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Does Footwear Influence Countermovement Jump Parameters Used to Assess Performance in Collegiate Basketball Players?

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ABSTRACT

Background: The countermovement jump (CMJ) is used to monitor short- and long-term changes in neuromuscular performance, where practically relevant alteration may be subtle, requiring detailed and consistent testing protocols to limit error and allow detection of meaningful change. Collegiate basketball players often wear different types of footwear depending upon the training activity, potentially influencing CMJ performance outcomes. **Objective:** This study evaluated the influence of footwear on key CMJ variables used for routine performance assessments in a cohort of 11 NCAA women's collegiate basketball players. **Method:** In a cross-over repeated measures study design, players performed three CMJs in Basketball-, Training-(Trainers), and Olympic Weightlifting (WL) shoes, in a randomized order during one testing session. One-way repeated measures analyses of variance ($p \leq .05$) and effect sizes (Cohen's d) were used to discern differences in CMJ variables among shoe conditions. **Results:** WL demonstrated greater Eccentric Mean Force ($p \leq .014$, $d \geq 0.03$) and lower Flight Time:Contraction Time ($p \leq .029$, $d \geq 0.31$), Jump Height ($p \leq .040$, $d \geq 0.32$), and Reactive Strength Index-Modified ($p \leq .032$, $d \geq 0.40$) than both Basketball and Trainers. Additionally, WL exhibited lower Concentric Mean Force ($p = .018$, $d = 0.19$), Concentric Mean Power ($p = .008$, $d = 0.29$), Eccentric Peak Force ($p = .050$, $d = 0.19$), and Flight Time ($p = .036$, $d = 0.31$) compared to Trainer. No significant differences and only trivial effects appeared between Basketball and Trainers ($p > 0.05$, $d < 0.1$). **Conclusion:** These findings suggest footwear significantly influences CMJ performance. WL shoes appear to negatively impact CMJ performance; however, Basketball and Trainers appear to exert negligible effects that should allow clinicians and practitioners to feel confident about measurement and data quality when performing short- and long-term CMJ measurements in either Basketball or Trainers.

Key words: Shoes, Athletic Performance, Basketball, Exercise Testing, Female

INTRODUCTION

The countermovement jump (CMJ) is frequently used in team sports to monitor changes in neuromuscular performance, which can be used to reflect athlete fatigue and readiness (Gathercole et al., 2015; Heishman et al., 2018; Spiteri et al., 2013). Additionally, examining trends of serial CMJ measurements over time can allude to longitudinal changes in neuromuscular performance, which contains practical relevance for sports scientists and applied practitioners (Ferioli et al., 2018; Heishman, Daub, Miller, Freitas, & Bemben, 2020). As such, both acute and chronic changes in neuromuscular performance can provide short term practical utility, such as guiding recovery strategies leading into competition, but may also provide useful long-term applications, such as identifying deficits that direct training programs for long-term development. However, both short and long-term changes may manifest as only subtle or small in magnitude, requiring detailed and consistent testing protocols to limit error and generate the clearest data for interpretation.

Collegiate basketball student-athletes wear an assortment of footwear depending upon their specific training activity for the day, such as during training exposures of sport-specific basketball practice, strength training, or energy system development. Most frequently, basketball players wear specific shoes during all basketball activities, such as those worn during practice and competition (Figure 1a) (Luczak, Burch, Smith, Lamberth, & Carruth, 2020). Beyond the superficial attraction of fashion and aesthetic appeal, basketball shoes are designed to enhance the foot to ground interaction in an attempt to enhance performance by providing the adequate traction and support required to meet the demands of the multi-directional sport-specific movements, including repeated cutting, accelerations, decelerations, jumping, and change-of-direction maneuvers (Luczak, Burch, Smith, Lamberth, & Carruth, 2020; Luczak, Burch, Smith, Lamberth, Carruth, et al., 2020; Nigg et al., 1995). Additionally, basketball footwear seeks to enhance movement efficiency

