Comparison of oxygen consumption while walking on treadmill wearing MBT Shoes versus Orthopedic Shoes – A treatise on shoe mass.

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Abstract

Purpose: The purpose of this study was to investigate if there was any difference in energy expenditure (kcal/min) and oxygen consumption ($\dot{V}O_2$) between subjects walking with Masai Barefoot Technology ® (MBT) shoes and regular orthopedic shoes. The research hypothesis was that MBT shoes demand more energy expenditure than regular orthopedic shoes. **Methods**: Seven women aged 49-65 were recruited for the study. The subjects were tested in two sessions, with a minimum of two weeks in between each sesssion. On each test session the subjects walked with both MBT shoes and orthopedic shoes which were adjusted in mass (g) to match the mass of the MBT shoes. While the subjects walked on a treadmill, the oxygen consumption ($\dot{V}O_2$), heart rate (min^{-1}) and self selected velocity (m/s) for each of the shoe types was measured. **Results**: Results showed that there is no significant difference in oxygen consumption ($\dot{V}O_2$) between the MBT and orthopedic shoes. Energy expenditure (kcal/min) was also calculated from the data and the results revealed that there is no significant difference between MBT and orthopedic shoes in energy expenditure (kcal/min) either. The self selected velocity (m/s) between the two shoe types was also found to be insignificant. **Conclusion**: The results showed no significant difference between the shoes. This could indicate that the specific construction of the MBT shoe has no effect on the energy expenditure (kcal/min) of its user. This lack of difference may be due to the equal mass of the shoes, but since oxygen consumption ($\dot{V}O_2$) was not investigated in orthopedic shoes with different shoe masses, this conclusion cannot be confirmed. The self selected velocity (m/s) was found to be insignificant and this finding could suggest to that prolonged usage of the MBT shoe may diminish gait parameters dissimilarities during ambulation. This study should therefore be seen as a pilot study and further investigation in this area should be pursued.

Keywords: Ambulation, Caloric expenditure, Oxygen uptake, Unstable shoe, Treadmill walking, Energy expenditure, Oxygen consumption, Self selected velocity, Masai Barefoot Technology, Orthopedic shoes.

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Introduction

Activity

It is well known that walking is the most common form of exercise and essential for a person's well-being. Human beings do not only ambulate to propel themselves for transportation from one place to another, but they use ambulation in a variety sports forms as well. Inactivity during adulthood can have a significant influence on the physical condition of people over 50 years and reduced activity during adulthood can have an impact on the likelihood of suffering from cardiovascular disease in the future (Franco *et al*., 2005). Furthermore, it is a known fact that being physically active has a positive effect on muscle strength, joint and bone health also that weight-bearing activities are essential for normal skeletal development and maintenance. Among the benefits of being physically active are the apparent positive effects on the bone density of postmenopausal women, which decreases the risk of developing osteoporosis (Nguyen, Sambrook, & Eisman, 1998; Oyster, Morton, & Linnell, 1984).

Nguyen, Center, and Eisman (2000) have suggested that maintaining an active lifestyle in late adulthood can restrain the advancement of osteoporosis. In addition, several studies have pointed out that any form of physical activity has anti depressive affects among adults (Martinsen, 1990; Teychenne, Ball, & Salmon, 2008), and that regular physical activity interventions also appear to enhance feelings of well-being.

Regular physical activity is also associated with lower mortality rates. Richardson, Kriska, Lantz, and Hayward (2004) conducted a prospective cohort study to investigate how a sedentary lifestyle would affect mortality in cardiovascular diseases. 9,824 adults in the age range of 51-62 represented the entire cohort. The data collected were, degree of activity level and health status. Findings indicated that the risk of mortality was highest among those with a sedentary lifestyle. Therefore the need to increase the physical activity is important for this high risk group, the authors highlight the group which is at greatest risk of cardiovascular disease would benefit the most from being more physically active, which will decrease their mortality rates. They also suggest that this matter should be a public health priority in order to decrease the mortality rate.

Pereira *et al.* (1998) suggested that an activity intervention during adulthood, such as walking, can be seen as a permanent lifestyle change. A sudden increase in activity can have positive effects on activity levels decades later in life and in that way have long term health benefits.

Activity is therefore not seen as the need to stay fit and prevent obesity, but rather can be seen as life prolonging and beneficial for reducing onset of a range of diseases.

If it can be demonstrated in this study that the Masai Barefoot Technology ® (MBT) shoe increases energy expenditure during walking, this might have implications for the shoe can being recommended as a training device for individuals who want to stay physically active.

Introduction to the MBT shoe

Masai Barefoot Technology ® (MBT) shoes have become very popular over the last couple of years. The footwear is designed to be unstable during gait and is claimed to stimulate and exercise the body in a variety of ways. The manufacturers of this footwear claim on their homepage that there are many benefits associated with using their shoe. Such benefits include the activation of neglected muscles, improved gait, posture and toning the body. Additionally, the shoe has been claimed to help with joint, muscle and ligament injuries as well as providing relief for back and lower limb problems (MBT Shoes - Home of the Anti shoe 2009).

The underlying construction of the MBT shoe is that the shoe has a rounded soft sole which provides a rocker bottom effect. The support base, which exists in normal footwear, is subsequently diminished and this makes the walking base unstable. The theory behind the shoes construction is that the surrounding lower extremity muscles have to contract more frequently and therefore the shoe is claimed to be an ideal training device for the lower extremity muscles (Nigg, Emery, & Hiemstra, 2006; Nigg, Hintzen, & Ferber, 2006).

Figure 1 *Shoe construction*

Figure 1. Picture reprinted with permission from the Masai company. The figure represents the material components in the MBT shoe

The construction of the MBT shoe is represented in (Figure 1). According to the manufactures specifications the shank is constructed of firm thermoplastic polyurethane (TPU) combined with glass fiber.Underneath this is the midsole which is made of polyurethane (PU) and has a pivot point underneath the metatarsal heads. The elliptical part underneath the heel region is called the Masai sensor. The manufacturers do not disclose what material the sensor is made of but claim that the Masai sensor is one of the reasons for the unique physiological advantages during locomotion. (MBT Shoes - Home of the Anti shoe 2009). The reasons for purchasing the MBT shoes can be numerous, due to individual expectations of the product.

Goal of the study

The main goal of this study is to investigate the energy expenditure (kcal/min) and oxygen consumption ($\dot{V}O_2$) of normal walking on a treadmill with the MBT shoes compared to orthopedic shoes in middle aged women.

The research hypothesis (H_1) is that subjects walking with the MBT shoes will demonstrate a higher oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) compared to walking the orthopedic shoes. The alternative hypothesis (H_0) is that there will not be a difference in oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) during walking between the shoes.

