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The Effects of UGG Boots on Lower Extremity Walking

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Abstract

UGG boots have become an increasingly popular choice in footwear. Women, especially, have bought UGG boots at a high rate, making the shoe one of the top footwear choices in today's world. UGG boots can be described as a type of flat footwear and flat footwear does not provide medial longitudinal arch support on the bottom of the foot. This lack of support may cause foot injury due to over pronation in the subtalar joint. There was still the question of if UGG boots limits rear foot pronation movement. The purpose of this study was to examine and compare the kinematics of barefoot walking and walking in UGG boots. Ten female subjects participated in the study and the results showed no statistically significant difference in the lower limb joints between the barefoot walking and the UGG boot walking. Additionally, no difference in the subtalar joint between the two types of footwear (Barefoot: 170.8 ± 8.5° vs UGG: 174.3 ± 4.1°) during the mid-support phase of the gait cycle was found. This study concludes that UGG boots do not limit rear foot motion in the pronation movement and future studies are warranted to evaluate the long term effects of UGG boots with various ankle pronation profiles.

Introduction

Walking is a basic and fundamental method of locomotion that provides both support and propulsion (Kharb, 2011). A person's walking gait, or their ability to propel forward their center of gravity, can vary greatly depending on the biomechanics, or study of movement, of their ankles and feet. Humans protect their feet and ankles with varying footwear, but often do not make choices which support their feet in an appropriate way. Since human feet and ankles support the entire body, the rest of the body is affected by the type of footwear—supportive or unsupportive—that is chosen.

According to ePodiatry, arches, or the curve on the sole of the foot, may often need to be supported by certain types of footwear or various foot orthotics. Most people have arches under their feet but Shercher (2008) reports 8-15% of the population have a cavus foot, which is an excessive upward arch, while nearly 20% of Americans have a flat foot, which is an excessive downward arch (Donatelli, 2000). Arch pain can result from improper positioning of the foot and ankle. Footwear that is flat and lacks arch support can cause injuries in the foot and ankle, in turn affecting the walking gait of the person, says epodiatry.com. There are three phases of walking gait, beginning with heel strike, or when the heel hits the ground, followed by mid-support, or when the whole foot is flat to the ground, and ending with toe off, or when the toe begins to come off of the ground, moving into the next step. As discussed in a study conducted by Glasoe, Yack, and Saltman (1999), the medial longitudinal arch serves as the chief load-bearing structure of the foot. In other words, majority of the weight is put on this part of the foot when walking, especially during the mid-support phase. If a shoe does not provide support to

Figure. 1. The classic style UGG boot used in this study.

this arch, the walking gait can be altered. This potential change in the walking gait could mean damage to the arch and pain in the foot and other areas of the body. In addition to the type of footwear the wearer chooses, the walking terrain affects the walking gait. When walking on an incline, the foot and ankle produce greater range of motion and alter the timing of heel strike and toe off compared to walking on flat ground. Combining these aspects of foot abnormalities and flat footwear creates a challenging environment for both the foot and ankle. The eversion and inversion, or side to side movement, of the foot and ankle that can result from walking on an incline is worsened while wearing shoes that lack support (Morley et al., 2010; Walker, 2015).

In recent years, Deckers Outdoor Corporation has reported that UGG boots, **Figure 1**, have become one of the top selling footwear choices in the world. UGG boots originated in Australia and New Zealand, are made of sheepskin with fleece on the inside. In the 1960's, UGG boots gained popularity because surfers often wore them to prevent cold, numb and wet feet. From the late 1990's to mid-2000's, UGG boots have emerged as a fashion trend in the United States and worldwide. In 2008, the Deckers company reported US$689 million in UGG boot sales, almost a 50-fold increase from 1995 (Abkowitz, 2009). The Huffington Post reports that according to a survey conducted by Beso Shoe, approximately 25% of American women own UGG boots. However, UGG boots are a flat shoe that provides minimal arch support, which may cause the foot to have excessive eversion motion. Price (2014) indicated that flat shoes can cause detrimental effects on foot health. Strachan (2010) further notes that UGG boots are designed more for the aesthetics and warmth rather than functional support. Moreover, Miller (2010) from New York Times reported on new evidence suggesting that UGG boots may be "ruining women's feet." ABC News reported similar information just months before the New York Times, also suggesting that UGG boots have harmful effects, including foot and ankle pain, on the wearer (Leamy, 2009). Additionally, a podiatric surgeon, Mike O'Neill, claims that they cause the ankle to be in the wrong position, leading to the femur changing alignment and abnormal movement in the acetabulum as well as a possible predisposition to back ailments (Irvine, 2010).

