Should high-top or low-top cleats be used when playing baseball?

Margo P. Wohlfeil,[a,#] Cole R. Neary,[b,#] Mitchell M. Klocke,[b] Johnny G Mills,[c] Rich C. Calvert,[d] & David S. Senchina[b]

[a]Biochemistry, Cell, and Molecular Biology Program, Drake University, Des Moines, IA
[b]Biology Department, Drake University, Des Moines, IA
[c]Pharmacy Program, Drake University, Des Moines, IA
[d]Athletics, Drake University, Des Moines, IA

https://doi.org/10.33697/ajur.2019.011

Students: Margo.Wohlfeil@ucsf.edu, cole.neary@drake.edu, mitchell.klocke@indianoloa.k12.ia.us, john.mills@drake.edu*
[#] These authors are sharing joint first-authorship.
Mentors: david.senchina@drake.edu, rich.calvert@drake.edu

ABSTRACT
There is a shortage of knowledge about how baseball cleat design may impact athletes. The purpose of this experiment was to determine if the height of the baseball cleat affected performance, perception of the cleat, and ankle range-of-motion. Thirteen subjects participated in the study, and each subject performed three drills (base-running, 5:10:5 "pro agility," and hitting) in both high-top and low-top baseball cleats. Performance time was measured for the first two drills. Perception of comfort, heaviness, shoe climate (heat), stability, and traction were measured for all three drills using 10-cm visual analog scales (VAS). Ankle range-of-motion (dorsiflexion, plantarflexion, eversion, and inversion) was measured using goniometry in both cleats, plus socks-only as baseline control. Shoe height did not significantly affect completion time in either the base-running drill (6.1±0.1 sec. in high-top vs. 6.1±0.1 sec. in low-top) or pro-agility drill (4.8±0.1 sec. in high-top vs. 4.6±0.1 sec. in low-top). There were significant differences in perception of heat (6.4 in high-top vs. 4.6 in low-top; $p<.001$), stability (6.9 in high-top vs. 5.1 in low-top; $p=.001$), and heaviness (6.0 in high-top vs. 4.1 in low-top; $p<.001$), but not in perception of comfort (6.1±2.0 in high-top vs. 6.6±1.5 in low top) or traction (7.3±2.0 in high-top vs. 7.4±1.5 in low-top). There were significant differences between high-top and low-top cleats in plantarflexion (42.5° in high-top vs. 47.5° in low-top; $p=.033$), eversion (7.9° in high-top vs. 11.3° in low-top; $p=.003$), and inversion (12.8° in high-top vs. 16.6° in low-top; $p=.044$), but not dorsiflexion (8.2° in high-top vs. 10.9°). For baseball players concerned about excessive ankle movements during play, these results suggest that using a high-top baseball cleat might reduce ankle range-of-motion without impairing performance or feeling burdensome.

KEYWORDS
Baseball; Cleats; High-Top; Low-Top; Perception; Performance; Range-of-Motion; Shoes

INTRODUCTION
Athletic shoes play a pivotal role in the comfort, protection, and motion of the athlete's ankle that can influence gross movement, performance, and potentially injury incidence.[1] Athletic shoes are created specifically for the sport that is being played,[2] the movements, and the amount of force applied to the foot during the sport.[3] The height of the shoe is one of the main features that affect the athlete. Athletes participating in sports with more lateral movements tend to wear a high- or mid-top cleat, and athletes participating in sports with more linear movements will tend to wear a low-top cleat.[2] In the context of this report, with high-top footwear the shoe collar (the upper rim of the shoe surrounding the ankle) completely covers the ankle malleoli ("ankle bones"), whereas with low-top footwear the shoe collar never comes up to the height of the ankle malleoli, and they remain exposed and with mid-top footwear the collar hits at the level of the malleoli.

Past studies have explored the effects of shoe height and its association with range-of-motion (ROM), performance, and ankle injuries during movements associated with basketball,[4–11] American football,[12–15] and volleyball.[16] The seven studies that examined ROM[4,8–11,13,16] all noted that the high-top shoes (or mid-top shoes in the volleyball study) reduced ankle rotation, extension/flexion, and/or eversion/inversion compared to their respective low-top counterparts. Regarding performance, five of the six studies that examined performance[8,9,11–13] showed that the high-top shoes did not affect performance compared to their respective low-top counterparts, whereas a sixth study[6] reported that the high-top was associated with slower performance. The potential effect of high-top shoes on ankle injuries is less clear. One relevant study[7] associated high-top shoes with reduced injuries, two additional studies[5,14] showed no association between shoe height and injury, and one last study[15] associated high-top shoes with increased injuries. Confounding factors such as concurrent use of taping/spatting and/or bracing, different player positions and anthropometrics, undocumented player changes in footwear during a game or season, or unaccounted out-of-sport physical activity patterns may explain why the injury results have been equivocal thus far. Sports medicine experts acknowledge these confounding factors and believe the preponderance of evidence still supports using high-top footwear as an ankle injury prevention measure.[17,18]

