**Houck et al. (2021) *Int J Res Ex Phys*. *17*(1):12-22.**

Sponsored by:
Exercise and Sport Science Program
Western Colorado University

International Journal of Research in Exercise Physiology

Original Research Article

# Jumpers' Subjective Perception of Footwear, but not Jump Performance, is Influenced in a Placebo-Like Manner by a Retail Orthotic

Carmen R. Houck[1], David S. Senchina[1]

[1]Kinesiology Program, Biology Department, Drake University, Des Moines, IA, USA

## Abstract

**Introduction:** Within the realm of sports and exercise, athletes have a desire to improve performance and a common strategy is via equipment. In this study, the performance effects and wearer perception of a butadiene and natural rubber retail orthotic was investigated. **Methods:** A total of 38 subjects (20 females and 18 males) were included. Subjects performed all tasks twice in identical shoes that differed in whether the orthotic was present or absent. Subjects were divided equally into two groups. In the Aware group (AWG), subjects were told which shoes contained the orthotic and which did not; in the Unaware group (UAWG), condition was not disclosed to them. Measurements included maximum vertical jump and broad jump performance, goniometry (dorsiflexion, plantarflexion, inversion, eversion), and several perceptual measurements (shoe comfort, shoe stability, shoe cushioning, and jump performance). **Results:** Across both groups, there were no significant differences for orthotic versus control in maximum vertical jump performance (18.1±5.7 in. for orthotic, 18.4±6.2 in. for control), broad jump performance (71.4±19.3 in. for orthotic, 70.2±19.5 for control), goniometry measurements, or performance perception. There were no differences in footwear perception scores between orthotic versus control in the UAWG, however, there were significant differences in the AWG such that they rated the orthotic condition as more comfortable after both jumps and more cushioned after the broad jump compared to control. **Conclusions:** Since there was no significant differences in jump performance, goniometry measurements, or performance perception in either group, and differences in footwear perception were seen only in the UAWG, results may indicate a placebo-like effect.

**Key Words:** Broad Jump, Horizontal Jump, Insert, Insole, Maximum Vertical Jump, Sockliner.

## Introduction

Athletes face conflicting or confusing information about the value of performance-enhancing equipment and attire. It can be difficult to know whether a given item is actually improving performance or not, and whether that improvement is coming from physical or psychological mechanisms. For example, several studies have shown that lightweight basketball shoes improve basketball-associated performance (such as vertical jump height) only when the athlete is aware that one pair of shoes is lighter relative to another[1,2], and can have no impact when athletes are unaware of shoe mass[3,4]. This suggests that product marketing may be more important than product design.

Orthotics (inserts, insoles, sockliners) are a common and easy way to alter shoes that may change how the shoes influence athlete performance. Studies have shown a variety of results on jump performance due to the addition of a shoe orthosis. One study showed that a carbon fiber insert placed in minimalist running shoes increased jump height compared to a no-insert control (70.6±11.4 vs. 69.7±11.5 cm. in males and 46.8±4.8 vs. 45.0±4.6 cm. in females)[5]. Another study showed that a polyurethane insert placed in both the medial and lateral compartments of basketball shoes also increased jump height compared to a no-insert control (63.2 vs. 61.5 cm)[6], which they attributed to the increased stiffness of the orthotic imparted to the footwear. When only a medial plate was used, there was no difference between insert and control. However, a third study using polyurethane inserts of various thicknesses placed inside cross-training shoes reported that a softer insole improved maximum vertical Jump (MVJ) compared to a stiffer version (56.6±9.4 vs. 53.0±10.7 cm.)[7]. A fourth study using a "thermoplastic elastomer" orthotic with basketball shoes reported that the orthotic did not improve either MVJ or broad jump performance (values not given in the paper)[8]. This latter study reported that subjects were blinded to footwear condition, whereas the other three did not report whether subjects were blinded or not. Using a different jumping test which mirrored how soccer players jump when they head balls, it was reported that a polyurethane orthotic inside a trainer shoe improved vertical jumping kinetics compared to the shoe alone, but only in "flexible flatfooted" individuals[9]. Whether subjects were blinded to condition or not was not reported.

