

# An Explanation of the Influence on Deciding which Type of Foot Strike to Use when Running Barefoot or in Minimalistic Shoes

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## ABSTRACT

*Buying minimalistic shoes does not mean that you know how to use them. Salespersons are rarely competent to give adequate advice how to transition to new shoes. The same happens when someone chooses to run barefoot. So, the aim of the present experiment was to find out whether giving or not giving an explanation of the correct technique of foot placement in barefoot running and running in a minimalistic shoe influences the frequency of rear-foot strikes in natural, rear foot strikers when running barefoot or in minimalistic shoes. Thirty-nine subjects (age =34.9±6.9 years, height =174±9 cm, mass =73.1±13.8 kg), randomly divided into four groups participated in this experiment. Subjects in groups 1 and 3 did not receive an explanation, while groups 2 and 4 did. Besides the difference in explanation, there was also a difference in the shoes worn during the intervention. Subjects in the groups 1 and 2 ran barefoot, while subjects in groups 3 and 4 ran in minimalistic shoes. The initial state of the foot strike patterns was measured in classic running shoes. During the intervention subjects ran according to the group they were in. 80% of the subjects in groups 1 and 3 took the most steps in a rear-foot strike pattern (Median =100) while only 21% of the subjects in groups 2 and 4 took the most steps in a rear-foot strike pattern (Median =15.7),  $U=64$ ,  $z=-3.619$ ,  $p(0.00)<0.05$ ,  $r=-0.58$ . The results show that an explanation and demonstration of the correct technique of foot placement in barefoot running and running in a minimalistic shoe is important when someone decides to switch from classic running shoes to minimalistic shoes or to go barefoot.*

**Key words:** running, barefoot, minimalistic shoes, explanation, strike type

## Introduction

Running barefoot or in minimalistic shoes has become very popular in recent years. Manufacturers have accepted this, and almost all of them have at least one model that complies with minimalistic shoes characteristics. There are many different models of minimalistic shoes, and all of them imitate in one way or another barefoot characteristics.

In the past and in some parts of the world there is still currently barefoot or one kind of minimalistic running and walking in everyday use<sup>1-4</sup>. In the 1970s modern running shoes were invented. At that time intensive development of the running shoes started. At the same time, EVA material was invented. EVA material is used in the shoe sole for cushioning. With development of the cushioning properties of running shoes the area under the heel became thicker and thicker. So, the position of the foot in running shoes changed from a flat to a decline position or from a neutral to a small plantar flexion in the ankle joint.

Probably the combination of the soft area under the heel and the height of the heel forced runners to change their foot landing technique<sup>5-7</sup>. From the mid-foot (the heel and ball of the foot lands simultaneously) and the fore-foot (the ball of the foot lands before the heel comes down) strikes it changed to a rear-foot (the heel lands first) strike. Currently, 75 to 95% recreational runners who wear classic running shoes use a rear-foot strike<sup>8,9</sup>. This kind of running and the running shoe itself decreases loading of the foot. Consequently, lower leg muscles and intrinsic muscles of the foot became weaker and less resistant to increasing loads<sup>1</sup>.

Using minimalistic shoes instead of classic running shoes in recreational running is a big change of the musculoskeletal loading pattern. The change is so large that many runners cannot tolerate it, and so become injured<sup>10,11</sup>. Nowadays, many »promoters« of barefoot running and minimalistic shoes advise slow progressive use of a new

running style<sup>12</sup>. Based on the previous experiments<sup>13–15</sup> many people believe that it is enough to change to running barefoot, or to a minimalistic shoe, and running technique will change automatically in the correct one. The other reason for automatic running technique change is the fact that running barefoot with a rear-foot strike produces high-impact collisions<sup>6</sup>. To avoid these high-impact collisions runners automatically switch to a mid-foot or fore-foot strike pattern<sup>6</sup>. So there is no need for additional running technique training under the supervision of an expert. While the cushioning property of the natural heel pad does not vary much between people<sup>6</sup>, there is a big difference between minimalistic shoe models in this property (Altra Zero Drop the One, Nike Free, Vibram FiveFingers). The rule of unpleasant, high-impact collisions probably does not apply to minimalistic shoes with a cushioning sole<sup>16</sup>. The aim of the present experiment was to find out whether giving or not giving an explanation of the correct technique for foot placement in barefoot running and running in a minimalistic shoe influence the frequency of rear-foot strikes in natural, rear foot strikers when running barefoot or in minimalistic shoes.