Less often studied is an athlete's perception of their footwear (for example, whether they find the footwear comfortable or stable), which will not only affect their footwear choices but also their performance.[19,20] Only one published study[13] (using football cleats) has previously looked at the association between shoe height and athlete perception of their footwear and reported that subjects found high-top cleats to be less comfortable, heavier, and more stable than low-top cleats. Since an athlete's perception of footwear often impacts their footwear selection (either initially or during the course of repeated exposure) and lack of comfort is often a predisposing factor for subsequent injury,[21] it is important to consider the relationship between shoe design elements and the overall perceptual experience of the user.[17]

Compared to the research done in basketball and football, there is little comparable data on baseball cleats. Baseball requires different movements than basketball or football,[22] so it is unclear whether results from those sports' footwear translate to baseball footwear. Only three published studies were found to have examined baseball cleat design in field contexts. Two studies[23,24] looked at only turf and soil variation and involved mechanical apparatuses instead of athletes, so they cannot speak towards athlete-associated outcomes. The third study[25] reported that differences in the number of forefoot studs across various low-top baseball cleats did not influence subjects' performance or perception of the footwear. None of the studies examined high-top baseball footwear; however, high-top baseball cleats may be an essential consideration in the context of baseball ankle injury prevention given that a recent review of collegiate baseball injuries from 1988-2004 showed 8% of all baseball injuries were ankle sprains.[26] Information was not available as to what type of shoe the athletes were wearing, yet based on the literature reviewed previously, high-top cleats could conceivably reduce current ankle injury rates.

The purpose of this experiment was to determine if the height of the baseball cleat affected a player's performance, footwear perception, and ankle ROM by testing a high-top baseball cleat and a low-top baseball cleat from the same manufacturing series across identical baseball field drills. From previous research, it was hypothesized that: a) there would be no difference in performance outcomes between the two cleats; b) the high-top cleat would be perceived as heavier, less comfortable, more stable, and hotter than the low-top cleat (with no differences in perceived traction); and, c) the high-top cleat would reduce ankle ROM compared to the sock-only control and low-top cleat.

METHODS AND PROCEDURES

Subject Characteristics

The procedures were approved by the Drake University Institutional Review Board (2012-13013) before the study was carried out, and each subject gave written consent prior to participation. The subjects were thirteen college-aged (18-22 years old) males who were recreationally active (engaged in 2.5 hours or more of moderate-vigorous weekly physical activity). The subjects were able to complete the drills safely in a men's size 10, 11.5, or 13-baseball cleat. College baseball players were not chosen for the study to avoid *a priori* biases.

Shoes

Two metal-studded baseball cleats were tested (**Figure 1**): a low-top (Under Armour Spine Metal; 1232831-002 Prod. Mo. October 2012) and a high-top (Under Armour Spine Highlight ST Metal; 1236979-001 Prod. Mo. November 2012; both from Under Armor, Baltimore, MD). The dimensions of the size 11.5 models were as follows: the low-top model was 13 cm high at the heel and near the tongue, and dropped to 10.5 cm between those features (i.e., in the malleolar notch); the high-top model was 20.5 cm tall at the front of the shoe and tapered to 17.5 cm by the heel, being tall enough to enclose the athletes' malleoli completely. The size 10 and 13 cleats were ~1 cm shorter or taller (respectively) for each of those measurements. Both cleats had an identical stud configuration on the outsole and were new at the start of the experiment, making shaft height the only difference in the two cleats. Each subject was given new mid-calf socks (95% polyester, 5% spandex; Body Glove International, Redondo Beach, CA) to wear during the experiment. Cleat presentation order was alternated.

Procedure

Anthropometrics were taken first, including height, weight, and body composition as determined by hand-to-foot bioelectrical impedance analysis [BIA] (BodyStat 1500; Cronkbourne, Douglas, Isle of Man, British Isles), followed by baseline measurements of ankle ROM (goniometry, including dorsiflexion, plantarflexion, eversion, and inversion) using a manual goniometer (HPMS Inc.; Windham, NH, USA), with subjects wearing socks but not shoes. The same experimenter performed all goniometry measurements throughout the entire study to ensure consistency across subjects.

Figure 1. Low-top (left) and high-top (right) cleats used in this study.

Subjects were then given either the low-top or high-top cleat, and the goniometry was repeated in that cleat in a counterbalanced fashion, such that half of the subjects' first trial was with the low-top cleat and the other half of the subjects' first trial was with the high-top cleat. Each subject then completed a structured five-minute warm-up routine that emphasized dynamic stretching, including exercises such as the alternating high knee, raises while moving forward and alternating lunge with elbow touch to the knee while moving forward.

Next, the subject performed three baseball field drills outdoors at Drake University's Ron Buel softball field; these drills were chosen to engage the subjects with the cleats in different contexts. The first drill was a base-running drill. The subjects started at home plate and ran an all-out sprint around first base and through second base. Each subject was shown a standardized path to run the bases (banana loop turn at first base towards second instead of a square cut) so that all subjects used the same base-running technique. Time was recorded using an electronic laser system (Brower Timing Systems LLC, Draper, UT, USA) when they crossed first base, and again when the subject ran through the second base. The second drill was a hitting drill and only tested perception. The subject was given ten baseballs to hit off a baseball tee into a net using a baseball bat. The third drill was a 5-10-5 ("pro agility") running drill. This drill was performed on the grass just outside the field using three disc cones each spaced 5 yards apart in a straight line. The subject started at the middle cone and was told to run to their right 5 yards, touch the cone, cut, and run back 10 yards to the leftmost cone, touch, cut, and then sprint through the original middle cone. Time was recorded manually. The subjects performed all three drills before switching into the second pair of cleats, and then the goniometry and three drills were repeated in the second cleat. Subjects performed all the drills for both cleats in a single session.