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and explosiveness through their lightweight constructs and materials (Vienneau et al., 2015). Complementing the ergogenic benefits, basketball shoes may also be considered personal protection equipment (PPE) during play, as a large emphasis in their design has concomitantly focused on mitigating injury risk (Brizuela et al., 1997; Fu et al., 2014; Liu et al., 2017; Zhang et al., 2019). Basketball shoes are equipped with added cushion to attenuate forces between the foot and hardwood surface, which may be particularly valuable during jumps and landings as ground reaction forces during jump take-off may exceed upwards of three-fold bodyweight and may exceed seven-fold body weight during landing (McClay et al., 1994). However, recent advancements regarding the design and development of the basketball shoe have shifted focus towards increasing ankle stability in an effort to reduce lower extremity injuries which appear to be the most prevalent injuries during basketball, however the effectiveness of these efforts remain unclear (Curtis et al., 2008; Ito et al., 2015; Meeuwisse et al., 2003). Nevertheless, basketball shoes have evolved into an essential piece of ergogenic and protective equipment for basketball players.

In addition to specialized basketball shoes worn during on-court activities, elite collegiate basketball players are often also issued cross-training shoes (Figure 1b) by the university, which act as a hybrid between classic running shoes and basketball shoes. Cross-training shoes are often used during energy system development or conditioning activities that require increased volumes of running, but still provide athletes the adequate stability necessary to perform speed and agility training. Consequently, such benefits have led to the use of the cross-training shoes during portions or all of strength training sessions. Moreover, athletes may also wear weightlifting (WL) shoes during specific strength training exercises and activities (Figure 1c). The use of WL shoes originated in Olympic-style weightlifters, where they are used during both training and competition, and recommended for the purpose of protecting the lifter's feet while also providing support for a firm and stable stance (Sato et al., 2012). These shoes are equipped with a rigid, noncompressible sole that also has an elevated heel in relation to the forefoot, placing the ankle in greater plantarflexion when standing (Fortenbaugh et al., 2008; Legg et al., 2017; Sato et al., 2012). The heel lift created by the shoe enhances the degrees of freedom at the ankle, improving biomechanical positions throughout the kinetic chain, ultimately allowing increases in range-of-motion during exercises such as the squat (Fortenbaugh et al., 2008; Sato et al., 2012). Some evidence has shown that the declined surface, an effect generated by the heel lift of the WL shoe, increases knee extensor muscle activation during the bilateral squat, potentially due to increases in knee flexion with added degrees of freedom at the ankle (Kongsgaard et al., 2006). These advantages in range-of-motion and stability have led to the use of WL shoes among other athletic populations, including collegiate basketball players during strength training activities.

The variety of footwear worn by collegiate basketball players throughout training makes understanding the potential influence of footwear on CMJ performance outcomes essential for both performance and medical staffs. Previous work has focused on comparing standard footwear to barefoot and minimalist footwear conditions (Blache et al., 2011; Harry et al., 2015; LaPorta et al., 2013; Smith et al., 2020). Minimalist footwear is characterized by its construction with lighter, more flexible materials and by a lower heel-to-toe drop than standard footwear (Esculier et al., 2015; Smith et al., 2020). Although, prior investigations have predominantly investigated the gross output of vertical displacement as the primary outcome for CMJ performance, contradictory evidence remains regarding the impact of footwear. La Porte et al. (LaPorta et al., 2013) identified increases in jump height (JH) during the CMJ when performed in barefoot and minimalist shoe conditions compared to traditional footwear. Similarly, in a case study design of one national level basketball player, Blache et al. (Blache et al., 2011) reported increases in JH while barefoot, as well as in six other minimalist footwear models when compared to standard footwear. In contrast, footwear appeared to have no influence on performance in other comparable investigations (Chowning et al., 2021; Harry et al., 2015; Luczak, Burch, Smith, Lamberth, & Carruth, 2020; Smith et al., 2020). These conflicting findings combined with previous work limiting CMJ performance analysis to JH warrants more investigation with inclusion of other key CMJ parameters that represent CMJ performance in the applied performance setting. In addition, despite the variety of footwear worn by the student-athletes throughout training, research has yet to examine the potential influence of the various footwear on CMJ performance indices commonly used for athlete profiling and monitoring strategies in collegiate basketball student-athletes. Therefore, the purpose of this study was to evaluate the influence of footwear on CMJ performance variables in a cohort of women's collegiate basketball players. Specifically, this

