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Do minimalist running shoes cause harm to runners?

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A Selective Evidence Based Medication Review

In Partial Fulfillment of Requirements for

The Degree of Master of Science

In

Health Science – Physician Assistant

Department of Physician Assistant Studies

Philadelphia College of Osteopathic Medicine

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Abstract

Objective: The objective of this systemic review is to determine whether or not running in minimalist running shoes causes injury to runners?

Study Design: Review of a cohort study completed in 2015, randomized control trial in 2013, and prospective randomized trial in 2014.

Data Sources: Three controlled trials published in English on Pub Med.

Outcome(s) Measured: The outcomes measured in these articles consisted of Limb and Joint stiffness, injury vs non injury, and number of injury events.

Results: Sinclair, et al, limb and knee stiffness were greater in the minimalist runners compared to the conventional runners¹. Ridge et al. increase in bone marrow edema was seen in the runners transitioning to minimalist running². Ryan et al. increase in calf/shin pain, plantar fasciitis, and stress fractures occurred in the runners with minimalist running shoes³.

Conclusion: All studies agreed the use of minimalist running shoe will cause injury. If a runner does choose to use a minimalist shoe, a slow transition is needed. Further studies need to look into the long term affects the minimalist shoes have on runners.

Keywords: Minimalist, Running, Injuries

Introduction

Every stride a runner takes can cause an impact on the human body. One of the most important decisions a runner can make is in the type of shoe they will run. The traditional running shoe supports the runner every stride they take and absorbs the impact when the heel strikes the concrete. Many shoe companies like Nike and Vibram have begun making the transition to minimalist running shoes. The minimalist running shoe are constructed very differently than the traditional shoe. The heel is at the same level as the toes and have minimal cushioning.¹⁻⁴ These minimalist running shoes resemble barefoot running and give the runner a feeling there not wearing any shoes at all. These running shoe companies make the runners believe that running in lighter shoes can allow the runner to become faster and stronger, when in reality may cause significant harm to the runner's body and their running career. This paper analyzes three controlled trails and the harm the minimalist running shoe has on the runner's body.

Nike is the most notable running shoe brand in the world. Their most famous minimalist running shoe is the Nike Free. This shoe costs around \$100. Runners typically buy new running shoes about 3-4 times a year depending on how many miles they run weekly.

40 million Americans are self proclaimed runners; whether its trail running, on the sidewalk, or around the track.⁴ Running related injuries affect 60% of runners, which amounts to 24 million runners total.⁴ Seventy percent of these injuries are recurrent issues that impact the runners performance.⁴ Once a runner becomes injured, they will have to seek treatment. On average 8-10 treatment sessions are completed per injury.⁴ This equals to 192 – 240 million treatment sessions.⁴ Each of these treatment sessions cost about \$150 per visit.⁴ This annual cost is on average 28.8-37.2 billion US dollars.⁴

Running related injuries to shoes can be as simple as plantar fasciitis or even a stress fracture.⁵ Plantar fasciitis is the inflammation of the fascia. The plantar fascia begins at the calcaneal tuberosity and divides into 5 separate distal attachments at the distal phalanges.⁵ When running mechanics are altered, the fascia becomes irritated and inflicts pain on the runner. The treatment of choice is beginning with with supportive therapy and splints. The supportive therapy consists of NSAIDS, ice, and resting.⁵ The splint provides tension on the toes to allow the fascia to be stretched. The next step in therapy is cortisone injections into the attachment of the fascia⁵. If none of the above relieves the pain, the runner can undergo surgery.⁵ A stress fracture could also occur in this circumstance. With repeated trauma to the foot, micro tears in the bone can occur. If this is not diagnosed and treated early, the stress fracture can become much worse. The treatment for a stress fracture is to rest, ice, compression, and elevate the affected foot.⁵ The fracture could take months for it to heal, so its important to be patient during this time. If the injury is still unrelenting, surgery can be scheduled.⁵

Objective

The objective of this systemic review is to determine whether or not running in minimalist running shoes causes injury to runners.