After each drill, the subjects were asked to rate their perception of the cleat's comfort, heaviness, foot climate (temperature), stability, and traction on separate 10-cm lines (visual analogue scales, VAS) with the left side of the line labeled as "The least (comfortable, heavy, hot, stable, traction) possible" and the right side of the line labeled as "The most (comfortable, heavy, hot, stable, traction) possible". Subjects made a vertical mark along the continuum to indicate their perception. VAS is scored by measuring from the left anchor to their vertical mark. A difference of ~1 cm or higher in any comparison is typically considered functionally significant.[20]

Statistics

All statistics were computed in IBM SPSS Statistics 25. For goniometry, one-way ANOVA tests were run for each of the four measurements separately, where the footwear condition (socks only, low-top, or high-top) was the independent variable, and either dorsiflexion, plantarflexion, eversion, or inversion was the dependent variable. A p-value of ≤ 0.05 was considered statistically significant. If a significant main effect was found, *post hoc* tests were computed using the least significant difference (LSD). For performance outcomes, paired samples t-tests comparing low-top to high-top were used, with four separate tests being run: one for each of the three base-running times (home plate to first base, first base to second base, and total route time) and one for the time to complete the 5-10-5 drill. After correcting the α-level for the multiple comparisons, p-values of ≤ 0.015 were considered significant. For perceptual outcomes, paired samples t-tests comparing low-top to high-top were used, with five separate tests being run for each of the measured variables (comfort, heaviness, foot climate (temperature), stability, and traction). Each respective test included subject scores from all three exercises together. After correcting the α-level for multiple comparisons, p-values of ≤ 0.01 were considered statistically significant.

RESULTS

Thirteen subjects participated in the study with the following characteristics (mean ± standard deviation): age = 19.5 ± 1.8, height = 177.8 ± 5.2 cm, weight = 79.2 ± 12.1 kg, and body fat percentage = 14.9 ± 4.5. Eight of the subjects wore a size 10 cleat, three of the subjects wore a size 11.5 cleat, and two subjects wore a size 13 cleat.

Performance

There were no significant differences found for performance between the two shoes during the two timed performance drills (all $p \geq 0.047$; **Table 1**).

		Low-Top	High-Top	*p*-value
Base-running Drill	Home Plate to 1st Base	3.17 ± 0.05	3.15 ± 0.04	0.424
	1st Base to 2nd Base	2.97 ± 0.06	2.96 ± 0.05	0.955
	Total (Home Plate to 2nd Base)	6.14 ± 0.10	6.11 ± 0.08	0.628
5-10-5 Drill		4.59 ± 0.12	4.81 ± 0.13	0.047

Table 1. Time (in s) for the base-running and 5-10-5 drills. There were no significant comparisons between shoes because the A-level was 0.0125 after correcting for multiple comparisons.

Perception

There were significant differences of footwear on perception for three of the five measures (heaviness, foot climate, and stability). Subjects perceived the high-top cleat as being significantly heavier ($p<.001$), hotter ($p<.001$), and more stable ($p=.001$) than the low-top cleat (**Figure 2**). There was no significant difference found for the perceived comfort or traction between the two cleats (both $p \geq 0.235$; **Table 2**).