Other researchers studied midsole variation and how it influenced jumping. Subjects wearing a stiff carbon fiber midsole in road running shoes had improved MVJ performance by an average of 1.7 cm compared to the same shoe without the test midsole[10]. Focusing instead on single-leg jump landings, another study reported that a stiffer fiberglass insole inserted into basketball shoes caused region-specific ankle and foot compensations compared to control basketball shoe[11]. Finally, inserting a carbon graphite footplate into a neutral cushioned running shoe was associated with changes in regional foot forces across seven jumping tasks[12]. Of the three midsole studies, only one[11] specifically reported that subjects were blind to footwear condition.

Previous research therefore suggests orthotics of different materials composition may influence jump performance positively or negatively. However, it is unclear what factors may be causing differences in results, and specifically the role that awareness/unawareness of footwear condition may play. The purpose of this study was to investigate the validity of a retail orthotic's claim that its addition would allow people to "jump higher and farther and increase your performance". It was first hypothesized that both maximal vertical jump and broad jump would be affected by the addition of a retail orthotic. It was second hypothesized that knowledge of footwear condition would cause improvements in jump performance.

## Methods

### Participants

Drake University's Institutional Review Board approved the experiment (IRB ID 2012-13013). There were two different groups of subjects in the study: in the first group (Fall 2019) subjects were unaware of which footwear condition they had, and in the second group (Fall 2020) subjects were informed and reminded of which footwear condition they had. The two groups will be hereafter referred to as "Unaware" (UAWG) and "Aware" (AWG), respectively. Thirty-eight different people participated across the two groups. To participate, they had to be free of any injuries that would hinder jumping performance and able to safely exercise in the shoe sizes we had.

### Procedures

The shoes used were New Balance 860, size 8 for females and size 11.5 for males (Figure 1). There were two pairs each of the females' and the males' shoes. One pair was unaltered from the manufacturer ("Control"), while the other contained a Springbak Springsole, made of butadiene and natural rubber, inserted under the regular shoes' insole ("Treatment"). All subjects were given a new pair of Nike Performance Cotton Cushioned ankle cut socks to wear throughout the experimental session. The overall experimental design is presented in Figure 2.

**Figure 1.** New Balance 860 shoes used in this study, with women's on the left and men's on the right.

Sponsored by:
Exercise and Sport Science Program
Western Colorado University

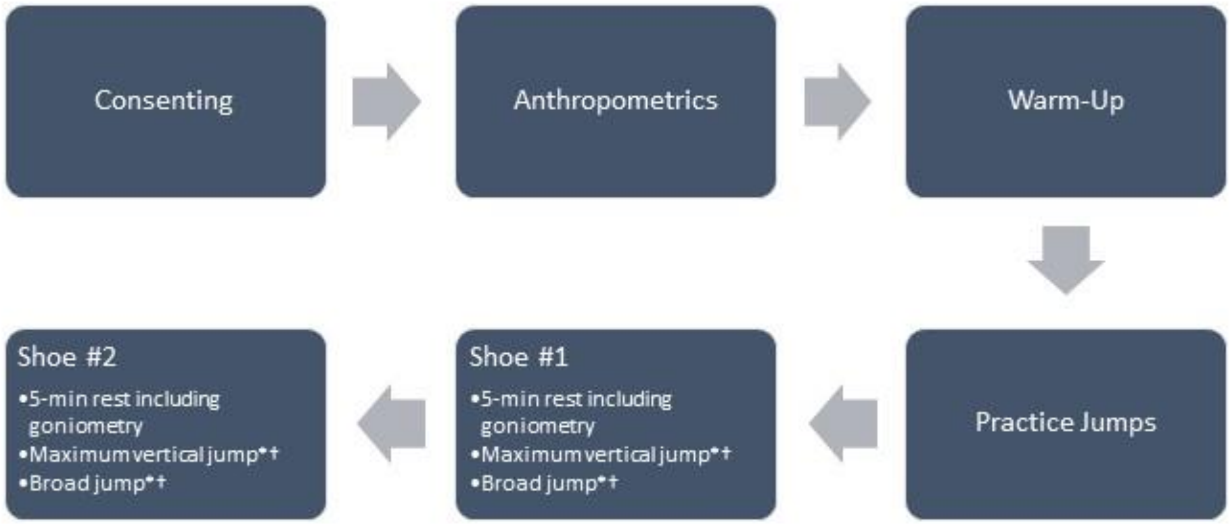


**Figure 2.** Experimental flow diagram. Shoes were presented to subjects in counterbalanced (alternating) order. Within a block, all sub-events occurred in the order shown. Asterisks indicate where subjects were asked to evaluate their performance after each individual jump using a Likert scale. Daggers indicate where subjects were asked to evaluate shoe properties after completing all three jumps at that station.

