The Biomechanical Effects of Elevated Heels on the Barbell Deadlift

by

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TABLE OF CONTENTS

ABSTRACT

This study evaluated the kinematic effects of performing a barbell deadlift with different elevated heel heights. Relative spine, lumbar, and knee angles as well as absolute trunk, femur, and shank angles were taken at two points of measurement: the initial lift off and when the bar passed the knee. Three-dimensional motion capture systems captured twelve reflective markers placed on body landmarks of the subjects while the barbell deadlift was performed at 70% of their 1 repetition maximum (1RM) load at constant barbell speeds with seven different heel heights in a randomized order. Separate one way repeated measures 7x1 (heel x body measurement) ANOVAs for each measurement was used. There was no significant differences ($p>0.05$) were found for anybody measurements between the heel heights. These data suggests that difference in heel height does alter deadlift kinematics.

LIST OF TABLES

CHAPTER I: INTRODUCTION

Nearly all sports use some type of equipment or apparel to help athletes maximize their performance and or reduce injury. Among these specialized equipment are different types of shoes. One specific shoe is design to aid in Olympic weightlifting. Weight lifting shoes have evolved as the sport of weight lifting has changed over the years. In 1929, the International Weightlifting Federation changed its competition protocol to just 3 exercises: the press, the snatch, and the clean-and-jerk then in 1972 eliminated the press and we are left with the current lifts in the clean and jerk and snatch. As the sport shifted, the need to produce more efficient lifting patterns drove the need for a shoe with an elevated heel (2).

Weightlifting shoes look markedly different from typical tennis shoes. They feature a hard and flat sole whereas typical tennis shoes have soft insoles that absorb shock and impact. Weight lifting shoes also have an elevated heel region in contrast to the leveled toe and heel regions of tennis shoes. Most, if not all, weight lifting shoes have a strap that is used to help tighten the fit of the shoes around the foot in addition to the shoe laces that are present within most tennis shoes. The hard, flat sole surface provides lifters a stable surface to generate muscular force. Kilgore (7) argues that, in the weight room, shoes should provide for seamless transfer of force between the ground and the barbell. The raised heel allows the weightlifter to get under the bar with a reasonably vertical disposition of the trunk in the “catch phase” of the clean exercise (2). This is done by allowing the lifter to fully bend at the knees, tilt the shins forward, and keep the feet flat on the floor (2). Along with the soles of weight lifting shoes, the strap also provides stability by giving lifters a snug fit and removing any space for the feet to slide around inside the shoe.

The concept of WLS is a relatively new and uncharted research area. There exists only a few published works that look at the effects of WLS and their effects on training. A small pool of studies have addressed WLS on the barbell back squat (BBBS) exercise and subsequent biomechanical changes (4, 13, 15). The National Strength and Conditioning Association (NSCA) recommends that lifters who engage the in the BBBS exercise should maintain a normal lordotic posture and keep the torso as vertical as possible (4). WLS have been shown to aid in proper squat techniques by providing less trunk lean, thus a more vertical trunk (4, 13). Sato et al (13) found less trunk lean with no changes in absolute thigh angles when wearing WLS. WLS also directly caused the absolute foot segment angles to be larger due to the heel construction of WLS than when barefoot or when wearing tennis shoes or barefoot-inspired shoes; subjects' heels were more elevated in WLS than in other footwear conditions. Sato (13) came to the conclusion that weightlifting shoes are beneficial to preventing injuries because they reduce trunk lean, which reduces the shear forces on to the lower back that is typically caused by excessive trunk lean. Research conducted by Fortenbaugh (4) determined that using weight lifting shoes in a squat helps decrease trunk movement, resulting in less forward trunk lean and increase ankle flexion. The ideal bar path is a vertical straight line when performing the BBBS, common bar path deviation from this vertical path is associated with hip displacement in the posterior direction. WLS help with the reduction of the forward lean of the trunk segment thus resulting in a more vertical path. Since the BBBS and BBDL incorporate the lower body musculature, many novice lifters might assume that they have a kinematic crossover effect between each other. However, according to Hales et al (6), the BBBS and the BBDL are significantly different from each other with respect to kinematics. Motion capture cameras recorded twenty-five powerlifting athletes competing in a regional powerlifting meet. Hip, knee, and ankle angles were measured at the sticking point of each lift. The BBDL had significantly higher absolute trunk and thigh angles throughout the movement than those of the BBBS. The BBDL also had significantly lower absolute shank angles throughout the motion. Whereas the BBBS is considered a smooth linear motion, Hales et al. (6) noted that the deadlift is a segmented movement. The BBDL's three segments are lift off (knee extension), the bar passing the knee (hip extension), and lift completion (hip and knee extension). Hales et al. analysis of the BBBS and BBDL indicate that the individual lifts are markedly different with no crossover effect between them. Thus, any correlations between WLS and the BBBS are not transferable to using WLS while performing the BBDL.