Despite there being limited research conducted on the UGG boot specifically, there has been extensive research on another flat shoe: the flip-flop. The flip-flop is quite similar to the UGG boot, for both are flat shoes providing little to no arch support. Studies conducted on flip-flops and their effects on walking gait have concluded that they have a definite effect on the gait

kinetics (Shroyer, 2015). Price et al. (2014) conducted a study on flip-flops and found flip-flops loosely secured and rubbery design resulted in altered gait parameters, particularly greater ankle dorsiflexion (13.0 ± 2.9°) compared to barefoot (13.5 ± 2.4°). Their research suggests that flip-flops cause the foot and ankle to flex upward—dorsiflexion—altering the gait of the person. There have been numerous reports claiming that flip-flops and other thong style shoes are responsible for a great deal of ankle and foot injuries. The spongy sole and lack of support in the flat flip-flop cause over pronation of the ankle, which can result in a more flat foot and foot injuries. Another study by Hetsroni (2006) indicated that over pronation, a combination of eversion abduction, and dorsiflexion movements, can lead to various injuries, particularly anterior knee pain. This over pronation occurring in flip-flops can be dangerous to the wearer. Another study by Zhang (2013) discussed that flip-flops made people have smaller steps and greater ground reaction forces, as well as different ankle and foot kinetics. Given the similarities between flip-flops and the research on UGG boots alone, this study expected to see similar problems in the UGG boot that have been found with the flip-flop. If flip-flops are cable of causing the foot flex in an upward direction, it is possible that flip-flops are also capable of causing the foot evert or invert, or move in a side to side manner. The investigator expected to see similar results in the UGG boots, given the similarities in the structure of the shoe.

Overall, this research project sought to understand how UGG boots affect the walking gait of its wearer. This research can help to educate the population, particularly females, on this particular brand of footwear, perhaps assisting in the decision to purchase and wear the UGG boot.

Methods

Ten female Bridgewater State University students (age = 21.3 ± 1.2) with a shoe size between 6 and 10 were recruited to participate in this study and the Institutional Review Board approval had been obtained prior to the study. The participants received a briefing on what the study required of them, and were given the decision to opt out following the briefing if they felt it necessary. Participants signed a written informed consent—detailing all the needs of the study—prior to beginning the actual study.

All participants arrived to the Biomechanics Laboratory. Each participant was given the chance to walk on the treadmill to become aware of the task if they felt it necessary. Each participant was then given a pair of UGG boots in their shoe size and was also asked to be barefoot for a portion of the research as well. During the testing, each participant walked for one minute at a speed of 1.3 m/s on a treadmill without any incline. A speed of 1.3 m/s was chosen because it mimics natural walking speed most closely. They walked in UGG boots and then walked while barefoot. Participants were given time to rest between trials if they feel it necessary. Data collection was concluded in half hour durations for each participant.

Five joint reflective markers were placed on the right side of the body at the shoulder (glenohumeral joint), hip (greater trochanter), knee (lateral epicondyle of tibia), ankle (lateral malleolus), and toe (base of fifth metatarsal). A Casio high speed video camera (Model: EX-FH25) was positioned to capture the sagittal

