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Individuals with both perceived ankle instability and mechanical laxity demonstrate dynamic postural stability deficits

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ABSTRACT

Background: Chronic ankle instability is a frequent and serious consequence of lateral ankle sprains. The contribution of perceived instability and potential for mechanical laxity to contribute to the overall deficit in dynamic postural stability is unclear. The purpose was to determine if those with mechanical laxity demonstrated significant differences in dynamic postural stability compared to controls, copers and those with perceived instability.
Methods: Of 93 participants, 83 recreationally active individuals were divided into 4 groups: controls, copers, those with perceived instability, and those with both perceived instability and mechanical laxity. Injury history and the Cumberland Ankle Instability Tool were collected, and an instrumented arthrometer was applied. Participants completed a single limb jump landing, balancing upon completion. Ground reaction force data were collected, scaled to body mass, and the Dynamic Postural Stability Indices were calculated for anterior–posterior, medial–lateral, vertical and composite. One-way ANOVAs with Tukey post-hoc tests ($\alpha < 0.05$) were conducted on each of the stability indices among the four groups.
Findings: The mechanically lax group had significantly greater mean (standard deviation) medial–lateral stability index scores 0.57 (0.62) than the coper group 0.24 (0.20; $P = 0.02$) and significantly greater composite index scores 0.73 (0.57) than the perceived instability 0.49 (0.09) and coper groups 0.47 (0.12 $P = 0.05$). No other indices were significantly different among groups.
Interpretation: Individuals with perceived instability and mechanical laxity exhibited dynamic postural deficits compared to copers and those with perceived instability alone. Mechanical laxity may contribute to the deficits in dynamic postural stability.

1. Introduction

Lateral ankle sprains are one of the most frequent sports-related injuries (Fong et al., 2007). Approximately 30%–75% of those who sprain their ankle will suffer recurrence and chronic symptoms (Anandacoomarasamy and Barnsley, 2005; Konradsen et al., 2002). This clinical condition is termed chronic ankle instability (CAI) and is characterized by ankle instability, “giving away”, and failure to return to levels of previous physical activity after injury (Gribble et al., 2013).

CAI is believed to be a result of perceived instability, mechanical laxity, and recurrent sprains, with individuals experiencing one, two or all three components (Hiller et al., 2011). Perceived instability, commonly known as functional ankle instability, is defined as the subjective feelings of giving way at the ankle (Hiller et al., 2011), while mechanical laxity is defined as the motion or laxity beyond physiologic limits (Gehring et al., 2014; Hertel, 2002). Perceived instability coupled with mechanical laxity has been identified in a subset of individuals with CAI (Hiller et al., 2011), and that subset has demonstrated differences in kinematics, kinetics, and variability of motion during a variety of tasks (Brown et al., 2008, 2011, 2012; Gehring et al., 2014). However, the contribution and role of mechanical laxity in the overall continuum of CAI is unclear (Gehring et al., 2014; Hertel, 2002), and not all individuals with CAI exhibit mechanical laxity (Hiller et al., 2011). Individuals with a history of ankle sprains that do not develop CAI are known as copers (Wikstrom and Brown, 2014). They may offer advantages as a comparison group to those with CAI because of similar injury exposures, but different, and improved, clinical outcomes (Hertel and Kaminski, 2005).

Dynamic postural stability is a measure of functional performance while stabilizing the body to transition from a moving to a static state (Wikstrom et al., 2007). One measure of dynamic postural stability is the Dynamic Postural Stability Index (DPSI) which involves a single-leg jump landing in which the participant must stabilize quickly upon landing upon a force platform (Wikstrom et al., 2007). Stability indices are calculated in the anterior–posterior, medial–lateral, vertical and composite directions by measuring fluctuations around a zero point. Differences in index scores have been demonstrated between controls and CAI groups (Brown et al., 2010; Ross and Guskiewicz, 2004;

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Wikstrom et al., 2007, 2012) but not always with similar results. No authors have compared differences in postural stability following lateral ankle sprain in individuals with perceived ankle instability and in individuals who present with both perceived ankle instability and mechanical ankle laxity. Inability to appropriately utilize the static restraint system (ligaments) surrounding the ankle complex may impact dynamic ankle joint control during dynamic sports-related tasks (Gehring et al., 2014), and could be driving some deficits observed in CAI groups, specifically the subset with mechanical laxity. Therefore, the purpose of this study was to determine whether dynamic postural stability performance is different among controls, copers, perceived instability, and perceived instability–mechanical laxity groups. We hypothesized that the DPSI and sub-direction indices would be larger in the instability groups than in the copers and controls.

2. Methods

2.1. Participants

No published DPSI literature with tabled data on perceived instability–mechanical laxity groups was available to perform an *a-priori* power analysis. Similar studies indicated that 30–64 participants were necessary in each group for CAI to control comparisons with power of 0.80, $\alpha < 0.05$, and effect sizes of 0.44–0.65 (Brown et al., 2010; Wikstrom et al., 2010). The research question addressed in this paper was secondary data analysis on subsets of CAI participants from a larger project with other dependent variables that ultimately drove sample size selection.

A total of 93 participants between 18 and 35 years of age who participated in at least 90 min of physical activity per week were recruited from physical education classes, club sports teams, and flyers in a recreational sport building. Participants completed the University's Institutional Review Board approved consent form. Data from 83 participants were included based on inclusion/exclusion criteria (Fig. 1).