Previous studies

It is documented that the use of the MBT shoe alters the kinematic and kinetics parameters of gait and as well as the muscular activity of the lower extremities calf muscles (Nigg, Hintzen, & Ferber, 2006; Romkes, Rudman, & Brunner, 2006). Nigg, Emery, and Hiemstra, (2006) demonstrated that the MBT shoe has a significant influence on static balance in patients with osteoarthritis, this was shown in a series of tests involving one legged balancing test over a 12 week period. These claims are supported to some degree by the work of Ramstrand, Andersson, and Rusaw, (2008) who suggest that the MBT shoe can have some effects on the reactive/dynamic balance in children with balance deficits. Other findings show that the MBT shoe can have an impact on pain reduction (Nigg, Emery, & Hiemstra, 2006).

The MBT shoes were found to shift the plantar pressure distribution under the foot while walking when compared to regular shoes. According to the research the MBT shoe decreases the peak pressure in the mid and hind foot while increasing the peak pressure under the toes by 78 % during walking (Stewart, Gibson, & Thomson, 2007). Some different results were found in the work of Maetzler, Bochdansky, and Abboud (2008) who demonstrated that use of the MBT shoe resulted in significantly higher peak pressures in the midfoot at times.

Nigg, Ferber, and Gormley (2004) investigated oxygen consumption ($\dot{V}O_2$)in the MBT shoe compared with regular training shoes. Eight subjects, five male and three female, with a mean age of 28($\pm$3.6) years with no prior experience in wearing MBT shoes participated in this study. Two test sessions were conducted, one at the onset of the study and the second session two weeks after wearing the MBT footwear throughout this time period. During testing, all participants walked on a treadmill. An initial warm up period of five to ten minutes allowed them to reach the testing velocity of 83,33 meters per minute and this velocity was kept constant for both types of footwear. The testing period consisted of four, five minutes walking trials, in each of which the subjects had three minute resting period to change footwear. They investigated oxygen consumption ($\dot{V}O_2$) expressed in ΔL/kg/min and heart rate (min^1) expressed as one heartbeat per minute to evaluate if there was any difference across the shoe types. Additionally, energy expenditure (kcal/min) was calculated by recording the Respiratory Exchange Ratio (RER) multiplied by ($\dot{V}O_2$) per minute of walking obtained from the metabolic system. The energy expenditure was reported in terms of caloric expenditure and the findings revealed that the subjects had an increased oxygen consumption ($\dot{V}O_2$) of 2.5 % when fitted with the MBT shoe. Nigg *et al*. (2004) state that these values were significant but no *p*-values are presented in the text and no change was found in the heart rate values. The researchers report that the difference found between the shoes cannot be explained by an increase in muscular activity, since these were found to be insignificant between the footwear during walking.

The study is limited by the fact that the investigators did not use considerable time for passive resting between the trials and this could have caused an elevation in the aerobic metabolism (McArdle, Katch, F., & Katch, V., 2001). Furthermore, the distribution of gender in the sample size could have had an impact as well. One study has reported significantly lower oxygen consumption ($\dot{V}O_2$) for women when compared to men $p<0.01$ (Booyens & Keatinge, 1957), whereas as other studies conclude that there is no difference between the two gender groups regarding oxygen consumption ($\dot{V}O_2$) (Waters, Lundford, Perry, & Byrd, 1988).
Even if there is diversity in the literature about gender differences and oxygen consumption ($\dot{V}O_2$), the two gender groups should not be merged together when a relatively small sample size is used, as is the case in that study.

Another limitation of the study by Nigg *et al*. (2004) is the velocity that was chosen for the testing procedure. The choice of a velocity of 83,33 meters per minute is a good replica of normal walking speed (Perry,1992), however self selected walking velocities are found to be significantly different between gender groups and significantly higher walking velocities are found among men (Waters *et al*., 1988). Given that there is an almost linear correlation between oxygen consumption and walking speeds in the range of 40 meters/min to 100 meters/min (Perry, 1992; Waters & Mulroy, 1999; Waters *et al*., 1988), this could be a factor which could have influenced the results found in the study by Nigg *et al*. (2004). A study by Romkes *et al*. (2006) found significant differences in temporospatial parameters when comparing the MBT with regular shoes. In the study subjects walking with the MBT were found to have a significantly lower cadence, stride length and velocity ($p<0.05$). Several studies have investigated the influence of cadence and stride length on energy expenditure (kcal/min) during walking when using a predetermined velocity compared to the subjects' self-selected velocity with preferred cadences and stride lengths (Holt, Hamill, & Andres,1991;Holt, Jeng, Ratcliffe,& Hamill, 1995; Hreljac & Martin, 1993; Zarrugh & Radcliffe, 1978;). Zarrugh and Radcliffe (1978) concluded that a freely chosen cadence and velocity requires less oxygen consumption ($\dot{V}O_2$) when compared to a forced/predetermined cadence and velocity. These findings are well supported by the work of Hreljac and Martin (1993). It should be noted that the higher oxygen consumption ($\dot{V}O_2$) reported in the MBT group by Nigg *et al*. (2004) could be explained by forcing the subjects to walk at a predetermined cadence rather than allowing them to select their comfortable cadence.

A further limitation of the Nigg *et al*. (2004) study is that the mass of the shoes was considerably different. The MBT shoes were heavier in mass compared to the training shoes and a difference of 292 grams could have influenced the cardio and pulmonary variables. Two studies have demonstrated that considerably more energy is required when walking with mass added to either the footwear or at the ankle (Jones, Toner, Daniels, & Knapnik, 1984; Miller & Stamford, 1987). Jones, Toner, Daniels, and Knapnik (1984) concluded that oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) increased significantly when "adding" additional mass to footwear. Oxygen consumption ($\dot{V}O_2$) increased by an average of 8 % when the boots' (average mass 1776 grams) and normal shoes' (average mass 616 grams) were compared with each other using different walking velocities . Similar findings were presented by Miller and Stamford (1987) who concluded that adding mass to the ankle can increase the oxygen consumption by an average of 0.8% when 100 grams of mass is added. Hardin, Van Den Bogert, and Hamill (2004) concluded that oxygen consumption increased significantly when soft midsoles were used while running on a variety of treadmill surfaces. In contrast, Frederick, Howley and Powers (1986) showed that softer soled running shoes reduced the oxygen consumption ($\dot{V}O_2$) by 2,4% during running testing.

Treadmill experiments are commonly used by clinicians and researches in laboratory setting to measure oxygen consumption and energy expenditure. Data from these experiments are used to quantify human metabolic expenditure in daily life (Perry, 1992; McArdle *et al*., 2001; Wilmore, & Costill, 1999; Åstrand, Rodahl, Dahl, & Strømme, 2003). Two studies conclude that there is no difference in oxygen consumption when treadmill walking is compared to level floor walking while ambulating at slow and self selected velocities (m/s) (Ralston, 1960; Murray, Spurr, Sepic & Gardner, 1985). Other studies have revealed that there is a significant difference and that lower oxygen consumption and energy expenditure can be observed when walking on a treadmill compared to level ground at comparable speeds (Pearce *et al.*, 1983; Wyndham, Van der Walt, Van Rensburg, Rogers, & Strydom, 1971). In contrast, studies conducted on older and younger population samples found significantly higher oxygen consumption (Parvataneni, Ploeg, Olney, & Brouwer, 2009) and elevated heart rate values during faster treadmill paces (Murray *et al*., 1985). In addition some studies have suggested that treadmill walking might be associated with increased cadence (steps/min) and shorter step length (m) compared to level walking (Alton, Baldey & Morrissey, 1998; Watt *et al.*, 2010). The concluding remark is that there is still diversity in the literature about how accurate treadmills approximate level walking, when it comes to metabolic expenditure and temporospatial parameters.

