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Original research

Y-balance test performance and BMI are associated with ankle sprain injury in collegiate male athletes

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ABSTRACT

Objectives: To determine if static balance, dynamic balance, ankle range of motion, body mass index (BMI), or history of an ankle sprain were associated with ankle sprain injuries within male and female collegiate athletes.
Design: Prospective cohort.
Methods: Three hundred and eighty-four male (age = 19.79 ± 1.80 years, height = 178.02 ± 10.39 cm, mass = 85.71 ± 17.59 kg) and one hundred and sixty seven female (age = 19.80 ± 1.52 years, height = 165.61 ± 7.08 cm, mass = 66.16 ± 10.53 kg) collegiate athletes involved in a variety of sports at a NCAA Division II or NAIA institution participated. Baseline measures of the Y-Balance (YBT), modified Balance Error Scoring System (mBESS), weight-bearing lunge test (WBLT), BMI, and history of ankle sprain were recorded. Participants were followed prospectively for two years and incidence of ankle sprain injury was documented. The average of the WBLT, mBESS, and YBT measures were used for analysis. Male and female participants were analyzed separately. Mann–Whitney U tests were utilized to identify variables which may be significantly associated with ankle sprain injury for logistic regression analysis.
Results: A total of 59 (38 males and 21 females) individuals sustained an ankle sprain during the follow up period. The binary logistic regression revealed BMI (Nagelkerke $R^2 = 0.069$; $X^2 = 12.89$; $p < 0.001$; OR = 3.85; 95% CI, 1.90–7.79; $p < 0.001$) and anterior reach of the YBT (Nagelkerke $R^2 = 0.074$; $X^2 = 13.70$, $p < 0.001$; OR = 3.64; 95% CI = 1.83–7.23; $p = 0.01$) were significantly associated with ankle sprain injury in male athletes. No variables were associated with ankle sprain injury within female athletes.
Conclusions: Male collegiate athletes with greater BMI and lesser YBT anterior reach were at a greater risk of sustaining an ankle sprain injury.

1. Introduction

Ankle sprains are one of the most common injuries among physically active individuals, accounting for 7–14% of all collegiate athletic injuries.[1,2] Many individuals who sustain an ankle sprain experience recurrent ankle sprains, develop chronic ankle instability,[3] and suffer long term consequences such as osteoarthritis,[4] and a decreased health-related quality of life.[5,6] Based on these long term consequences, it is important to increase efforts to prevent ankle sprain injuries.[7]

An important step in preventing ankle sprain injuries is to identify modifiable risk factors. Commonly reported risk factors for ankle sprain injuries include a previous history of ankle sprain and increased body mass index (BMI).[8–10] Individuals with a history of ankle sprain are reported to have up to a 6 times greater risk of sustaining another ankle sprain when compared to those with no history of ankle sprain injury.[9] A recent study identified high school and collegiate football athletes with an elevated BMI are more likely to sustain a lateral ankle sprain.[11] Research further supports that individuals who have a high BMI and a previous history of ankle sprain injury are 19 times more likely to sustain a subsequent ankle sprain injury.[9] Based on these findings, an elevated BMI and a previous history of ankle injury should be considered risk factors for an ankle sprain injury.

Several studies have attempted to identify variables related to dynamic balance, static balance, and ankle range of motion (ROM) to predict lower extremity injuries in physically active populations. The Y-Balance Test (YBT) is a clinical measure utilized to evalu-

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ate dynamic balance. Asymmetries between limbs in the anterior direction have been associated with over 2 times increased risk of lower extremity injury.[12] Static balance measured by a single limb balance test has been associated with 2.5 times greater risk of lower extremity injury in high school, collegiate, and physically active athletes.[13,14] Additionally, a deficit in dorsiflexion ROM has previously been linked with an increased risk of lower extremity injury.[14–16] The above mentioned factors have all been associated with an increased risk of lower extremity injury, but have not been investigated collectively to predict ankle sprain injuries.

A recent study[11] investigated the association between BMI, previous history of ankle sprain, and performance on the Star Excursion Balance Test (SEBT) and ankle sprain injury occurrence in high school and collegiate male football athletes. The results indicated the most prominent predictor of ankle sprain was poor performance on the anterior reach of the SEBT while BMI was also a significant predictor of ankle sprain injury. Although this study indicates that dynamic balance and BMI are important factors for understanding ankle sprain risk, it is unknown whether these results can be generalized among male and female athletes who participate in a variety of sports. An additional study utilized both male and female collegiate athletes and found no correlation between performance on the YBT and subsequent lower extremity injury occurrence.[17] Stiffler et al.[18] found an asymmetry in the anterior direction of the SEBT to be predictive of lower extremity injury when controlling for sport, sex, and athletic position. There is a possibility that injury risk prediction for certain variables is specific to demographic variables such as gender.