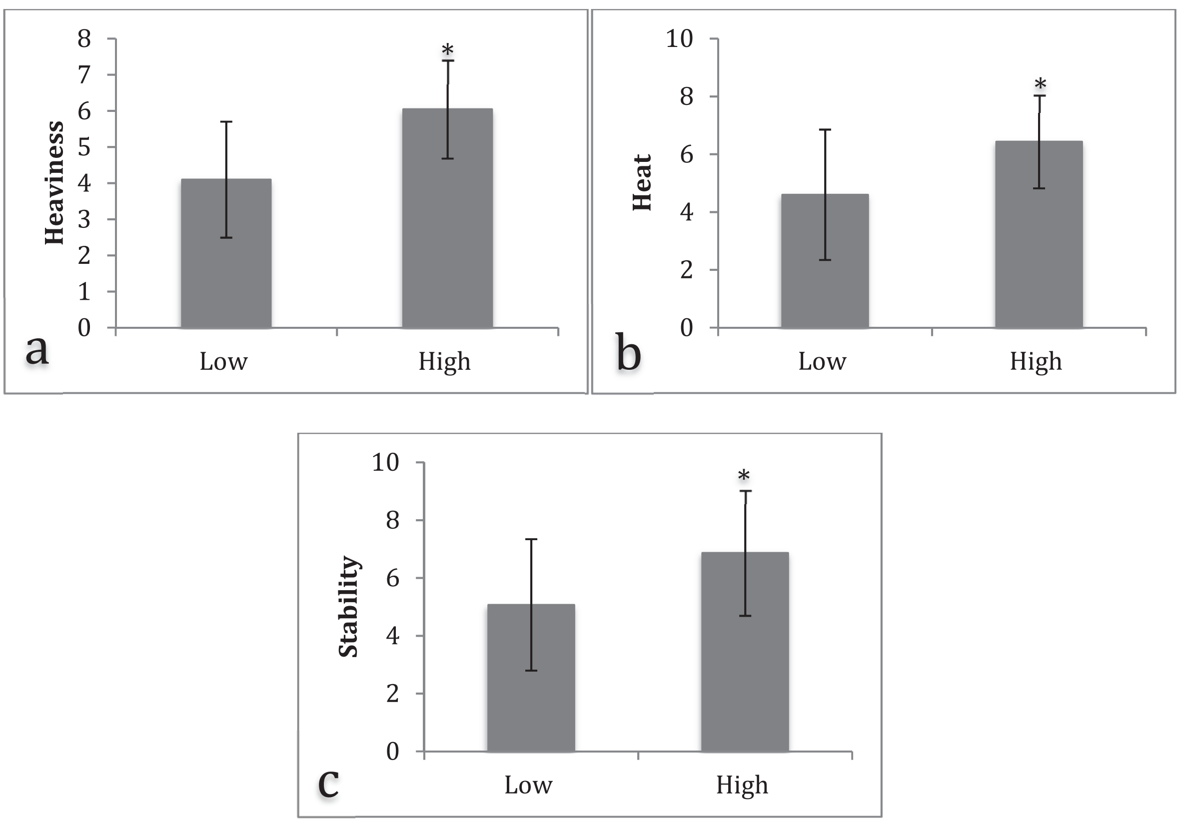

Figure 2. Perception of **(a)** heaviness, **(b)** foot climate (heat), and **(c)** stability in the low-top cleat vs. the high-top cleat. Values are in cm and based off a 10-cm scale, with higher values indicating more of a given perception. Asterisks mark significant differences between the high-top cleat and low-top cleat (all $p \leq 0.001$)

.

	Comfort	Traction
Low-Top	6.6 ± 1.5	7.4 ± 1.5
High-Top	6.1 ± 2.0	7.3 ± 2.0

Table 2. Perception of comfort and traction in the low-top cleat vs. the high-top cleat. Values are in cm and based off a 10-cm scale, with higher values indicating more of a given perception. There were no significant comparisons between shoes for comfort or traction (both $p \geq 0.235$).

Goniometry

There were significant differences for all four ankle motions (dorsiflexion p=.037, plantarflexion p<.001, eversion p<.001, inversion p=.008). *Post hoc* tests were then used to examine possible pairwise differences among the three footwear conditions. Dorsiflexion was significantly higher in the sock-only condition compared to the high-top cleat (p=.012), but there were no significant differences between the sock-only condition and the low-top cleat, nor between the low-top cleat and the high-top cleat (both $p \geq 0.092$; **Figure 3a**). For plantarflexion, there were significant differences between all footwear comparisons such that plantarflexion was higher in the sock-only condition compared to the low-top cleat (p=.001) and the high-top cleat (p<.001), and greater in the low-top cleat compared to the high-top cleat (p=.033; **Figure 3b**). For eversion, there were significant differences between all footwear comparisons such that eversion was greater in the sock-only condition compared to the low-top cleat (p=.042) and the high-top cleat (p<.001), and greater in the low-top cleat compare to the high-top cleat (p=.003; **Figure 3c**). Inversion was significantly less in the high-top cleat compared to both the sock-only condition (p=.002) and low-top cleat (p=.044) but was not different between the sock-only condition and low-top cleat (p=0.249; **Figure 3d**).

