



## Original research

## Dynamic postural stability differences between male and female players with and without ankle sprain



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## ABSTRACT

**Objectives:** To evaluate dynamic stability index (DSI) differences between males and females for different jump directions. To examine both preseason DSI differences between players with and without a history of ankle sprain, and between players with and without an ankle sprain during the subsequent season.

**Design:** Prospective cohort design.

**Setting:** Laboratory.

**Participants:** 47 male ( $22.9 \pm 3.9$  y) and 19 female ( $21.5 \pm 2.9$  y) sub-elite and elite team sport players.

**Main outcome measures:** Ankle sprain history was collected using an injury history questionnaire. DSI of a single-leg hop-stabilization task measured preseason was collected using force plates and calculated using a Matlab program. Ankle sprains were reported during the subsequent season.

**Results:** Male players demonstrated larger DSI than female players on forward medial/lateral stability index (MLSI) and vertical stability index (VSI), diagonal VSI, and lateral anterior/posterior stability index (APSI) and VSI. Forward, diagonal and lateral dynamic postural stability indices (DPSI) were larger for males ( $p < 0.001$ ). No significant differences were found between players with and without a previous ankle sprain nor between players with and without an ankle sprain during the subsequent season.

**Conclusion:** Male players showed larger DSI scores than female players, indicating lower dynamic stability. Sex-specific training sessions or prevention programs should be developed.

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## 1. Introduction

Epidemiological studies have reported high incidence of ankle sprains in team sports such as basketball, football, soccer, softball, volleyball and baseball (Doherty, Delahunt, Caulfield, Hertel, Ryan, & Bleakley, 2014; Waterman, Owens, Davey, Zacchilli, & Belmont, 2010). Most literature has shown that in these indoor and court sports more ankle sprains occur in female players compared to male players (Doherty et al., 2014). This difference in incidence suggests that mechanisms and risk factors for ankle sprain in males and females should be examined separately. Ankle sprains may have some debilitating consequences for the player. For instance,

the risk of reinjury is large (Van Rijn, Van Os, Bernsen, Luijsterburg, Koes, & Bierma-Zeinstra, 2008) and a potential long term consequence is chronic ankle instability (CAI) (De Vries, Kingma, Blankevoort, & Van Dijk, 2010; Gribble et al., 2014; Wikstrom, Naik, Lodha, & Cauraugh, 2010). CAI was defined as “an encompassing term used to classify a subject with both mechanical and functional instability of the ankle joint” (Gribble et al., 2014). Moreover, it has been reported that 10–40% of players with long term issues following an ankle sprain still perceive instability and a feeling of giving way (Karlsson & Lansinger, 1992; Kerkhoffs, Handoll, de Bie, Rowe, & Struijs, 2007; Valderrabano, Wiewiorski, Frigg, Hintermann, & Leumann, 2007), even up to three years after recovering from an ankle sprain (Van Rijn et al., 2008). Furthermore, CAI could lead to an increased risk of ankle osteoarthritis (Gross & Marti, 1999).

The greatest risk factor is a history of ankle sprain (Van Rijn et al., 2008). One of the explanations for this increased risk may be a decreased neuromuscular control following an ankle sprain

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(De Vries et al., 2010). Balance deficits are a measure of neuromuscular control (De Vries et al., 2010). A review has shown that athletes who sprained their ankle still show balance deficits during a static balance task after four weeks (McKeon & Hertel, 2008). These deficits were found not only in the injured ankle, but also in the contralateral ankle that was not injured (McKeon & Hertel, 2008; Wikstrom, Naik, et al., 2010; Wikstrom, Tillman, Chmielewski, Cauraugh, Naugle, & Borsa, 2010).

Furthermore, a recent review showed some evidence that postural sway and balance are risk factors for ankle sprains in team sport players (Dallinga, Benjaminse, & Lemmink, 2012). Two studies including male or a combination of male and female basketball players found a higher postural sway being predictive for ankle sprains (McGuine, Greene, Best, & Levenson, 2000; Wang, Chen, Shiang, Jan, & Lin, 2006), however one study including male volleyball players did not find this relationship (Hadzic, Sattler, Topole, Jarnovic, Burger, & Dervisevic, 2009). Those three studies used static balance tasks for measuring postural sway, for instance standing on one leg (Hadzic et al., 2009; McGuine et al., 2000; Wang et al., 2006). Furthermore, low odds ratios for postural sway were reported in these studies (McGuine et al., 2000; Wang et al., 2006), indicating that ankle sprain risk increased slightly when postural sway increased.

