE IT'

In the words of scientist and researcher Dr Peter Francis, 'Our physiology and musculoskeletal systems adapt to stress. For example, if you don't use a muscle, it becomes smaller. If you don't use a tendon it loses its capacity for energy storage and release. Footwear removes stress from certain parts of our feet e.g. our intrinsic foot muscles. These muscles become weaker. Recent research demonstrates that when you remove the cushioning from shoes, the muscles grow stronger again.'

'Proprioception is recommended in the prevention and rehabilitation of musculoskeletal injury in almost every sport. A highly specific form of proprioceptive training for runners would be to remove their shoes and run or walk on a variable surface e.g. at a grass park. With greater freedom, the foot responds to its environment, allowing all systems (Neural and Musculoskeletal) to respond so almost no two steps would be the same. As most of us have grown up in shoes, a very careful transition to such activities would be required not to overload our systems – much like any new training intervention.'



Figure 2 Observation of shod (left) and barefoot (right) running at a grass park.

The urban runner with an evolutionary legacy: Suggestions towards a middle ground: Francis, 2020



# HOW OUR FOOTWEAR HABITS INFORM OUR FUTURE HABITS

Maisie Squibb, MSc is studying the footwear habits on children in Britain, Ireland and Australia for her PhD:

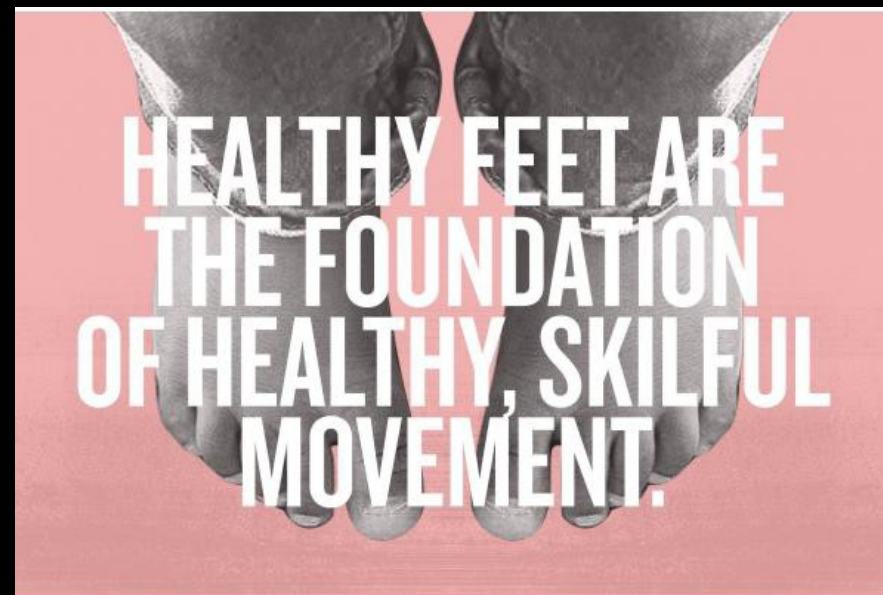
“The overall narrative of my PhD is to explore and evaluate how footwear habits affect the characteristic/structure of the foot and consequently functional movement in children and adolescents.

Study 1 - aims to reveal the footwear habits and their effects on the foot structure and functional movement.

Study 2 - Foot structure and functional differences in adolescents in the UK and New Zealand with different footwear habits

Study 3 - Effects of a minimalist footwear intervention on foot structure and adolescents.”  
Maisie Squibb, MSc

This is the largest study of its kind to determine the footwear habits of children and adolescents across the UK and Ireland



Footwear habits affect foot structure and functional movement in children. Squibb et al 2022



# THE IMPACT OF FOOTWEAR ON KNEE OSTEOARTHRITIS

This research into musculoskeletal health-related conditions is taking place at Leeds Beckett University by Hannah Blackburn, MSc, Dr Peter Francis, Professor Mark Thompson and Dr Catherine Tucker.

The PhD research will take place from 2019-2022. "The overall aim of the PhD is to explore the utility of footwear for the management of osteoarthritis of the knee.