A variety of methods have been employed by clinicians and researchers to assess human energy expenditure. Energy expenditure can be measured using different approaches including direct or indirect calorimetry. Direct calorimetry is a more complex way of measuring human energy expenditure and requires advanced clinical laboratory settings. Direct calorimetry basically measures heat produced by the body during exercise or resting, these measurements take place in closed environments. Indirect calorimetry is a simpler method of measuring energy expenditure and includes techniques such as open circuit spitometry and closed-circuit spirometry. The most common way is through open circuit spirometry, this approach allows clinicians and researchers more freedom to apply it in a larger variety of clinical settings. There are three common techniques in open circuit spirometry; the portable spirometer allows the clinicians and researchers to investigate under more real life situations because the system collects the inspired and expired metabolic gases into a small portable apparatus (McArdle *et al.*, 2001).

The bag technique, including the Douglas bag method, is the classic approach for measuring metabolic gases and is recognised as being the ‘gold standard’ in the field, but this method is now less used by clinicians than it once was (Åstrand *et al.,* 2003). The bag method consists of a two valve mouth piece, where ambient air is collected through one valve during inhalation and the expired air is passed on through the second valve, where it is stored into a bag. A meter collects a small sample of the expired air for the analysis of oxygen (O_2) and carbon dioxide (CO_2) concentration.

The last technique open circuit spirometry is used to measure oxygen consumption though computerized metabolic measurement systems. This technique allows the clinicians and researchers to simultaneously record cardio and pulmonary variables and has a number of time saving benefits. During metabolic processing, this technique allows for real time graphical visualization of metabolic variables. The basic functions included in the computerized systems are flow and volume measurement calibrations systems for expired and inhaled air, oxygen (O_2) and carbon dioxide (CO_2) gas analyzers, which chemically measure the concentrations of gasses in the expired air. There is a variety of computerized systems available on the market and some systems include instruments such as heart rate and blood pressure monitors. Some systems even have features which can communicate with treadmills and bicycle ergometers to automatically regulate workload intensities, testing duration and velocities (McArdle *et al.,* 2001). These computerized systems have been found to be a reliable method for measuring cardio pulmonary variables (Carter & Jeukendrup, 2002; Rietjens, Kuipers, Kester, & Keizer, 2001).

Methods

Subjects

Seven female test subjects with ages between 49-65 years with a mean age of 59,143(± 5,274) years were identified for the study. Data related to all of the participants is displayed in (Table 1). The mean body weight of subjects was 69,714(±10,436) kg and the mean height was 170,286(±5,057) cm. Two of the seven subjects took cardiovascular medication (SB1 and SB7) and one of the seven subjects took preventive medication for Diabetes Mellitus Type diabetes II (SB4).

Table 1

Subjects data

Subject	Age:	Height (cm):	Body weight (kg):	Medications:
SB1	58	169	92	Metoprolol,Enalapril,Simvastin
SB2	65	173	70	
SB3	57	175	70	
SB4	49	160	60	Metformin
SB5	63	173	64	
SB6	60	173	65	
SB7	62	169	67	Simvastin,Waran, Atacand
Mean(±*SD*)	59,143(±5,274)	170,286(±5,057)	69,714(±10,436)	

Note. Subject=SB; Mean = Mean values; Standard deviations (±*SD*); Height (cm); Bodyweight (kg); Age (years).

Five of the seven subjects were recruited through records available from a previous MBT research study conducted at Jönköping University, Sweden in the Fall 2007. These subjects were invited by the researchers to participate in the current study through an email. Another two subjects volunteered to participate in the current study in response to a poster placed at Team Ortopedteknik AB in Jönköping. The eligibility criteria for participation in the current study was ownership and usage of a pair of MBT shoes for a period of at least 3 months prior to the commencement of the current study. Additionally, the study subjects were required to have a moderately active lifestyle, hereby defined as being physically active for at least two-three times per week while using the MBT shoes as a regular part of their weekly physical activity.

All participants received either verbal or written information about precautions they had to follow prior to the initial test. A reminder email was sent out to all the seven subjects at least four days prior to both test days. The subjects were instructed to not participate in any highly sport or physical activities which might cause exertion prior to the test days and also to not consume a heavy meal at least 3 hours prior to the commencement of testing. Drinking coffee and smoking 2 hours before the test was categorically prohibited as per the guidelines given by (Brauer, Jorfeldt & Pahlm, 2003; Åstrand *et al*., 2003).

The participants were also requested to not change their regular physical and daily lifestyle and were encouraged to walk with their MBT shoes to the greatest extent possible. Tests were performed at the same time of day on both test sessions to mitigate any impact circadian rhythms may have on the test results (Jonson,Westling,White, & Wollmer, 1998).

Ethical considerations

An information sheet/consent document (Appendix 1) was developed by the researchers to describe the testing procedure, present general information about the research and to describe the researchers responsibility regarding confidentiality. All seven subjects were assured of the confidentiality of their personal and result information using codes, and that the coded information could not be traced back to them. The participants were assured and assuaged that they had at any time in the test, the option of terminating the test in the event of physical or psychological discomfort. As the design of the MBT shoes is such that the test subjects may not be stable, the subjects were informed that one of the researchers would be in close proximity of the subjects during the testing in order to deal with balancing or other stability issues.

Testing protocol

The testing took place in the biomechanics laboratory at Jönköping University in Sweden on two different test sessions with a window of at least two weeks in between both. This means that all seven subjects had a window of at least two weeks between their first test day and their second test day. The dual testing was performed on two separate days to ensure that the test results were not only consistent but also to minimise any errors or deviations hence improving data integrity and consistency. This repeat measure design allowed the researchers to determine the reliability of the study and to see if the results were consistent over time (Golafshani, 2003). On both test sessions, the oxygen consumption of all seven subjects was measured while the subjects walked on a Cybex® CX-445T Treadmill for a specified duration, as seen in the results.

The test structure consisted of two trials on each test sessions, where the first trial was performed using shoe type A while the second trial was performed using shoe type B on the first test session. For the first trial of the first test session the shoe type was selected using a draw where all seven subjects were asked to randomly pick one of the two pieces of paper placed in a bowl. One piece of paper had MBT shoe written on it while the other piece of paper had orthopedic shoe. The subjects were not aware of the shoe type they would be wearing for the first trial until they selected one of the two pieces of paper.

After the subjects had found out which shoe type, either A or B, they had selected they performed the first trial using that shoe type and then the second trial was performed wearing the alternate shoe. This random selection of shoes was done only for the first test session.

For the second test the shoe type used for the first and second trials were reversed. The purpose behind this was to eliminate any bias towards a particular shoe type during both tests. Also, this randomization approach allowed for the selection of the footwear type for both the test sessions. Table 2 represents the two possible randomization options of the footwear selection and the order of further testing.

