

Recent Innovative Footwear Designs

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Introduction

Over the last several years, we have been inundated with unconventional footwear designs that are engineered to mimic the perceived benefits of barefoot locomotion and/or function as a muscular training intervention. What is unclear to most foot care specialists is whether there are applications for these types of footwear and what the contraindications are. In the current Industry Bulletin, we will be presenting some of the biomechanical research that has been performed on these new footwear concepts. Specifically, we will be discussing the MBT (Masai Barefoot Technology) and Minimalist (Vibram Fivefingers®) shoe designs. In addition, we will share some of our Professional Advisory Board's recommendations for this footwear in clinical practice.



Biomechanical Research: MBT Footwear

The vast majority of research that has been conducted on MBT footwear has investigated the footwear design influences on dynamics (kinematics and kinetics) and muscular activity of the lower extremity. Other companies are also offering their version of this footwear type which is often referred to as: toning, unstable and/or physiological footwear. Sketchers (Shape-Ups), New Balance (Rock and Tone; WW1442) and Reebok (Easytone) are a few examples.

Several research studies have been conducted on MBT shoes. However, the findings of these studies should not be extrapolated to other brands as they all differ somewhat in design. Nevertheless, the biomechanical influence of MBT shoes has been studied during standing, walking and running.

During **standing**, Nigg et al. (2005) reported that the activity of the muscles (tibialis anterior (TA), medial gastrocnemius (mGAS), biceps femoris (BF), vastus medialis (VM) and gluteus medius (GM)) increased an average of 39% during standing when wearing the MBT shoe. In a subsequent study, Landry et al. (2009) analyzed the activity of the extrinsic foot muscles (flexor digitorum longus, soleus, peroneals, anterior compartment group (TA, EHL, EDL)) while standing in the MBT shoe.

These authors reported that the activity of all muscles except the soleus were increased while standing in the MBT footwear. In addition, both studies revealed that postural sway increased while wearing the MBT shoes.

During **walking**, Nigg et al. (2005) compared the kinematic and kinetic differences between walking in MBT shoes and the New Balance 756 WB (Figure 1). These authors reported that when individuals



Figure 1: New Balance 756 WB

walked in the MBT shoes, they contacted the ground with the ankle in a greater angle of dorsi-flexion and that increased dorsi-flexion was increased throughout stance until midstance. Romkes et al. (2006) supported these findings in a subsequent study. In addition, Nigg and colleagues reported that there was an increase in the muscle activity.

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Recent Innovative Footwear Designs (cont'd)

Increases in muscular activity included the: gastrocnemius (55%); vastus medialis (4%) and gluteus medius (16%). Conversely, wearing MBT shoes led to decreases in the activity of the tibialis anterior (26%) and biceps femoris (55%).

The increases in muscular activity that have been reported in the literature have fueled the concept of the *Toning or Physiological* footwear category. Specifically, the idea that MBT shoes may function as a motor-sensory tool. That is, an unstable shoe may function as a training tool to strengthen the muscles that act on, or about, the foot and ankle complex (Nigg, 2009). This concept is not unlike that of wobble board therapy that is frequently prescribed for individuals with lateral ankle instability (Emery et al., 2005).



Figure 2: MBT M-walk

Lastly, researchers have examined what happens when individuals run in MBT shoes (Boyer et al., 2009). This study was conducted using the MBT M-walk shoe (Figure 2) and compared running dynamics with that in a New Balance shoe (NB 658). Similar to walking, **running** in MBT shoe led to greater ankle dorsi-flexion at initial contact and this was maintained until midstance.

Clinical Applications and Contraindications

Foot care specialists are often asked two questions regarding this footwear category:

- 1) Are there certain pathologies where my patient might benefit from wearing MBT shoes? and
- 2) When is wearing a MBT shoe contraindicated?

To answer these questions, we consulted with our *Professional Advisory Board (PAB)* to try to come up with some guidelines for their use. Table 1 outlines some of the pathologies where our PAB members described there being positive clinical outcomes from MBT intervention.