First, the subjects came into the lab and filled out the informed consent form. Anthropometric data (age, height, weight) was collected as well as brand, model, and size of the subject's own shoes.

Next, the subject was led through a standardized warm-up in their own shoes. The warm-up included static and dynamic stretching. Then, the subject was allowed two practice jumps for both the maximum vertical jump and the broad jump in their own personal shoes. Standing reach was also established on the Vertec.

To begin the experiment proper, the subject was then given the first shoe. UAWG subjects were not told whether their shoes were the control or treatment shoes, while AWG subjects were told. Once subjects put the shoes on, a five-minute timer was started (to ensure consistency in time the subjects wore the shoes prior to exercise). During the five minutes, goniometry measurements were taken including ankle inversion, ankle eversion, ankle dorsiflexion, and ankle plantarflexion. Two different investigators performed the goniometry: one person did all the goniometry for the UAWG, and the other person did all the goniometry for the AWG. Subjects sat on a plinth for the remaining five minutes.

Upon the completion of the five minutes, the subject was led to the Vertec and timing mat for the maximum vertical jump test. For AWG subjects, one experimenter at the Vertec station asked them to confirm which footwear condition they were wearing (control or treatment); this confirmed that they were aware which condition they were performing in. If a subject misremembered (or couldn't remember) which condition they were wearing, they were reminded. This step was omitted with UAWG subjects. The subject was instructed to step onto the mat and jump as high as possible, hitting the Vertec pegs at the height of their jump. In between each jump the subjects had 45 seconds, during which they were asked on a Likert scale of 1-6 on how well they thought the jump went. After 3 maximal vertical jumps, the subjects were asked to rate the shoes for comfort, cushioning, and stability. Each rating was done on a visual analog scale (VAS), when the subject marked how comfortable, cushioned, and stable the shoes felt.

Then, the subjects performed the broad jump trials. For AWG subjects, an experimenter again asked them which footwear condition they were in, and for UAWG subjects this step was again sidestepped. For the broad jump the subjects were required to start with both feet planted with the toes touching the start line and instructed to jump as far forward as possible. For the jump to be valid, the subjects had to land with both feet planted at the end of the jump. The subjects repeated the broad jump 3 times with 45 seconds in between each jump. After each jump, they were asked to rate their jump performance on a Likert scale from 1-6 and at the end of the 3 trials, they were asked to rate comfort, cushioning, and stability on VAS scales.

All procedures that were part of the experiment proper were then repeated in the second shoe condition. The shoe condition received first was counterbalanced within the study design. The subject was then given the option of water and/or a sports drink.

Performance data (jump height, time, goniometry values, Likert values) were inputted into Excel. Values from the VAS scales were determined by measuring the distance (in tenths of centimeters) from the left anchor to where they had made a mark along the 10cm line.

**Statistical analyses**

The data was entered in JAMOVI to run an ANOVA test with a p-value of 0.5 to identify any significant differences.

**Results**

Subject Characteristics

Table 1 shows the characteristics of the two populations (broken down by sex). There were no significant differences in any characteristics between the females of the two studies or the males of the two studies.

Ankle Goniometry

None of the ankle movements were influenced by the orthotic, regardless of population (Table 2).

**Table 1.** Physical characteristics of the study populations given as averages ± standard deviation.

| | Unaware Group (*n*=20) | | Aware Group (*n*=18) | |
|---|---|---|---|---|
| | Females (*n*=11) | Males (*n*=9) | Females (*n*=9) | Males (*n*=9) |
| Age (years) | 20.5 ± 1.2 | 20.9 ± 1.5 | 20.0 ± 1.0 | 20.4 ± 1.7 |
| Height (cm) | 165.6 ± 4.8 | 178.8 ± 6.4 | 165.4 ± 4.6 | 182.0 ± 4.8 |
| Weight (kg) | 64.5 ± 11.0 | 87.2 ± 18.5 | 71.3 ± 14.4 | 84.0 ± 12.0 |
| Personal Shoe Size (in) | 8.5 ± 1.1 | 11.6 ± 0.8 | 8.3 ± 0.8 | 10.9 ± 0.6 |
| Personal Shoe Mass (g) | 194.2 ± 27.1 | 335.3 ± 54.2 | 228.8 ± 42.5 | 326.4 ± 78.0 |

