Masai Barefoot Technology (MBT) – Fashion or Physiotherapeutic Intervention: A Systematic Review

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ABSTRACT

Footwear like the Masai Barefoot Technology® (MBT) is known world-wide and it is used as a therapeutic device by many physiotherapists. The aim of this review is to analyze the MBT shoe as an interventional tool and to compare its use as a therapeutic device with ordinary flat bottom shoes while walking. The review focuses especially on applications of the MBT shoe to patients suffering from ankle instability or lower back pain. A literature search in four databases (PubMed, Google Scholar, PEDro, PiCarta) was carried out using a combination of relevant keywords in order to find adequate publications. Those which met all inclusion criteria were included and rated using a modified PEDro scale. The content of each paper was categorized and tabulated. 15 studies were rated to be sufficient: twelve dealing with ankle instability, three with lower back pain and one of them with both. Walking or standing with the MBT shoe revealed significant differences compared to walking or standing with ordinary flat bottom shoes in patients suffering from ankle instability but in patients suffering from lower back pain no significant differences were found. Hence, there are advantages when treating ankle instability with the MBT shoe but all patients need to be assessed and instructed thoroughly before using this shoe, since it might not be the device of choice for all of them.

In summary, the MBT shoe is a valid therapeutic device for patients with ankle instability, whereas no beneficial therapeutic effects could be demonstrated for lower back pain patients. More in-depth studies are recommended to receive further evidence about the use of the shoe in lower back pain patients.

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Keywords: Masai Barefoot, Technology, MBT, shoe, rocker bottom, low(er) back pain, ankle, instability, unstable

INTRODUCTION

Walking is a highly autonomic movement based on a high rate of stability (Stöggel et al. 2010). Especially in our developed industrial society people are mainly walking on flat, hard and monotonous surfaces (Amann et al. 2003). Moreover, conventional shoe designs support the foot and improve stability leading to an overprotection and underuse of musculature which generally helps to stabilize our joints. As a consequence a higher risk for musculoskeletal injuries and a loss of muscle coordination and weakness occur (Landry et al. 2010).

A widespread disease in society today is back pain leading to high costs for the health care system. According to estimations 85% of individuals in our western society suffer from back pain once in their life-time (Riepl 2010). An increasing shift towards chronic lower back pain (LBP) has been noticed over the last 50 years and it is assumed that there is a correlation between psychological and social
factors and back pain. Symptoms can already arise at a young age and often result from a poor postural stability, abnormal biomechanical stress and excessive load on the spine, obesity, as well as degeneration and inactivity (Riepl 2010). Therapy options are various depending on the cause: invasive therapies such as surgery or local pain injections; conservative therapy including e.g. physiotherapy, stress relief, chiropractic therapy, psychotherapy, relaxation, medication, et cetera.

Topp et al. (1984) and McQuine et al. (2000) have reported that poor postural stability is a predisposing factor for ankle sprain in active individuals. In particular, it is the most frequent injury in athletes playing volleyball, basketball, soccer or handball and is responsible for about 50% of their injuries (Bahr et al. 1997). Mechanical and functional instability are the main complications following ankle sprain (Wester et al. 1996). Currently, conservative treatment is the preferred therapeutic option after ankle sprain. In the acute phase bandages, stabilizing shoes and orthoses are used hand in hand with anti-edema methods and a gentle training of the muscles. Unfortunately, 20% of sprained ankle joints remain unstable leading to a chronic instability (Kälin et al. 2007). Traditionally a combination of coordination, balance and strength training is carried out in order to compensate for this instability and to prevent repeated injuries (Michell et al. 2006). Training devices such as the wobble boards have been proven to be effective (Wester et al. 1996, Waddington et al. 2004).