Figure 1. Examples of each shoe condition; a. = Basketball Shoe; b. = Training shoe; c. = Olympic Weightlifting Shoe

study sought to examine the differences in CMJ performance when the CMJ was performed in Basketball shoes (Basketball), Training shoes (Trainers), and Olympic Weightlifting shoes (WL). The research team hypothesized WL would exhibit greater CMJ performance in all variables compared to both Basketball and Trainer, due to the rigid sole allowing an increase in force transfer. Additionally, the research team hypothesized that no differences in performance would be detected between Basketball and Trainers as these shoes appear to have relatively similar heel-to-toe drop and sole cushioning.

METHODS

Design

A randomized cross-over within subject study design was used to evaluate the potential influence of the independent variable of footwear worn on the dependent variables of countermovement jump (CMJ) performance, which are outlined in Table 1. In a randomized order, participants performed three CMJs with a Basketball, Trainer, and WL shoe (Figure 1a-c). Testing took place during the preseason training period. All testing transpired at the basketball performance training center, prior to the beginning of the athlete's strength training session. Participants did not have team practice or training 48 hours prior to testing.

Table 1. Description of Countermovement Jump Performance Variables

CMJ Variable	Description
Concentric Duration [ms]	Duration of the concentric phase
Concentric Impulse [Ns]	Concentric force exerted multiplied by time taken
Concentric Mean Force [N]	Mean force during the concentric phase
Concentric Mean Power [W]	Mean power during the concentric phase
Concentric Peak Velocity [m/s]	Greatest velocity achieved during the concentric phase
Contraction Time [ms]	Duration from jump initiation to take-off
Eccentric Duration [ms]	Duration of the eccentric phase
Eccentric Mean Force [N]	Mean force during the eccentric breaking phase
Eccentric Mean Power [W]	Mean power during the eccentric phase from start of movement to zero velocity
Eccentric Peak Force [N]	Greatest force achieved during the eccentric phase
Flight Time [ms]	Time spent in the air from jump take-off to landing
Flight Time: Contraction Time	Ratio of flight time-to-contraction time
Jump Height [cm]	Maximal jump height computed using flight time
Peak Power [W]	Greatest power achieved
Reactive Strength Index-Modified	Jump height (calculated from flight time) divided by contraction time

CMJ=countermovement jump; cm=centimeters; ms=milliseconds; m/s=meters per seconds; Ns=newtons; W=watts; (Heishman, Daub, Miller, Freitas, Frantz, *et al*., 2020)

Participants

A convenience sample of 11 NCAA Division 1 collegiate female basketball players (mean ± SD, n = 11, age = 19.9 ± 1.45 years, height = 180.3 ± 9.4 cm, body mass = 82.3 ± 8.6 kg) were included in this study. The sample size was determined based upon previous published data (LaPorta et al., 2013), calculated in G*Power (G*Power, Dusseldorf, Germany) with a proposed minimum effect size of 0.4, power (1- β) of 0.8, $\alpha < 0.05$ for multiple comparisons, and correlation of 0.7 for repeated measures. Additionally, recruitment was limited due to roster size of the basketball team, as researchers wanted to maintain ecological validity of the sample including only varsity athletes. The current data was collected as part of the university's sport science initiative. All procedures were in line with the Declaration of Helsinki and participating athletes provided consent before participating.