**Table 2**. Ankle goniometry in each footwear condition prior to jumping in the shoes, expressed in degrees and given as averages ± standard deviation.

| Ankle Movement | Orthotic | Unaware Group | Aware Group |
|---|---|---|---|
| Eversion | No | 20.5 ± 8.9 | 26.3 ± 6.7 |
| | Yes | 20.6 ± 6.0 | 26.0 ± 7.1 |
| Inversion | No | 27.2 ± 9.3 | 31.4 ± 6.7 |
| | Yes | 27.0 ± 9.1 | 34.6 ± 6.9 |
| Dorsiflexion | No | 16.5 ± 7.2 | 24.8 ± 6.1 |
| | Yes | 16.3 ± 5.8 | 24.0 ± 7.4 |
| Plantarflexion | No | 52.0 ± 7.3 | 47.3 ± 7.6 |
| | Yes | 52.0 ± 7.4 | 47.5 ± 6.9 |

Jump Performance

Neither vertical jump performance (Figure 3) nor broad jump performance (Figure 4) was influenced by the orthotic, regardless of population.

Subjective Perception of Performance

Subjects' self-ranking of their performance on a Likert scale (Table 3) was not influenced by the orthotic, regardless of population.

Subjective Perception of Footwear

With the UAWG, there were no differences in subjects' perception of footwear comfort, cushioning, or stability (Table 4). With the AWG, subjects perceived the footwear as better cushioned when the orthotic was present (versus absent) after both vertical and broad jumps, and the footwear containing the orthotic as more comfortable after the broad jump but not the vertical jump (Table 3). No differences were seen in perception of footwear stability.