The MBT shoe (Figure 1), invented by the Swiss engineer Karl Müller, was developed as “The Anti-shoe” and is intended to lead the wearer to a more active gait (MBT 2010). By its unique sole construction that is curved and has a soft heel sensor and a balance area it simulates an uneven soft ground featuring a 3D-instability (Riepl 2010; Romkes 2008). It is argued that a higher muscle activity in the lower extremity and in the back is required when wearing this shoe (Landry 2010, Riepl 2010). Furthermore, the producers of the MBT shoe claim plenty of benefits amongst others changes in gait and posture, a reduction of pain and stress on the joints, and an increase of balance and ankle stability. Since the MBT shoe alters the center of pressure on the foot and improves proprioception, Stöggel et al. (2010) found that it can be used as a preventative and therapeutic device during every day life, e.g. to ensure a safer mobility and to lower the risk of falling.

The aim of this review is to analyze the MBT shoe as an interventional tool and as an object on the market for therapeutic use compared to ordinary flat bottom shoes while walking. It focuses especially on the option to use this shoe in physiotherapy for patients suffering from LBP and acute or chronic ankle instability. The following hypotheses are formed:

H01: The MBT shoe indicates no significant differences while walking compared to ordinary flat bottom shoes when using it as a device for a physiotherapy driven intervention in patients suffering from ankle instability

H02: The MBT shoe is not a valid device to be used in patients with ankle instability.

H03: The MBT shoe indicates no significant differences while walking compared to ordinary flat bottom shoes when using it as a device for a physiotherapy driven intervention in patients suffering from LBP.

H04: The MBT shoe is not a valid device to be used in patients with LBP.

Confirming or abolishing these hypotheses is of clinical relevance for health care workers as this product has been an issue of controversial discussions since its release in 1996 and has increasingly attracted attention in the past few years. The hypotheses of this systematic review are resolved by meta-analyzing publications that include the MBT shoe in at least one of the study groups. Any aspect of walking had to be investigated.

METHODS

Search strategy
A research question was formulated using the PICOT strategy: Does literature show any evidence for the hypothesis that there is a significant difference between using ordinary flat bottom shoes and MBT shoes in patients with ankle instability and chronic LBP while walking? A search for relevant studies was performed in four

Figure 1: Masai Barefoot Technology® (MBT) shoe with its curved and unstable sole construction
databases: PubMed, Google Scholar, PEDro and PiCarta. Uniformly all databases were checked for keywords as well as combinations of keywords. Additionally, abstracts of international studies and full versions of an assortment of articles relevant to our topic were allocated from the MBT academy. Articles were relevant to our review when a topic related content was detected in the title or the abstract. Furthermore, all reference lists were scanned for additional studies. A MeSH search in PubMed did not create new outcomes. As a result, 59 articles were found to be related to our topic.

SEARCH CRITERIA

Articles qualified to be relevant to our study when they included the following criteria: the MBT shoe had to be used in at least one of the study groups and any aspect of walking had to be analyzed. Those articles that contained these two criteria were further examined for these items: is there a control group included in the study, does the sample size in the trial and the control group feature at least ten participants, have the methods been applied coherently and are the hypotheses clearly stated. Furthermore, abstract, introduction, methods, results, discussion (conclusion) and references had to be present.

QUALITY CONTROL

All articles that fulfilled these requirements were graded (Table 1) for their quality by all researchers using the grading list attached as appendix 1 which includes aspects of the PEDro scale combined with added specified criteria. Articles had to reach a minimum score of 70 out of 100 to be included into this review in order to satisfy an acceptable quality level. In all studies participants as well as therapists and analyzers were not blinded to the intervention and the purpose of the study. Care had to be taken in case the author/s is/are closely related to the product company or does/do have any commercial interest.

RESULTS

A PubMed search using the following keywords: “masai, barefoot” yielded 11 peer-reviewed publications dealing with MBT shoes. An additional paper addressing LBP was found using “unstable” and “low back pain” as key words. All of these papers qualified for our objectives and have been included in our analysis. The articles meeting the inclusion criteria have been rated 77.47 ± 5.67 (average ± SD) (Table 1). Most of them addressed the ankle or foot instability, two (Romkes et al. 2006, Landry et al. 2010) of them also gave some information about the effect on LBP and only one mainly addressed LBP. In order to cover the LBP topic more widely two academic papers (Riepl 2010, Stegen 2002) have been included additionally into the analysis.

In order to get a survey of the articles the content of each paper was categorized and tabulated (Appendix 2). Articles dealing with foot/leg instability were separated from those addressing the trunk or spine.