The previous literature has also failed to address is the ideal height of WLS. The most popular commercial weight lifting shoes (Nike Romaleo II, Adidas Adipower WLS, Reebok CrossFit Lifter Plus 2.0) all have an effective heel height of 0.75" but no data is available as to why that heel height was chosen. The FastLift 335 by Inov-8 feature an effective heel height of 0.65", likewise with no rationale for the heel height. WLS with a greater heel height in theory would lead to greater absolute shin angle and even more of an erect posture allowing for less shear force on the back. This would then allow for a vertical bar path of the deadlift of the floor and further eliminate the bending over commonly seen with deadlift exercises. This in turn may allow for a reduction in injury and more weight to be lifted. Yet with no current research being conducted on WLS heel height combined with deadlifting these claims have no scientific rational.

As WLS are being used by more than Olympic lifters, power lifting athletes for example, the research from this present study is crucial in closing the gaps that exists in the literature to help coaches and athletes make informed decisions about training equipment and apparel. This current study will be able to provide evidence as to the kinematic effects of elevated heels of several heights. The purpose of the following study was to analyze the three-dimensional kinematics of multiple heel heights while performing the barbell deadlift.

CHAPTER II: REVIEW OF LITERATURE

The concept of weightlifting shoes is a relatively new and uncharted research area. There exists only a few published works that look at the effects of weightlifting shoes and their effects on training. Consequently, criteria of inclusion for this review of literature will look at the kinematics of the barbell squat (BBBS) and barbell deadlift (BBDL) exercise, as well as variations of the typical barbell movement (dumbbell, single legged, etc.) Agreements and disagreements between literatures will be looked at with particular attention to the lower extremities and the trunk. Literature that measures changes with respect to kinematic variables while using weight lifting shoes (WLS) will also be looked at.

Squat and Deadlift Form

The back squat is used to strengthen the lower body, primarily the quadriceps, hamstrings, and gluteals (11). The National Strength and Conditioning Association (NSCA) states that proper form while performing the barbell back squat (BBBS) exercise consists of 1) starting the movement by allowing the hips and knees to slowly flex while keep the torso angle as constant as possible, 2) maintaining a position with the back flat, elbows high, and chest up and out, 3) keeping the heels on the floor and the knees aligned over the feet, and 4) continuing downward until the thighs are parallel to the floor. During the upward phase, the NSCA instructions state to 1) extend the hips and knees at the same rate to keep the torso angle constant and 2) maintain the back rigidity, elbows and chest positions (18).

The deadlift is used to strengthen the lower body, focusing on the gluteals, hamstrings, and quadriceps much like the BBBS (10). The NSCA instructs that when performing the BBDL, lifters should initiate the lift by extending the hip and the knees while keeping the torso angle constant, 2) not let the hips rise before the shoulders, 3) to keep the bar as close to the shins as possible, and, as the bar rises above the knees, 4) to move the hips forward and establish full knee and hip extension. During the downward phase, lifters should allow the hips and knees to flex to slowly lower the bar to the floor while maintaining a rigid torso (18).