Procedures

Participants performed three CMJs in each shoe condition (Basketball, Trainers, WL), with the average of the three jumps used for the analysis (Claudino et al., 2017). The order of footwear condition was randomly assigned to each participant. All participants were familiar with the CMJ testing protocol and it is routinely performed on a regular basis for athlete monitoring and profiling purposes. Before CMJ testing commenced, participants performed the same standardized warm-up, which included dynamic stretching and locomotion patterns (i.e., skipping, jogging, and running), similar to previous literature (Heishman et al., 2018; Heishman, Daub, Miller, Freitas, Frantz, et al., 2020). The intensity of movements gradually amplified over the course of the warmup to ready participants for maximal jump performance when testing. CMJs were performed on the ForceDecks FD4000 Dual Force Platforms hardware (Vald Performance, Brisbane, Australia), with a sample rate of 1000 Hz. Participants were directed with the same instructions prior to each jump trial, including to "jump as high and as fast as possible," as well as supported with standardized and consistent verbal encouragement to facilitate maximal effort during each CMJ attempt.

Countermovement Jump

Participants performed the CMJ with hands placed on their hips to mitigate the influence of the arm swing and isolate the lower extremity function, which is routinely used in athlete monitoring protocols to examine acute fatigue and neuromuscular readiness (Heishman et al., 2018; Heishman, Daub, Miller, Freitas, & Bemben, 2020; Heishman, Daub, Miller, Freitas, Frantz, et al., 2020). Participants started in the tall standing position, with their feet placed hip width to shoulder with apart, while also ensuring equal weight distribution on each force platform, and their hands akimbo. From there, the participant rapidly decended into the countermovement position to a self-selected depth and immediately proceeded into a maximal effort vetical jump, and then finally landed in an athletic position on the force platforms. After each jump attempt, the participants reset to the starting position and repeated the previous steps for a total of three jumps. If at any time throughout the jump the participant lost contact between their hands and hips, or displayed excessive knee or hip flexion while in the air, the jump was deemed invalid and repeated. These methods were repeated for the two subsequent footwear conditions, with each condition separated by a minimum of 2 minutes rest.

All data were processed and analyzed by the ForceDecks commercially available software (Vald Performance, Brisbane, Australia) and detailed methods can be found elsewhere (Heishman, Brown, et al., 2019; Heishman, Daub, Miller, Freitas, Frantz, et al., 2020). The variables of interested are outlined in Table 1 and were selected due to their practical relevance and potential value to applied practitioners, in conjunction with being previously reported in the literature.

Statistical Analysis

Descriptive statistics are reported as mean ± SD, unless otherwise mentioned. First, the combination of descriptive and graphical information accompanied by the Shapiro-Wilk test statistic was used to establish data normality. A one-way repeated measures analysis of variance was used to discern differences among conditions (Basketball vs. Trainer vs. WL). When a significant main effect was detected, post-hoc pairwise comparisons with Bonferroni corrections were used to isolate simple effects between conditions. Additionally, the magnitude of difference within each pairwise comparison was evaluated using Cohen's d (d) effect sizes and were interpreted as trivial (0–0.19), small (0.20–0.49), medium (0.50–0.79), and large (≥0.80) (Cohen, 1992). All data were analyzed using SPSS, Version 27 (SPSS INC., Chicago, IL). Statistical significance was set at $p \leq 0.05$.

RESULTS

A significant main effect for differences across conditions was detected for Concentric Duration ($F(2,20) = 3.86$, $p = .038$), Concentric Impulse ($F(2,20) = 5.47$, $p = .017$), Concentric Mean Force ($F(2,20) = 6.22$, $p = .008$), Concentric Mean Power ($F(2,20) = 7.18$, $p = .004$), Eccentric Mean Force ($F(2,20) = 13.85$, $p < .001$), Eccentric Mean Power ($F(2,20) = 2.48$, $p = .014$), Eccentric Peak Force ($F(2,20) = 5.07$, $p = .017$), Flight Time ($F(2,20) = 6.36$, $p = .007$), Flight Time:Contraction Time ($F(2,20) = 8.43$, $p = .002$), Jump Height ($F(2,20) = 6.52$, $p = .004$), and Reactive Strength Index-Modified ($F(2,20) = 10.29$, $p = .001$).

