

Running biomechanics, the influence of different footwear conditions

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Primary Objective: Part 1: To investigate the running biomechanics of toe-rocker shoes versus standard running shoes
Part 2: To investigate the running biomechanics of barefoot running in comparison to minimalist and standard running shoes
Part 3: To...

Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Other condition
Study type	Observational non invasive

Summary

ID

NL-OMON37413

Source

ToetsingOnline

Brief title

Running Biomechanics

Condition

- Other condition
- Joint disorders

Synonym

forefoot pain, Metatarsalgia

Health condition

Overuse Injuries, mtatarsalgia

Research involving

Human

Sponsors and support

Primary sponsor: Rehabilitation

Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: Barefoot running, Metatarsalgia, Overuse injuries, Rocker shoe

Outcome measures

Primary outcome

Part 1: Plantar peak pressure in metatarsal region (kPa)

Part 2: Peak vertical ground reaction forces (N)

Part 3: Volume of oxygen uptake ($\text{ml.kg}^{-1}.\text{min}^{-1}$)

Secondary outcome

Part 1: Spatio-temporal parameters of gait (step rate, step length, stance time).

Hip, knee and ankle joint angles in the sagittal plane during stance phase of running (kinematics outcome measures). Hip, knee and ankle joint moments and power in the sagittal plane during stance phase of running (kinetics outcome measures). Activity patterns of four lower leg muscles: Tibialis Anterior and Gastrocnemius (lateral and medial) and Soleus during stance phase of running and shoe comfort level.

Part 2: Spatio-temporal parameters of gait (step rate, step length, stance time)

Hip, knee and ankle joint angles during the stance phase of running (kinematics outcome measures). Hip, knee and ankle joint moments and power during the stance phase of running (kinetics outcome measures). Activity patterns

(Electromyography (EMG) with surface electrodes) of four main lower leg muscles:

Tibialis Anterior and Gastrocnemius (lateral and medial) and Soleus during stance phase of running, and shoe comfort level.

Part 3: Heart rate, respiratory exchange rate, running perceived exertion

Study description

Background summary

Athletes with overuse injuries of the ankle and foot regions are often encountered in clinical practice.^{1,2} One of the common foot overuse injuries in athletes and especially in runners is metatarsalgia.^{3,4} Metatarsalgia refers to localized or generalized forefoot pain in the region of the metatarsal heads.⁵ The main cause of metatarsalgia in around 70% of the cases is related to biomechanical factors and especially to an overload in forefoot region.⁶ A treatment option is to reduce the plantar loading in the forefoot region.^{5,7} This treatment goal can be achieved with the use of a rocker profile in the toe region of the shoe (toe-rocker shoe, figure 1-B).⁸ It is shown that this type of shoe can reduce the pressure in forefoot region 12% to 55% in walking.⁹ In addition, different changes in kinetics and kinematics of lower extremity have been reported due to toe-rocker shoes; for instance a decrease in dorsal flexion external moment of the ankle in the late stance during normal walking.¹⁰ This biomechanical effect could be beneficial in Achilles tendinopathy treatment.¹¹ At this moment we perform a study to the effects of a toe-rocker shoe during slow running in patients with Achilles tendinopathy. This study has been approved by the METc of the UMCG (nr: NL34288.042.¹¹) While it has been shown that rocker shoes have effects on the biomechanics of the lower extremity during walking, it is not clear whether the effects are similar in more dynamic tasks like running. Since speed influences biomechanical parameters such as plantar pressure pattern,^{12,13} lower extremity muscle activity^{14,15}, and the gait kinetics and kinematics,^{16,17,18} the biomechanical efficacy of rocker shoes needs to be assessed in (fast) running as well.

In recent years, barefoot running has become more popular around the world, and thus more scientific attention has been paid to the barefoot running biomechanics.¹⁹ Although not scientifically proven, it is believed that barefoot running has the potential ability to reduce running injuries as well.²⁰ Reduction of vertical ground impact forces, increase in foot muscles strength and increased activity of calf musculature in barefoot running are

believed to be among the biomechanical factors involved in injury prevention.²⁰ However, the results are controversial. For instance, both increase and decrease in vertical ground impact forces have been reported for barefoot running.^{19,21,22,23} Furthermore, hardness and properties of shoe sole are thought to be linked with comfort and rate of running injuries.²⁴ Due to lack of protection, barefoot runners are at risk of skin wounds, manufactures have increased interest in so-called minimalist shoes (Figure 1-C). Minimalist shoes with a thin midsole are believed to mimic barefoot running while providing a layer of protection compared to barefoot running, and therefore can be used as an alternative to barefoot running.^{19,22} It has been reported that minimalist shoes have similar walking economy to barefoot condition.²⁵ Consequently, it can be hypothesized that economy of running with minimalist shoes is more efficient than other shoe conditions such as standard running shoes (Figure 1-A) or rocker shoes. However, the knowledge regarding these aspects is still scarce.

As a consequence, in this study the influence of different footwear conditions on running biomechanics and economy will be assessed in one session using three separate experimental parts.

Study objective

Primary Objective:

Part 1: To investigate the running biomechanics of toe-rocker shoes versus standard running shoes

Part 2: To investigate the running biomechanics of barefoot running in comparison to minimalist and standard running shoes

Part 3: To investigate the running economy of minimalist shoes and toe-rocker shoes in comparison to standard running shoes

Secondary Objective(s):

Part 1: To assess lower extremity kinetics, kinematics and also lower leg muscular activity

in comparison to standard running shoes during running

Part2: To assess kinetics, kinematics and muscular activity of the lower extremity of toe-rocker shoes in comparison to standard running shoe

Part 3: To assess some other physiological parameters (heart rate, respiratory exchange rate), perceived exertion of running with 3 different shoe conditions and the first impression of comfort of the different shoe types.

Study design

In one single session subjects will undergo three separate experimental parts. The estimated time for each measurement is about 45 minutes (2-3 hours in total). The location will be in the Sports Field Lab Groningen, School of Sports Studies, Hanze University of Applied Sciences, Groningen. Each part follows a cross-over design to account for order effects in comparing different

shoes. Participants are randomized to the different orders in running with pairs of shoes.

Study burden and risks

All participants in the study will run inside the lab on a treadmill at sub-maximal speed and over-ground at their normal comfortable speed. The toe-rocker shoes are standardized and modified by orthopedic shoe technicians. This adaptation is provided for different diagnoses in regular patient care. No risk is expected for running trials. The runners don't have a direct benefit from this study.
Participation will be rewarded with a 20€ shopping bon.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age

Adults (18-64 years)

Elderly (65 years and older)

Inclusion criteria

Healthy female endurance runners (18-50 years old) who run at least twice a week a minimal distance of 5 km per session.

Experienced in treadmill running (or willing to familiarize with it during one session, some time before the measurements)

Exclusion criteria

(a) Current pain in the lower limb or back.

(b) History of severe injuries to back or lower extremity.

Study design

Design

Study type: Observational non invasive

Masking: Open (masking not used)

Control: Uncontrolled

Primary purpose: Prevention

Recruitment

NL

Recruitment status: Recruitment stopped

Start date (anticipated): 10-04-2012

Enrollment: 18

Type: Actual

Ethics review

Approved WMO

Date: 08-03-2012

Application type: First submission

Review commission: METC Universitair Medisch Centrum Groningen (Groningen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL39247.042.12