Squat Literature

Research on squat kinematics typically measures the joint angles of the ankle, knee, and hip (5, 9, 19, 20) as well as the absolute torso angle (5, 9, 20).

WLS are said to help with ankle mobility issues (2) and Macrum et al. (9) looked at the kinematic effects of restricting ankle dorsiflexion range of motion (AD-ROM) while squatting. Thirty healthy men and women were recruited for the study. Subjects were required to be physically active with no physical injuries. Three-dimensional kinematics were recorded with 7 120-Hz cameras. Subjects performed 7 squats under 2 separate conditions: wedge and no-wedge. To imitate limited AD-ROM, custom wedges were used while subject performed the squats. The wedges were created with a 12 degree forefoot angle. Results showed that limited AD-ROM produced decreased peak knee flexion while increasing peak knee valgus angles and medial knee displacement. The wedges used in this study mimic the opposite effect of WLS. It is necessary to study the effects that WLS can have on peak knee flexion and valgus angles.

Additionally, Fukagawa et al. (5) looked at the effects of aging on squat kinematics between older and younger men. Twenty-two healthy subjects (14 males and 8 females) from various age groups ranging from 21 to 75 years of age volunteered to perform single-legged deep knee squats. Using three-dimensional motion capture, subjects performed 3 squats as deep as possible under a self-selected speed and posture. The influence of aging was evaluated by measuring kinematic variables of the trunk, hip, knee, and ankle joints. Results showed a positive correlation between age and the time to execute the movement and that older subjects exhibited more abduction. Older subjects also showed a trend towards more forward leaning of the trunk. They concluded that age can alter the movement pattern of the squat. These altered patterns, namely the trunk lean, may be corrected by using WLS.

Furthermore, Zeller et al. (19) looked at gender differences while performing single legged squats. Using three-dimensional motion capture, 9 male and 9 female collegiate athletes performed 5 single-legged on the dominant leg going as low as possible without losing balance. Results showed that females show more ankle dorsiflexion, ankle pronation, hip adduction, hip flexion, and external rotation of the hip as well as less trunk flexion when compared to the male athletes. Once the hip moves into adduction, the femur will internally rotate which will cause the knee to go into a valgus position. Women also started in a more valgus position and remained in a more valgus position than men throughout the squat. These sum effect of these events will put women in to a “position of no return”, which are associated with women’s lack of ability to maintain knee varus during the squat when compared to men. This may indicate that women are more likely to rupture their anterior cruciate ligament because of the difficulty in controlling the musculature associated with the hip joint, especially the gluteus medius. The work of Zeller, Macrum and Fukagawa suggest that special equipment like WLS may be able to help special populations of lifters perform exercise with a form that prevents long-term injuries.

Deadlift Literature

Research on deadlift kinematics typically measures the joint angles of the ankle, knee, and hip (1, 3, 17) as well as the absolute torso angle (3). Measurements are typically taken at the point of initial lift off (LO) and when the bar passes the knee (KP), while a few look at the measurements when the lift is complete (LC) (1, 3, 14, 17).

Escamilla et al. (3) looked at kinematic differences between conventional and sumo style deadlifts while also comparing two- and three-dimensional measurements. They used two 60-Hz video cameras to record 12 sumo and 12 conventional style power lifters at a during a national powerlifting championship. Results showed that the sumo style had a thigh position that was 11-16 degrees more horizontal at LO and KP. The conventional style showed more extension in the hips and knees by 12 degrees. The sumo group had a more vertical trunk and thigh positions, employed a wider stance, and turned their feet more outward. Ankle and knee moments were significantly larger between the two groups at LO, KP, and LC, whereas the hip moments did not show any significant differences. Escamilla also suggested using a two-dimensional motion capture system is acceptable when looking at the conventional deadlift, but it is more accurate to use three-dimensional motion capture.