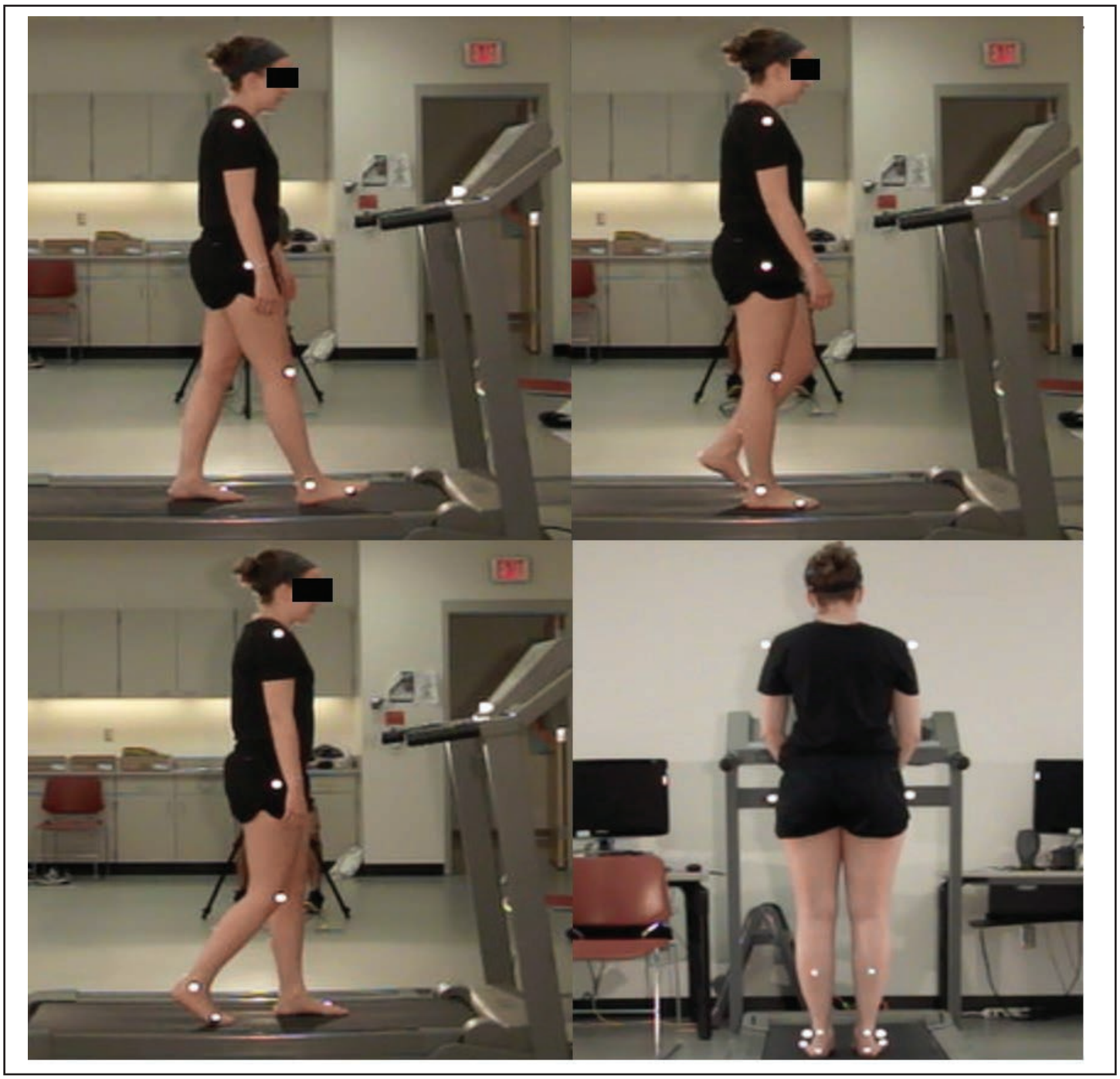

Figure 2. Images from top to bottom, left to right, show one of the subjects during heel strike, mid stance, toe off, and from ear view. All joint markers placed can be seen in these images.

view of the walking motion at 120 frames/second in conjunction with a 650W artificial light. This camera was used to determine the hip joint flexion/extension, knee joint flexion/extension, and ankle joint dorsiflexion and plantar flexion movements. Additionally, three joint markers were placed on the back side of the body at the mid calf, Achilles tendon, and heel. Another Casio video camera of the same model was positioned to

Table 1. Lower kinematic comparisons between barefoot foot and UGG boots.

Joint Angle	Mean ± SD (BF vs UGG)	*p*
Hip (°)	170.9 ± 5.5 vs. 169.0 ± 6.0	.129
Knee (°)	163.1 ± 7.1 vs. 161.3 ± 6.1	.113
Ankle (°)	100.7 ± 4.4 vs. 100.5 ± 3.4	.863

*Statistical significant at $p < 0.05$

Table 2. Kinematic comparisons between barefoot foot and UGG boots at subtalar joint.