Table 1: Recommendations for MBT Intervention

- Hallux limitus and rigidus
- Bunions
- Plantar heel pain and plantar fasciitis/fasciosis
- Metatarsalgia
- Off-loading MTPJ pathology
- Painful callosity
- 2nd MTP capsulitis
- Neuroma
- Foot osteoarthritis
- Individuals in standing professions

Interestingly, there was a general consensus regarding the types of pathologies that may benefit from MBT footwear and those conditions when MBT footwear should not be recommended (Table 2). When we look closer at the contraindications, most make perfect sense given what we have learned about the footwear's biomechanical influence. The increased ankle dorsiflexion that has been reported in the literature would most likely aggravate Achilles tendon pathology. In general, any kind of unstable footwear is going to be contraindicated for individuals with postural and balance issues, and ankle instability.

What might be invaluable to the foot care specialist are the potential benefits of this footwear for patients with the conditions listed in Table 1. It may be that MBT shoes provide an additional intervention that leads to improved patient outcomes.

Table 2: Contraindications for MBT Intervention

- Achilles and Peroneal tendinopathy
- Poor postural control and balance
- Ankle instability
- Neuropathy
- Neurological deficits
- Stress fractures
- Knee pathology
- Walking on flat and predictable surfaces

Recent Innovative Footwear Designs (cont'd)

Biomechanical Research: *Minimalist Footwear*

As this year unravels, we are going to see more types of *Minimalist Footwear* emerge. Unfortunately, there haven't been many biomechanical studies performed thus far so it is difficult to comment on their influence. There has been one study that has looked at the *Vibram Fivefingers*® (Figure 3) to try and determine whether dynamics during running are similar to running completely barefoot. Squadrone & Gallozzi (2009) compared running in the *Vibram Fivefingers*® with running in a neutral running shoe.

These authors reported that there were very similar results when comparing barefoot running to running with the *Vibram Fivefingers*®. However, there were differences between running with the *Vibram Fivefingers*® (and barefoot) and in the neutral running shoe. Most notably, the impact peak exhibited during running shoe trials was greater and the foot and ankle kinematics were different. Prior to foot contact, the ankle tended to be in a more plantar-flexed position when running in the *Vibram Fivefingers*®. The authors attributed the decrease in impact peak to the altered ankle kinematics. Peak pressure was greater while running in the running shoe under the heel, midfoot and hallux. Whereas, pressure was significantly greater under the toes when running in the *Vibram Fivefingers*®.

Clinical Applications and Contraindications

The clinical applications for wearing *Minimalist Footwear* in a clinical population is difficult to ascertain. Some have recommended minimalist footwear as a training and/or rehabilitation tool. The individuals who may benefit from



Figure 3: *Vibram Fivefingers*

training in *Minimalist footwear* don't necessarily show up in your office. Our PAB did express that there may be some benefit for the elite runner to train for a percentage of time in a *Minimalist shoe* as long as it is performed in a safe and predictable environment.

There may very well be an advantage to training in this footwear for the elite runner. Again, the idea of *Minimalist footwear* as training or rehabilitation tool stems from research on wobble board therapy (Emery et al., 2005). Whether the use of the *Vibram Fivefingers*® or the *Nike Free*® (Figure 4) leads to enhanced proprioception and muscular strength, we simply don't know at this point.



Figure 4: *Nike Free*

Similarly, we do not have enough information to comment on contraindications. For the most part, common sense is the best practice. We do not have any injury pattern data for individuals running in *Minimalist Footwear*. In traveling around and speaking to colleagues, many report having examined patients with blood blisters and metatarsal stress fractures as a result of running in the *Vibram Fivefingers*®. However, this may be due to people not being respectful of the environment they are wearing them in.

For the vast majority of recreational runners, it is likely that adaptations in running style would in fact be more beneficial than shedding one's shoes. Studies have recently reported significant decreases in the load placed on the lower extremity merely by adjusting variables such as stride frequency (Heiderscheit et al., 2010). By increasing stride frequency, these authors reported decreases stride length and in the load insulted (energy absorbed) on the hip and knee. It has also been suggested that methods such as the Pose method of running better resemble a natural running form (Abshire, 2010).