EXCLUDED ARTICLES

Our initial search generated 59 articles, which all included topics of relevance to our research. Although all the material acquired has been of value and usefulness in gaining knowledge for the kinetic and anatomical understanding of the effects wearing the MBT shoe has on LBP as well as on ankle instability, we ended up with 15 articles that fulfilled all the criteria predefined for our research. All articles that did not include the MBT shoe but another rocker bottom shoe were excluded.

Table 1: Grading outcome of used article

<table>
<thead>
<tr>
<th>Article</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyer et al. 2009</td>
<td>76 = B-</td>
</tr>
<tr>
<td>Buchecker et al. 2010</td>
<td>72 = C</td>
</tr>
<tr>
<td>Kälin et al. 2007</td>
<td>80 = B</td>
</tr>
<tr>
<td>Landry et al. 2010</td>
<td>84 = B</td>
</tr>
<tr>
<td>Nigg et al. 2005</td>
<td>70 = C</td>
</tr>
<tr>
<td>Nigg et al. 2006</td>
<td>84 = B</td>
</tr>
<tr>
<td>Nigg et al. 2009</td>
<td>74 = C</td>
</tr>
<tr>
<td>Nigg et al. 2010</td>
<td>78 = B-</td>
</tr>
<tr>
<td>Ramstrand et al. 2008</td>
<td>79 = C+</td>
</tr>
<tr>
<td>Ramstrand et al. 2010</td>
<td>82 = B</td>
</tr>
<tr>
<td>Riepl 2010</td>
<td>87 = B+</td>
</tr>
<tr>
<td>Romkes et al. 2006</td>
<td>74 = C+</td>
</tr>
<tr>
<td>Stegen 2002</td>
<td>70 = C</td>
</tr>
<tr>
<td>Stewart et al. 2007</td>
<td>70 = C</td>
</tr>
<tr>
<td>Stöggl et al. 2010</td>
<td>82 = B</td>
</tr>
</tbody>
</table>

MBT SHOE AND FOOT/ANKLE INSTABILITY

There are 12 papers dealing with gait, where the intrinsic instability introduced by the MBT shoe was compared to a control group or a pre-training effect was compared to a post-training effect. Most papers report about tests that are performed under static and dynamic conditions, i.e. walking or running. Static testing means that the balance is tested when the subject is challenged by an external perturbation or when it is taken out of support.

The content of the papers was grouped into the following categories:
The study design in five papers was a pre- vs. post-training comparison, whereas in seven papers the data of the intervention group were compared to a control group (treated parallel). There has not been an independent control group in 8 out of 12 studies.

The number of hypotheses to be answered by the study varied from 1 to up to 6. The hypotheses in the pre-/post investigations questioned whether there is a therapeutic effect on instability, kinematic or kinetic data or balance after a predefined training interval using the MBT shoe. The length of the time interval from pre- to post-measurements varied from 2 to 12 weeks.

The size of the sample groups varied between 8 and 30 persons, except one study which included 57 subjects (Nigg et al. 2006).

The methods that were applied are:
- Gait analysis with/without force platform on runway or treadmill
- EMG (skin-mounted electrodes in all cases)
- Force platform
- Pressure distribution measurement (insole sensor)

Gait analysis was carried out using modern digital motion analysis systems equipped with 6 to 8 cameras. It gave access to a number of kinetic and kinematic parameters such as joint angles, walking speed, cadence, stride length, step length, joint moments and range of joint movement.

The EMG activity level and activity pattern was used to measure contraction and co-contraction of agonist and antagonist muscle groups and also to quantify joint load. Higher activity levels in co-contraction are interpreted as a stabilizing effect.

The force platform was mainly used to measure the excursion of the centre of pressure (COP) in balance testing and for 3D-force measurements of the ground reaction force during gait analysis. In two studies (Ramstrand et al. 2008, Ramstrand et al. 2010) the Pro Balance Master was used for balance testing.

Two studies (Landry et al. 2010, Stöggl et al. 2010) were performed using an insole pressure sensitive foil with 99 sensors distributed under the foot that is capable of showing the dynamic pressure distribution and the track of the resulting force during stance and walking.

