Non-Contact ACL Injury Risk Reduction in Female Soccer Athletes

Background: Female soccer athletes are at a 3 times greater risk of sustaining a non-contact anterior cruciate ligament (ACL) injury compared with male soccer athletes.

Purpose: The purpose of this study was to determine the effects of training and a wearable neuromuscular device (WND) on non-contact ACL injury risk in female soccer athletes.

Study Design: Prospective, intervention cohort study.

Methods: A total of 424 female soccer athletes (age range: 12-25 years) from 24 teams participated in this study. Each team was randomly selected to one of four experimental conditions: standard training (ST) with (8 teams, n=124) or without (4 teams, n=74) a wearable neuromuscular device (WND); and neuromuscular training (NMT) program with (6 teams, n=105) or without (6 teams, n=119) a WND. The WND was a thigh compression sleeve that provided focused topical pressure over the medial quadriceps and hamstrings muscles. Each team performed 7-9 weeks of pre-season training (46-64 hours per athlete). The NMT training protocol was a 3-phase program (duration 15-20 min) that was instructed by an exercise specialist 2 to 3 times per week at the beginning of practice. The ST program consisted of a team's normal practice regiment. Compliance with the intervention program was monitored by an exercise specialist, research assistant or the team's manager and the number of new non-contact ACL injuries were tracked by an athletic trainer.

Main Outcome Measures: The absolute difference (±95% CI) between the total number of non-contact ACL injuries per 100 athlete-seasons at the beginning (control) and throughout the one year duration of the study was computed for each experimental condition (absolute risk reduction, ARR). The treatment effects were determined by computing the inverse of the ARR metrics (number needed to treat, NNT) and statistical significance (p=.05) was determined if the 95% confidence interval did not include zero.

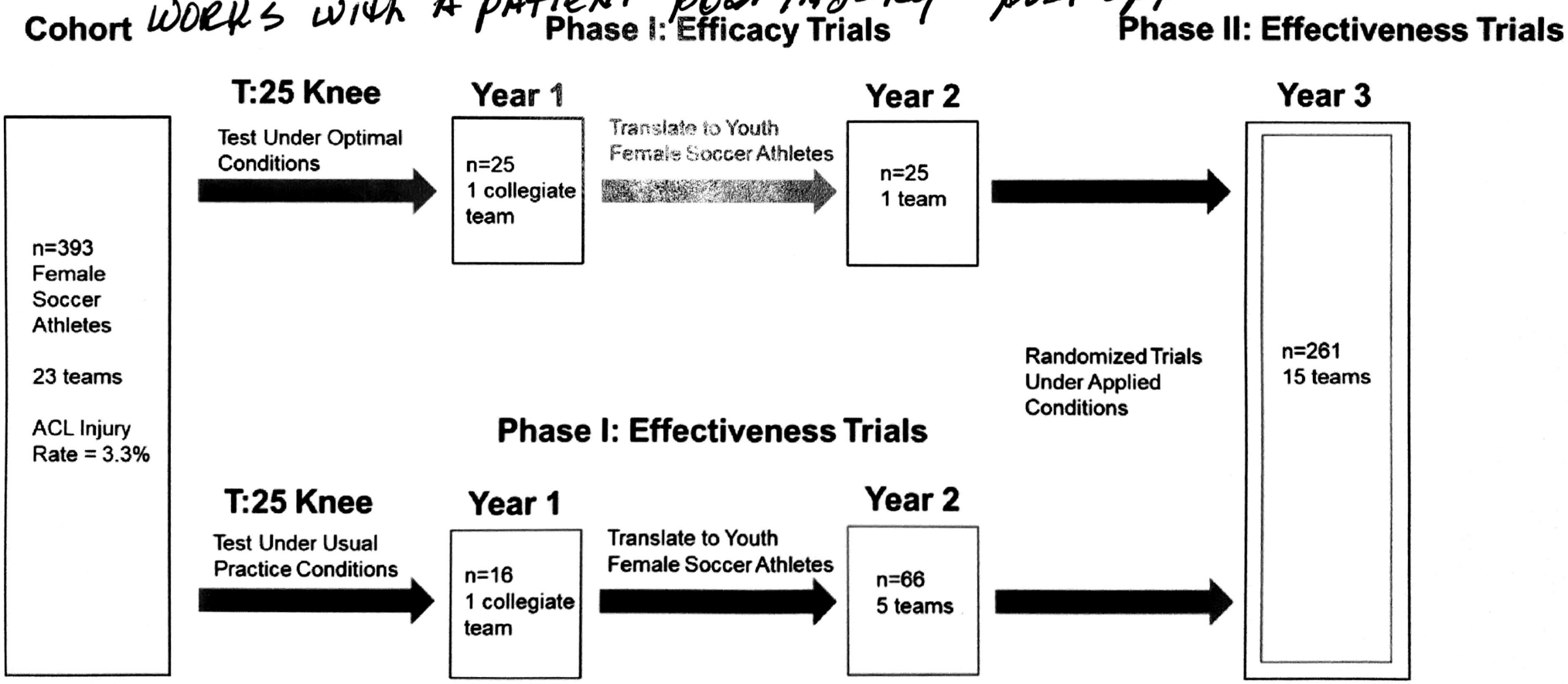
Results: A total of 21 non-contact ACL injuries were reported at the onset of the study (NMT, n=4; NMT with WND, n=8; ST, n=2; ST with WND, n=7). Three new non-contact ACL injuries were documented (ST, n=2; ST with WND, n=1). Statistically significant ARR values ranged from 3.4 to 7.6 (NMT with WND: ARR, 7.6 (2.5, 12.7); NMT: ARR, 3.4 (0.1, 6.6); ST with WND: ARR, 4.8 (0.5, 9.2); all p<.05) and only the ST condition did not reduce the risk of a non-contact ACL injury. The NNT ranged from 13.1 to 29.8 (NMT with WND: NNT, 13.1 (7.9, 39.3); ST with WND: NNT, 20.7 (10.9, 207.4); NMT: NNT, 29.8 (15.2, 812.6).