As outlined in Table 2 and Figure 2, pairwise comparisons revealed significant differences between Weightlifting and Basketball shoes, with Weightlifting exhibiting significantly greater Eccentric Mean Force ($p = .014$, $d = 0.03$), as well as significantly lower Flight Time:Contraction Time ($p = .029$, $d = 0.31$), Jump Height ($p = .035$, $d = 0.33$), and Reactive Strength Index-Modified ($p = .032$, $d = 0.40$) when compared to Basketball. Additionally, pairwise comparisons revealed significant differences between Weightlifting and Trainer shoes, with Weightlifting demonstrating significantly greater Eccentric Mean Force ($p = .002$, $d = 0.05$), Eccentric Mean Power ($p = .008$, $d = 0.12$), as well as significantly lower Concentric Mean Force ($p = .018$, $d = 0.19$), Concentric Mean Power ($p = .008$, $d = 0.29$), Eccentric Peak Force ($p = .050$, $d = 0.19$), Flight Time ($p = .036$, $d = 0.31$), Flight Time:Contraction Time ($p = .015$, $d = 0.39$), Jump Height ($p = .040$, $d = 0.32$), and Reactive Strength Index-Modified ($p = .004$, $d = 0.49$). Although there was a main effect, no significant differences during pairwise comparisons emerged

Table 2. Countermovement Jump Performance Results Across Conditions

Variable	Basketball	Trainer	Weightlifting
Concentric Duration [ms]	231.3 ± 45.9	228.2 ± 45.0	234.5 ± 43.7
Concentric Impulse [Ns]	188.2 ± 23.8	187.4 ± 23.1	184.6 ± 21.9
Concentric Mean Force [N]	1645.1 ± 188.2	1650.1 ± 182.4	1616.6 ± 164.0#
Concentric Mean Power [W]	2129.2 ± 279.3	2142.2 ± 265.4	2070.2 ± 235.0#
Concentric Peak Force [N]	2143.6 ± 435.7	2183.8 ± 467.5	2110.5 ± 379.9
Concentric Peak Velocity [m/s]	2.41 ± 0.14	2.42 ± 0.15	2.39 ± 0.11
Contraction Time [ms]	642.7 ± 84.4	638.4 ± 86.6	655.3 ± 81.6
Eccentric Duration [ms]	411.6 ± 46.0	410.1 ± 49.6	420.7 ± 46.2
Eccentric Mean Force [N]	810.1 ± 85.5	808.6 ± 84.2	812.5 ± 83.9*#
Eccentric Mean Power [W]	496.2 ± 111.3	492.2 ± 102.9	504.6 ± 110.3
Eccentric Peak Force [N]	2105.6 ± 405.8	2128.6 ± 421.6	2054.3 ± 343.9#
Flight Time [ms]	478.8 ± 29.2	479.2 ± 28.6	470.8 ± 24.3
FT:CT	0.76 ± 0.09	0.76 ± 0.09	0.73 ± 0.09*#
Jump Height [cm]	26.7 ± 3.7	26.6 ± 3.8	25.6 ± 3.0*#
Peak Power [W]	3694.9 ± 444.2	3766.3 ± 454	3697.4 ± 409.2
RSI_{Mod} [m/s]	0.44 ± 0.06	0.45 ± 0.06	0.42 ± 0.05*#

Data presented as mean ± standard deviation. FT:CT=Flight Time: Contraction Time; RSI_{Mod}=Reactive Strength Index-Modified; * = significantly different from Basketball, p≤0.05; # = significantly different from Trainer, p≤0.05.