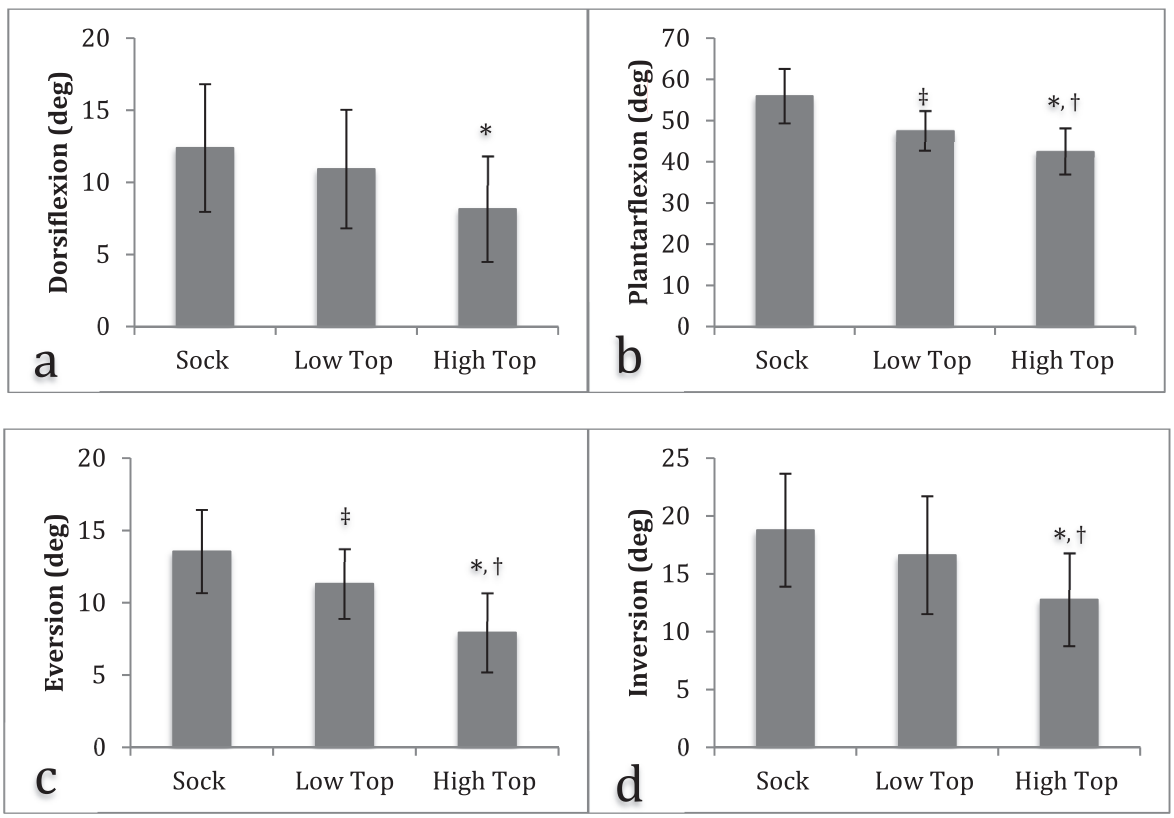

Figure 3. Range-of-motion (expressed as °) for **(a)** dorsiflexion, **(b)** plantarflexion, **(c)** eversion, and **(d)** inversion in the sock-only condition (baseline) and while wearing the low-top cleat and the high-top cleat. Asterisks mark a significant difference between high-top and sock. Daggers mark a significant difference between high-top and low-top. Double daggers indicate a significant difference between low-top and sock. See preceding text for individual p-values for all possible comparisons.

DISCUSSION

Performance

Hypothesis A was that there would be no statistically significant performance differences when the baseball drills were performed in low-top compared to high-top baseball cleats. Results supported that hypothesis (**Table 1**). This is the first known study to investigate how baseball shoe height could impact performance in a baseball field setting.

Previous studies on true high-tops and athletic performance have been limited to basketball and football. Both of the football studies[12,13] (spaced forty years apart and involving football cleats of very different designs and materials respective to their time periods) tested low-top to high-top football cleats in football-specific field drills; both found insignificant differences in performance time, and concluded that the shaft height of the football cleat did not affect athlete performance. Likewise, three of four contemporary basketball shoe studies[8,9,11] that utilized basketball-specific court drills found insignificant differences in performance time and reached a similar conclusion. A lone basketball study[6] found that their high-top shoe model decreased obstacle course times and vertical jump height, but it is unclear why that particular experiment differed from the others. Results from the present study were thus similar to the majority[8,9,11–13] of those previous basketball and football studies in showing that high-top shoes did not appear to deleteriously affect performance.

Some high-top athletic shoes have a consistent or mostly consistent collar height around the circumference of its shaft (such that the collar height is always above the height of the ankle malleoli, regardless of whether it is directly above the malleoli or elsewhere such as above the Achilles tendon). Whereas other high-top athletic shoes have a variable collar height (such that the collar is always higher around the malleoli, but then noticeably dips around the Achilles tendon such that it is then at or below the height of the malleoli). Current high-top baseball and football cleats tend to be of the former variety, whereas current high-top basketball shoes are more often of the latter variety. Based on the pictures provided in the publications or historical context, the football and baseball cleats used in the aforementioned studies all had consistent collar height, whereas the basketball shoes used in the aforementioned studies all had variable collar height. The collective findings may suggest that consistent high collar height around the entire circumference of the ankle does not harm performance (*i.e.*, there may be no practical benefit of having a lower collar height at the Achilles tendon, or stated another way, the additional material around the Achilles tendon may not impede its movement). However, it should be noted that field and court surfaces present very different conditions for athletic performance, so a direct comparison between the two surfaces would be necessary to investigate that possibility.

Perception

Hypothesis B was that the high-top cleat would be perceived to be less comfortable, hotter, more stable, and heavier than the low-top cleat (with no differences in perceived traction). The data for heaviness, foot climate, and stability (**Figure 2**) were consistent with the hypothesis; however, the data for perceived comfort (**Table 2**) opposed our hypothesis because subjects reported no perceived differences between the high-top and low-top baseball cleats. As mentioned previously in "Methods and Procedures," other research teams have established that a difference of ~1 cm or greater indicates a functionally relevant difference between two perceptual scores. **Figure 2** shows that the threshold was exceeded for all three statistically significant comparisons.