Table 2

Randomization of the footwear types

		OR	
Test session 1			
Trial 1	OS		MBT
Trial 2	MBT		OS
		Min. 2 weeks between	
Test session 2			
Trial 1	OS		OS
Trial 2	MBT		MBT

Note. OS=Orthopedic shoe*;* MBT= Masai Barefoot Technology shoe. The subjects randomly selected OS or MBT shoe to start the first trail on first test session. The order of testing was reversed on the second test session, which occurred at least two weeks after the first test session.

Given that the mass of the shoes can influence energy expenditure (Jones *et al*., 1984; Miller & Stamford, 1987), it is imperative that both shoes under investigation are of similar mass. As the MBT shoes are heavier than the OS shoes, the researchers added mass to the OS shoes using custom flat insoles so the OS shoe mass was similar to that of MBT shoes. At the beginning of each trial the subjects were asked to determine their comfortable walking speed in the selected pair of shoes on the treadmill. Findings by Romkes *et al*. (2006) showed that subjects walking in MBT shoes have a significantly lower walking velocity, shorter cadence and step length compared to walking while wearing regular shoes. Earlier studies on unstable shoe constructions confirm these findings (Attinger, Stacoff, Balmer, Durrer &

Stüssi, 1998). Due to the fact that oxygen cost is correlated with walking speed (Waters & Mulroy, 1999; Waters *et al*., 1988), and that previous studies conducted on cadence and step length show that energy expenditure increases when trying to attain a forced velocity (Holt *et al.,* 1991; Holt *et al.*, 1995;Hreljac & Martin, 1993;Zarrugh & Radcliffe, 1978) the researchers felt that it was crucial to measure the comfortable cadence of all seven subjects with both types of shoes as this would best reflect the daily walking patterns of the subjects.

During test two velocity (m/s) was maintained to the same level as for test one with each of the two shoe conditions. The testing procedure is presented in (Table 3). The execution of the complete testing protocol for both trials took about 30-40 minutes to perform. During the first trial, irrespective of the shoe type selected (OS or MBT) where the selection was with the random selection approach as described in Table 2, the subjects had to lie down in a supine position for six minutes while trying to relax. This phase in the testing process is referred to as the resting phase. It was selected to ensure similar preconditions for each of the trials and to allow the oxygen intake and the aerobic metabolism rate to stabilize (McArdle *et al*., 2001; Åstrand *et al*., 2003). After six minutes of rest the subjects were asked to step on to the treadmill and were instructed to select a comfortable walking speed while the display screen on the treadmill was covered so that the subjects were not able to see the actual velocity they had. This phase lasted three minutes and is referred to in this study as the acceleration phase. The moment the subjects felt that they had found their comfortable walking speed, the speed was written down by the researcher who was standing beside the treadmill during all the testing. The actual testing phase for data collection started at the ninth minute of the testing protocol and, for ease of understanding the terms velocity and speed are used interchangeably in this study. The self selected velocity (m/s) was kept constant for six minutes of testing and the collection of data lasted to the fifteenth minute. A six minute period of data collection was chosen on the basis that 3-6 minutes is accepted as a sufficient amount of time for the heart rate (min^{-1}) and pulmonary parameters to reach steady state/plateau level (Jonson *et al.*, 1998; Perry, 1992; Wilmore & Costill, 1999; Åstrand *et al.*, 2003). After testing, the subject had a cool down period where they could gradually decrease the in speed and had a few minutes to change shoes. The same testing procedure was executed for trial two using the other shoe; the self selected speed being the only variation between the two trials conducted during the same test session.

Table 3

Test procedure

Trial 1 (MBT or OS)[a]	Time
Resting phase	6 minutes
Acceleration phase	3 minutes
Testing phase	6 minutes
Warm down phase[b]	
Total	15 minutes
Trial 2 (MBT or OS)[a]	**Time**
Resting phase	6 minutes
Acceleration phase	3 minutes
Testing phase	6 minutes
Warm down phase[b]	
Total	15 minutes
Total test session	30-40 minutes

Note. OS= Orthopedic shoe; MBT = Masai Barefoot Technology shoe.

[a] Based on a randomization of the shoe type as described in (Table 2).

[b] The subjects were allowed to decrease the self selected velocity (m/s) and change the shoe type.

Heart rate (beats/min) has a linear relationship to oxygen consumption and adapts itself to metabolic task demands (McArdle *et al.,* 2001; Waters & Mulroy, 1999). Given this fact, the researchers recorded the heart rate (beats/min) during the entire procedure using a Polar WearLink ®+ 31 Coded Heart Rate Transmitter placed on the subject's chest as per the manufactures instructions. The Polar WearLink ®+ 31 Coded Heart Rate Transmitter transmitted electrocardiogram (ECG) signals from the heart to the receiver unit connected to the metabolic gas analysis system (Polar - Listen to your body 2009). As signal strength was not ideal between the heart rate monitor and the receiver on the gas cart the researchers also collected the heart rate (min^{-1}) data with a Polar S410™ Heart Rate monitor every thirty seconds. By doing this they could check the accuracy and reliability of the values obtained by the metabolic system. Heart rate values were written down every thirty seconds during the resting and testing period in accordance to (Åstrand *et al*., 2003).

All metabolic gases produced during the testing protocol (Table 4) were obtained with an Oxycon Pro® (Hoechberg, Jaeger, Germany), this cardiac pulmonary device has previously been determined to be a valid measurement system (Carter & Jeukendrup, 2002; Rietjens *et al*., 2001). During testing all subjects were required to breathe though a mask which was placed over their nose and mouth. Metabolic data was collected and averaged in 20 second time intervals. The Oxycon Pro® was calibrated at least forty minutes prior to testing in the morning and in the afternoon to ensure that changes in the room's temperature, humidity and oxygen levels did not affect the results (Akumed, 2009). It is important to note that talking and other noise was kept to a minimal during the entire testing period, so that the data collection would not be affected. Specific variables obtained from Oxycon Pro® during the testing protocol are listed in (Table 4). Pulmonary gas exchange variables were measured using the breath by breath software provided with the Oxycon Pro® machine (Cardinal Health, 2009; Perry, 1992;Waters & Mulroy, 1999; Åstrand *et al*., 2003).

Table 4*:*

Variables obtained from the Oxycon Pro® machine's breath by breath software

Abbreviations:	Specification:	Units:	Description:
HR	Heart rate	[min^{-1}]	Heart Rate is the number of heart beats per minute.
$\dot{V}O_2$	O_2 uptake[a]	[ml/min][a]	The amount of oxygen assimilated in milliliters per time unit during inhalation. O_2 uptake * is usually expressed as (ml x kg^{-1}x min^{-1}) (Waters & Mulroy,1999)
$\dot{V}CO_2$	CO_2 output	[ml/min]	The amount of carbon dioxide production expressed in milliliters per time unit during exhalation. CO_2 output is usually expressed as (ml x kg^{-1}x min^{-1}) (Waters & Mulroy,1999)
RER	Respiratory Exchange Ratio		RER is the ratio of CO_2 in relation to O_2 uptake during aerobic exercise conditions. If the RER ratio is greater than 0.90 this indicates that anaerobic activity occurs during exercise. $RQ=\dot{V}CO_2/\dot{V}O_2$ (Perry, 1992)

Note: [a] O_2 uptake is expressed in ml/min but normalized to the bodyweight by the researchers and stated as the actual oxygen consumption ($\dot{V}O_2$) in this paper.

