INTRODUCTION

Low back pain accounts for approximately 5.5% of running injuries each year (Lopez, Hespanhol, Yeung, & Costa, 2012). Although the exact underlying cause of low back pain in runners is currently unknown, research has demonstrated that individuals with low back pain exhibit a reduction in passive hip extension range of motion compared to asymptomatic individuals (Roach et al., 2015; Van Dillen, McDonnell, Fleming, & Sahrmann, 2000). Reduced active hip extension flexibility has been correlated to greater anterior pelvic tilt during running (Franz, Paylo, Dicharry, Riley, & Kerrigan, 2009; Schache, Blanch, & Murphy, 2000). In turn, greater anterior pelvic tilt has been associated with greater extension of the lumbar spine during running (Schache, Blanch, Rath, Wrigley, & Bennell, 2002). Since it is postulated that excessive lumbar spine extension may contribute to low back pain, the kinematic relationship between hip, pelvis, and lumbar spine provides a potential mechanism to help explain low back pain during running.

Improving flexibility of the hip flexors may be a useful intervention in terms of reducing low back pain. Winters et al. (2004) found that six weeks of either passive or active stretching of the hip flexors was effective at increasing passive hip extension flexibility. Moreside & McGill (2012) reported similar results when they also implemented a six week passive stretching program in individuals with limited passive hip extension flexibility. However, in a follow-up study, the same aforementioned authors (Moreside & McGill, 2013) found that improvements in
passive flexibility at the hip flexors did not necessarily result in improvements in active hip extension flexibility during several functional dynamic movement tasks. However, no study has yet examined the effects of static hip flexor stretching on active hip extension flexibility during running.

Research suggests that reduced passive hip extension flexibility may put an individual at risk for low back pain by decreasing active hip extension flexibility while increasing both anterior pelvic tilt and lumbar spine extension during running. Therefore, the purpose of this study is to analyze the effects of a three week stretching program on the passive hip extension flexibility, as well as on the sagittal plane kinematics of the hip, pelvis, and spine when running. It is hypothesized that an increase in both the passive and active hip extension flexibility will be measured following the three week stretching program. It is also hypothesized that the increase in passive and active hip extension flexibility will be accompanied by decreases in both the anterior pelvic tilt and lumbar spine extension.

**METHODS**

**Experimental Design**

This will be a laboratory based, single-group, longitudinal, quasi-experimental study. The independent variable will be time (baseline and three weeks later). The dependent variables will include passive peak hip extension during the modified Thomas test (MTT), as well as peak hip extension, peak anterior tilt, and peak lumbar spine extension during gait.

**Participants**

The study group of 25 participants will be chosen from a sample of convenience. Participants must be between the ages of 18-40 and regularly engage in physical activity that involves running (for at least 30 minutes three times per week). In order to participate, subjects
must exhibit reduced passive hip extension flexibility based on measurements from the modified Thomas test. Subjects will be excluded from participating if they currently experience any pain in the lower extremities or spine, have suffered an injury to the lower extremity or spine that limited activity in the past three months, have undergone major surgery to the lower extremity or spine at any time, or if they are not comfortable running on a treadmill without the use of handrails. Participants will be recruited using convenience sampling from the university campus. Physical and online flyers as well as word of mouth will be utilized to recruit.

**Procedures**

Participants will be required to complete one screening visit to establish whether they meet the inclusion criteria for limited passive hip extension. During this visit, participants will undergo a passive hip extension flexibility assessment using a modified Thomas test (MTT). Participants will be positioned on their back with their measured hip at the edge of the treatment table and their tested leg hanging passively off the table. At the same time, the opposite leg will be held by the participant with the hip and knee in a flexed position against the chest. Participants will be instructed to pull their knee straight to their head in order to prevent any hip abduction. Care will also be taken to ensure that the participant’s low back lays flat against the table so that the pelvis and lumbar spine remain in a neutral position throughout the entire test. Using a digital inclinometer placed on the thigh, the hip extension range of motion will be measured. Measurements will be considered negative if the thigh drops below the horizontal and positive if the thigh remains above the horizontal. Participants will be considered to have limited hip extension flexibility if they produce a positive measurement.

Participants who qualify for the study will complete two separate data collection sessions both prior to (PRE) and following (POST) a three-week static hip flexor stretching program.
Both data collection sessions will include the MTT, hip flexor and hip extensor muscle strength tests, and a gait analysis.

Measurements of subject’s muscle strength will be taken during the session using an isokinetic dynamometer (Biodex Medical Systems, Inc., New York, NY). Lower extremity and spine kinematic data will be collected while participants run at a self-selected speed on a treadmill collecting at 1000 Hz (Bertec, Columbus, OH). Retroreflective markers will be placed on the spine and bilaterally on the pelvis and lower extremity. 3D coordinate data will be collected at 200 Hz (Motion Analysis Corp, Santa Rosa, CA). Joint/segment angles will be calculated in Visual 3D (C-Motion Inc, Germantown, MD).

The three-week home-based stretching program will consist of a standing hip flexor stretch and a kneeling modified lunge stretch, which will be performed each day. 10 repetitions will be completed for each stretch on each limb with a 10 second hold and a 10 second rest between each repetition.

Variables of interest include peak passive hip extension flexibility, as well as peak active hip extension flexibility, peak anterior pelvic tilt, and peak lumbar spine extension when running. Dependent t-tests will be used to compare PRE and POST variables of interest before and after the three-week stretching program with a significance level of $p < 0.05$. 

REFERENCES