Methods

The method of selecting studies to analyze required the follow criteria. The population in the studies consisted of healthy male and female runners who are older than 18 years old. The intervention groups in the 3 studies ran in minimalist running shoes, while the control group ran in the conventional running shoe. The minimalist running shoes used in the studies were Nike

and Vibram. The outcomes measured were injuries, pain, and mobility. The three studies consisted of cohort, prospective randomized control study, and randomized control study.

During research and selection of studies, key words used were “Minimalist”, “Running”, and “Injuries.” The articles that were selected were written in English and published in peer reviewed journals selected from Pubmed. The articles were selected based on their pertinence to the clinical question and if they included patient oriented outcomes (POEM). All articles were relevant and published after 1999. The inclusion criteria consisted of controlled and randomized trials. Under the age of 18 and unhealthy were the 2 main exclusion criteria’s for selecting studies. All statistics reported were achieved with P Value, Post HOC, ANOVA, Partial omega, NNT, AAR, RRR, RR, and PMANOVA.

Table 1: Demographics & Characteristics of Included studies

Study	Type	# Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Sinclair et al. 2015 1.	Cohort	15	23.5 +/- 2.5 yr	Running 35 KM a week Free of injuries	NONE	0	Conventional running shoe mobility VS. Minimalist running shoe mobility
Ridge et al. 2013 2.	Randomized Control Trial	43	26.5 +/- 6.6 yr	Complete an average of 15-30 miles a week for 6 months before the study	Previously run in Vibrams before the study Lower body injury that prevented them from running for at least 3 days a week within the past 6 months.	7	Conventional Running shoe vs Minimalist shoe comparing injuring vs non injury
Ryan, et al. 2014 3.	Prospective Randomized Clinical Trial	103	19-50	Minimum of 5 years of running experience Running on a regular basis (min	History of surgery to plantar fascia or Achilles tendon Diagnosis of osteoarthritis or a degenerative musculoskeletal disorder affecting lower extremity	4	Conventional running shoe vs Minimalist pain and

				of once per week) over the past 6 months Able to run for 60 minutes continuously Tolerate 20-40km/week	Taking analgesic medications Currently running in minimalist running shoes Highly pronated or supinated foot posture Running related injury requiring a stoppage of training for 2 weeks or more in the past 6 months		number of injury events
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Outcomes Measured

The outcomes measured in these articles consisted of mobility, injuries, and number of injury events. Mobility was tested by testing the participant’s limb and joint stiffness. The runners ran on a force platform that was embedded into the floor that measured pressure.¹ Each participant wore retroreflective markers placed on their medial and lateral malleoli, medial and lateral epicondyles of the femur, and greater trochanter.¹ These markers were then converted into a visual 3D model. As the runner ran over the platform, angle of foot strike, peak angle, joint angular excursion, and peak joint movement parameters was measured.¹ A mathematical equation was made using the parameters to calculate the limb and joint stiffness.¹

Injury was tested in the study by a MRI of the participant’s feet and also including the distal fibula and tibia. The researchers used the marrow edema scores (MES) that is used by radiologist to assess injury on MRI. Score of 0 pertaining to a normal MRI.² Score of 1 pertaining to remodeling in the bone.² Score of 2 pertaining to a stress reaction with some area of concern.² Score of 3 pertaining to a stress injury with definite cause of concern.² Score of 4 pertaining to a fracture.²

Number of injury events was measured by 3 consecutive missed workouts secondary due to pain.³ Pain was measured using a visual analog scale and their corresponding location.³ These

variables were assessed at week 2,4,8, and 12.³ All the data was entered into there personal computer and analyzed using a statistical software.³

Results

The three trials included in this review assessed the risk of minimalist running shoes compared to the conventional running shoe on the runner. Only one study out of the three contained dichotomous data. The two other studies contained continuous data that could not be converted to dichotomous data, so risk reduction (RRR), absolute risk reduction (ARR) and numbers needed to treat (NNT) could not be calculated.