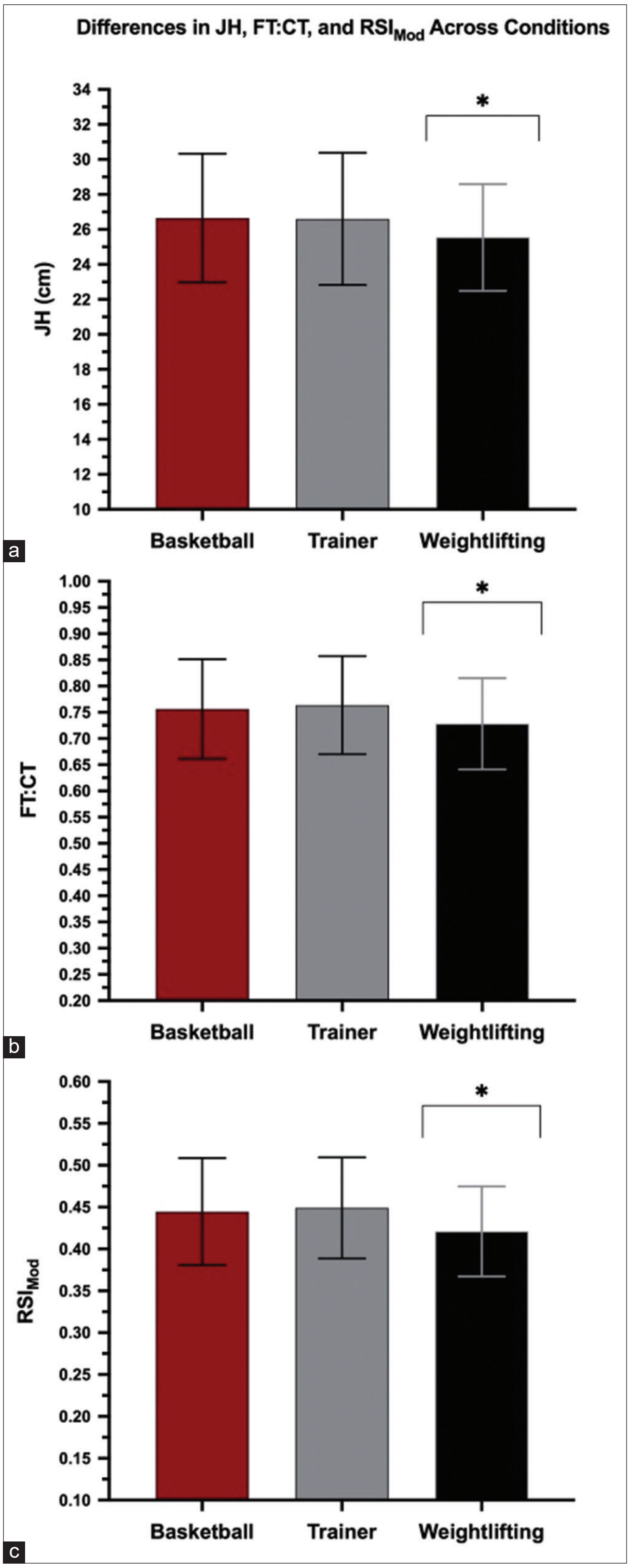

Figure 2. Differences in Jump Height (JH), Flight Time:Contraction Time, and Reactive Strength Index Modified (RSI_{Mod}) across conditions. Presented as Mean ± SD;* = Statistically different from Basketball and Trainer, $p < 0.05$.

for Concentric Duration or Concentric Impulse (*p* > .05). Importantly, no significant differences for any variable and only trivial to no effects were detected between Basketball and Trainers (*p* > .05, *d* < 0.09). There were no significant main effects detected across conditions for Contraction Time (*p* = .070), Concentric Peak Velocity (*p* = .095), Eccentric Duration (*p* = .151), Eccentric Mean Power (*p* = .110), or Peak Power (*p* = .062).

DISCUSSION

The purpose of this study was to evaluate the influence of footwear on CMJ performance variables in a cohort of women's collegiate basketball players, specifically comparing performance when performed in Basketball, Trainers, and WL shoes. The primary findings of the present study were 1) statistically significant differences appeared of small to medium magnitude in CMJ variables favoring the Basketball and Trainers over the WL shoes, but 2) there were no statistically significant differences for any CMJ variable between the Basketball and Trainers conditions. These findings contain practical relevance for practitioners and clinicians that incorporate CMJ testing into athlete monitoring strategies, performance testing batteries, or return-to-play and return-to-competition protocols.