Data analysis included filtering of EMG signals and statistical tests for normal distribution of data for interval- and nominal-scaled variables. For some variables the averaged result of up to ten trials was used. For interval-scaled variables Student’s T-test and/or ANOVA (Analysis of Variance) were mainly used to test for significant differences, for nominal-scaled variables Mann-Whitney U Test or Wilcoxon Test were applied.

Kinematics

All investigators performing gait analysis observed a greater dorsiflexion of the ankle from heel strike during the first half of the stance phase for individuals walking with the MBT shoe. This led to an increased tension in the Achilles tendon and triceps surae muscles. The second half of the stance phase did not show significant alterations for the ankle compared to the flat bottom shoe gait. At the knee and hip level extension and flexion angles were slightly reduced and the anterior tilt of the pelvis was also reduced. No significant differences could be seen in the frontal and transverse plane.

Kinetics

Persons wearing the MBT shoe had a decrease in walking and running speed, cadence, step length and stride length. But they also demonstrated a higher variability in kinetic parameters walking with the MBT shoe for the first time. In running the first force peak on heel strike was lower compared to normal shoes. In all investigations the moments at the ankle were decreased whereas the results for the knee were not consistent: both a “no change” and a decrease were observed.

The pressure distribution showed a pressure decrease in the hind- and midfoot, but an increase in the forefoot. Thus, an anterior shift of plantar pressure could be demonstrated.

EMG

The activity of the musculus (m.) tibialis anterior (tib. ant.) and mm. gastrocnemii increased in the second half (m. tib. ant.) or in the first half of the gait cycle. There was a co-activation of these antagonists before heel-strike. Overall, the activity level of all muscles of the shank was higher when persons wore the MBT shoe (Table 2), a higher activity level could also be demonstrated for the m. vastus medialis (med.) and lateralis (lat.).
Balance
Balance performance was quantified using the excursions of the center of pressure (COP). The COP excursions were consistently greater for the MBT shoe than for the flat bottom shoe. Females showed higher excursions than males. In children a learning effect for reactive balance was found. Persons being tested for balance before and after the MBT training period also showed such a learning effect achieving a better balance performance after having been trained (Table 3). One has to say that balance performance did also improve with normal shoes after the training period so no significant difference between MBT and normal shoe could be demonstrated.

Table 2: EMG measurement outcomes

<table>
<thead>
<tr>
<th>Study</th>
<th>Muscle Action</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buchecker et al. 2010</td>
<td>gastrocnemius medialis ↑, vastus lateralis ↑, biceps femoris: no change</td>
<td></td>
</tr>
<tr>
<td>Landry et al. 2010</td>
<td>tibialis anterior ↑, flexor digitorum longus ↑, peroneus longus ↑, soleus: no change</td>
<td></td>
</tr>
<tr>
<td>Nigg et al. 2005</td>
<td>tibialis anterior ↑, gastrocnemius medialis ↑, vastus medialis ↑, biceps femoris ↑</td>
<td></td>
</tr>
<tr>
<td>Romkes et al. 2006</td>
<td>tibialis anterior ↑, gastrocnemius medialis &amp; lateralis ↑, vastus medialis &amp; lateralis ↑, semitendinosus: no change</td>
<td></td>
</tr>
<tr>
<td>Stöggl et al. 2010</td>
<td>tibialis anterior ↑, gastrocnemius medialis ↑, vastus medialis ↑, biceps femoris ↑, peroneus longus ↑</td>
<td></td>
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</tbody>
</table>

Pain
One investigator addressed pain in patients with osteoarthritic knees (Nigg et al. 2006). He could demonstrate that by using the MBT shoe the pain score was reduced for an intermediate time interval for walking and rest and that the patients developed a better static balance. But at the end of the therapy there was no difference to the conventionally treated group. A recommendation was made based on the study of Romkes et al. (2006) that patients suffering from knee problems might experience more pain because of a potentially higher load for the knee (knee moment, increased activity of m. vastus med. and lat.).