Data processing

The resting phase was used as a baseline to achieve the same preconditions for each of the subject and for each of the shoe types. The primary goal of this study was to investigate oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) during walking. Therefore, the researchers analyzed data only when the subjects were ambulating on the treadmill. Six minutes of testing was the time range the researchers choose to allow the subjects to achieve steady state conditions during walking (Jonson *et al.,* 1998; Perry, 1992; Wilmore, & Costill, 1999; Åstrand *et al.,* 2003). The researchers choose to look at the following parameters: heart rate (min^{-1}), Respiratory Exchange Ratio (RER), oxygen uptake (normalized to the subjects' bodyweight, $\dot{V}O_2$) and caloric expenditure (kcal/min). Data was analyzed only from the last minute of the testing phase to ensure that steady state conditions were achieved (Itoh, Fukuoka, Endo, & Nishi, 2002; Jones *et al.,* 1984; Waters *et al.,* 1988). The mean values for each of the subjects on each of the variables were inserted into SPSS for further statistical processing.

Caloric expenditure (kcal/min), which is the same as energy expenditure, in this paper was calculated based on respiratory exchange ratios (RER). The subject's four respiratory exchange ratios (RER) were measured and the mean value calculated. Using the data table in accordance with McArdle *et al*. (2001), caloric equivalents expressed in kcal per liter of oxygen, were taken as the mean value. This caloric equivalent value was multiplied with the mean oxygen consumption ($\dot{V}O_2$) in liters per minute from the last minute of the testing phase obtained by Oxycon Pro® in order to get the output expressed in kcal/min (see Equation 1). This method of analysis was performed to allow for a direct comparison of the data to that from Nigg *et al*. (2004).

Equation 1

$$\text{Caloric expenditure (kcal/min)} = \frac{\text{Kcal (RER) equivalent}}{O_2\text{ per liter}} \times \frac{O_2\text{ consumption in liters}}{\text{min}}$$

Note. The equation researchers calculated the caloric expenditure expressed in (kcal/min). The subject's four respiratory exchange ratios (RER) were measured and the mean value calculated. Using the data table in accordance with McArdle et al., (2001), caloric equivalents expressed in kcal per liter of oxygen, was taken for the mean value. This caloric equivalent value was multiplied with the mean oxygen consumption (V O2) in liters per minute from the last minute of the testing phase obtained by Oxycon Pro® in order to get the output expressed in kcal/min.

Analysis of data and statistics

Reliability of the chosen methods was tested by the researchers with comparisons between the footwear and across test sessions.

All statistical tests were performed in SPSS version 16.0. The accepted alpha level for statistical significance was set at $\alpha=0.05$. A Shapiro-Wilk test was conducted to test if the data was normally distributed and a non parametric test (Wilxocon signed rank test) was chosen if normal distribution was not present in all variables. Otherwise a parametric Paired *t* test was chosen.

If no difference was found in shoe type across the test sessions, the data was merged for further analysis of between two shoe types. All data is presented as mean values (Mean) and standard deviations (±*SD*) for each of the tested parameters.

Additionally the researchers conducted a post hoc power analysis on the results to determinate the probability of committing a Type II error.

Results

Mass

Throughout the study the researchers attempted to keep the mass of both brands of shoes similar. A paired *t* test revealed no significant difference in mass in grams (g) between the OS and MBT shoes. The mean difference was recorded as 0,04 (±1,84) grams.

Velocity (m/s)

Table 5 represents the self selected velocity data (m/s) for each of the subjects in each shoe type. The results of a Wilcoxon signed rank test showed no significant difference across the velocities $p=0.398$.

Table 5.

Self-selected velocity data

Subjects	OS velocity (m/s)	MBT velocity (m/s)
SB1	0,75	0,69
SB2	1,06	1,14
SB3	0.86	1,06
SB4	1,11	1,08
SB5	0,72	0,61
SB6	0,81	0,58
SB7	0.97	0,81
Mean(±*SD*)	0,897(±0,152)	0,853(±0,238)

Note. Velocity is expressed as meters per second (m/s); SB=Subject; OS= Orthopedic shoe; MBT= Masai Barefoot Technology shoe; Mean values =Mean; Standard deviations (±*SD*).

Heart rate (min^{-1})

As the researchers were concerned about the reliability of the heart rate (min^{-1}) measurements achieved from the Oxycon Pro®, a paired *t* test was chosen to compare the Oxycon figures with heart rate data that was collected simultaneously from a Polar S410™ Heart Rate monitor. A paired *t* test revealed no significant difference between heart rate (min^{-1}) values between the two systems. The Oxycon Pro® heart rate variables were therefore seen as reliable and were used in all subsequent analyses. Table 6 lists the heart rate (min^{-1}) data in each of the subjects.

A significant difference was noted in the MBT shoe across the two test sessions (p =0.031). The mean heart rate was higher on the first test session 93,18 (± 9,83) min^{-1} compared to the second session 86,54 (±11,78) min^{-1}. However no difference was observed across test session one and two in OS shoe. The results of a paired *t* test showed that there were no difference in heart rate (min^{-1}) between the MBT shoe and OS shoe on session one or two (p>0.05)

Table 6
Oxycon Pro® heart rate variables

Subjects	MBT 1	MBT 2	OS 1	OS 2
SB1	98,25	88,75	92,5	82,25
SB2	99,25	96	103,5	99,75
SB3	79	78	77	76,25
SB4	105,25	106,25	118,50	105
SB5	88,75	72,75	78,75	75
SB6	99,25	86,75	93	89,5
SB7	82,5	77,25	81	78
Mean±(*SD*)	93,18(±9,83)*	86,54(±11,78)*	92,04(±15,04)	86,54(±11,93

Note. Heart rate expressed in heart beats per minute (min^{-1}) for each of the subjects (SB); OS 1= Orthopedic shoe on test session one; OS 2 = Orthopedic shoe on test session two; MBT 1= Masai Barefoot Technology shoe on test session one; MBT 2= Masai Barefoot Technology shoe on test session two; Mean values =Mean; Standard deviation (±*SD*).

*p= 0.031 (i.e., MBT 1 vs. MBT 2)

Oxygen consumption ($\dot{V}O_2$)

Table 7 represents the mean values for oxygen consumption during the last minute of the testing phase in each of the subject. A paired *t* test was conducted and no difference was observed for each of the shoe types when comparing session one and two (p>0.05). Given that no difference was noted across trials, the data was merged for the remainder of the analysis.

A comparison of MBT and OS shoes through a paired *t* test revealed no significant difference in oxygen consumption ($\dot{V}O_2$) (p>0.05). The mean value for MBT session was 12,3(± 3,28) ml/kg/min and 12,75(±4,38) ml/kg/min for the OS shoe.

