

## Abstract

The literature has shown a link between visual impairments and an increased risk of falling in older adults (Lord, 2002). Falling is a major reason for hospitalization, injury, and death amongst individuals over 65. Multifocal eyeglasses, which are designed for both distance viewing and correcting presbyopia, distort vision in the lower part of the visual field at ground level while walking. This project provides clarification on the relationship between multifocal eyeglasses and gait. Specifically, this pilot study analyzes performance of 6 young, healthy individuals while wearing progressive and single lens glasses. Using the Dynamic Gait Index-modified (DGI-m) and Motion Capture Analysis (MCA). Participants complete a series of trials containing the DGI-m and the step/ramp obstacle. MCA measures participant's joint flexion and extension of the lower extremities to detect changes in gait. MCA data is being collected and analyzed using the Cortex 2.0.0 software, and the DGI-m is scored by a trained rater. These preliminary results provide the groundwork for future research to analyze different interventions that reduce the number of falls while wearing multifocal eyeglasses. These interventions include changing single lens glasses, a falls intervention with education on bifocals, and Superfocus manually adjustable multifocal lens glasses. Within-subject analysis of MCA and DGI-m was used to compare multifocals to single lens glasses to portray the need for multifocal interventions.

## Background

It is estimated that over 85% of all adults over the age of 45 will develop presbyopia (Holden, 2008). This condition develops with age and causes loss of near distance viewing. Reading glasses are used to correct presbyopia. When an individual develops presbyopia and has a far distance viewing impairment, reading glasses are not sufficient to cure both impairments. Because of this dilemma, multifocal lenses, which include lined bifocals, trifocals, and progressive lenses, are often prescribed. In lined bifocals the lower lens corrects near distance and the upper lens acts as regular distance corrective lenses. In progressive lenses, which are more common today, there is more limited vision because of the additional region for middle distance viewing vision (Figure 1). In an attempt to make the transitions from the different lens fields smoother without having a bifocal line, progressive lenses have distortion on the sides of the lens caused by grinding (Figure 2). This distortion results in loss of visual acuity. Progressive lens users experience a warping effect when turning their head and may experience discomfort because of this. The effects of multifocal lenses could be a factor that cause increased risk rates for falls in aging individuals.

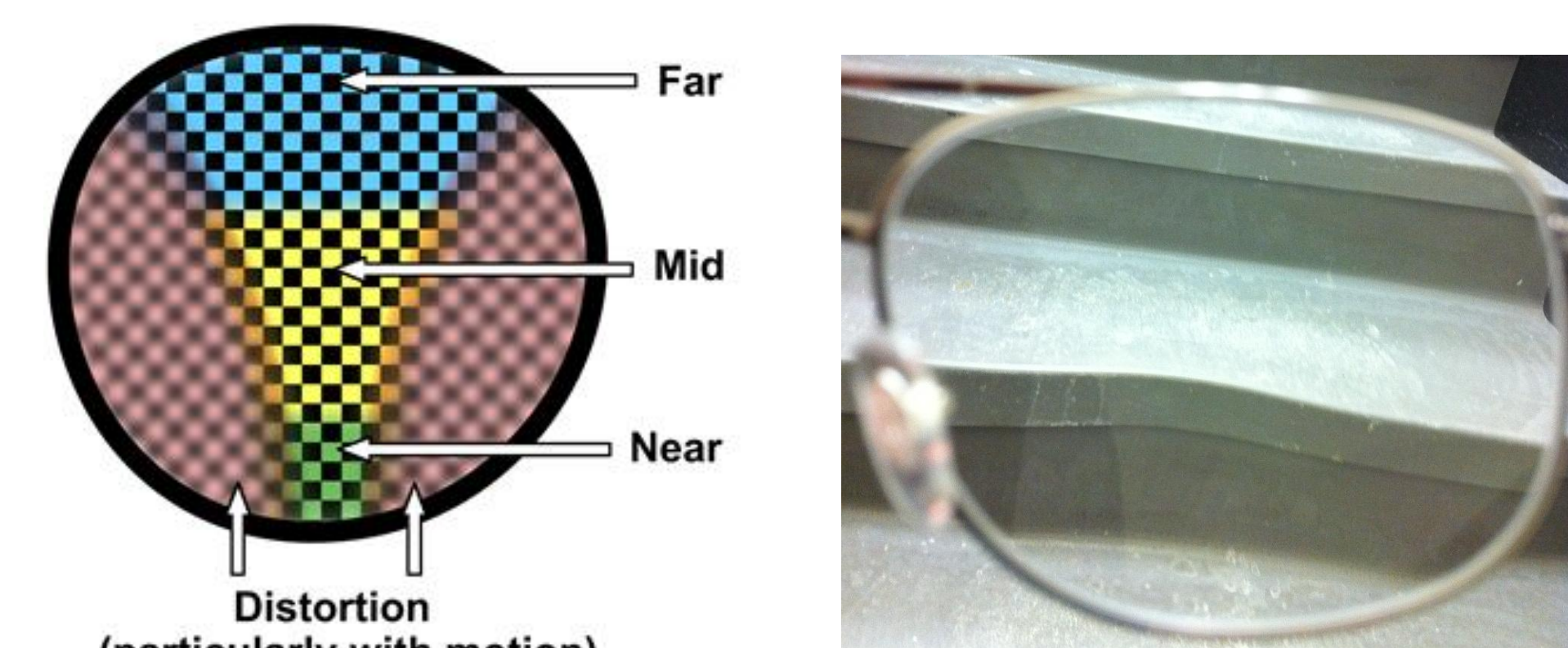


Figure 1: Progressive lens regions Figure 2: View through progressive lens

In 2005, about 1.8 million individuals ages 65 and older were treated for nonfatal falls (Center for Disease Control and Prevention). In 2000, older individual fall injuries has cost the U.S. \$19.2 billion (Center for Disease Control and Prevention). Vision has been found to be an important factor in gait (Marigold, 2008). Visual impairments have been linked to changes in gait speed and gait variability, standing balance, toe clearance, and foot distance approaching a step (Mohagheghi, 2004). These vision impairments lead to falls or are identified as risk factors for falling (Horowitz, 2004). The relationship between vision and falls has generally focused on older adults. However, in this study we are looking at young, healthy adults and their initial adaptation and effect of progressive lenses. Studying young, healthy participants will control for variables like poor health and age. Young adults are more agile and will be able to catch themselves if they experience a near fall, but as individuals age multifocal lenses increasingly become potential risk factor for falls.

### Hypotheses:

1. Young, healthy adults wearing progressive lenses will experience greater variance in toe clearance and lower DGI-m scores than when wearing single lenses while walking at a normal pace.
2. The DGI-m scores and MCA toe clearance will correlate for both lens conditions.

## Methods

This study examined performance of six young, healthy adults while wearing +2.75 progressive lens and non-corrective single lens glasses for a 1.5 hour testing session. The study was approved by the University of Wisconsin-Milwaukee Institutional Review Board. Two measures are used in trials: Dynamic Gait Index-modified (DGI-m) and Motion Capture Analysis (MCA). