

## ORIGINAL RESEARCH

## EFFECTS OF NORMAL AGING ON LOWER EXTREMITY LOADING AND COORDINATION DURING RUNNING IN MALES AND FEMALES

Paul W. Kline, PT<sup>1</sup>D.S. Blaise Williams III, PT, PhD<sup>2,3</sup>

## ABSTRACT

**Background:** Runners sustain high injury rates. As greater numbers of individuals continue to run past the age of 60, normal physiological changes that occur with aging may further contribute to injuries. Male and female runners demonstrate different mechanics and injury rates. However, whether these mechanics further diverge as runners age and whether or not this potential divergence in mechanics may or may not be associated with a potential for increased injury risk is unknown.

**Hypothesis/Purpose:** The purpose of this study was to compare measures of loading and lower extremity coupling during running with respect to age and sex. It was hypothesized that males and females would demonstrate increasingly diverging mechanics with increased age.

**Methods:** Forty-one subjects were placed in four groups: younger males (n = 13), younger females (n = 6), older males (n = 16), and older females (n = 6). Ten running trials were collected and analyzed for each subject. Kinematic data were collected and reconstructed using a nine-camera motion analysis system and commercial software. Vertical loading rate (VLR), initial (GRF<sub>1</sub>) and peak vertical ground reaction force (GRF<sub>2</sub>) and lower leg joint coupling were calculated for each subject. Analysis was performed using a 2-factor ANOVA (sex X age) to determine differences between groups during the stance phase of running.

**Results:** Compared to younger subjects, older subjects demonstrated higher GRF<sub>1</sub> per body weight (Y: 1.70 (0.19), O: 1.96 (0.23), p < 0.01), higher VLR in body weight/second (Y: 44.17 (6.73), O: 52.76 (8.39), p < 0.01) and lower GRF<sub>2</sub> per body weight (Y: 2.47 (0.18), O: 2.35 (0.18), p = 0.04). However, no differences existed between males and females or further diverged in the older subjects. There were no differences between or within groups in joint coupling. Finally, no significant differences were seen between sexes and no interactions were found between any variables in the current study.

**Conclusions:** Older runners experience greater GRF<sub>1</sub> and VLR and lower GRF<sub>2</sub>. These are factors previously associated with tibial loading and stress fractures. Males and females do not differ on these factors suggesting older female runners may be at no greater risk than younger runners or male runners for lower extremity bony injury based on normal mechanics.

**Key words:** Aging, coupling, loading, running, sex

**Level of Evidence:** 3

## CORRESPONDING AUTHOR

D.S. Blaise Williams, PT, Ph.D.  
West Hospital Building, 1200 East Broad  
Street  
Richmond, VA 23298  
Phone: (804) 828-1444  
Fax: (804) 828-8111  
E-mail: dswilliams@vcu.edu.

<sup>1</sup> Division of Physical Therapy, College of Health Sciences, University of Kentucky, Lexington, KY.

<sup>2</sup> VCU RUN LAB Department of Physical Therapy, Virginia Commonwealth University, Richmond, VA

<sup>3</sup> Department of Kinesiology and Health Sciences, Virginia Commonwealth University, Richmond, VA

No external funding was sought or received for this work. The authors have no conflict of interest.