## Materials and Methods

### Participants

Nineteen male and 20 female runners participated in the experiment (age =34.9±6.9 years, height =174±9 cm, mass =73.1±13.8 kg). They were randomly divided into four groups. The only criteria were that each group contained close to an even number of male and female participants. The basic statistics of each group are presented in Table 1. At the time of the experiment all of the participants were heel strikers, and they had no previous experience with barefoot running (systematic training) or minimalistic shoe running. No one had a history of ankle or foot disorders within six months prior to the experiment. The experiments were in accordance with the guidelines of the Helsinki declaration and approved by the Institutional Ethics Commission. All participants gave written informed consent.

### Measurement setup

The measurements were made on an athletic track covered with a synthetic surface (tartan). The length of the track was 70m with two 20m long straight sections. The

subject ran 16 laps for a warm-up. The first ten laps were at a self-paced velocity. The break between runs was 1 minute. The next three laps were to accommodate to the predetermined velocity of 3.5m/s. Before the next run a 1 minute break was used. The last three laps of the warm-up were used for measuring the initial state. The running velocity was 3.5m/s. The break before the intervention was at least 3 minutes long. The intervention was divided into 6 intervals with a 1 minute break between consecutive intervals. Each interval was 3 laps or 210m long.

All laps were filmed in the sagittal plane with a high-speed camera (Panasonic, DM-FZ200, Japan), with a frequency of 100fr/s<sup>8</sup>. The camera was rotated on the horizontal plane during the filming to follow the subject along the straight section of the track. For ensuring the right running velocity, an acoustic BEEP was played every 1.43s. At the moment of the BEEP the subject had to be at the marker positioned near the track. The distance between markers was 5m.

All participants ran in their own running shoes during warm-up and during the measuring of the initial state. The participant's running shoes were different brands and models. In general all running shoes were classic running shoes with an elevated heel. The average difference between the heel sole height and the fore-foot sole height was 1.3±0.3cm.

During the intervention, half of the subjects ran barefoot while the other half ran in minimalistic shoes (Altra, Zero Drop the One). The characteristics of this model are a flat sole (no inclination, with a sole thickness of 1.8cm), and a wide front part of the shoe (toe area).

Half of the subjects got an explanation about correct technique of foot placement in barefoot running and minimalistic foot running. Demonstration and explanation methods were used. The subjects received an explanation that rear-foot strikes are potentially dangerous for developing overuse injuries, and that they should use a mid-foot or fore-foot strike pattern. A video about barefoot running with a rear-foot strike (<https://www.youtube.com/watch?v=SPP7jFiTocQ>, obtained 1.7.2014), and a fore-foot strike (<https://www.youtube.com/watch?v=TjrEyfQC5NQ>, obtained 1.7.2014) with additional ground reaction force was showed. The explanation of latero-medial movement of the foot in the contact phase was made with the aid of a picture<sup>17</sup>.

The measurements were divided into two parts: warm-up and intervention. The warm-up was the same for all subjects. The intervention was different and was group-

**TABLE 1**  
DESCRIPTIVE STATISTICS OF THE GROUPS

Group number	Group characteristics	Number of subjects	Age	Weight	Height
1	barefoot – without explanation	11	32.3	70.3	1.73
2	barefoot – with explanation	11	35.1	71.2	1.75
3	minimalistic – without explanation	9	32.9	77.7	1.74
4	minimalistic – with explanation	8	40.3	74.5	1.72

dependent. The difference was whether subjects got an explanation about correct technique of foot placement in barefoot running and minimalistic shoe running, or not. Subjects in groups 1 and 3 did not get an explanation, while groups 2 and 4 did. Beside the difference in explanation there was also a difference in the shoes worn during the intervention. Subjects in groups 1 and 2 ran barefoot, while subjects in groups 3 and 4 ran in minimalistic shoes.

All 34 laps were filmed. The subjects ran for 2380m. For a further analysis, laps from 14 till 16, and the last two laps in each interval during the intervention were used. In each analyzed lap only steps made in the straight section were used. The first analyzed step was the first step with the right leg in the strait (no more disturbances due to a track curve). Six consecutive steps with the right leg were analyzed. Eighteen steps were analyzed in the warm-up, while 108 steps were analyzed in the intervention. For a comparison between the warm-up and the intervention, the number of rear-foot strike steps was expressed as a percentage of all analyzed steps in the warm-up and the intervention, respectively. A 100% result means that the subject used a rear-foot strike in all steps made in this part of the experiment. Whether the rear-foot strike, mid-foot strike, or fore-foot strike was used the following definitions were used<sup>6</sup>:

- rear-foot strike – the heel lands first,
- mid-foot – the heel and ball of the foot land simultaneously,
- fore-foot – the ball of the foot lands before the heel comes down.

The data were analyzed with the IBM SPSS Statistics 21.0 package (IBM Corp., USA). Non-parametric tests (Wilcoxon signed-rank test, Mann-Whitney test) were used to compare the effects of experimental conditions. For all analyses,  $p < 0.05$  was assumed to be statistically significant.