The lone previously published study[13] to look at shoe height and athlete footwear perception was in the context of football cleats and football-specific field drills, and it is the only point of comparison for the present perceptual data. The previous study reported that subjects perceived the high-top cleat to be less comfortable, heavier, and more stable than the low-top cleat (it did not assess foot climate or traction); thus, results are mostly consistent between the previous and present studies. One important difference between the football cleat used in the previous study and the baseball cleat used in the present study is the material that made up the shoe shaft—the football cleat had very thick padding throughout its circumference, whereas the baseball cleat had thinner fabric-like material. Since football is a contact sport and most high-top football cleats are used by linemen, the additional padding serves a protective function. Differences in the shoe shaft composition may explain why there were differences in comfort perception between the two studies; however, more studies will be needed to investigate that possibility.

Range-of-motion

Hypothesis C was that the high-top baseball cleat would significantly reduce the ankle ROM compared to the sock control and low-top cleat. The first part of this hypothesis concerned the high-top cleat *vs.* sock-only control, and in those comparisons, results indicated the high-top cleat significantly reduced all four motions (dorsiflexion, plantarflexion, eversion, and inversion) compared to the sock control (**Figure 3**). The second part of this hypothesis concerned the high-top cleat vs. the low-top cleat. Plantarflexion, inversion, and eversion were reduced in the high-top cleat compared to the low-top cleat (**Figures 3b**, **3c**, and **3d**), but there were no differences in dorsiflexion between the two cleat models (**Figure 3a**). Overall, these results support the hypothesis that the high-top cleat significantly reduced ankle ROM.

Sport-associated ankle sprains are typically caused by excessive inversion (as opposed to eversion) movements.[27–29] If high-top athletic footwear is to reduce ankle sprain injury rates in athletes, then such footwear should limit inversion. Both the present study (**Figure 3**) and all of the previously mentioned basketball and football shoe studies that measured inversion[4,9,10,13] found the high-top shoe reduced inversion compared to the low-top shoe. Given that these studies collectively utilized a variety of techniques across a variety of sport-specific shoe models and athletes, and all yielded the same conclusion, high-top athletic footwear is likely efficacious in reducing inversion.

Interpreting the dorsiflexion/plantarflexion results requires more nuance. Inversion sprains typically occur when the foot is simultaneously in a forced plantarflexed condition.[29] Poor dorsiflexion strength and/or low dorsiflexion ROM (*e.g.*, as would be needed to oppose a force plantarflexed position) has been associated with higher inversion sprains in some prospective studies of college-aged athletes[30,31] but not in others.[32,33] In the present study, the high-top cleat limited plantarflexion (but not dorsiflexion) compared to the low-top cleat (**Figure 3**). If one errs on the side of caution and assumes excessive plantarflexion and/or dorsiflexion deficiencies may contribute to the occurrence or severity of inversion ankle sprains, then it is beneficial for high-tops to limit plantarflexion but not dorsiflexion. Two of the previously mentioned high-top studies also looked at dorsiflexion/plantarflexion movements. The one basketball study that did so[11] found that the high-top shoe significantly reduced plantarflexion and had various effects on dorsiflexion compared to the low-top shoe, whereas the one football study that did so[13] found that the high-top shoe reduced dorsiflexion (but not plantarflexion) compared to the low-top shoe. Since there is only one study each from baseball, basketball, and football to compare and their collective results appear equivocal, it is likely premature to form any conclusions about high-top athletic footwear generally in terms of this motion or whether high-top cleats might be protective in terms of baseball athletes recovering from ankle injuries.

Limitations

Several limitations exist in this study. First, recreationally active students were used instead of baseball athletes to avoid any biases that baseball athletes may have towards one cleat type or another, which could have influenced study outcomes (based on their past playing experiences); thus, subjects in the present study may not have run the drills with the same amount of speed and force generated by a baseball player. Use of recreationally active individuals instead of competitive university athletes, whether to avoid *a priori* bias or for convenience sampling, is typical in footwear research. Of the twenty direct experimental or prospective studies cited in this publication[4–16,19,20,25,30–33], eleven utilized recreationally active individuals (whether to avoid bias or as convenience sampling), eight utilized competitive university athletes, and one was indeterminate in regards to subject status. Second, only one baseball cleat design was used in the present study. In baseball, there are many different cleat manufacturers, and within each, there are many different styles of cleats. Therefore, these findings will not likely apply to all styles of baseball cleats. Third, this field study did not have access to technology that could have improved precision, or allowed for measuring of joint angles (*e.g.*, ankle, knee, hip) during the field drills. This data could show ankle ROM in real time during the specific drills, or how the shoe height affected the entire kinetic chain. Goniometry in this study was limited to voluntary movements while seated, and not actual game movements; further, the baseline goniometry was performed before warm-up to avoid subject attentional and physical fatigue (logistically allowing us to separate each round of goniometry by approximately 20 minutes). Fourth, this was an acute experiment that did not simulate a full game or practice experience, and results may be different if the athlete was tested throughout a season.

CONCLUSIONS

There were three significant findings with regards to the specific baseball cleat model used in this study: (1) the high-top baseball cleat did not negatively influence baseball drill performance compared to the low-top cleat; (2) the high-top baseball cleat is perceived as equally comfortable but more stable than the low-top baseball cleat; and (3) the high-top baseball cleat reduces eversion, inversion, and plantarflexion compared to the low-top cleat. Athletes or coaches considering high-top baseball cleats may be able to use this knowledge in selecting footwear, and the findings may allay concerns baseball athletes have about high-top cleats slowing their movements. This study is novel because it is the first to examine the role of baseball cleat shaft height in the context of athlete performance, footwear perception, or ankle ROM, and is only the second baseball footwear study directly involving athletes.