Schellenberg et al. (14) compared kinematics between the barbell deadlift exercise and the exercise known as "Good Mornings" (GM) to understand the differences in the knee, hip, and torso biomechanics. Thirteen subjects performed GM with a load of 25% bodyweight as well as BBDL with 25% and 50% bodyweight. Three dimensional motion capture was used to analyze sagittal moments and joint angles of the knee, hip, and trunk. The group saw that Good Mornings showed less peak knee flexion and hip flexion angles than deadlifts. GM are more preferred to increase hamstring strength, but BBDL are preferred to increase hip and overall strength.

Beggs (1) looked at lower body kinematics while subjects performed the BBDL with various grips. The most common grip styles are a double overhand grip and a grip where one hand is pronated and the other is supinated. Beggs recruited 10 male experience subjects to measure wrist, elbow, knee, and hip angles while performing the BBDL with 3 different types of grips at 60% and 80% 1RM. However, no differences were seen in any lower body kinematics between any of the grip conditions. Therefore, any grip preference that subjects have will not affect the lower body kinematics in the current study.

Swinton et al. conducted two studies looking at the deadlift (16, 17). In one study (17), the research team compared the kinematics and kinetics of the deadlift while using a straight barbell (SBD) against a hexagonal bar (HBD). Nineteen male active competitors of the Scottish Powerlifting Association participated in the study. Subjects were tested for their 1RM after a training cycle. Subjects performed their own warm-up and then engaged in a randomized sequence of bar type and loads ranging from 10 to 80% 1RM. All testing was done to correspond with normal training times. Inverse dynamics and three-dimensional spatial tracking of eternal resistance was used to quantify the kinematic and kinetic variables. Results showed that the subjects could lift more weight when using the HBD (265 ± 41 kg vs 245 ± 39 kg). Across the submaximal loads, the barbell used had a significant effect on the kinematic and kinetic variables. The design of the HBD placed the load behind the knee for the majority of the movement which lowered the peak moments on the lumbar spine, hips, and ankles while increasing peak knee moments. The use the hexagonal bar to manipulate load placement suggests that it is a better choice for strength training.

The other study conducted by Swinton (16) looked at the effects of deadlift training with and without chains. The purpose of the study was to investigate whether the deadlift could be effectively incorporated into explosive resistance training and to investigate whether the inclusion of chains enhanced the suitability of the deadlift for explosive resistance training. Twenty-three resistance trained athletes performed the BBDL with 30%, 50% and 70% 1RM loads at submaximal velocities (SMAX) and maximal velocities (MAX) as well as with 20% and 40% of their 1RM added in the form of chains at maximum velocities (MAX20 and MAX40). The velocity and acceleration of the barbell was measured as well as repetition time duration, peak force, average velocity, peak velocity, average power, peak power, peak RFD, and impulse. Significant increases in force, velocity, power, and RFD were seen when velocities increased from SMAX to MAX conditions. Using chains enabled lifters to maintain a greater force at the end of the concentric phase and significantly increased peak force and impulse while decreases in velocity, power, and RFD were seen. Swinton et al. concluded that using chains may both have positive and negative effects on the kinematics and kinetics of the BBDL.

Both studies by Swinton et al. advocate using maximum speed and testing the 1RM at the same time of day to mimic competition style lifting.

Weightlifting Shoe Literature

The concept of WLS is a relatively new and uncharted research area. There exists only a few published works that look at the effects of WLS and their effects on training. A small pool of studies look at the barbell back squat (BBBS) exercise and biomechanical changes (4, 13, 15).