Table 7

Oxygen consumption ($\dot{V}O_2$)

Subjects	MBT 1	MBT 2	OS 1	OS 2
SB1	8,67	9,16	7,46	8,93
SB2	14,66	12,81	12,96	13,01
SB3	10,55	11,02	10,11	10,04
SB4	20,9	15,67	24,51	18,5
SB5	11,95	8,47	11,15	8,87
SB6	13,86	10,67	14,04	12,49
SB7	12,46	11,37	14,09	12,35
Mean(±*SD*)	13,293(±3,904)	11,310(±2,396)	13,474(±5,411)	12,027(±3,334)
Mean(±*SD*)[a]	12,3(±3,28)		12,75(±4,38)	

Note. The table represents the oxygen consumption ($\dot{V}O_2$) mean values (Mean) from the last minute of the testing phase of each of the subjects (SB) .The $\dot{V}O_2$ values are expressed in ml/kg/min.

[a]Merged data; The oxygen consumption ($\dot{V}O_2$) data for each of the shoe type was merged together, since statistical testing showed no difference across trials p>0.05.

Caloric/energy expenditure

The results of a Wilcoxon signed rank test showed that there was no significant difference in caloric expenditure (kcal/min) when comparing session one to two for each of the shoe types (MBT p=0.18 and OS, p=0.31). The data from OS and MBT shoe was therefore subsequently merged for analyzing the difference between the shoe types. No significant difference was observed between the shoes (p= 0.90). The mean values and standard deviations (*SD*) for the caloric expenditure for the OS shoe was 4,19(±1,07) kcal/min and for the MBT shoe 4.16(±0,77) kcal/min.

Power analysis

A post hoc power analysis was performed to investigate if the sample size was sufficient enough to reveal any differences in the oxygen consumption ($\dot{V}O_2$) and caloric expenditure (kcal/min) as well to examine the risk of committing a Type II error. The power analysis was carried out using following software (Lenth, R. V. (2006-9)). The power analysis was calculated based on the mean values (*Mean*) and standard deviations ($\pm SD$) for caloric expenditure (kcal/min) and oxygen consumption ($\dot{V}O_2$).

The results from the oxygen consumption ($\dot{V}O_2$) revealed a test power of P=0,05. If a power of P=0,80 was desired, this would have meant that a sample size of minimum 1162 subjects would be needed to participate in the study. The results from the caloric expenditure (kcal/min) showed a power of P= 0,050. To achieve a test power of P=0.80 a sample size of 15160 subjects would be required.

Discussion

Findings

The results of this paper did not reveal any significant differences in oxygen consumption ($\dot{V}O_2$) or energy/caloric expenditure (kcal/min) while walking with MBT shoes compared to OS shoes ($p>0.05$). The mean values obtained for oxygen consumption in this study are, however, in accordance with findings in the literature when taking the self selected velocity and the influence of subject age into consideration (Perry, 1992; Waters & Mulroy, 1999;Waters *et al.*, 1988).

The researchers' findings regarding oxygen consumption ($\dot{V}O_2$) and caloric/energy expenditure (kcal/min) of MBT shoes is in opposition to results presented by Nigg *et al*. (2004), which is shown here in (Table 8.) Nigg *et al*. (2004) reported ($\dot{V}O_2$) values of 13.19 L/kg/min for subjects walking in MBT shoes. If the results of the present study are converted to the same units values for the MBT group would be 0.0123L/min/kg. Given that Nigg *et al*.'s (2004) values are so high that the authors of this paper suspect that an error has been made in the units reported and that they are in fact reporting in ml/min/kg. If this is the case, then values from the present study are very close to those reported by Nigg *et al*. (2004). Significant differences were however reported by Nigg *et al*. (2004) but no differences were found in the present study. Potential reasons for this could include the chosen study design, since researchers are not aware of how the statistical processing of data, since the authors do not state the time frame in which the data was analyzed. It is likely that the steady state conditions were not reached if the data was analyzed troughout the five minutes trials of each pair of shoes (Itoh *et al*., 2002; Jones *et al*., 1984; Waters *et al.*, 1988) and that the author's did not allow sufficient time between each of the trials to allow the stabilization of oxygen consumption and aerobic metabolism (McArdle *et al*., 2001;Åstrand *et al*., 2003).

Table 8
Comparison between reviewed literatures

	Current study		Nigg et al. 2004		Romkes et al. 2006	
	MBT	OS	MBT	Control	MBT	Control
Velocity *(m/s)*	0,853(±0,238)	0,897(±0,152)	1,38	1,38	1,28(±0,12)	1,39(±0,15)
Heart rate *(min^{-1})*	*	89,29(±13.35)	93,20(±13,24)	93,60(±12,70)		
Caloric expenditure (*kcal/min)*	4.16(±0,77)	4,19(±1,07)	4,84(±0,06)	4,71(±0,77)		
Oxygen Consumption ($\dot{V}O_2$)	12,30(±3,28) *ml/kg/min*[a]	12,75(±4,38) *ml/kg/ min*[a]	13,19(±0,83) *L/kg/min*[b]	12,87(±0,95) *L/kg/min*[b]		

Note. The data is presented as mean values and standard deviations (±*SD*). Caloric expenditure (kcal/min) and Oxygen consumption ($\dot{V}O_2$) values are taken from "Effect of an unstable Shoe construction on lower extremity gait characteristics," by B. Nigg, R. M. Ferber, and T. Gormley, 2004, Human Performance Laboratory, University of Calgary, Canada. *A project report for Masai Switzerland* . Whereas velocity (m/s) values are taken from "Changes in gait and EMG when walking with the Masai Barefoot Technique" by J. Romkes, C. Rudman, and R. Brunner, 2006. *Clinical Biomechanics, 21*(1), 75-81.This was conducted to give an overview and as a reference point to be able to compare data with values obtained in this current study.

[a]Oxygen Consumption ($\dot{V}$O2) expressed as ml/kg/min. [b] Oxygen Consumption ($\dot{V}$O2) is stated expressed as L/kg/min

**p*= 0.031, significant difference found in heart rate values in the MBT shoe see table 6 for details

Velocity

An interesting finding was discovered when the velocity was examined. No differences in the self selected velocities were found when the MBT shoe was compared with the OS shoe ($p>0.05$). This study's findings are in contrast to the findings by Romkes *et al*. (2006), who found a significant difference in all temporospatial variables during ambulation compared to regular shoes (Table 8).