Muscle force
Corresponding to the higher EMG activity levels a strengthening of the muscle of the shank namely the m. tib. ant., m. peroneus longus and brevis, m. gastrocnemius med. and lat. could be observed when testing their corresponding moments. Co-activation of extensors and flexors was also an indicator that both muscle groups are strengthened to compensate for the inherent higher instability with the MBT shoe. The anterior shift of load or pressure respectively led to a higher plantar flexion moment of the toes namely the m. flexor hallucis longus was strengthened. The cross sections of the muscles of the shank increased after the MBT training period.

Table 3: Centre of pressure (COP) measurement outcomes; anterior-posterior (a-p) and medial-lateral (m-l) excursion

<table>
<thead>
<tr>
<th>Study</th>
<th>Movement</th>
<th>Measurement outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landry et al. 2010</td>
<td>a-p: greater excursions pre and post training; significant decrease after training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m-l: greater excursions pre and post training; significant decrease after training</td>
<td></td>
</tr>
<tr>
<td>Nigg et al. 2005</td>
<td>Speculation: MBT can be used as a training device for stability and proprioception</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female COP excursion higher in anterior-posterior (significant) and medial-lateral (not significant) direction then in men</td>
<td></td>
</tr>
<tr>
<td>Nigg et al. 2010</td>
<td>Speculation: females less stable in anterior-posterior direction</td>
<td></td>
</tr>
<tr>
<td>Ramstrand et al. 2010</td>
<td>Improvement in balance performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speculation: MBT may be used as a training tool to improve balance</td>
<td></td>
</tr>
<tr>
<td>Stöggl et al. 2010</td>
<td>a-p: no difference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m-l: greater excursions (significant)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speculation: MBT might be used as a training shoe in standing and walking</td>
<td></td>
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</table>

MBT shoe and lower back pain
Only three papers addressed the effect of walking with the MBT shoe on lower back pain (Stegen 2002, Nigg et al. 2009, Riepl 2010). One paper mainly dealing with instability also provided some information on trunk control when testing balance (Landry et al. 2010).

Postural sway
The postural sway showed greater excursions for individuals wearing the MBT shoe. These excursions could be significantly reduced due to a training therapy but they were still greater than with flat bottom shoes. The balance could be improved in the MBT group whereas in the control group no change was seen. Experienced golf players did not show the same training effect on balance after a six-week training period with MBT sandals (Nigg et al. 2009).
Lower back pain
The golfers reported a continuous decrease of low back pain when wearing the MBT shoe during the game (Nigg et al. 2009). Neither was the golf performance altered by the potential instability of the MBT shoe nor was the balance performance changed. A reduction of LBP occurred both in the MBT group and in the control group when they received standard physiotherapy without any statistical difference (hence not attributable to MBT shoe).

The SF-36 form revealed significant improvements for the MBT group after an 8-week training which was not seen in the control group, both getting the same type of physiotherapy. The same result was observed for the functional capacity of the lower back (Stegen 2002).

Muscle force
After the training period the muscle force of the erector trunci and abdominal muscles improved for males in both the MBT- and the control group, whereas for females only the muscle force of the MBT group improved. The best effect was seen for the erector trunci muscles (Riepl 2010).

DISCUSSION

There is a common agreement in several papers that the MBT shoe does have significant effects: the muscle activity of the lower leg is increased during the stance phase and while walking, the dorsiflexion at heel strike and during the first half of the stance phase is increased and the pressure distribution shows a shift from the hindfoot to the forefoot (Appendix 2). All these effects hold the inherent potential that the MBT shoe can be used as a tool for and during physiotherapeutic training or treatment.

The ankle joint - EMG outcomes
All the EMG measurements show similar results (Table 2): an increase in the activation pattern when the patient is walking with the MBT shoe compared to walking with the ordinary flat bottom shoe (“control shoe”).