Sinclair et al. (15) aimed to determine how different types of footwear influence the three-dimensional kinematics of the BBBS. Fourteen experienced males performed the BBBS at 70% 1RM in the following footwear conditions: standard athletic shoes, WLS, barefoot, and barefoot-inspired shoes. Compared to the barefoot condition, the running shoe showed increased squat depth and knee flexion angle WLS shoes showed significantly greater peak ankle dorsiflexion, less peak ankle eversion. However, despite the biomechanical advantages given by WLS and running shoes, lifters preferred to train in barefoot-inspired shoes or in a barefoot condition.

Sato et al. (13) wished to compare the kinematics of BBBS between two footwear conditions to evaluate the results with respect to the recommendations put forth by the NSCA position statement for proper squat technique. Twenty-five athletes (20 males, 5 females) who were collegiate athletes in football, rugby, soccer, and volleyball with at least 5 years of weight lifting experience were used for the study. A 1RM test was completed when their off-season training began. Two-dimensional video capture of the sagittal plane was recorded with a 60 Hz digital camera while the subjects wore reflective markers. Data was collected while subjects performed the BBBS at 60% 1RM while wearing running shoes or in a barefoot condition. Speed of bar ascent and descent was kept constant by using a metronome. The absolute angle of the trunk, thigh, and shank were measured as well as the relative angles of the hip, knee, and ankle joint. Results showed that the peak trunk angle was significantly reduced (greater trunk flexion) in the barefoot condition with a greater peak thigh angle and peak shank angle. The peak knee flexion angle was significantly greater in the barefoot condition. However, hip and ankle peak flexion angles were nearly identical. The barefoot condition showed two unfavorable results (higher trunk flexion and non-parallel thigh angle) and two favorable results (vertical shank segment and less knee flexion). Though the cushioning of running shoes may not be the best option in producing maximum force, utilizing a barefoot may be as inefficient in safely performing the BBBS.

Sato (13) also sought to validate a higher degree of foot segment angle by wearing WLS and to determine the kinematics differences between WLS and running shoes during the BBBS. Twenty-five inter-collegiate athletes and sport club members with 5-7 years of weight lifting experience volunteered for the study. Squats were performed in running shoes and WLS at 60% 1M to avoid altered kinematics that is caused by using heavier loads. Trunk lean displacement, peak thigh flexion angle, and foot segment angle were measured. Results showed that the foot segment angle and trunk lean displacement showed significant differences between WLS and running shoes, but no significant differences were seen in the thigh segment angle. They concluded by saying that WLS are beneficial because less shear stress is seen on the spine due to the WLS causing less trunk lean. If less shear stress is seen on the spine with WLS during the BBBS, looking at the effects of WLS on the deadlift is critical in trying to prevent possible injuries.

CHAPTER III: METHODS

Experimental Approach

Determining any kinematic changes between heel elevations when performing the barbell deadlift (BBDL) is essential to optimizing deadlift technique and reducing injury. The independent variable will be the heel elevation and the dependent variable will be the relative hip and knee angles, as well as the absolute thigh, ankle, and trunk angles. These measurements are instrumental in achieving correct form while engaging in the BBDL with weightlifting shoes (13). The current study will look at the same kinetic variables as the above mentioned research: relative hip, knee, and ankle angles as well as absolute thigh and trunk angles (1, 3, 4, 5, 6, 9, 13, 14, 15, 17, 19, 20,). In addition, ground reaction forces will be measured (14). Three-dimensional motion capture will be used since it is more accurate that two-dimensional capture (3). In the experimental procedures, custom-made wedges will be made to simulate the effects of wearing WLS (9). One-RM will be measured truly since prediction equations are not as useful for the BBDL (8).

Subjects

Males with at least one year of BBDL experience whose one repetition maximum (1RM) was at least 1.5 times their bodyweight were recruited from the Texas Tech University Sports and Recreation Center. All subjects came in to the Human Performance Lab on two separate visits. The first visit determined their 1RM under the supervision of qualified instructors. Subjects also familiarized themselves with the testing protocol.