In the future, it could be beneficial to repeat this study with college baseball players or different models/brands of baseball cleats or to perform a longitudinal study looking at the effects of the cleats over several practices or games. Baseball athletes concerned about ankle stability frequently use other external ankle support devices such as braces or taping instead of or in addition to high-top footwear, so future studies could also look at the effects of those items combined or separately to see if there are advantages of one method versus another or potential additive effects. Studying other design features of the cleat like its material, stud configuration, mass, and sole properties may provide additional insights into optimal baseball footwear design.

Acknowledgments
We thank our 13 subjects who volunteered their time to participate in this study. Also, we thank you Drake Athletics for allowing our research team to use Ron Buel field for the field drills.

REFERENCES

1. Barnes, R. A., and Smith, P. D. (1994) The role of footwear in minimizing lower limb injury, *J Sports Sci* 12(4), 341–353. *https://doi.org/10.1080/02640419408732180*
2. Caselli, M. A. (2006) Selecting the proper athletic shoe, *Podiatry Manag* 25(8), 147–156.
3. Shorten, M. (2004) Running Shoe Design: Protection and Performance, in *Marathon Medicine* (Pedoe, D.T., Ed.) 159–169, Royal Society of Medicine Press Limited: London, UK.
4. Ashton-Miller, J. A., Ottaviani, R. A., Hutchinson, C., and Wojtys, E. M. (1996) What best protects the inverted weightbearing ankle against further inversion? Evertor muscle strength compares favorably with shoe height, athletic tape, and three orthoses *Am J Sports Med* 24(6), 800–809. *https://doi.org/10.1177/036354659602400616*
5. Barrett, J. R., Tanji, J. L., Drake, C., Fuller, D., Kawasaki, R. I., and Fenton, R. M. (1993) High- versus low-top shoes for the prevention of ankle sprains in basketball players. A prospective randomized study, *Am J Sports Med* 21(4), 582–585. *https://doi.org/10.1177/036354659302100416*
6. Brizuela, G., Llana, S., Ferrandis, R., and García-Belenguer, A. C. (1997) The influence of basketball shoes with increased ankle support on shock attenuation and performance in running and jumping, *J Sports Sci* 15(5), 505–515. *https://doi.org/10.1080/026404197367146*
7. Garrick, J. G., and Requa, R. K. (1973) Role of external support in the prevention of ankle sprains, *Med Sci Sports* 5(3), 200–203. *https://doi.org/10.1249/00005768-197323000-00020*
8. Lam, G. W. K., Park, E. J., Lee, K.-K., and Cheung, J. T.-M. (2015) Shoe collar height effect on athletic performance, ankle joint kinematics and kinetics during unanticipated maximum-effort side-cutting performance, *J Sports Sci* 33(16), 1738–1749. *https://doi.org/10.1080/02640414.2015.1011206*
9. Liu, H., Wu, Z., and Lam, W.-K. (2017) Collar height and heel counter-stiffness for ankle stability and athletic performance in basketball, *Res Sports Med* 25(2), 209–218. *https://doi.org/10.1080/15438627.2017.1282352*
10. Ottaviani, R. A., Ashton-Miller, J. A., Kothari, S. U., and Wojtys, E. M. (1995) Basketball shoe height and the maximal muscular resistance to applied ankle inversion and eversion moments, *Am J Sports Med* 23(4), 418–423. *https://doi.org/10.1177/036354659502300408*
11. Yang, Y., Fang, Y., Zhang, X., He, J., and Fu, W. (2017) Does shoe collar height influence ankle joint kinematics and kinetics in sagittal plane maneuvers?, *J Sports Sci Med* 16(4), 543–550.
12. Bauer, H. (1970) The effect of high-top and low-cut football shoes on speed and agility, *Athl J* 50, 74-75,86-87.
13. Daack, C. W., Senchina, D. S. (2014) A field study of low-top vs. mid-top vs. high-top American football cleats, *Sports* 2(4), 85–98. *https://doi.org/10.3390/sports2040085*
14. Iacovelli, J. N., Yang, J., Thomas, G., Wu, H., Schiltz, T., and Foster, D. T. (2013) The effect of field condition and shoe type on lower extremity injuries in American football, *Br J Sports Med* 4(12), 789–793. *https://doi.org/10.1136/bjsports-2012-092113*
15. Rovere, G. D., Clarke, T. J., Yates, C. S., and Burley, K. (1988) Retrospective comparison of taping and ankle stabilizers in preventing ankle injuries, *Am J Sports Med* 16(3), 228–233. *https://doi.org/10.1177/036354658801600305*
16. Cronin, A. (2001) Effect of Selected Ankle Supports on Resistance to Inversion Force and Range of Motion. B.Sc., University of Ottawa: Ottawa, Ontario, Canada.
17. Petrov, O., Blocher, K., Bradbury, R. L., Saxena, A., and Toy, M. L. (1988) Footwear and ankle stability in the basketball player, *Clin Podiatr. Med Surg* 5(2), 275–290.
18. Ryan, A. J. (1986) Ankle sprains: A roundtable, *Phys Sportsmed* 14(2), 101–118.
19. Lam, W. K., Sterzing, T., and Cheung, J. T.-M. (2011) Reliability of a basketball specific testing protocol for footwear fit and comfort perception, *Footwear Sci,* 3(3), 151–158. *https://doi.org/10.1080/19424280.2011.630680*
20. Mills, K., Blanch, P., and Vicenzino, B. (2010) Identifying clinically meaningful tools for measuring comfort perception of footwear, *Med Sci Sports Exerc* 42(10), 1966–1971. *https://doi.org/10.1249/MSS.0b013e3181dbacc8*
21. Mündermann, A., Stefanyshyn, D. J., and Nigg, B. M. (2001) Relationship between footwear comfort of shoe inserts and anthropometric and sensory factors, *Med Sci Sports Exerc* 33(11), 1939–1945. *https://doi.org/10.1097/00005768-200111000-00021*
22. Dutra, T. (2010) Baseball and Softball, in *Athletic Footwear and Orthoses in Sports Medicine* (Werd, M. B., and Knight, E. L., Eds.) 303–306, Springer, New York.
23. Brosnan, J. T., McNitt, A. S., and Serensits, T. J. (2009) Effects of varying surface characteristics on the hardness and traction of baseball field playing surfaces, *Int Turfgrass Soc Res J* 11, 1053–1066.
24. Goodall, S. A., Guillard, K., Dest, W. A., and Demars, K. R. (2005) Ball response and traction of skinned infields amended with calcined clay at varying soil moisture contents, *Int Turfgrass Soc Res J* 10, 1085–1093.