The findings of this paper could indicate that prolonged usage of the MBT shoe may have an impact on temporospatial parameters during ambulation. The findings can point to the fact that a longer adaptation period to the MBT shoe may even out the differences in time distance parameters, compared to the four weeks of acclimation period used in the study by Romkes *et al.* (2006). However, since the researchers did not inspect the different parameters of gait, no conclusion can be made. The self selected velocity (m/s) for each of the shoe types was kept the same on session two. It was conducted in this manner, because the researchers wanted to see if the results were consistent over time and it was only by chosing the same velocity for session two that comparisons across the testing sessions could be conducted. However, a limitation in this study could be that individuals who are unfamiliar with walking on a treadmill could have chosen a lower/higher velocity than their actual normal, comfortable velocity due to insecurity. The researchers could have addressed this by allowing an acclimatization process prior to testing, so the subjects could have become more accustomed and familiar with walking on a treadmill. Given this it is probable that the subjects would have chosen another velocity, if asked in test session two. Since the velocity was controlled in session two and knowing that "forced" velocity changes the temporospatial parameters during gait and has an impact on the oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) (Holt *et al.*, 1991; Holt *et al.*, 1995; Hreljac & Martin, 1993; Zarrugh & Radcliffe, 1978). However, the researchers did not detect any significant differences in oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) throughout the sessions among the shoe types.

Reliability of the study design

The authors of this paper believe that the findings might be reliable, since the results were consistent over time. The time between the two testing session (repeated measurement design) and randomization of the shoe types did not reveal any significant differences within the footwear type across the two testing sessions on caloric expenditure (kcal/min) and oxygen consumption (ml/kg/min) (p>0.05). However, a significant difference was noted in the heart rate (min^{-1}) values of the test subjects for the MBT shoe across the testing sessions (p<0.05), this study's results show that heart rate values were higher during session one 93,18(±9,83) min^{-1} and lower during the second 86,54(±11,78) min^{-1}as listed in (Table 6). The increased and decreased values in the heart rate are, however, in accordance with findings in oxygen consumption ($\dot{V}O_2$) across the testing sessions. The values were noted to be 902,46(±182,77) ml/kg/min for session one and 778,32(±133,89) ml/kg/min during second testing (table 7). Since heart rate (min^{-1}) is stated to be in linear relationship to oxygen consumption (McArdle *et al*., 2001; Waters & Mulroy, 1999), the heart rate (min^{-1}) may have affected oxygen consumption ($\dot{V}O_2$) values. Yet statistical testing did not reveal any significant difference in oxygen consumption ($\dot{V}O_2$) (p>0.05) in the MBT shoe's results across the testing sessions. The elevated values for the heart rate (min^{-1}) on session one for the MBT shoe may be explained by the fact that the subjects felt unfamiliar and unsecure walking with the MBT shoe on a treadmill, when taking MBT's unstable shoe construction into consideration.

However, the randomization of the shoes did not affect the findings among the shoe types within each testing session. No significant differences in heart rate (min^{-1}), oxygen consumption ($\dot{V}O_2$) or caloric expenditure (kcal/min) between the MBT shoe and the OS shoe trials were found within each testing session ($p>0.05$). Furthermore, the repeated measurement design did not reveal any differences between the two shoe types throughout the sessions. Other factors which could have affected the results, such as the circadian rhythms, were controlled by the researchers by performing the test sessions at the same time of the day (Jonson *et al*,. 1998). The researchers attempted to decrease the likelihood of elevated aerobic metabolism between the trials (McArdle *et al*., 2001), by subjecting the subjects to the same preconditions in form of a resting period of six minutes before each trial to allow the oxygen consumption and the rate of aerobic metabolism to stabilize (McArdle *et al*., 2001; Åstrand *et al*., 2003).

Mass issue

In the study by Nigg *et al.* (2004) it was suggested that it could be the mass of the MBT shoe which caused the increased oxygen consumption (ml/kg/min) and energy expenditure (kcal/min). Literature substantiates that the mass of shoes can have an influence in this way (Jones *et al.*, 1984; Miller & Stamford, 1987). The researchers counteracted and controlled for mass in this study and investigated the role of mass, by adding additional mass to the OS shoe through custom flat insoles. The mass was found to be similar between the MBT and OS shoe in this study ($p>0.05$). Other parameters which could have influenced the outcome in addition to mass were found to be statistically insignificant. Velocity (m/s) was not found to be significantly different between the MBT and OS shoe, a factor which could have influenced oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) (Waters & Mulroy, 1999; Waters *et al.*, 1988). Indeed the researchers could have examined consumption ($\dot{V}O_2$) in relation to the distance travelled by each of the subjects to counteract velocity variations between the shoe types, but since the velocity difference was found to be insignificant the researchers choose not to do this. Subject body weight (kg) was taken into consideration for each of the seven subjects while calculating the oxygen consumption ($\dot{V}O_2$) expressed in ml/kg/min. Heart rate (min^{-1}) may have influenced the outcome (McArdle et al., 2001; Waters & Mulroy, 1999), since a significant difference was found during the trial with the MBT, but

the researchers explained the difference with the decreased and increased oxygen consumption (ml/kg/min). In spite of that, the researchers did not find significant differences in oxygen consumption across the MBT sessions or between the MBT and OS shoe.
These stated parameters could have affected the data, but during the course of the study were found to have an insignificant impact. The researchers would like to assume that the reason behind the inconclusiveness of study might be the equal mass of the shoes, which explains why no statistically significant differences were found in the measured parameters.
If the above mentioned statement is true it might not be the MBT shoe's specific properties, but the mass of the shoe as the MBT shoe is manufactured to be heavier compared to regular and orthopedic shoes, that is the reason for that no differences were found in this study.
Therefore, it could be assumed that if an increase in energy expenditure (kcal/min) is desired a MBT shoe might serve as a training device as found in the Nigg *et al.* (2004), but the same effects could be achieved by inserting/adding additional mass through insoles on individuals' regular shoes or just purchasing heavier shoes. Since an OS control group without mass added was not available for this study, further comparisons could not be made by the researchers. Based on the findings of Nigg *et al*. (2004) and the literature (Jones *et al.*, 1984;Miller & Stamford, 1987), the researchers would have expected a higher oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) if a comparison of the MBT shoe and an OS shoe (without additional mass) had been conducted within the framework of this study.

Limitations of the study

The small sample of subjects included in this study may have affected the results. When oxygen consumption was used as the variable of interest a post hoc power analysis revealed the power of the present study to be P=0,05035. These weak power values could mean that there is a high probability that the researchers did not have enough subjects to find any differences in this study (Type II error). This study should therefore be seen as a pilot study and encourage further investigation in the area should be done.
Another limitation is that some of the subjects who participated in this study took cardio vascular and diabetes medication (Table 1). Indeed this would have affected the cardio and pulmonary variables if comparisons had been conducted against a control group which consisted of another sample of individuals. Yet, the researchers tested the same subject with two different shoe types. If the MBT shoe was actually found to increase the oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) it would have been revealed regardless of the medical condition of the subjects.

Other things to consider are the physiological factors connected to the usage of a face mask during the testing sessions. The subjects were not familiar with the use a facemask and this may have felt unpleasant and claustrophobic for some of them and in this way could have had an impact on the results.

Recommendations for further studies

The researchers strongly recommend further studies on whether or not prolonged usage of the MBT shoe can alter gait parameters in a smoothing manner on for instance, kinetics and kinematics. The temporospatial parameters during ambulation would be especially worthwhile investigating, since the authors of this paper found that there was no significant difference in velocity (m/s) between the MBT and OS shoe (p>0.05). Additionally further research should be conducted on oxygen consumption ($\dot{V}O_2$) and energy expenditure (kcal/min) with a larger sample size with a control shoe without any mass added to identify if the mass actually is the explanation that no differences were found within this study.