Conclusions. This study shows that neuromuscular training reduces the risk of a non-contact ACL injury in female soccer athletes and that a WND augments these effects.

A pair of T.25 Knees can provide your patients with 55 hrs of neuromuscular training when worn as prescribed, in 8 weeks at a cost of $110. T.25 Knees should last 18 months.

The figure below illustrates my approach to investigating the effects of the T:25 knee on ACL injury risk reduction. Based on this approach, the T:25 Knee with or without a neuromuscular program was calculated to reduce ACL injury risk (both statistically significant; $p<.05$). We did find 1 non-contact ACL injury for an athlete using the T:25 Knee during Year 3, and this individual was from a team that did not have a neuromuscular training program. Despite this injury, using the T:25 Knee alone was found to have 4.0 times lower ACL injury risk, relative risk reduction of 76%. Grouping all athletes that used the T:25 Knee with or without a formal neuromuscular training program had a 6.9 times lower ACL injury risk, a 85% relative risk reduction. So although the T:25 Knee appears to be a neuromuscular program by itself, having a movement professional providing (external) movement quality instruction and feedback; and the T:25 Knee to provide internal feedback (proprioception) may be the optimal approach for reducing ACL injury risk in young female soccer athletes. It is not clear if the effects of either approach is age dependent at this time.

the same results can occur in a clinical setting when a PT or ATC works with a patient post injury - post opp



Narrowing the Functional Movement Gap in Female Soccer Athletes

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PURPOSE: The purpose of this study was to assess knee kinematics and movement ability in female soccer athletes before and after a novel, preventive neuromuscular training program.

METHODS: Twenty-one, elite female soccer athletes (age, 13.3 ± 0.6 y) participated in a 7-week, training program with a wearable neuromuscular device (WND). Sagittal and frontal plane knee kinematics were measured during a single-leg hop and balance test, performed bi-laterally, with inertial measurement units. Movement ability was measured with a computer-adaptive test version of the Movement Ability Measure (MAM-CAT). The MAM-CAT has 18 items, three for each of the six movement dimension of strength, flexibility, speed, accuracy, endurance and adaptability. Each item contains six statements representing six increasing movement ability levels addressing how respondents currently move and how they would prefer to move during activities of daily life and sports participation. The MAM-CAT software computes logit scores based on a multi-dimensional item response theory model and transforms current and preferred movement ability scores to equal 0 for "cannot move" through 6 for "moves competitively." Changes in summed current movement ability and current-preferred differentials (movement gap) were compared pre and post training with paired t-tests (p=.05). Maximum knee valgus and flexion; and knee valgus and flexion positions at ground contact were contrasted with a 2-way (pre, post; dominant leg, non-dominant leg) repeated measures ANOVA. A self-assessment transition item of pre versus post movement ability with five Likert response options ("much better", "slightly better", "about the same", "slightly worse", and "much worse") was used to determine the minimal important difference (MID) by the mean change method between "slightly better" and "about the same" subgroups.