25. Gibson, D. G., Calvert, R. C., and Senchina, D. S. (2014) Does the number of spikes in the baseball cleat forefoot impact on performance or perception of traction?, *J Athl Med* 2(2), 53–65.
26. Hootman, J. M., Dick, R., and Agel, J. (2007) Epidemiology of collegiate injuries for 15 sports: Summary and recommendations for injury prevention initiatives, *J Athl Train* 42(2), 311–319.
27. Barrett, J., and Bilisko, T. (1995) The role of shoes in the prevention of ankle sprains, *Sports Med,* 20(4), 277–280. *https://doi.org/10.2165/00007256-199520040-00005*
28. Garrick, J. G. (1977) The frequency of injury, mechanism of injury, and epidemiology of ankle sprains, *Am J Sports Med* 5(6), 241–242. *https://doi.org/10.1177/036354657700500606*
29. Verhagen, E. A., van Mechelen, W., and de Vente, W. (2000) The effect of preventive measures on the incidence of ankle sprains, *Clin J Sport Med* 10(4), 291–296. *https://doi.org/10.1097/00042752-200010000-00012*
30. Baumhauer, J. F., Alosa, D. M., Renström, A. F., Trevino, S., and Beynnon, B. A (1995) Prospective study of ankle injury risk factors, *Am J Sports Med* 23(5), 564–570. *https://doi.org/10.1177/036354659502300508*
31. Willems, T. M., Witvrouw, E., Delbaere, K., Mahieu, N., De Bourdeaudhuij, L., and De Clercq, D. (2005) Intrinsic risk factors for inversion ankle sprains in male subjects: A prospective study, *Am J Sports Med* 33(3), 415–423. *https://doi.org/10.1177/0363546504268137*
32. Beynnon, B. D., Renström, P. A., Alosa, D. M., Baumhauer, J. F., and Vacek, P. M. (2001) Ankle ligament injury risk factors: A prospective study of college athletes, *J Orthop Res* 19(2), 213–220. *https://doi.org/10.1016/S0736-0266(00)90004-4*
33. Payne, K. A., Berg, K., and Latin, R. W. (1997) Ankle injuries and ankle strength, flexibility, and proprioception in college basketball players, *J Athl Train* 32(3), 221–225.

ABOUT STUDENT AUTHORS

Margo Wohlfeil graduated from Drake University in December of 2017 with a B.A. in Biochemistry, Cell, and Molecular Biology. She is currently working as a Junior Research Specialist in a pediatric oncology lab at the University of California, San Francisco.

Cole Neary graduated from Drake University in December of 2018 with a B.S. in Biology. He is now working for the Drake University Athletic Department as a development coordinator.

Mitchell Klocke currently lives in Indianola, IA. He graduated from Drake University in May of 2018 with a B.A. in Biology, as well as a B.S.E in Secondary Education. Currently, he teaches 7th-grade science at Indianola Middle School in Indianola, IA.

Johnny Mills will graduate from the College of Pharmacy and Health Science at Drake University in May of 2021 with his Pharm.D. He plans to work in the pharmaceutical industry or community setting after his education.

PRESS SUMMARY

Thirteen recreationally active males completed a series of drills in high-top and low-top baseball cleats and performance outcomes, ankle range-of-motion (ROM), and athlete perception were all recorded. Shoe height had no impact on performance; however, the high-top cleat limited ankle ROM and was perceived as heavier, stable, and hotter. The results suggest that high-top baseball cleats may be a viable solution for players concerned about ankle stability, without negatively impacting performance.