Subjects underwent the testing protocol on the second visit that occurred a minimum of seven days later to account for recovery. Subjects were asked to refrain from all lower body training 3 days prior to 1RM testing and 3 days prior to experimental testing.

Instrumentation

Six custom-made wooden heel blocks of varying heights (0.25, 0.50, 0.75, 1.00, 1.25, and 1.50 inches) were fabricated for the study. Subjects were be prepared with reflective markers on the second metatarsal head, lateral malleolus, lateral femoral epicondyles, greater trochanter, sacrum, T10, and C7. Vicon Nexus 1.8.5 (Vicon Motion Systems Ltd., Denver, CO) captured the subjects' movements at 100 Hz with 5 overhead cameras.

Procedures

The data was collected in the Texas Tech Human Performance laboratory. All subjects signed a consent form. During the first visit, subjects' true 1RM were determined by attempting maximal loads. If a lift is successful, 5 to 20 pounds were added. Rest times will range from 2 to 4 minutes. The process was repeated until the 1RM is found (8). On the second visit, anthropometric data was recorded and testing protocol took place. All subjects completed the protocol barefoot. Subjects performed 3 repetitions at 70% 1RM (17) as explosively (16, 17) as possible while keeping optimal form under each heel elevation condition in a randomized order. Subjects were given 2 minutes to rest between each lift.

Data Processing

Relative spine, relative lumber, and knee angles and absolute spine, lumbar, thigh, and shank angles will be measured at lift off (LO) and at the moment when the bar passes the knee (KP) (3) in LabVIEW (National Instruments Corporation, Austin, TX) program with a low pass Butterworth filter at 10Hz. The average of the three attempts during each condition will be used for analysis.

Statistical Analysis

Statistical analysis was conducted in SPSS (version 21.0, IBM SPSS Inc., Chicago, IL). Seven separate one way ANOVAs (7 Heel Heights × 1 Angle) ($p < 0.05$) will be conducted for each measured angle at LO and KP. Post Hoc test will be implemented, if necessary.

CHAPTER IV: RESULTS AND CONCLUSION

Results

Twenty-two males (23.9 ± 2.23 years old, 175.95 ± 8.21 cm, 82.59 ± 14.26 kg) participated in the study. The subjects 1RM lifted on the first visit was 177.03 ± 30.67 kg (2.17 ± 0.29 × bodyweight). Seventy percent of their 1RM was rounded to the closest 5 pounds due to the availability of weightlifting plates.

There were no significant differences found at LO for Absolute Spine (p=*.610*), Absolute Lumbar (p=*.795*), Absolute Femur (p=*.231*), Absolute Shin (p=*.714*), Relative Spine (p=*.510*), Relative Lumbar (p=*.507*), and Relative Knee (p=*.247*). There were no significant differences found at KP for Absolute Spine (p=*.818*), Absolute Lumbar (p=*.852*), Absolute Femur (p=*.858*), Absolute Shin (p=*.290)*, Relative Spine (p=*.942*), Relative Lumbar (p=*.863*), and Relative Knee (p=*.802*). Tables 1 and 2 represent the data collected from this study.

Table 1: Kinematic Data at Lift Off

Heel Height	Absolute Spine		Absolute Lumbar		Absolute Femur		Absolute Shin		Relative Spine		Relative Lumbar		Relative Knee	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
0.00	69.86	7.85	51.19	7.07	77.36	6.85	64.12	5.48	19.10	4.08	130.40	15.22	131.76	14.85
0.25	69.80	7.67	52.44	9.29	75.44	6.78	64.21	5.92	18.86	6.52	128.73	15.48	131.12	16.05
0.50	70.25	7.47	51.45	7.16	76.71	6.29	63.46	4.88	19.54	6.46	129.94	14.37	130.29	14.12
0.75	69.50	6.59	51.58	7.40	76.03	6.02	63.08	5.39	19.53	6.44	128.10	13.31	128.60	13.45
1.00	69.73	6.59	51.95	7.24	76.96	6.27	63.12	3.99	18.49	5.50	129.72	13.22	130.73	12.37
1.25	72.71	7.02	51.71	9.05	77.21	6.35	63.82	5.47	20.85	8.56	129.83	17.21	132.14	13.79
1.50	70.33	7.29	51.77	6.99	77.14	5.93	63.02	5.24	19.32	5.71	129.35	12.06	130.98	13.68