## Results

The data are presented according to the groups that divided the subjects (Table 1). There were no significant differences between groups in warm-up conditions. All subjects used a rear-foot strike in all analyzed steps.

Subjects in the first group ran barefoot and without explanation about the correct technique of foot placement in barefoot running. Three subjects (27%) in this group changed their technique of foot placement on the ground completely, while eight subjects (63%) continued to use a rear-foot strike pattern in more than 90% of the steps. The difference between running in classic running shoes (Median =100) and running barefoot (Median =95.4) was statistically significant  $z = -2.371$ , ( $p = 0.018$ )  $< 0.05$ ,  $r = -0.51$ .

In the second group subjects ran barefoot and received an explanation about the correct technique of foot placement in barefoot running. Eight subjects (72.7%) changed their running technique from a rear-foot strike, to a mid-foot or fore-foot strike. The rest three subjects (27.3%) still used a rear-foot strike pattern in more than 70% of all

analyzed strides. The difference between running in classic running shoes (Median =100) and running barefoot with an additional explanation (Median =5.6) was statistically significant  $z = -2.840$ ,  $p (0.005) < 0.05$ ,  $r = -0.61$ .

Subjects in the third group ran in minimalistic shoes and without an explanation about the correct technique of foot placement when running in minimalistic shoes. 88.9% or eight subjects continued to use a rear-foot strike pattern in all analyzed strides, while only one subject (11.1%) changed from a rear-foot strike to a mid-foot or fore-foot strike in around 80% of all analyzed strides. There was no statistically significant difference between running in minimalistic shoes (Median =100) and running in classic running shoes (Median =100),  $z = -1$ ,  $p (0.317) > 0.05$ ,  $r = -0.24$ .

In the fourth group, subjects ran in minimalistic shoes and received an explanation about the correct technique of foot placement when running in minimalistic shoes. In this group seven subjects (87.5%) used a mid-foot or fore-foot strike more often than a rear-foot strike. Only one subject (12.5%) did not change the type of foot placement on the ground at all. The difference between running in classic running shoes (Median =100) and running in minimalistic shoes with additional explanation (Median =23.6) was statistically significant  $z = -2.521$ ,  $p (0.012) < 0.05$ ,  $r = -0.63$ .

To reveal whether giving the explanation about the correct technique of foot placement when running barefoot or in minimalistic shoes is important, groups 1 and 3, and groups 2 and 4 were united into new groups 1NO and 2EX, respectively. The common characteristic of group 1NO was that they did not get an explanation about the correct technique of foot placement when running barefoot or in minimalistic shoes, while the common characteristic of group 2EX was that they received the explanation. Sixteen subjects (80%) in group 1NO took the most steps using a rear-foot strike pattern. On the other hand, only four subjects (21%) in group 2EX took the most steps in a rear-foot strike pattern (Figure 1). The difference between group 1NO (Median =100) and group 2EX (Median =15.7) was statistically significant  $U = 64$ ,  $z = -3.619$ ,  $p (0.00) < 0.05$ ,  $r = -0.58$ .

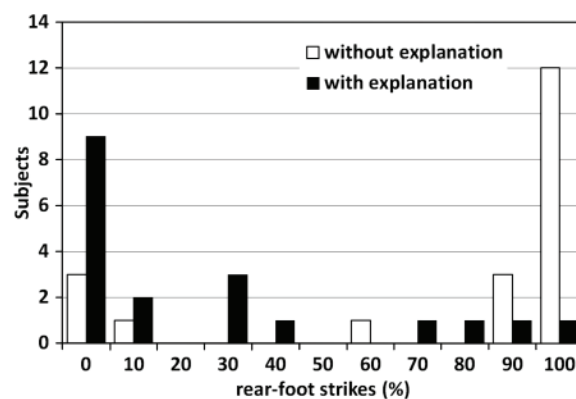


Fig. 1. Percent of rear-foot strikes when running with or without an explanation

Legend: 100% means that all strides were rear-foot strikes.

## Discussion

The aim of the experiment was to find out whether giving or not giving an explanation of the correct technique of foot placement in barefoot running and running in minimalistic shoes influence the frequency of rear-foot strikes in natural rear-foot strikers when running barefoot or in minimalistic shoes. Subjects that received the explanation of the correct technique of foot placement had fewer rear-foot strikes while running barefoot or in minimalistic shoes than subjects who didn't get the explanation. It is possible to conclude that an explanation of the correct technique of foot placement is important and necessary when recreational runners switch from classic running shoes, to minimalistic running shoes, or to barefoot running.

The subjects that did not receive an explanation of the correct technique of foot placement in barefoot running and running in minimalistic shoes had to rely on their previous experience about techniques of avoiding high-impact collisions with the heel. Eighty percent of subjects that did not receive the explanation remained predominantly rear-foot strikers. This confirmed previous experiment results that state that most runners who are predominantly rear-foot strikers in classic running shoes will remain rear-foot strikers in barefoot running<sup>6</sup>.