Previous research contains conflicting observations regarding the influence of footwear on CMJ performance. In parallel with decreased JH observed with WL in the present study, LaPorte et al. (LaPorta et al., 2013) and Blache et al. (Blache et al., 2011) identified increase JH in minimalist footwear and barefoot compared to standard footwear. Previous work has focused on the comparison of barefoot and minimalist footwear conditions to standard footwear. Minimalist footwear have a lesser heel-to-toe drop and are typically built with lighter, more flexible materials than standard footwear (Esculier et al., 2015; Smith et al., 2020). Intuitively, this creates an obvious contrast to the WL shoes in the present study, which are designed with a rigid, noncompressible sole and increased heel lift, which elevated the rearfoot in relationship to the forefoot, subsequently increasing the heel-to-toe drop compared to standard footwear (Sato et al., 2012). Although the WL shoe may be advantageous during the squat and other weightlifting exercises for a variety of reasons (Legg et al., 2017; Sato et al., 2012), the culmination of data suggests an apparent inverse association between shoe heel-to-toe drop and CMJ performance. However, the inclusion of barefoot or minimalist conditions needed to bolster this proposition were not included in current study design due to increases in perceived risk of performing maximal jumps on the hard surface of the force platform combined with the lack of practical relevance to athlete monitoring protocols.

Tendonous structures have a high capacity to store and transfer elastic energy, playing a vital role in SSC action, especially when coupled with the other elastic properties of the musculoskeletal system (Nicol et al., 2006; Roberts, 2016). The elevated heel of the WL shoe increases the forefoot to rearfoot slope, likely decreasing ankle flexion as the athlete descends to their self-selected depth during the CMJ movement, subsequently limiting tendon lengthening during the stretch phase of the SSC, ultimately resulting in less energy transfer in the concentric or propulsion phase. To the same effect, potential contributions from the proprioceptive stretch-reflex may be suppressed with less ankle flexion required to achieve the desired jump depth in WL shoes, but stimulated when more ankle flexion is incorporated into the movement while wearing the Basketball and Trainers in the present study or during the barefoot and minimalist conditions of previous work (Blache et al., 2011; LaPorta et al., 2013). While the speculated contribution of the stretch-reflex could partially explain disparity in performance, research examining joint kinematics are required to be certain. These findings may prompt practical considerations among coaches and clinicians associated with footwear selection when prescribing exercises directed at maximizing SSC function during training, such as plyometric activities.

Previous work has also failed to detect an influence of footwear on CMJ performance, with a large emphasis on comparing barefoot and minimalist footwear to other shod conditions (Chowning et al., 2021; Harry et al., 2015; Luczak, Burch, Smith, Lamberth, & Carruth, 2020; Smith et al., 2020). Interestingly, previous investigations reporting no differences in CMJ performance with various footwear conditions implemented the CMJ method of allowing the arm swing, while both La Porte et al. (LaPorta et al., 2013) and the present study, which observed differences in CMJ performance, in the CMJ approach that restricts the arm swing. Previous work has already documented the influence the arm swing exerts on kinetic and kinematic CMJ parameters (Feltner et al., 2004; Hara et al., 2008; Heishman, Brown, et al., 2019; Heishman, Daub, et al., 2019). As such, the present study employed the CMJ method restricting arm movement as it is often the preferred method used in the applied setting to monitor acute changes in performance and readiness (Gathercole et al., 2015; Heishman, Daub, Miller, Freitas, & Bemben, 2020; Rowell et al., 2018), as it is thought to isolate lower extremity function and has been demonstrated to enhanced reliability in key metrics (Heishman, Daub, Miller, Freitas, Frantz, et al., 2020). Nevertheless, it is possible that participants may be able to biomechanically compensate for small deficits and mask differences in CMJ performance generated by footwear with the arm swing, however this should be investigated by future literature.

The present study adds a novel approach by including a temporal analysis to discern where the kinetic alterations may arise. The WL shoe appeared to increase eccentric forces and power, while decreasing concentric force and power compared to the Basketball and Trainers. Increases in force and power during the eccentric phase may reflect the greater cushion of both the Basketball and Trainers, which could dissipate forces as the athlete descends into the countermovement or unweighting phase of the CMJ. In contrast, the rigid, less-cushioned sole of the WL shoe allowed more force to be transferred to the force platform. However, the Basketball and Trainers exhibited increases in force during the concentric phase regardless of their heavier cushioned sole, which has been speculated to possibly reduce force transfer (LaPorta et al., 2013). The reductions in force and power during the concentric or propulsion phase while wearing the WL are likely explained again by the elevated heal constraining SSC function, as previously discussed.