RESULTS: Each athlete had an average of 11.3 ± 2.9 hours of weekly athletic exposure of which 6.9 ± 1.7 hours were performed in the WND. At the end of the training program, 62% of the athletes reported "slightly better" movement ability and 33% reported "about the same." The MID for narrowing the movement gap was calculated to be 1.1. Group mean current movement ability scores increased 7% (p=.008) and the current-preferred differentials decreased on average by 25% (p=.035) and exceeded the MID metric. Group mean (±SD) sagittal and frontal plane kinematics collapsed across both legs are graphically presented. Maximum knee valgus and knee valgus position at ground contact decreased on average by 6.5 ± 3.9° and 4.1 ± 5.5° (both, p<.001). Maximum knee flexion and knee flexion position at ground contact were on average increased by 14.5 ± 8.1° and 7.9 ± 9.3° (both, p<.001).

CONCLUSIONS: The novel preventive neuromuscular training program narrowed the functional movement gap in a primary biomechanical variable associated with knee injury risk and induced movement quality improvements that were perceived from the female athlete's point of view.

A Novel Movement Ability Training Program Enhances Performance in Female Soccer Athletes

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PURPOSE: The purpose of this study was to assess the effects of a novel training program on the field-based performance testing of speed, power and movement quality. **METHODS**: Twenty-five, elite female soccer athletes (13.3 ± 0.6 y; 161.9 ± 5.3 cm; 50.9 ± 4.9 kg) participated in a 7-week, training program performed with a wearable neuromuscular device (WND). The training program was directed by an exercise specialist and consisted of a three-tier progression of exercise complexity and intensity to enhance the athlete's movement ability. All athletic exposures with and without the WND were recorded and analyzed descriptively. Field-based measurements of speed, power and movement quality were performed at the start (pre) and the end (post) of the training program. Speed was measured with a stop watch during a 20 yard sprint. Power was calculated from the flight times of three, single leg maximum vertical jumps captured with a wireless inertial measurement unit attached with double sided adhesive over the sacrum. Movement quality was determined by video analysis of three drop jump landings using the original and modified Landing Error Scoring System (LESS). A one-way repeated measures ANOVA contrasted pre and post sprint times and the average number of landing errors scored by the standardized methods of the LESS and the modified LESS. A two-way (time, leg) repeated measures ANOVA was used to measure the change in average and peak single leg jump heights ($p=.005$). **RESULTS**: Twenty-two athletes completed pre and post testing. Each athlete had an average of 11.3 ± 2.9 hours of weekly athletic exposure of which 6.9 ± 1.7 hours were with the WND. Over the course of training, speed increased 4% (pre, 3.36 ± .06 s; post, 3.22 ± .04 s; $F(1,21)=10.171$, $p=.004$), average and peak power increased 40% (pre, .125 ± .003 m; post, .175 ± .006 m; $F(1,21)=59.618$, $p<.001$) and 37% (pre, .140 ± .004 m; post, .192 ± .007 m; $F(1,21)=48.482$, $p<.001$) and movement quality increased by 20% (LESS: pre, 6.7 ± .4 errors; post, 5.3 ± .5 errors; $F(1,21)=15.032$, $p=.001$; modified LESS: pre, 7.3 ± .4 errors; post, 5.8 ± .5 errors; $F(1,21)=22.353$, $p<.001$). **CONCLUSIONS:** The novel training program enhanced the field-based measurements of speed, power and movement quality in elite female soccer athletes.

CAN A WEARABLE NEUROMUSCUAR DEVICE REPLACE NEUROMUSCULAR TRAINING PROGRAMS?

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Background: Scientific studies have shown female soccer athletes to be 3 times more likely to injure their anterior cruciate ligament (ACL) than their male counterparts and the majority of these injuries are from a non-contact mechanism. The biomechanical factors of this phenomenon have been extensively studied in a laboratory-based setting, but there has been little progress in reducing the incidence of ACL injury in young female athletes. It is plausible, therefore, to suggest that the biomechanical improvements noted in a laboratory-based setting do not directly translate to a field-based setting. Preventive neuromuscular training programs are typically field-based and have been shown to be an effective intervention for reducing ACL injury risk by improving dynamic, frontal-plane knee stability. However, these programs are time consuming and prone to compliance and implementation issues. For these reasons, researchers have attempted to identify the minimum viable training program or wearable device that can be studied in the field using video cameras to determine their influence on movement-related risk factors for ACL injury.

