ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

ATHLETIC PERFORMANCE AND PROPRIOCEPTION IS IMPROVED WITH ENHANCED COMPRESSION APPAREL

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SUMMARY
Athletic compression apparel is becoming widely adopted at all levels of competition, but the performance benefits remain incompletely defined. The objective of this study was to assess the effect of custom-fit compression suits on agility, jump, and proprioceptive performance. Athletes were tested in three apparel conditions: loose-fitting shorts and shirt (control), standard compression suit, and enhanced compression suit with bonded thermoplastic polyurethane bands. The standard compression suit did not significantly affect task performance, relative to control. Conversely, the enhanced compression suit contributed to significant improvements in vertical jump height (+2.4%), broad jump distance (+2.8%), and trunk repositioning accuracy (+6%).

INTRODUCTION
The gap between winning and losing in athletic competition is continually getting smaller. As a result, athletes and teams are interested in adopting incremental performance advantages where available. Compression garments have become popular with athletes due to aesthetics and comfort, as well as data that support claims of enhanced performance (e.g., vertical jump height [1]; repeated power production [2]; and tissue oxygenation [3]). However, studies have also demonstrated negligible athletic performance benefit [4, 5].
The purpose of this study was to evaluate the performance advantage, or lack thereof, of compression garments in an elite athlete population. Furthermore, the objective was to assess the effectiveness of a custom-fit, one-piece, enhanced compression suit, designed to increase core stability.

METHODS
Twenty-seven male University of Michigan varsity athletes (football: n=15; basketball: n=13) volunteered to participate. The study consisted of three test sessions, and was approved by the University of Michigan Institutional Review Board.

Session One: Body Measurements & Compression Apparel
Twenty-five anthropometric measurements were taken for all athletes. Measurements were used by adidas® to construct subject-specific compression garments (CG). CGs were one-piece with a front zipper (Fig 1). Upper-body coverage differed for football and basketball suits: football CGs had sleeves that started proximal to the elbow, and basketball CGs had a sleeveless, open-shoulder design. Two CGs were made for each athlete: one *standard compression* (SC) and one *enhanced compression* (EC) suit. SC and EC suits were identical, with one exception: EC suits had bonded thermoplastic polyurethane (TPU) bands (Fig 1).

Figure 1. (left) Basketball compression suit. (right) Example of football compression garment with bonded thermoplastic polyurethane (TPU) bands.

Session Two: Agility & Jump Tests
Participants were evaluated in three performance drills in the following order: three-cone agility, countermovement vertical jump, and broad jump.
Three-cone drill time was measured with photoelectric gates. Maximal countermovement vertical jump (CMJ) was assessed with a Vertec device. Broad jump required the athlete to jump forward from standing and land without taking additional steps for stabilization.

Session Three: Proprioception
Trunk proprioception was assessed with passive repositioning in the Trunk Modular Component (TMC) for the Cybex HUMAC NORM system. Participants were positioned into 30 and 60 degrees of trunk flexion and asked to recreate that position three times.
The test protocol for performance and proprioception tasks was repeated for three apparel conditions: athletes' own loose-fitting shorts and shirt (N), custom-fit standard compression (SC), and custom-fit enhanced compression (EC). EC suits were visually distinguishable from SC suits, although athletes were not informed as to which suit, if any, may assist or impede performance. All apparel conditions were tested on the same day using a balanced randomized block design to account for the influence of apparel order.
One-way repeated measures ANOVA and Tukey's multiple comparisons test were used to assess the effect of apparel. A significance level of $p<0.05$ was used for all tests.

RESULTS AND DISCUSSION

Three-cone agility drill times were not significantly different between apparel conditions. Mean vertical jump height was 2.4% (p<0.05) greater with EC, relative to N, although not consistently across athletes (main effect, p>0.05) (Fig 2). Athletes consistently had a greater broad jump distance in EC, relative to N and SC (p<0.001). Mean jump distance with EC was 2.8% (p<0.001) and 2.6% (p<0.01) greater, relative to N and SC, respectively (Fig 2).