The participants were categorized and placed into one of four groups. The perceived instability group and the perceived instability–mechanical laxity group self-reported a history of mild to moderate ankle sprain at least 12 months before the study that required immobilization or non-weight bearing status for at least 3 days and had to report a CAIT score ≤24, indicating poor perceived ankle function (Gribble et al., 2013). The perceived instability–mechanical laxity group also demonstrated mechanical laxity ≥29.4° in inversion (Rosen et al., 2015) as indicated by an instrumented arthrometer. The coper group also self-reported a history of mild to moderate ankle sprain at least 12 months before the study that required immobilization or non-weight bearing status for at least 3 days and had to report a CAIT score of ≥28, indicating good perceived ankle function (Hiller et al., 2006; Wikstrom and Brown, 2014). The control group participants self-reported no history of significant ankle sprain(s), no history of repeated episodes of giving way, and had to score ≥28 on the CAIT questionnaire (Gribble et al., 2013). The involved limb was used for the instability groups and was defined as either the unilaterally injured limb, or the lower scoring limb on the CAIT if there was a history of bilateral injury. The coper group's test limb met previously published criteria (Wikstrom and Brown, 2014). The control group test limb was the dominant limb (Hoffman et al., 1998).

In addition, participants were excluded from the study if they reported a history of any of the following: 1) surgery and fracture in lower extremity; 2) current signs and symptoms of acute ankle sprains such as swelling, discoloration, heat, and pain; 3) pregnancy; or 4) diagnosis of a vestibular disorder, Charcot–Marie–Tooth disorder, Ehlers–Danlos disorder, or other nerve or connective tissue issues.

2.2. Procedures

Participants completed an injury history and activity questionnaire and the Cumberland Ankle Instability Tool (CAIT) (Hiller et al., 2006). The participants' age, gender, height and mass were measured. The

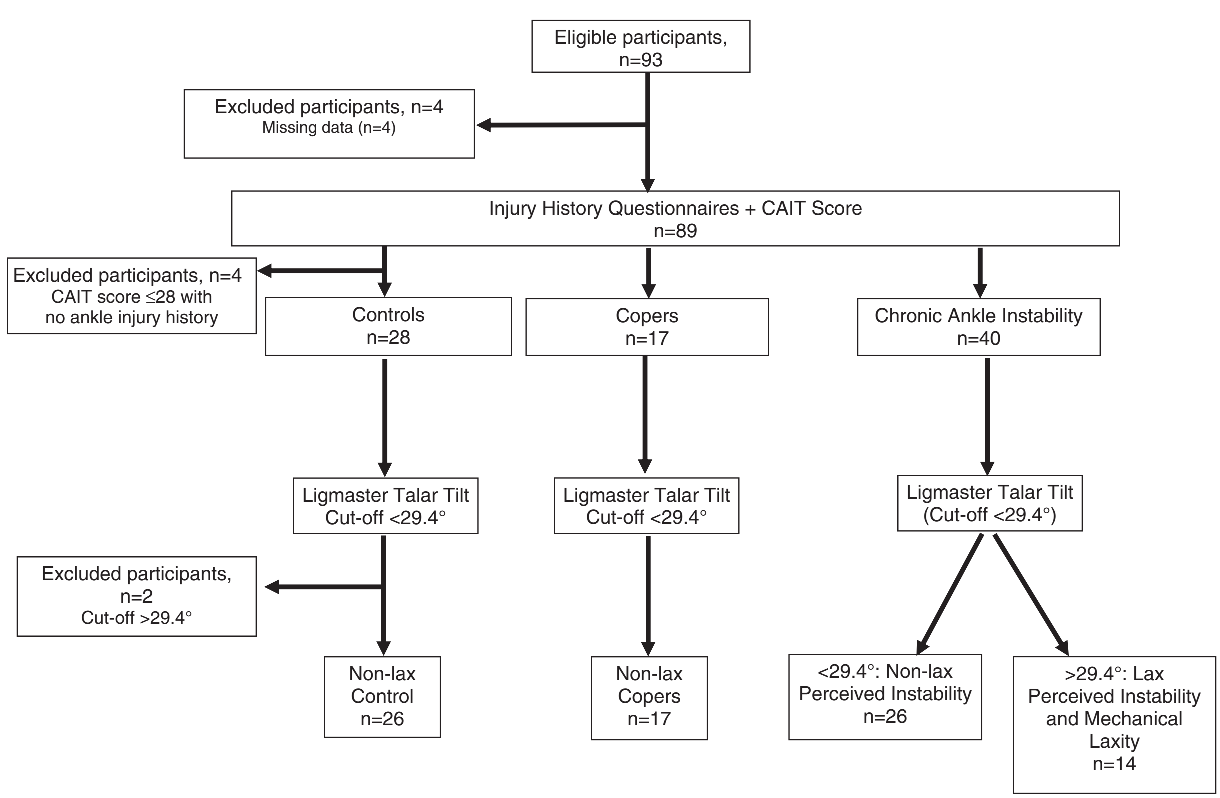

Fig. 1. Flow chart of eligible participants for arthrometer talar tilt test comparisons. Abbreviations: CAI, chronic ankle instability; CAIT, Cumberland Ankle Instability Tool.