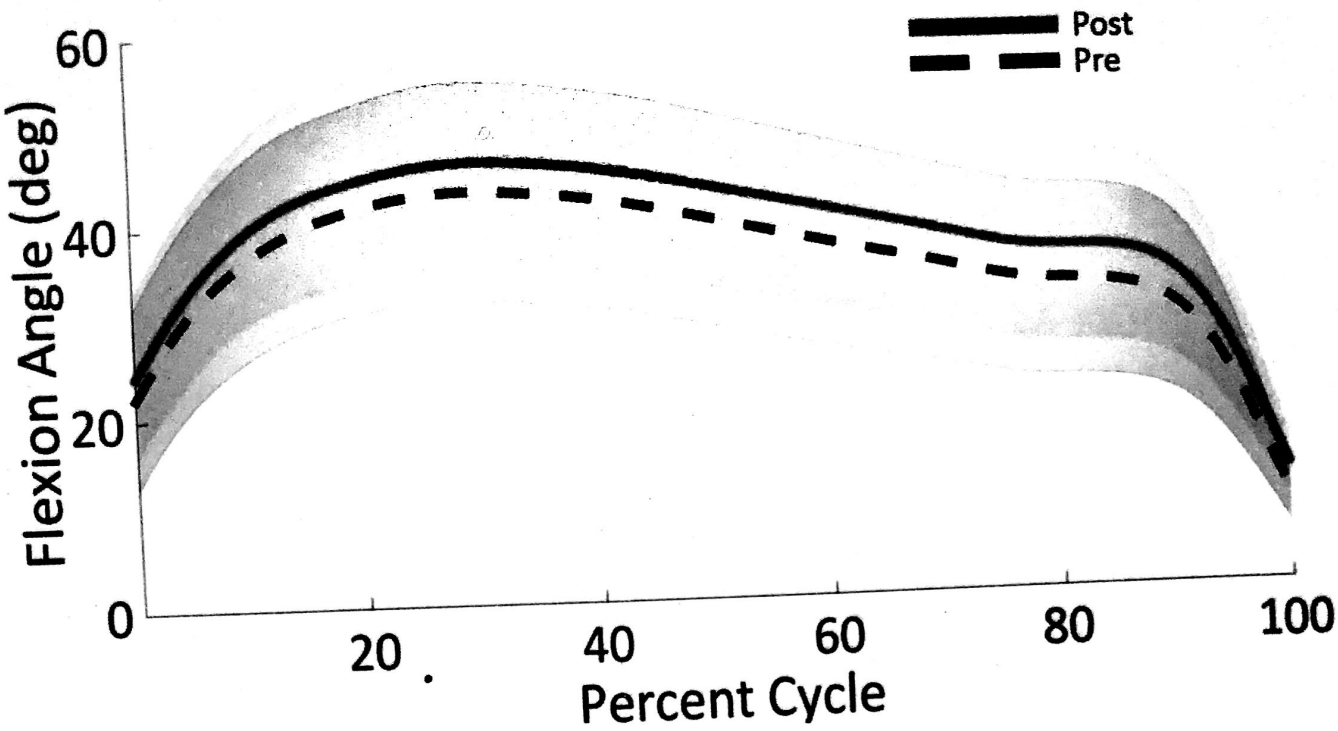
Purpose: The aim of this study was to evaluate the effectiveness of a wearable neuromuscular device (WND) with or without the addition of a field-based, preventive neuromuscular training program on jump-landing risk assessment in young female soccer athletes.