Running with shoes or barefoot is another factor that influences whether a rear-foot or mid-foot strike is going to be chosen. A chance to use a mid-foot or fore-foot strike is higher when running barefoot than when running with shoes (minimalistic or classic running shoes)<sup>15</sup>. The same was found in the present experiment, where 27% of the subjects who ran barefoot and did not get an explanation (group 1) switched from a rear-foot strike to mid-foot or fore-foot strikes, while in group 3 almost all subjects (8 from 9 subjects) remained rear-foot strikers.

The characteristic of minimalistic shoes was that the height of the sole under the heel was the same as the height of the sole under the toe region. If the inclination of the sole is the only factor that determines the type of foot placement<sup>5,7</sup>, then all subjects who ran in minimalistic shoes should use a mid-foot or fore-foot strike. But this was not the case. Obviously the cushioning property of minimalistic shoes was high enough that subjects in group 3 continued to use a rear-foot strike. Whether the tartan surface helps in this remains unclear, since 27% of subjects (group 1) that ran barefoot switched from a rear-foot to mid-foot or fore-foot strike. Previous experiments have shown that if the surface is soft enough, a rear-foot strike is used when running barefoot<sup>16,18</sup>.

Subjects ran barefoot or in minimalistic shoes for 1260m in intervals of 210m, and over the whole experiment about 3000m. Since they were all recreational runners, the covered distance should not have been a problem for them. Nevertheless, most of the subjects who used mid-foot or fore-foot strikes in the intervention reported muscle soreness in plantar flexors and the intrinsic muscles of the foot. This confirms the results of a previous experiment that say that classic running shoes weaken plantar flexors and intrinsic muscles of the foot<sup>1</sup>. Because changing the foot placement from a rear-foot to a mid-foot or fore-foot strike increases the load on plantar flexors and the intrinsic muscles of the foot<sup>6,19,20</sup>, runners should be very careful and consider a gradual progression of running in minimalistic shoes or barefoot<sup>12,20</sup>.

To conclude, these findings show that an explanation and demonstration of the correct technique of foot placement in barefoot running and running in a minimalistic shoe is important for someone deciding to switch from a classic running shoes to minimalistic shoes or barefoot. Probably a couple of lectures with a professional running trainer would be sufficient to meet the criteria of correct technique of foot placement in a running new technique.

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## **OBJAŠNJENJE UTJECAJA NA ODLUKU KOJU VRSTU TRČANJA PRIMJENITI PRI BOSONOGOM TRČANJU ILI TRČANJU U MINIMALISTIČKOJ OBUĆI**

### **SAŽETAK**

Kupnja minimalističke obuće ne znači i to da znate kako ju koristiti. Prodavači su rijetko kompetentni dati adekvatan savjet o prelasku na novu obuću. Isto se događa kada se netko odluči na bosonogo trčanje. Stoga je cilj ovog istraživanja bio saznati utječe li davanje ili ne davanje objašnjenja o ispravnoj tehnici pozicioniranja stopala pri bosonogom trčanju i trčanju u minimalističkoj obući na učestalost udara na petu stopala kod prirodnog, bosonogog i trčanja u minimalističkoj obući. Trideset i devet ispitanika (dob = $34,9 \pm 6,9$  godina, visina = $174 \pm 9$  cm, masa = $73,1 \pm 13,8$  kg), nasumce podijeljenih u četiri skupine sudjelovalo je u ovom eksperimentu. Ispitanici u skupinama 1 i 3 nisu dobili objašnjenje, a skupine 2 i 4 jesu. Osim razlike u objašnjenju, tu je i razlika u obući koju su nosili tijekom intervencije. Ispitanici u skupinama 1 i 2 su trčali bosu, dok su ispitanici u skupinama 3 i 4 trčali u minimalističkoj obući. Početno stanje obrazaca pozicioniranja stopala mjereno je u klasičnim tenisicama. Tijekom intervencije subjekati su trčali shodno tome kojoj su skupini pripadali. 80% ispitanika iz skupina 1 i 3 napravilo je većinu koraka u obrascu udara na petu stopala (Median =100), dok je u skupinama 2 i 4 to učinilo samo 21% ispitanika (Median =15,7),  $U = 64$ ,  $z = -3,619$ ,  $p(0.00) < 0,05$ ,  $r = -0,58$ . Rezultati pokazuju da su objašnjenje i demonstracija ispravne tehnike pozicioniranja stopala važni i kod bosonogog i kod trčanja u minimalističkoj obući, kada se netko odluči s klasičnih tenisica za trčanje prijeći na te oblike trčanja.