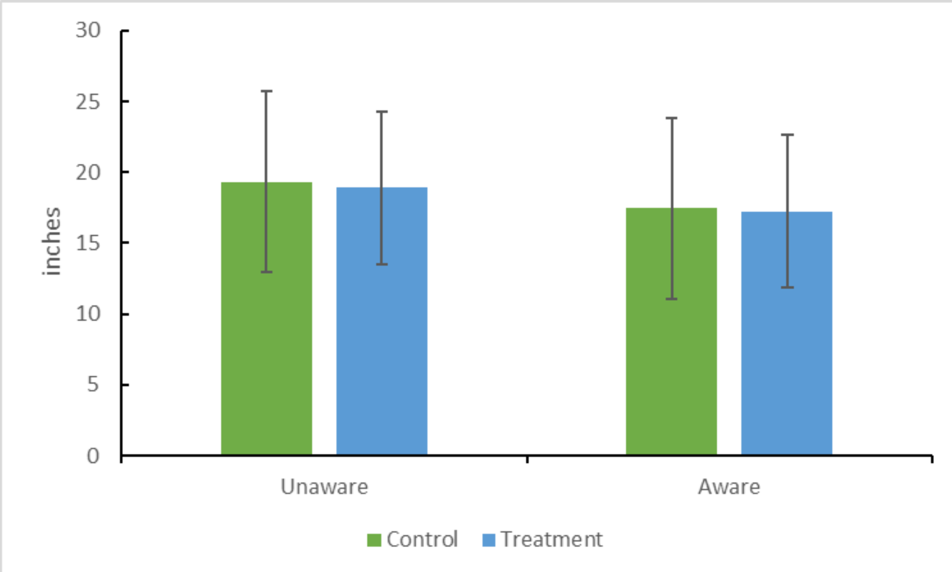


**Figure 3.** Vertical jump performance shown as averages ± standard deviation.

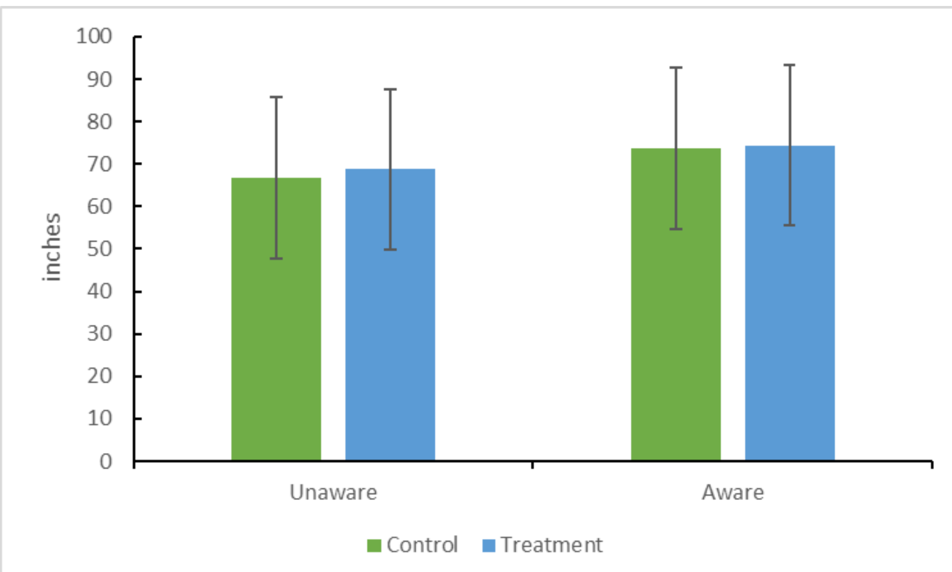


**Figure 4.** Broad jump performance shown as averages ± standard deviation.

**Table 3.** Subjects' subjective perception of their jump performance as assessed on a six-point Likert scale given as averages ± standard deviation.

| Task | Orthotic | Unaware Group | Aware Group |
|---|---|---|---|
| Vertical Jump | No | 4.1 ± 0.7 | 4.7 ± 0.6 |
| | Yes | 4.2 ± 0.7 | 4.6 ± 0.8 |
| Broad Jump | No | 3.8 ± 0.8 | 4.3 ± 0.9 |
| | Yes | 3.7 ± 0.8 | 4.6 ± 0.6 |

**Table 4**. Subjects' subjective evaluation of footwear characteristics given as averages ± standard deviation. Matching symbols indicate significant differences between the pair of values sharing that symbol: asterisks (*) indicate a significance difference in perception of footwear comfort after the broad jump with vs. without the orthotic in the Aware group, daggers (†) indicate a significant difference in perception of footwear cushioning after the vertical jump with vs. without the orthotic in the Aware group, and double daggers (‡) indicate a significant difference in perception of footwear cushioning after the broad jump with vs. without the orthotic in the Aware group.

| Perceptual Variable | Task | Orthotic | Unaware Group | Aware Group |
|---|---|---|---|---|
| Comfort | Vertical Jump | No | 6.9 ± 1.3 | 6.4 ± 1.6 |
| | | Yes | 6.4 ± 1.7 | 7.0 ± 1.0 |
| | Broad Jump | No | 7.0 ± 1.4 | 5.5 ± 2.0* |
| | | Yes | 6.6 ± 2.0 | 7.0 ± 1.2* |
| Cushioning | Vertical Jump | No | 7.1 ± 1.9 | 5.9 ± 2.0† |
| | | Yes | 6.7 ± 1.8 | 7.1 ± 1.4† |
| | Broad Jump | No | 6.8 ± 1.7 | 5.3 ± 2.1‡ |
| | | Yes | 6.6 ± 1.9 | 7.0 ± 1.7‡ |
| Stability | Vertical Jump | No | 7.0 ± 2.0 | 6.2 ± 2.1 |
| | | Yes | 6.9 ± 2.0 | 7.0 ± 1.4 |
| | Broad Jump | No | 6.7 ± 2.1 | 5.8 ± 2.2 |
| | | Yes | 6.4 ± 2.2 | 6.8 ± 2.0 |

## Discussion

### Results Implications

Across the two groups of subjects, this study found use of this specific retail orthotic had no significant effect on jump performance, jump perception, or footwear perception *except* when subjects knew whether a given pair of shoes included the orthotic or not. With the AWG there were significant differences in perceived comfort for the broad jump as well as significant differences in perceived cushioning for both vertical and broad jump, whereas no significant differences were seen for the same variables in the UAWG. These findings suggest that a placebo-like effect occurred such that perceptions among members of the AWG were impacted by their knowledge of footwear condition.

Comparing these results to previously published work is tenuous. One reason is because this study used a "field study"-type approach whereas other studies used more technical kinematic- or kinetic-focused approaches. For example, while this study found no significant differences by sex for any of the performance and perception variables measured, other studies have reported sex differences in jump landing mechanics and loading[13,14].