Conditions	Mean ± SD (BF vs UGG)	*p*
Joint Angle (°)	170.8 ± 8.5 vs. 174.3 ± 4.1	.273
Velocity (°/s)	-18.6 ± 46.0 vs. -8.0 ± 22.5	.494
Acceleration (°/s^2)	-427.4 ± 437.2 vs. -857.5 ± 543.5	.591

*Statistical significant at $p < 0.05$

capture the rear view of the walking motion at the same rate with a 650W artificial light. This camera identified ankle eversion and inversion movements, **Figure 2.**

A two-dimensional kinematic analysis was conducted for each type of footwear at zero degree incline angle with Ariel Performance Analysis System (APAS™) motion software on the right side of the body. All video trials were then transferred onto a computer in the Biomechanics Lab for gait analysis. The mid foot support phase of each of the three gait cycles was analyzed and used for statistical analysis. A total of 120 trials (10 participants x 3 mid supports x 2 camera views x 2 types of footwear) in the study were analyzed, which is a typical sample size. A t-test was conducted at $\alpha = 0.05$ between the two types of footwear. All statistical analyses were conducted with SPSS software.

Results

The results of this study indicate that there is no significant difference between walking barefoot and walking in UGG boots in either the right or rear sides of the body at a zero incline during mid support, **Table 1**. No difference in the subtalar joint between the two types of footwear (Barefoot: 170.8 ± 8.5° vs UGG: 174.3 ± 4.1°) during the mid-support phase of the gait cycle

was found, **Table 2**. This lack of statistical significance means that the UGG boots do not seem to limit the rear foot motion during pronation movement as initially hypothesized for this study. In other words, the foot does not roll inwardly, pronation/eversion, when walking in UGG boots, particularly from the rear view.

The numerical data showed mean displacement of both right and rear views that were all in close proximity to one another, with very little deviations, **Tables 1 & 2**. These numbers being so close to each other could mean that walking in UGG boots somewhat mimics the barefoot walking.

Discussion

The findings of this study were consistent with previous research studies in terms of the ankle's dorsiflexion movement. Price et al. (2014) conducted a study on flip-flops, and found ankle's maximum dorsiflexion during stance on flip-flops were 13.0 ° $\pm$ 2.9° compared to the barefoot condition of 13.5° $\pm$ 2.4°, which is equivalent to 103.0° $\pm$ 2.9° for flip-flop and 103.5° ± 2.4° for barefoot in their study. In this study the ankle's dorsiflexion movement at mid support stance was 100.5 ± 3.4° and 100.7 ± 4.4° for UGG and barefoot conditions, respectively, and these findings are quite similar to Price's study. The slight ankle joint difference between this study and Price's study may be due to the fact that Price et al. (2014) examined the maximum dorsiflexion joint angle at mid support while this study evaluated the instant of entire foot contact at the mid support. This study suggests that even though UGGs are a type of boot, the mass of the boots may be minimal; hence, they do not significantly change or affect the ankle's dorsiflexion movement while walking in short duration. The effects of wearing boots for a long duration period of time on the ankle joint remained to be examined.

UGG is a type of flat footwear and the results of this study showed that there is no significant difference between the barefoot and UGG conditions in terms of ankle's eversion/pronation and inversion/supination movements. Morley et. al (2010) conducted a study to examine the ankle's eversion/pronation and inversion/supination movements between shod and barefoot running. Morley et al. (2010) found that the low pronation group (3 – 8.9°) did not show any difference in the ankle's maximum eversion movement between barefoot and shod conditions. However, the middle pronation (9 – 12.9°) and high pronation (13 – 18°) groups showed significant increase in ankle's pronation movement during shod condition. Therefore, since this study did not find any difference between UGG and barefoot condition, it may be possible that all participants in the current study exhibited the same ankle joint movement profile as the low pronation group from Morley's study. These participants had a minimal ankle pronation to begin with in barefoot condition, so with a type of flat footwear such as UGG, they do not cause excessive pronation. A person with a middle pronation or a high pronation ankle profile may be different and future studies are warranted to evaluate the effects of UGG boots on various ankle pronation profiles.