There were no significant differences in any CMJ performance variables between Basketball and Trainers and trivial to no effects were observed. Although CMJ testing is utilized throughout athlete performance, to our knowledge, this is the first study to compare CMJ performance in cross-training shoes to basketball specific footwear. These finding may offer the most practical value to practitioners and clinicians by suggesting controlling for footwear between Basketball or Trainers in serial assessments may not be required, mitigating a logistical challenge accompanying data acquisition in the applied performance environment. Although not directly examined in this study, the lack of observed differences may relate to the Basketball and Trainer sharing similar constructs, such as heel-to-toe height, as well as sole cushioning and stiffness. Basketball shoes often include increased ankle support through ankle collar height and stiffness, however their effect on performance remains trivial (Brizuela et al., 1997; Liu et al., 2017). Also noteworthy, while these findings may seem to challenge the ergogenic benefit of Basketball shoes, jumping is only one component of the sport-specific movements required during play and other factors should be considered (Luczak, Burch, Smith, Lamberth, & Carruth, 2020; Mohr et al., 2016; Vienneau et al., 2015; Zhang et al., 2019).

This study was focused on examining a practical relevant question regarding data collection by coaches and practitioners in the applied setting, therefore the testing protocol placed a large emphasis on ecological validity, which has led to some potential limitations. Firstly, not all athletes wore the same exact model of Basketball shoe, which could introduce variability of the Basketball shoe data; however, previous work has shown no difference in performance across various basketball shoe models (Luczak, Burch, Smith, Lamberth, & Carruth, 2020). Secondly, although previous work has demonstrated performance may not be affected by subtle differences in shoe weight if participants are unaware of such differences (Mohr et al., 2016), this study did not include perceived or psychologic effects of shoe type, which could underlie the observed differences in performance across conditions. Finally, the small sample size is always a challenge when performing research in high-level athletic population and these findings may only be generalizable to other female collegiate basketball players.

The results of this study offer direct practical implication for practitioners and clinicians. Controlling for footwear during CMJ performance assessments in an effort to enhance data quality by maximizing the signal-to-noise ratio of athlete profiling and monitoring strategies can be logistically challenging in the applied performance setting. However, these findings demonstrate Basketball and Training shoes exerting negligible differences on CMJ performance results. Therefore, concerns from practitioners and clinicians associated with controlling for footwear between Basketball and Training shoes during CMJ testing appears unnecessary. Additionally, clinicians and practitioners should not test CMJ performance with athlete wearing WL shoes, as their performance will be blunted and may also consider avoiding the use of WL shoes when performing other exercises directed at maximizing SSC function, even if frequent shoe changes are required within a training session, as performance in these tasks will also likely suffer in WL shoes.

CONCLUSION

In summary, this study examined the influence of Basketball, Trainers, and WL shoes on CMJ performance indices commonly used to develop physical performance profiles and monitor acute neuromuscular readiness in collegiate basketball student-athletes. This study identified significant decreases of small to medium magnitude in CMJ performance when performed in the WL shoes compared to both the Basketball and Trainers. However, no differences in CMJ performance were noted between Basketball and Trainers. Therefore, at minimum practitioners and clinicians should avoid performing CMJ assessments in WL shoes or comparing CMJ performance performed in WL shoes with other footwear (e.g., Basketball or Trainers), but may also consider avoiding the execution of exercises in WL shoes that are targeted at optimizing SSC utilization, such as plyometrics. Collectively, Basketball and Trainer footwear appears to exert negligible effects on CMJ performance. These observations should allow clinicians and practitioners to feel confident about measurement and data quality when performing short- and long-term CMJ measurements in either Basketball or Trainers.

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