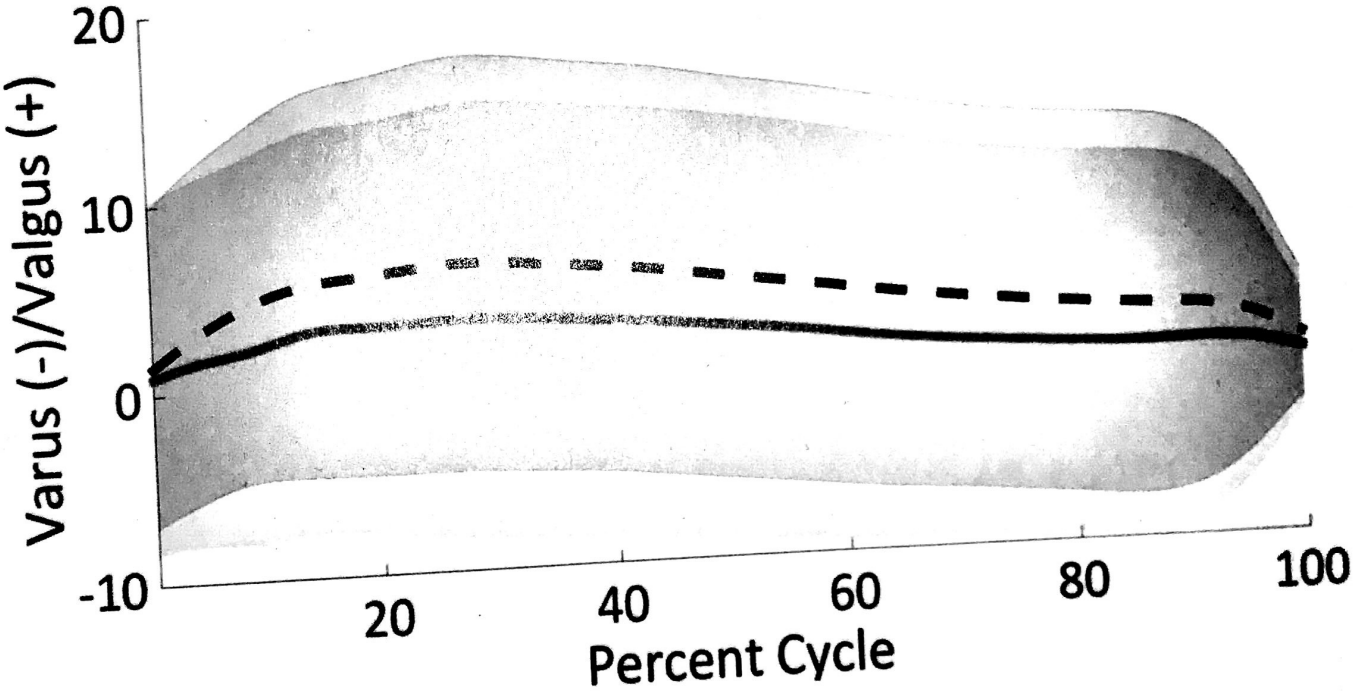
Methods: Thirty-nine female soccer players (161.0 +/- 6.6 cm; 49.4 kg +/- 5.9; 13.3 +/- 0.5 y) from two different teams in a local soccer club volunteered to participate in this study. Team 1 (n = 25) performed a 6-week, field-based NMT program while wearing a WND. The NMT was instructed by a trained exercise specialist. The NMT program was divided into three, two-week blocks of progressively increasing levels of exercise complexity and intensity focused on improving the strength and activation behavior of the trunk, hip and thigh muscles. Field-based movement testing was performed in the first week before training began (pre-test) and in the seventh week upon completion of the NMT program (post-test). During testing video cameras recorded a jump-landing task in the frontal and sagittal planes. The Landing Error Scoring System (LESS) and a novel version of the LESS (LESS-RMC) was used to asses movement quality related to ACL injury risk. Team 2 (n=14) wore the

WND for an equal amount of athletic exposures over 7 weeks but did not perform the NMT program. Four different raters were recruited to visually score all jump landing trials using the two different rating protocols during the pre-test and post-test. For each visual assessment (LESS & LESS-RMC) a repeated measures ANOVA was conducted to explore within group (test) and between group (team) differences.

Results: Repeated measure ANOVA results for the LESS score scale indicated a significant within factor difference in pretest and post test scores $F(7.398, 27.533) = 8.598$, $P < 0.05$. Pretest scores for team 1 (6.18 +/- 1.68) and team 2 (6.95 +/- 0.94) both saw a significant reduction in ACL risk scores to 5.44 +/- 1.70 and 6.31 +/- 1.75, respectively. ANOVA results for the LESS-RMC scale also indicated a significant within factor difference in pretest and posttests $F(6.756, 35.624) = 6.069$, $p < 0.05$. Pretest scores for Team 1 (6.02 +/- 1.99) and Team 2 (6.49 +/- 1.33) both saw a significant reduction in ACL risk scores to 5.10 +/- 1.77 and 6.09 +/- 1.50, respectively. ANOVA results revealed no significant differences between team scores for the LESS ($F(0.031,27.533) = 0.036$, $p > 0.05$) or LESS-RMC ($F(1.053,35.624) = .946$, $p > 0.05$) scales.

Conclusion: The results reveal that the NMT program utilized in this study had no statistically significant additive effect on the visual risk assessment scores for Team 1 compared to Team 2, who had no NMT intervention and only wore the WND. Collectively, these results suggest that simply wearing a WND during 6 weeks of practice may be a less evasive and cheaper alternative to a NMT program.


Post
Pre
Flexion Angle (deg)
60
40
20
0
20
40
60
80
100
Percent Cycle


Varus (-)/Valgus (+)
20
10
0
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20
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