In four out of five articles (Nigg et al. 2005, Romkes et al. 2006, Käling et al. 2007, Landry et al. 2010, Stöggle et al. 2010) the EMG is used to measure the activity level of the muscles of the leg. The EMG results not only demonstrate higher activity levels while walking with the MBT shoe but also while standing. Thus, the inter- and intramuscular coordination of these muscles are trained. The MBT shoe can therefore be used to increase the active stabilization of the ankle to compensate for the loss of passive, ligamentous stabilization in case of ruptured ligaments after an ankle sprain. Continuous wear of the MBT shoe after the physiotherapy period leads to a significantly higher maximum strength of the peroneal muscles and the triceps surae muscle (Käling et al. 2007, Landry et al. 2010). Furthermore, the smaller extrinsic foot muscles are strengthened which may be beneficial from a biomechanical point of view because their geometrical position develops larger lever arms for a better control of the subtalar joint (Landry et al. 2010). A conceptual model suggests that these muscles sense changes in position of the subtalar joint axis “faster” than the larger extrinsic foot muscles (e.g. triceps surae with the Achilles tendon) and by reacting earlier, these muscles may maintain the balance more effectively and with less force.

People having no prior MBT experience show a higher variability in the majority of the kinetic and kinematic variables initially, but only on a low, non-significant level and only for the time of the training period. After the training period these individuals adapt to the instability. This demonstrates the potentially inherent training effect of the MBT shoe in individuals with good proprioception (Stöggle et al. 2010).

Center Of Pressure outcomes and kinematics
Nigg et al. (2005), Kälín et al. (2007) and Landry et al. (2010), show that the COP excursion in the anterior-posterior and medial-lateral direction is significantly greater for the unstable MBT shoe compared to the control shoe or a barefoot condition. There is a decrease in running and walking speed, cadence, step length and stride length and a higher variability in kinetic parameters when wearing the MBT shoe for the first time (Romkes et al. 2006, Stewart et al. 2007). In running the first force peak on heel strike is lower compared to normal shoes. In all investigations the moments at the ankle decrease, whereas results for the knee are not consistent: both a “no change” and a decrease have been observed. The pressure distribution shows a pressure decrease in the hind- and midfoot, but an increase in the forefoot. An anterior shift of the plantar pressure can be shown (Nigg et al. 2005, Romkes et al. 2006, Stewart et al. 2007, Nigg et al. 2010).

Measurements during a static balance test demonstrate greater pressure excursions with the MBT shoe compared to the control shoe (Nigg et al. 2006). This result matches the muscle activity measurements using the EMG when testing stability. It also indicates that the MBT shoe can be used as a training tool to improve stability control while standing and walking in order to make the individuals walk and stand safer and to lower the risk of falling (Appendix 2).

Can the MBT shoe be beneficial for ankle instability?
The MBT shoe is considered to have the potential to replace the wobble board in stability training. It is conceptually similar to wobble board training in injury rehabilitation (Waddington et al. 2004, Landry et al. 2010). The MBT shoe
offers the advantage that one can generate the same training effects while walking, avoiding the static 15 min exercise program being executed on a wobble board. Patients would train while performing activities of daily living, which would enhance the training effect. (Landry et al. 2010). The MBT shoe would be more beneficial since it can train multiple areas at the same time. Additionally, proprioception will be trained during the performance of other exercises in order to keep the body straight (Woollacott et al. 2002).

The MBT shoe shows significant changes while walking compared to ordinary flat bottom shoes when using it as a device for patients suffering from ankle instability as a physiotherapy driven intervention. Therefore, H_01 could be disproved. Due to the changes in COP and in kinematics the MBT can be used as a training method to strengthen the leg muscles (Romkes et al. 2006).

Consequently we can refuse Null-Hypothesis 2 (H_02). Evidence has shown that the MBT shoe is a valid device for patients suffering from chronic ankle instabilities as it strengthens the smaller extrinsic muscles of the ankle joint (Appendix 2). As it increases the muscle activity of selected smaller intrinsic muscles, some of the smaller extrinsic foot muscles are activated, too, whereas these muscles remain less active when wearing a more stable shoe (Landry et al 2010).