Two main limitations can be addressed in current studies examining the relationship between ankle sprain and stability. At first, in most studies static balance tasks were used to measure stability. Two reviews showed that static balance tasks could not detect stability differences, since they might not be sensitive enough to find small differences in postural control (McKeon & Hertel, 2008; Wikstrom, Naik, et al., 2010; Wikstrom, Tillman, et al., 2010). Dynamic balance tests, such as landing and stabilizing after a single leg jump, may be more capable to better detect these differences, since they are more challenging and sport specific (McKay, Goldie, Payne, & Oakes, 2001; McKeon & Hertel, 2008; Wikstrom, Naik, et al., 2010; Wikstrom, Tillman, et al., 2010). The second limitation was that sex differences in stability were not taken into account. For instance, females showed higher dynamic stability scores on a forward jump task compared to males (Wikstrom, Tillman, Kline, & Borsa, 2006). These findings contribute to the difference in ankle sprain incidence based on sex; female players presented a higher incidence of ankle sprains (Doherty et al., 2014). Although, it should be mentioned that one study that examined injury rates for different age groups found higher ankle sprain occurrence for male players in the age of 15–24 years (Waterman et al., 2010). In summary, the strategy for dynamic postural stability might be different for male and female players. Dynamic tasks are recommended to measure differences in postural stability between injured and non-injured players.

In this perspective, a single-leg hop-stabilization task was developed to determine the dynamic stability index (DSI) (Wikstrom, Tillman, & Borsa, 2005). The DSI measures the ability of a player to maintain static balance after a dynamic task (Wikstrom, Tillman, Schenker, & Borsa, 2008). A benefit of the single-leg hop-stabilization task is that it includes jumps in different directions, such as forward, diagonal and lateral. This makes it more sport specific than only performing forward jumps. One of the outcome measures was the dynamic postural stability index (DPSI), a composite score of the medial/lateral, anterior/posterior and vertical DSI (Wikstrom et al., 2006). It was suggested that the DPSI could be used for preseason screenings for CAI (Wikstrom, Tillman, & Borsa, 2005; Wikstrom, Tillman, Smith, & Borsa, 2005). However, to the authors' knowledge, the relationship between the DPSI and acute ankle sprains has not been examined yet.

Compared with other currently used stability measures, the dynamic, challenging and sport specific aspects of the task used to

determine DSI could make it more suitable to detect differences in dynamic stability between male and female players with and without a history of an ankle sprain. It might be suitable to detect preseason dynamic stability differences between players with and without ankle sprain during the subsequent season as well. Moreover, the DSI may assist in determining sex differences. Therefore, the first aim was to determine if sex differences in DSI could be detected for different jump directions. The second aim was to examine whether the DSI measured preseason could discriminate (a) between male and female players who had a history of an ankle sprain and players who did not and (b) between male and female players who sustained an ankle sprain during the subsequent season and players who did not. The first hypothesis was that male players would show lower DSI scores than female players for all directions. The second hypothesis was that players with a history of an ankle sprain and players who sprained their ankle during the season would show higher DSI scores compared to their non-injured counterparts.

## 2. Methods

### 2.1. Design

A prospective cohort design was used to analyze the relationship between the DSI and ankle sprains in male and female team sport players. At the start of the season the DSI was measured during a single-leg hop-stabilization task. In addition, previous injury data were collected in order to provide insight in injury history of players. Ankle sprains were reported during the subsequent season. Written informed consent was obtained from all players and approval was granted in accordance with ethical standards of the local medical ethical committee, conforming to the Helsinki Declaration.

### 2.2. Subjects

Two male basketball teams, three volleyball teams (two male and one female) and one korfbal team (mixed) playing at elite and sub-elite level participated in this study. Korfbal is a team sport in which 4 males and 4 females play in one team, this sport shares similarities with basketball and netball (Zwerver, Bredeweg, & van den Akker-Scheek, 2011). More information about this sport can be found in supplementary material provided elsewhere (Zwerver et al., 2011). In total, eighty players were invited to participate in this study. The exclusion criterion was a current injury to the ankle. Eleven players were not able to attend the baseline measurements due to practical reasons. Three players dropped out during the season (2011–2012). One of these three players moved to another city during the season, the other two players stopped playing at the sub-elite or elite level. Therefore, 66 players (47 male (21 volleyball, 10 korfbal, 16 basketball) and 19 female (9 volleyball, 10 korfbal)) were included (Table 1).

### 2.3. Procedures

At baseline, players completed an injury history questionnaire about location, severity and type of previous injuries experienced

**Table 1**  
Descriptive statistics of 66 players (mean  $\pm$  SD).

	Female (n = 19)	Male (n = 47)
Age (years)	21.5 $\pm$ 2.9	22.9 $\pm$ 3.9
Height (cm)	175.9 $\pm$ 7.3	193.5 $\pm$ 7.9
Mass (kg)	69.0 $\pm$ 11.7	87.1 $\pm$ 10.6
BMI (kg/m <sup>2</sup> )	22.2 $\pm$ 2.8	23.3 $\pm$ 2.5

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