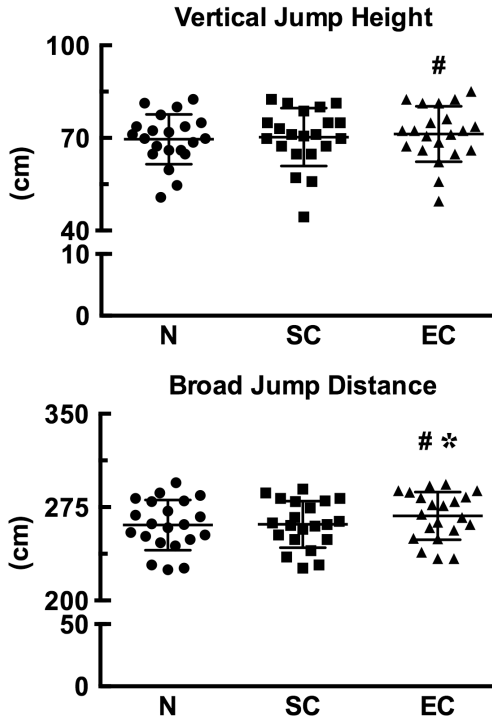

Figure 2. (left) Scatter plot of jump height for football and basketball athletes (mean ± SD underlaid; points distributed in horizontal for clarity). (right) Scatter plot of broad jump distance. Apparel conditions: normal (N), and standard (SC) and enhanced compression (EC). Mean significantly different than # N and * SC.

Athletes were better able to reposition their body to a given flexion angle with EC (p<0.01; Figure 3). Mean positioning error in EC was 6% (p<0.01) and 4.2% (p<0.01) lower for the 30° and 60° targets, respectively, relative to N. Additionally, with a 60° target, mean error was 32% (p<0.05) lower in EC than in SC.

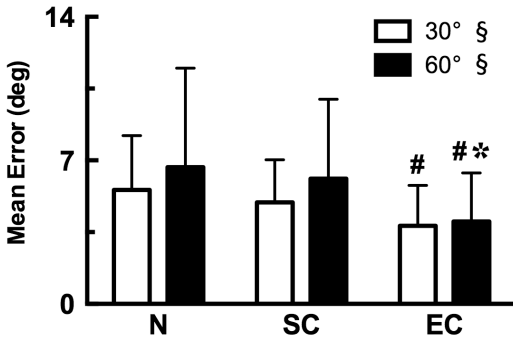

Figure 3. Trunk repositioning error for 30- and 60-degree flexion targets in normal (N), and standard (SC) and enhanced compression (EC). Mean significantly different than # N and * SC. § significant main effect of apparel.

Maximal vertical jump height was shown previously to increase with the use of compression shorts by 5% [1]. In addition, compression apparel positively influenced proprioception at the knee [6] and hip [7] joints. In this study, standard compression (SC) suits did not provide a significant performance or proprioceptive advantage, relative to normal training apparel (N). However, a direct comparison of results is problematic, due primarily to differences in garment material and construction. Potentially, the level of compression applied in this study was insufficient to elicit a significant performance benefit.

With the addition of stiffer TPU bands (EC condition), performance was positively affected, particularly for the broad jump and proprioception task. It is likely that, in conjunction with surface compression, the TPU bands provided additional positional feedback. Ostensibly, augmented proprioception was utilized during jump tasks to improve technique by optimizing joint angles for increased power production. The elasticity of the bands may have further contributed propulsive force, as well as mechanical support, allowing for a lower squat depth before jumping [1]. In addition to the acute performance benefit measured herein, enhanced proprioception contributes to reduced injury risk [8].

Anecdotally, perceptual responses tended to be most positive toward the EC garment; athletes described feeling "faster" and "stronger." Thus, the psychophysical benefits, despite being benefits nonetheless, confound the underlying biomechanical and physiological effects.

CONCLUSIONS

This study demonstrated significant vertical jump, broad jump, and proprioceptive performance benefit from wearing a custom-fit compression suit with bonded TPU bands. Maximal mean jump height and distance was increased by 1.7 cm and 7.4 cm, respectively. Considering the small discrepancy among competitive athletes, the performance advantage provided by enhanced compression apparel could mean the difference between first and second, winning and losing, and getting noticed at a pre-draft evaluation.

Future work will aim to extract the primary biomechanical, physiological, and psychophysical predictors of improved performance elicited by compression apparel.

ACKNOWLEDGEMENTS

Financial support for this research was provided by adidas AG. The authors have no conflict of interest to declare.

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