In the study conducted by Sinclair et al. a cohort study was completed with 15 male runners. The inclusion and exclusion criteria are noted in Table 1. The 15 runners ran in 7 different running shoes down a track and limb and joint stiffness was calculated.¹ One of the 7 shoes was a conventional running shoe and the others were minimalist running shoes. The 7 different shoes were randomized for each runner.¹ The minimalist running shoes used in the study were Saucony Pro Grid Guide II, Vibram Five Fingers, Vivo Barefoot ultra, Merrelle Bare Access, Inov-8 Evoskin, and Nike Free.¹ The participants in the study also ran barefoot on the track and Limb and Joint stiffness was also calculated.

Post Hoc analysis, P value, and partial omega, were completed to evaluate the mobility in the runners. The partial omega was used to calculate the effect size.¹ Mean and standard deviation was also calculated for each joint in the study (See table 2). Post hoc analysis showed limb compression was higher in the Conventional running shoes and Nike Free compared to the other running shoes and barefoot running.¹ The p value was < 0.05 and a partial omega of 0.22.¹ Post hoc analysis revealed Limb stiffness was larger in the minimalist running shoes and barefoot running compared to the conventional running shoes.¹ With a P value < 0.05 and a

partial omega of 0.23.¹ Post Hoc Analysis of the knee stiffness demonstrated the barefoot running, Vibram, Invo, Merrelle and were larger than the conventional running shoe and Nike Free.¹ With a P value of <0.05 and partial omega of 0.22.¹ Finally, Post hoc analysis revealed the ankle stiffness was greater in the conventional shoes, Nike Free, and Vivo running shoes compared to the barefoot running and Invo 8.¹ The P value was <0.05 and partial omega 0.23.¹

Table 2: Mean and Standard Deviation of Conventional Vs. Minimalist footwear

Variables	Conventional		Vibram Five Finger		Invo-8		Merrell		Nike Free		Vivo		Barefoot	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Limb Compression	.05	.01	.04	.01	.04	.01	.04	.01	.05	.01	.05	.01	.04	.01
Limb Stiffness	460	140	560	110	620	280	680	470	480	260	490	140	610	210
Knee Stiffness	5	1	6	1	6	1	6	1	5	1	5	2	7	2
Ankle Stiffness	11	5	9	2	7	2	11	4	13	2	11	2	7	1

This study revealed the change in running mechanics in the barefoot running and minimalist running shows has an affect on the runner’s mobility. “It is proposed that this observation related to the decrease in limb compression noted during BF and minimalist conditions which in junction with the similar GFR values observed between the footwear leads to higher limb stiffness.¹” The decrease in limb compression was caused by the decrease stance time with barefoot running and minimalist running.¹ Clinically, when the runner has decrease time on the ground while running can be associated with higher levels of bone related injury thus alters the mobility of the runner.¹

In the study conducted by Ridge et al., a randomized control trial was completed on 36 experienced recreational runners. Twenty-one of the participants were male and 15 were female.²

The inclusion and exclusion criteria is noted in Table 1. The participants were randomly assigned into a minimalist group or control group. The minimalist group gradually transitioned into there minimalist running shoes. The minimalist running shoe used in this study was the Vibram Five. A protocol was given to the runners to make sure their mileage was equal. The control group ran in a conventional running shoe. The runners underwent a MRI before the 10 week running sessions and after it was completed. This study contained dichotomous data. Tables 3 and 4 analyze the data in the study.

Table 3: Efficacy of subjects in the injury versus non injury groups

CER	EER	Relative Risk Reduction (RRR)	Absolute Risk Reduction (ARR)	Numbers Needed to Harm (NNH)
.06	.52	7.67	.46	3

Table 4: Number of Subjects in the injury versus non injury groups

Post test marrow edema scores (MES)	Control	Vibram
Non injury (0-1)	16	9
Injury (2-4)	1	10

The results of this study showed injuries were more common in the subjects transitioning to minimalist running.² The pre MRI scores were not statistically different between the two groups before the subjects began running (P = 1.0 for bone, P = .191 for soft tissue).² But after the subjects finished the 10 week running, the MRI scores were higher with the participants transitioning to the minimalist running group (P = .0009).² This P value is significant. In respect to soft tissue, the groups were not significantly different to post training MRI scores (P = .444).² This P value is not significant.² The relative risk reduction for this study was 7%. The ARR in the study was 46%. Which equivalents to the control group had a 46% reduction of risk of having a running related injury. The NNH in the study was 3. Meaning every 3rd runner using the minimalist running shoe will have injury.