**MBT and ROM – benefits and drawbacks**

A decreased ROM may be the cause for over-use injuries in patients being active in sports. An example of an overuse injury is a stiff Achilles tendon (e.g. due to old scar tissue). By using the MBT shoe the Achilles tendon is slightly tensioned because of the greater dorsiflexion angle at heel strike which is maintained through mid-stance (Boyer et al. 2009, Landry et al. 2010, Stöggle et al. 2010). The MBT shoe has been proven to be beneficial in patients suffering from plantar fasciitis due to a relieve of pressure in the midfoot and the longitudinal arch when wearing it (Stewart et al. 2007). A question of interest for future investigations would be whether the MBT shoe is capable of reducing the rate of overuse injuries or even of preventing them.

**Lower back pain and MBT**

According to Landry et al. (2010) a conceptual model suggests that the muscles crossing two joints have an advantageous geometrical position with large lever arms leaving muscles such as the extensor muscles of the lower back (Riepl 2010) to work when wearing the MBT. These muscles sense changes in position in the sacroiliac (SI) and lumbar joint «faster» than the flexor muscles. By reacting sooner these muscles maintain and stabilize the lumbar spine more effectively with less force (Landry et al. 2010, Riepl 2010). LBP can be caused by an imbalance of muscle activity when extensor muscles are weaker than flexor muscles. LBP often arises from weakened extensor muscles of the back and weakened abdominal muscles. Therefore, there is a potential chance that strengthening the back extensors by walking with the MBT shoe will have a beneficial effect on LBP (Stewart et al. 2007, Riepl 2010).

Additionally, one would expect that the load on the spine is distributed more evenly resulting in less pressure on the SI joint and the lumbar segments since the individual is standing more upright and is maintaining this posture better when wearing the MBT shoe (MBT 2010). The question still remains if the posture is modified by solely wearing this shoe. Further studies measuring changes in pelvic and spinal angles when wearing the MBT shoe compared to wearing a conventional shoe are needed to answer this question.

One would assume that individuals demonstrate more physical activity and alterations of their posture when wearing the MBT shoe as it provokes a continuous stabilization and avoidance of remaining in the same position for long periods. Although these balancing movements are small, proprioception would constantly have to stay active. The question is whether there is a learning effect insofar that trained people can minimize these balancing movements in order to reduce the loading of the lumbar spine. No study was found to confirm this theory although the MBT academy does claim this.

Supporting H_03 the MBT shoe indicates no significant differences while walking compared to conventional flat bottom shoes when using them as a device in patients suffering from LBP as a physiotherapy driven intervention. This hypothesis cannot be disproven due to a lack of scientific relevant data and the lack of articles with exact measurement outcomes. There are theories stating that the MBT shoe does indeed provoke changes in the walking pattern of LBP patients. But this cannot be confirmed by this systematic review since no evidence to support this assumption could be found in the literature (Appendix 2).

**Effectiveness of logbooks and training diaries for lower back pain**

Stegen et al. (2002) and Nigg et al. (2009) both state that wearing the MBT shoe over a certain period of time helps the patient to suffer less pain or even to get rid of back pain several days after starting to wear it (logbooks). The main purpose of these diaries has been to document that the MBT shoe was regularly used for walking regarding duration, activity, (standing, walking, sitting) sensation and pain. As diaries are personal recordings these results are of
limited objective value. Hence, one can question the validity of their outcomes. There was no physical data being recorded in both of these studies although both articles state that there is a significant difference in the perceived LBP between the control and the MBT groups when comparing pre and post intervention measurements using the Visual Analogue Scale (VAS) and the functional questionnaire Hannover Back. As the MBT shoe has been on the market for several years and has become a product of the media, it could be that the volunteers in both of these studies have been able to get information about the possible therapeutic benefits via the Internet or by acquaintances leading to a possible placebo effect. Therefore, a potential bias remains that could interfere with the given results.

This leads us to hypothesis H2a: Our conclusion is that the MBT shoe is not a valid device for patients with LBP. Although conducted studies claim that there is validity we cannot support this with our systematic review due to the lack of well designed studies and subjective opinions of individuals attending the investigations.

Conclusion
The MBT shoe activates lower leg muscles, it facilitates a greater range of ankle dorsiflexion and stimulates patients in improving their balance while standing and walking. There is evidence that it can be used as a training device in physiotherapy for these purposes. Up to now there is little or no evidence that wearing the MBT shoe helps to reduce lower back pain.

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