Conclusion

The research hypothesis (H_1) is rejected and the alternative hypothesis (H_0) is accepted with caution due to weakness in the power test.

Despite this, the researchers found that the Masai Barefoot Technology shoe did not increase energy expenditure (kcal/min) and oxygen consumption ($\dot{V}O_2$) in the test subjects while walking with self selected velocities on a treadmill compared orthopedic shoes (p>0.05).

The apparent reason behind there being no difference in oxygen consumption and energy expenditure might be due to the similar masses of the shoes, but since the researchers did not investigate multiple orthopedic shoes with different shoe masses, a conclusion cannot be reached. The findings though, could suggest that the specific construction of the MBT shoe has a negligible effect on the energy expenditure (kcal/min) of its user and the same effects can be achieved by using extra insoles to increase the mass of regular shoes, but additional studies needs to be performed to confirm this hypothetical assumption.

The lack of difference in oxygen con-sumption between the shoes could also be attributed to the fact that the subjects, who participated in this study, were used to wearing the MBT shoes on a daily/weekly basis and there-fore were conditioned to use them. Also, the self selected velocity (m/s) was found to be in-significant between the two shoe types and prolonged usage of the MBT shoe may diminish the parameter variance during ambulation in contrast to previous studies conducted on temporospatial variables. This gives room for further studies within this area are required to either accept or reject the hypothesis.

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Appendix

Informationsblad

För det första vill vi tacka er för att ni har valt att vara med i denna studie. I informationsbladet kan ni läsa hur testet kommer gå till och etik. Du har tillfrågats om du vill delta i detta forskningsprojekt om masai skor. Innan du bestämmer dig ber vi att du läser igenom denna information. Du kommer också att få en muntlig information med möjlighet att ställa frågor under studiens förlopp.

Studiens förlopp

Studiet kommer till att ske under våren 2009 på hälsohögskolan vid två tillfällen. Det är under två veckors mellanrum. Veckorna 14-15 och 17-18. Ni har fått välja veckodag och klockslag själva, med villkor på att det är vid samma tid under båda besöken.

Bakgrund och syfte med studien

Hur energiförbrukningen påverkas vid gång med masaiskor jämfört med vanliga ortopediska skor. De som gör masaiskorna har påstått att energikonsumtionen är högre när man går i deras sko. Det är ett påstående som ännu inte är bevisat i någon vetenskaplig studie. Syreupptagning och syreförbrukning hos varje person kommer att mätas, vilket vi sedan kan använda för att beräkna energikonsumtionen samt beräkna skillnaden i energikonsumtion mellom skorene.

Förfrågan om deltagande

Denna förfrågan har skrivs av Anna Thuesen och Benjamin Lindahl för att be dig delta i forskningsstudien. Om du väljer att delta och samtycker med detta dokument så kommer du att informeras kontinuerligt om alla händelser i studien. Självklart kan du välja att avbryta när du vill. Bara kontakta oss via e-post eller telefon. Fullföljer du hela studien kommer ni få en invitation att vara med då studien presenteras i början av juni.

Information före testet:

Före studien kommer ni att få muntligt och skriftlig information om vad ni måste veta innan testen börjar. Vi ber dig att inte dricka kaffe eller äta för mycket under två till tre timmar före testet. Användningen av masaiskor bör inte ändras och ska anpassas till normala dagliga aktiviteter.

Under testet:

Du får ett papper att läsa igenom och skriva under. Du kommer få ett frågeformulär där du får svara på frågor om din hälsa och frågor relaterade till hur mycket du använder dina masaiskor. Höjd och vikt kommer att mätas.

Du kommer att få gå på ett löpband med både masai och vanliga skor. Du kommer få välja en hastighet som du själv finner bekväm. Under första försöket kommer ni få dra lott om vare sig ni ska gå med masaiskor först eller inte. En pulsmätare kommer fästas om midjan och en syremätare kommer placeras runt munnen och näsan.

Testets utförande

Resting period: Du kommer till att ligga stilla och vila på en brits under 6 min. Försök att slappna av så mycket du kan.

Acceleration phase: Du kommer själv till att öka hastigheten till en bekväm hastighet som du tycker passar din vanliga gånghastighet. Detta kommer att ta 3 min.

Testing phase: Du kommer till att gå den förvalda hastighet i runt 6 min.

Warm down: Vi kommer till att minska hastigheten under 2-3 min.

Efter det första testet görs samma test med den andra skon.

Vilka är riskerna:

Det finns näst intill inga risker med att delta i denna studie. På grund av masaiskons ostabila konstruktion, kommer det alltid att stå en person som säkerhet.

Hantering av data och sekretess:

Alla data kommer att vara märkta med en kod og inte med deltagernes namn. Koden kommer endast ansvariga för studien att ha tillgång till. När datainsamlingen är klar kommer koder som kan kopplas till uppgifter om hur man mår att förstöras för att skydda deltagarnas integritet. Alla arbetsuppgifter som behandlar personliga uppgifter kodas och studiens uppgifter förvaras på en plats i hälsohögskolan. Nyckel till dessa koder förvaras på annan plats av undersökarna för att deltagarnas uppgifter inte ska kunna röjas.

Hur får jag information om studiens resultat?:

Svar på egna data som framkommit i studien kan erhållas om det önskas från Anna Thuesen eller Benjamin Lindahl. Ni kan få svar via e-post eller via telefon. Datainsamlingen förväntas avsluta omkring vecka 18 då den statistiske analysen av data påbörjas.

Frivillighet:

Som försöksperson har du rätt att gå in i studien, och att avsluta ditt deltagande i försöksstudien när du själv vill. Om Du skulle ha några frågor kan du ta upp dessa med oss antingen vid testets förlopp eller ringa numret nedan.

Med vänliga hälsningar och stort tack för hjälpen att ni ville delta i vår studie!

Ansvariga och kontaktpersoner:

Anna Thuesen | Benjamin Lindahl

Mail: annatudse@yahoo.dk | Mail: oih6libe@hhj.hj.se

Jag har fått information att de uppgifter som insamlas om mig i studien kommer att behandlas konfidentiellt, på ett sådant sätt att min identitet inte kommer att avslöjas för obehöriga.

Jag är informerad om rättigheten att få information angående testernes resultater, liksom om rättigheten att få allt datamaterial förstört och personuppgifter borttagna.

Jag tillåter att uppgifterna får bearbetas av personal som arbetar med studien under förutsättning att sedvanlig sekretess upprätthålls.

Jag har informerats muntligen om studien och jag har läst den skriftliga informationen. Jag har fått svar på mina frågor och jag samtycker till att delta i studien. Mitt deltagande är frivilligt och jag kan avbryta när som helst utan förklaring utan att det påverkar mitt omhändertagande.

…………………………………. ……………………………………

Deltagares namnteckning   Ort/datum

…………………………………

Namnförtydligande

…………………………………. ……………………………………

Informerande persons namnteckning   Ort/datum

…………………………………

Namnförtydligande