In the study conducted by Ryan et al. a prospective randomized control trial was completed on 99 runners. Runners were randomly assigned to a conventional shoe, partial minimalist shoe, and full minimalist shoe. The inclusion and exclusion criteria is in table 1. Each runner underwent a baseline assessment with an extensive running related history and anthropometric measurements.³ The participants then began a 12 week running program and ending with a 10km race. Each week the runner gradually increased their weekly mileage and tapered the last 2 weeks to prepare for the race. Each runner kept a running journal and would record if they were in any running related pain and where it was located. These outcomes were assessed at baseline, week 2, 4, 8, and 12.³

Table 5: Relative Risk

	Partial Minimalist Running Shoe	Full Minimalist Running Shoe
Relative Risk	310%	160%

A RMANOVA was used in this study to compare the different types of running shoes.³ Overall there were a total of 23 injury events recorded by the participants in the study.³ The partial minimalist running shoe and full minimalist running shoe compared to the conventional running shoe had a 310% and 160% RR.³ Which means there was a 310x and 160x more risk to have an injury with the shoe compared to the conventional running shoe.³ The partial minimalist running shoe resulted in the greatest injury rate.³ The pain scales over the 12 weeks reported little difference. The only pain scale that was significant (P<.01) was the shin/calf pain in full minimalist shoes than both other footwear groups.³

Discussion

When a runner decides to run in a minimalist shoe, the health of the runner will be compromised compared to the conventional shoe runners. The three studies in this review

demonstrated the affect of minimalist running have on the human body. Each study displayed different types of running related injuries a runner can have while using minimalist running shoes. In the study conducted by Sinclair, et al. limb and knee stiffness were greater in the minimalist runners compared to the conventional runners.¹ In the study conducted by Ridge et al, increase in bone injury was seen in the runners transitioning to minimalist running.² In the study conducted by Ryan et al. an increase in calf/shin pain, plantar fasciitis, and stress fractures occurred in the runners with minimalist running shoes.³

Although these studies supported the hypothesis, there were limitations in each study. In the study conducted by Sinclair, Atkins, and Taylor, only males were included in the study. If female runners were compared to male runners the study could have had a different outcome. The female body has different limb stiffness parameters and kinetics as compared to the male.¹ This would have changed the study drastically if females were used in the study. In the study conducted by Ridge et al, 4 of the participants did not keep up with their weekly logs but were still included in the final result of the study.² The lack of documentation can be seen as a limitation in the study.² In the study conducted by Ryan et al. the researchers stated a limitation in the study was time.³ The study only assessed the injuries in the 12-week time span. This was relatively short. Long term clinical affects cannot be assessed in this study because the time spent with the participants was limited.³

Conclusion:

Even though these shoes are relatively new, all studies suggest minimalist running can cause harm to runners. The outcomes measured in the studies were statically significant and proved the hypothesis of this systemic review. The numerous injuries through out the study were provoked by the change of the runner's gait¹⁻³. The change in the shoes support changes the gait

of the runner and inflicts injury. Runners who used minimalist running shoes had 3 times more injuries than the conventional shoe runners¹⁻³. All studies agreed, if a runner is going to transition to minimalist running, they need to have a slow transition to allow the runner's body adjust to the new running form¹⁻³. Further research needs to be aimed at long term effects the minimalist shoes have on the runner. The research should be longer than 12 weeks and make sure they include both sexes. Clinicians need to be aware of these circumstances when a runner comes into their office and complaining of running related pain.

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