There are some limitations in the study that should be considered. In this study, three joint reflective markers were placed on the mid-calf, Achilles tendon, and heel to measure the subtalar joint movement. This technique is slightly modified from Morley et al. (2010)'s study. Having the subtalar joint covered by the boots during

the testing and data collection may be a limitation, with potential to alter proper location of the joint marker on the subtalar joint. However, the results of this study showed consistent and similar findings on ankle's pronation/eversion movement with Morley et al. (2010) and Price et al. (2014)'s studies. In this study, the ankle's pronation/eversion movement was 170.8 ± 8.5° for barefoot and 174.3 ± 4.1° for UGG. Morley et al (2010) reported the maximum ankle's eversion movement was 6.3 ± 2.6° for barefoot and 6.7 ± 2.1° for shod condition, which is equivalent to the current study's 173.7 ± 2.6° for barefoot and 173.3 ± 2.1° for shod condition. Additionally, Price et al. (2014) reported maximum ankle's eversion movement during stance was -4.3 ± 2.1° for barefoot and -4.4 ± 1.9°, which is equivalent to the current study's 175.7 ± 2.1° for barefoot and 175.6 ± 1.9° for shod condition. The slight difference in the ankle eversion between this study and the previous studies may be because this study examined the ankle's eversion between this study and the previous studies may be because this study examined the ankles eversion angle at the instant of entire foot contact with the ground rather than evaluating the ankle's maximum eversion angle, as mentioned. Another limitation of this study is that the UGG boots used were brand new. Typically, a person wears UGG boots for enough time that they will mold to the shape of their foot, which can be the root of some of the problems the researchers had initially expected to see throughout the course of this study. As some sources and wearers describe, the UGG boots have a somewhat malleable bottom sole. This sole has the potential to begin to change into the shape of the wearer's foot. Dr. Ian Drysdale, who is the head of the British College of Osteopathic Medicine, discussed that the foot will slip around inside the flat shoe and can cause it to fall towards the instep of the foot with each additional step. He discusses how this can endanger the arch because of the repeated falling and inward motion, the shoe takes that shape and can leave the ankle with pain and future problems (Springer 2012). The slipping of the foot and the shaping of the boot with prolonged wear could be a very interesting area of study. Future studies could consider testing people in their own personal, worn in pairs of UGG boots. This potential study would need certain variables to be pinpointed—including how long the boots have been owned and how much they have been worn. However, looking at those different variables could yield interesting results, possibly mimicking the information Dr. Drysdale pointed out. Another factor to be considered in this study is the speed and the use of treadmill. Everyone walks at a different natural walking speed, making it difficult to pinpoint what would be the most appropriate speed to be used throughout this study. Additionally, the treadmill may not have mimicked the way each participant would have walked on the ground. Therefore, the findings between treadmill and on the ground may be different.

Conclusions

It was hypothesized that because UGG boots are flat footwear lacking medial longitudinal arch support on the bottom of the foot, there would be over pronation in the sublatar joint. This over pronation was believed to be capable of causing injuring and altering the walking gait of the wearer. Ten healthy females participated in this study, and a treadmill speed that closely mimicked natural walking patterns was used to obtain accurate data. The lack of significant data found in this study means that with the given conditions, UGG boots do not limit rear foot motion in the pronation movement.

However, the participants in the study may have low pronation ankle profiles. Additionally, the participants wore brand new UGG boots for a short period of time. Therefore, future studies are warranted to test participants with various ankle pronation profiles and also to examine the long term effect of wearing UGG boots.

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About the Author

Ariana LaFavre is a graduating senior majoring in Physical Education with a concentration in Motor Development Therapy, and minoring in Psychology. She began her research in the fall of 2015 through a Semester Research Grant, under the mentorship of Dr. Tom Wu (Movement Arts, Health Promotion, and Leisure Studies). She continued her research in the summer of 2016 with funding provided by the Adrian Tinsley Program's Summer Research Grant. Ariana plans to apply for conferences with hopes of presenting her research in the future. She plans to attend graduate school, pursuing a career in healthcare.