Another reason is because previous research has concentrated on the shoes themselves or ankle restriction devices (such as taping strategies or braces) and not orthotics. One study of recreationally-trained men jumping barefoot, in minimalist shoes, or standard cross-training shoes reported that when subjects wore the trainers their perceptions of comfort and "footwear performance" were generally higher despite no differences in jump performance between the three conditions[15]. A possible interpretation is that large differences between footwear variables (such as heel-to-toe drop, shoe mass, or joint restriction) are required before subjects report differences in perceptual variables for different footwear conditions. If true, that interpretation also supports the possibility of a placebo-like effect in the present study: since the shoes themselves were identical across trials, and since the orthotic was thin and flexible and positioned beneath the sockliner, the two shoe conditions would have been indistinguishable to subjects. Differences in perceptual scores were seen only when subjects were told whether the shoes contained the orthotic or not, again supporting the idea that a placebo-like effect may have occurred. These notions are speculative since the present study and the footwear study differed in so many respects. Separately and as another example, one study of female basketball players jumping in three different braces, standard ankle taping, or no ankle support found that devices generally impeded vertical jumping, likely by decreasing range-of-motion (ROM)[16]. These latter findings are incongruent with the present study since the present study found no significant differences in ankle ROM between AWG and UAWG. Note that the methods between the former and latter studies were very different.

**Limitations and Future Directions**

It is important to acknowledge limitations to the study and study design. First, as stated previously, this was a "field study"-type experiment and lacked the sophistication that force platforms or motion capture systems would contribute. Second, given that this was a two-year study conducted by two different kinesiology classes, and therefore different student-experimenters worked with the UAWG and AWG, it is possible differences in experimenter behaviors or techniques between years influenced the results. Steps were taken to minimize this, including having the second year (AWG) class follow the previous class' method and consulting them when confusions arose. Third, only jumping-type activities were assessed. The orthotic being tested claims to improve performance variables other than jumping which were not assessed. It is possible a more holistic approach including multiple different types of performance outcome would have revealed effects from the orthotic. One study of NFL players found a positive correlation between vertical jump and maximum speed as well as a positive correlation between horizontal jump and maximum speed and acceleration[17]. If such findings also apply to the general public, and given that there were no significant differences for jump height nor jump distance in the present study, it is also possible a broader survey would not have changed the conclusions. Fourth, there was no control over how deeply people squatted (the countermovement) before jumping. It has been shown that both muscle force and power output are influenced by countermovement depth[18]. Fifth, subjects recruited varied in athletic background and activity level. This may contribute to a large variation in performance and perception caused by differences in subjects' experience and general fitness level. However, one study found that a standard vertical jumping test such as the one employed in the present study was a "reliable" measure across multiple age groups and athlete types[19]. Related to this, there was only one size of shoe available for each sex, which constrained the potential participant pool. Shoe "fit" influences footwear perception scores[20], and the single available size may not have been the optimal "fit" for all those who participated.

This research could take several different trajectories in the future. One possibility would be to repeat the study with a different type of orthotic material. The orthotic used in this study was on the lower end of the price scale. We also identified carbon fiber inserts that cost ten times as much, but chose the lesser-priced orthotic because it was more affordable and therefore would conceivably be purchased/used by a greater number of consumers. Another possibility would be to employ different measures with the current orthotic. Many of the studies described in the introduction also measured jump forces, energy return, lower limb joint angles, and related outcomes, and it is possible effects may be seen from those outcomes. Both the packaging and the website associated with the current orthotic gave additional claims about the orthotic's effects on other types of performance, so a third option might be to study those other claims. During the preliminary work for this study, we found that most manufacturers gave multiple performance claims for a single orthotic. A larger, multi-claim study involving multiple exercises within the same study design would be possible.

## Conclusions

This study found that (1) there was no significant difference in jump performance due to the orthotic, and this held true whether subjects knew (AWG) or didn't know (UAWG) what they were wearing, and (2) if people know they were wearing an orthotic that claims to enhance performance, then it may improve their perceptions of footwear comfort or cushioning (placebo-like effect).

## Acknowledgements

The authors would like the thank participants for their time and participation.

Sponsored by:
Exercise and Sport Science Program
Western Colorado University

In addition, we would like to thank BIO133 class of fall 2019 and BIO133 class of fall 2020 for helping run this study.

## Address for Correspondence

Senchina DS, PhD, Kinesiology Program, Biology Department, Drake University, Des Moines, IA, USA. Phone: (515) 271 2956;
E-mail: dssenchina@drake.edu.