We have launched one of the first studies to gather the opinions from healthcare professionals all over the UK and Ireland, on the use of footwear for the management of osteoarthritis of the knee. Findings from the study have not yet been identified due to the recent release of the study... but watch this space"

The utility of footwear for the management of osteoarthritis of the knee, Blackburn, et al 2022

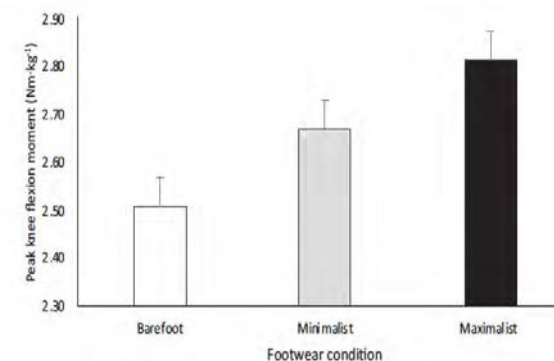
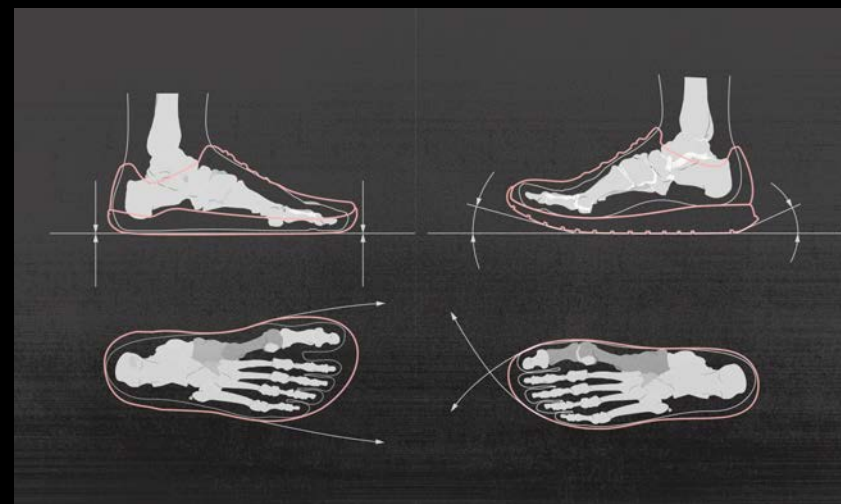


Figure 3. Peak knee flexion moment of 15 recreational runners during running over ground on an indoor runway while barefoot, in minimalist and in maximalist shoes. Columns and error bars are mean and standard error expressed at a common speed of 2.59 m·s<sup>-1</sup>.





**CHAPTER**

**3**



# CHAPTER 2:

# RECLAIMING OUR BALANCE AND FOOT STRENGTH

## SUMMARY:

Barefoot is the solution and there is an increasing wealth of scientific research to back this up.

Minimal and indigenous footwear is defined before exploring the University of Liverpool study which shows how Vivobarefoot footwear increased foot strength by 60%, as well as the positive

impact of Vivobarefoot on both balance and avoiding falls in older people, when compared to conventional padded shoes.

The chapter also explores the differences in the foot shape and function of habitually unshod populations, as well as the negative effects of habitual conventional footwear use.



# RECLAIMING OUR BALANCE AND FOOT STRENGTH

**FORWARD**  
**KRIS D'AOUT**  
**LIVERPOOL UNIVERSITY**

Walking on two feet has defined us and our ancestors, for six million years. It is only in the last few hundred years, at most, that we have started to use shoes that interact mechanically with us, through features such as heels, cushioning and “arch support”.

In our work, we focus on walking in healthy people, with the aim to keep them healthy for as long as possible in life. We therefore ask questions like: are the mechanical features in conventional shoes

helpful at all? How does footwear influence gait, stability and strength? What is we started footwear design from scratch (i.e., barefoot as the norm), and only added proven beneficial features (or at least, non-detrimental features)?

Our past and on-going research shows that footwear influences the shape of the foot and its pressure distribution and that minimal shoes have several advantages. We have shown

that they stimulate stronger feet - or rather they preserve the foot's natural strength, unlike conventional shoes. Minimal shoes also make people more stable during standing and walking. Our work across the world has shown that minimal shoes are not limited to the western world – indeed indigenous populations used them long before we invented a name for them.