Gaining a better understanding of the modifiable risk factors associated with increased risk of ankle sprain injury is needed to develop effective injury prevention strategies. There is a lack of prospective studies investigating a multitude of risk factors for ankle sprain injury at the collegiate level within a variety of sports. Additionally, there is a lack of studies investigating injury prediction for males and females separately. Therefore, the purpose of this study was to determine if performance on the YBT, static balance, dorsiflexion ROM, BMI, and history of previous ankle sprain are associated with ankle sprain injury in collegiate athletes within each gender. We hypothesized that poor performance on the YBT, an increased asymmetry between limbs on the YBT, poor static balance, poor dorsiflexion ROM, elevated BMI, and history of previous ankle sprain will be associated with ankle sprain injury within male and female collegiate athletes.

2. Methods

A prospective cohort design was used to determine the risk factors for ankle sprain injury. Three hundred and eighty-four males (age = 19.79 ± 1.80 years, height = 178.02 ± 10.39 cm, mass = 85.71 ± 17.59 kg) and one hundred and sixty-seven females (age = 19.80 ± 1.52 years, height = 165.61 ± 7.08 cm, mass = 66.16 ± 10.53 kg) volunteered to participate. Participants were collegiate athletes involved in a variety of sports at a Division II (n = 69) and National Association of Intercollegiate Athletics (n = 482) school (Table 1). All participants were recruited during pre-participation physical exams. Participants were included if they intended to participate in a sport at either of the two institutions. Participants were excluded if they had a current injury or disease that prevented them from completing any of the baseline ROM and balance measures. This study was approved by the IRB of all involved institutions.

Participants signed an informed consent document, completed an injury history questionnaire, and had their height and weight measured (Health O Meter® with Height Rod, Bedford Heights, OH) to calculate BMI prior to performing the baseline measures. The injury history questionnaire assessed previous history of injuries to the ankle, knee, and hip. Limb length was measured from the ASIS to the medial malleolus (cm). The order of the functional tests (YBT, single limb balance, and weight-bearing lunge test (WBLT)) and limb tested first during each test were counterbalanced. All investigators were Athletic Trainers who were trained by the principal investigator to collect the functional measures. Standard operating procedures were utilized for each test to ensure uniformity with the administration of the test.

Table 1
Subject sport and frequency of ankle sprain.

Sport	Injured (%)	Uninjured	Total
Baseball	3 (6)	51	54
Men's basketball	6 (9)	61	67
Women's basketball	6 (17)	29	35
Football	24 (15)	137	161
Men's lacrosse	0 (0)	19	19
Men's soccer	3 (5)	59	62
Women's soccer	6 (13)	42	48
Softball	2 (7)	28	30
Men's tennis	2 (20)	8	10
Volleyball	6 (20)	24	30
Men's other	0 (0)	11	11
Women's other	1 (4)	23	24
Total	59 (11%)	492	551

Dynamic balance was assessed using the YBT (Perform Better; Warwick, RI). While barefoot, participants balanced on the center board of the YBT instrument. They were instructed to keep their hands on their hips and reach as far as possible by pushing a board into the anterior, posteromedial, and posterolateral directions. Four practice trials in each direction were followed by three test trials for each direction. YBT reach distances were normalized to leg length (%). Between-limbs symmetry was calculated as the absolute difference between limbs for each direction. The YBT has previously been determined to have good intrarater (ICC = 0.85–0.91) and interrater (ICC = 0.99–1) reliability.[19]

Static balance was measured using the single limb stable surface condition of the Balance Error Scoring System (BESS).[20] This test was performed barefoot utilizing a single limb stance on a stable surface with the eyes closed. The participant maintained balance on a single limb with their eyes closed for 20 seconds while the rater recorded errors. Each participant performed one test trial on each limb with a maximal score of 10 errors recorded. This stance of the BESS has good intrarater (ICC = 0.88–0.99) and interrater (ICC = 0.83–0.98) reliability.[21,22]

Dorsiflexion ROM was measured using the WBLT. To complete the WBLT, participants performed a forward lunge towards a wall allowing the knee to contact the wall. The foot was progressively moved backwards until maximum dorsiflexion was reached while the knee maintained contact with the wall and the heel remained planted on the floor. The distance from the great toe to the wall was recorded and measured in cm. Three practice trials followed by three test trials were recorded for each limb. The WBLT has good interrater (ICC = 0.80–0.99) and intrarater (ICC = 0.65–0.99) reliability.[23]

During the injury surveillance period, ankle sprain injuries were recorded by Athletic Trainers at each institution utilizing an electronic medical record system. An ankle sprain was classified as an injury if there was damage to any of the ankle ligaments and the injury limited athletic participation for at least 1 day. The involved limb, mechanism of injury, and date of injury were recorded by the Athletic Trainer and this information was provided to the principal investigator. Participants were followed for incident ankle sprain injury for up to two years or as long as they remained a student athlete.

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