Table 2: Kinematic Data at Knee Passing

Heel Height	Absolute Spine		Absolute Lumbar		Absolute Femur		Absolute Shin		Relative Spine		Relative Lumbar		Relative Knee	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
0.00	27.32	5.79	96.91	11.06	65.46	6.57	84.15	3.89	91.67	9.34	33.72	8.12	148.36	7.95
0.25	26.57	3.83	97.37	8.70	65.56	5.58	82.93	6.86	91.24	5.89	33.28	6.48	152.54	15.08
0.50	26.85	4.84	97.45	10.57	64.45	4.30	84.23	3.00	90.46	8.33	33.72	7.03	148.86	6.06
0.75	26.92	4.31	95.74	11.28	65.08	7.11	83.98	4.08	90.31	9.00	33.70	6.48	148.57	7.64
1.00	26.49	5.04	98.24	9.83	65.75	5.78	83.60	3.84	90.96	7.84	33.62	7.16	147.75	7.66
1.25	26.67	3.85	96.64	11.29	65.71	6.81	84.80	3.40	90.09	7.91	34.43	5.92	148.76	7.83
1.50	26.05	5.46	98.18	11.15	65.99	7.21	84.64	3.20	90.43	9.01	34.06	7.83	149.52	8.15

<u>Conclusion</u>

The purpose of the following study was to analyze the three-dimensional kinematics of multiple heel heights while performing the barbell deadlift. Statistical analysis showed no differences ($p > 0.05$) in any of the calculated angles between the 7 heel heights. Tables 1 and 2 show the absolute and relative angles at LO and KP.

The present data suggests that the elevation of the heel due to WLS have no effect on the kinematics of barbell deadlift performance. This could be explained as a result of the athletes lifting the bar with their lower back rather than with their legs. WLS were designed to let athletes engage in smaller Absolute Shin angles to keep a more upright back with their knees moving forward while in the catch phase of the Olympic lifts. While being elevated on the heels in this study, athletes still set up in a familiar position. The shin angle amongst the athletes did not change. This implies that ankle mobility has no effect on the set up of the BBDL.

The BBDL is considered to be an “objective lift”. The squat is considered a subjective lift because the athlete can adjust the path of the bar to their specific anthropometrics and range of motion as the bar is unracked from a height that is optimal to the athlete. Unlike the squat, the barbell during a deadlift is pulled from 8 inches from the floor. Athletes must adjust their bodies to the height of the bar and pull it in a manner that is most conducive to their biomechanics. Thus, each individual athlete will have their own motor pattern when executing the BBDL.

However, this study also has its limitations. The data also suggests that weight lifting shoes do not have a rationale for being manufactured at 0.75”. WLS shoes were made to help those with limited mobility in the ankle while performing the Olympic lifts (the clean and the snatch). Ankle mobility is more of an issue during the catching of the barbell into a deep squat. From literature, WLS have been shown to give lifters a more vertical torso while still reaching a parallel thigh angle (4, 13, 15). But these studies look specifically at the back squat, which is not the type of squat performed in a clean or snatch.

Further research in the area of WLS should look at the squats associated with the Olympic lifts: the front squat and the overhead squat. Since WLS show no effect on the deadlift portion of the Olympic lifts, these two squat patterns are the key movements to look at when looking at WLS kinematics. Also, the electromyography (EMG) of the associated muscles groups (quadriceps, hamstrings, gluteals, erector spinae, etc.) should be measured to see any changes in muscular activity.

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