## References

1. Mohr M, Trudeau MB, Nigg SR, Nigg BM. (2016). Increased athletic performance in lighter basketball shoes: shoe or psychology effect? *Int J Sports Physiol Perform*, 11, 74-79.
2. Kose B. (2018). Does the weight of basketball shoes affect speed and jumping performance? *Phys Educ Students*, 6, 316-319.
3. Worobets J, Wannop JW. (2015). Influence of basketball shoe mass, outsole traction, and forefoot bending stiffness on three athletic movements. *Sports Biomech*, 14, 351-360.
4. Lam WK, Kan WH, Chia JS, Kong PW. (e-pub ahead-of-print). Effect of shoe modifications on biomechanical changes in basketball: a systematic review. *Sports Biomech*, 1-27.
5. Gregory RW, Axtell RS, Robertson MI, Lunn WR. (2018). The effects of a carbon fiber shoe insole on athletic performance in collegiate athletes. *J Sports Sci*, 6, 219-230.
6. Lam WK, Lee WCC, Lee WM, Ma CZH, Kong PW. (2018). Segmented forefoot plate in basketball footwear: does it influence performance and foot joint kinematics and kinetics? *J App Biomech*, 34, 31-38.
7. Noghondar FA, Bressel E. (2017). Effect of shoe insole density on impact characteristics and performance during a jump landing task. *Footwear Sci*, 9, 85-101.
8. Ho M, Kong PW, Chong LJ, Lam WK. (2019). Foot orthoses alter lower limb biomechanics but not jump performance in basketball players with and without flat feet. *J Foot Ankle Res*, 12, 1-14.
9. Arastoo AA, Aghdam EM, Habibi AH, Zahednejad S. (2014). Kinetic factors of vertical jumping for heading a ball in flexible flatfooted amateur soccer players with and without insole adoption. *Prosthet Orthot Int*, 38, 204-210.
10. Stefanyshyn DJ, Nigg BM. (2000). Influence of midsole bending stiffness on joint energy and jump height performance. *Med Sci Sports Exerc*, 32, 471-476.
11. Taylor JB, Nguyen AD, Parry HA, Zuk EF, Pritchard NS, Ford KR. (2019). Modifying midsole stiffness of basketball footwear affects foot and ankle biomechanics. *Int J Sports Phys Ther*, 14, 359-367.
12. Queen RM, Verma R, Abbey AN, Nunley JA, Butler RJ. (2014). Plantar loading during jumping while wearing a rigid carbon graphite footplate. *Gait Post*, 39, 707-711.
13. Butler RJ, Wilson JD, Fowler D, Queen RM. (2013). Gender differences in landing mechanics vary depending on the type of landing. *Clin J Sports Med*, 23, 52-57.
14. Butler RJ, Russell ME, Queen R. (2014). Effect of soccer footwear on landing mechanics. *Scand J Med Sci Sports*, 24, 129-135.
15. Harry JR, Paquette MR, Caia J, Townsend RJ, Weiss LW, Schilling BK. (2015). Effects of footwear condition on maximal jumping performance. *J Strength Cond Res*, 29, 1657-1665.
16. Mackean LC, Bell G, Burnham RS. (1995). Prophylactic ankle bracing vs. taping: effects on functional performance in female basketball players. *J Orthop Sports Phys Ther*, 22, 77-82.
17. Robbins DW and Young WB. (2012). Positional relationships between various sprint and jump abilities in elite American football players. *J Strength Cond Res*, 26, 388-397.
18. Mandic R, Jakovljevic S, Jaric S. (2015). Effects of countermovement depth on kinematic and kinetic patterns of maximum vertical jumps. *J Electromyogr Kinesiol*, 25, 265-272.
19. Rodriguez-Rosell D, Mora-Custodio R, Franco-Marquez F, Yanez-Garcia JM, Gonzalez-Badillo JJ. (2017). Traditional vs. sport-specific vertical jump tests: reliability, validity, and relationship with the legs strength and sprint performance in adult and teen soccer and basketball players. *J Strength Cond Res*, 31, 196-206.
20. Tay CS, Sterzing T, Lim CY, Ding R, Kong PW. (2017). Overall preference of running shoes can be predicted by suitable perception factors using a multiple regression model. *Hum Fact*, 59, 432-411.