# VIVOBAREFOOT CAN FUNCTIONALLY BE CONSIDERED ‘MINIMAL FOOTWEAR’

**BASED ON PLANTAR PRESSURE RECORDINGS, WE CONCLUDE THAT ALL THREE TYPES OF INDIGENOUS FOOTWEAR SHOWN, AS WELL AS COMMERCIAL MINIMALIST SHOES, CAN FUNCTIONALLY BE CONSIDERED AS ‘MINIMAL FOOTWEAR’.**

Definition: Footwear providing minimal interference with the natural movement of the foot due to its flexibility, low heel to toe drop, weight and stack height, and the absence of motion control and stability Devices.

Vivobarefoot, like indigenous footwear, are wide, thin and flexible.



Plantar pressures in three types of indigenous footwear, commercial minimal shoes and conventional western shoes compared to barefoot walking. Willems Curtis D'Aout, 2020



# FOOT STRENGTH

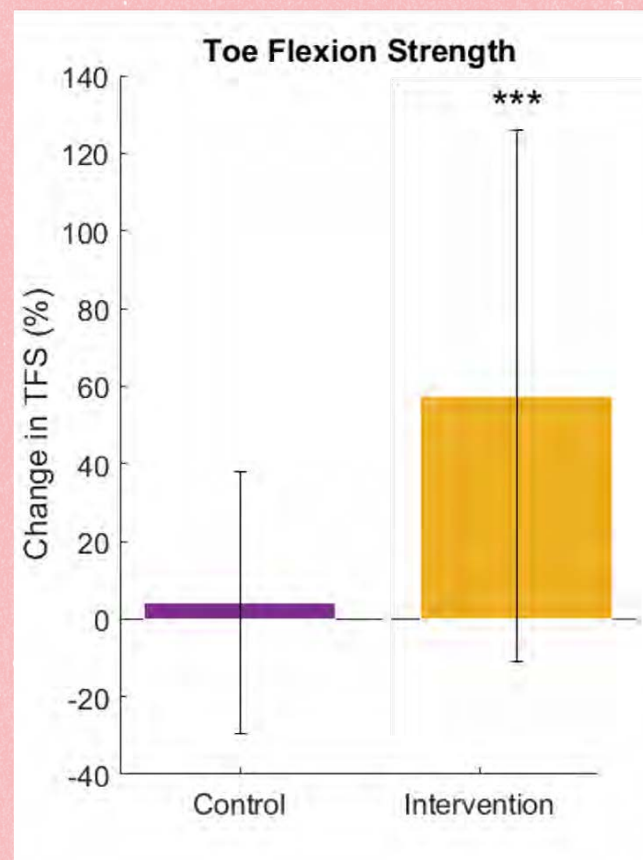
THE CHART SHOWS HOW TOE FLEXION STRENGTH INCREASES SIGNIFICANTLY WITH THE INTERVENTION OF MINIMALIST FOOTWEAR.

Control: no significant change  
(4.4  $\pm$  33.7%,  $p = 0.5316$ )

Intervention: significant change  
(57.4  $\pm$  68.4%,  $p = 0.00076$ )

Foot strength increased by ~60%  
due to daily activity in minimal  
footwear

Daily Activity in minimal footwear increases  
foot strength: Curtis, 2020





# BALANCE AND STABILITY

**CONVENTIONAL FOOTWEAR WAS COMPARED TO MINIMALIST, MEASURING THE STABILITY OF WEARER DURING STANDING AND WALKING AND WHILE COMPLETING A TIMED 'GET UP AND GO' ACTION. THE RESULTS:**

Compared to the conventional shoe, participants:

- Were more stable during standing and walking in the majority of minimal shoes, and
- completed the TUG (timed up and go) test faster when wearing the minimal shoe with wider sole.

So the minimal footwear improves biomechanical measures, both of postural and dynamic stability.

Loss of stability is an important factor for increasing the risk of falling in older people.

The greater contact area between the foot and the ground may reflect a more stable base of support and a greater transmission of tactile information about surface to the foot, resulting in a faster TUG test.

Poor TUG tests are also associated with increased risk of falls.



Minimalist shoes improve balance and stability in middle aged and older people: Cudejko, 2019.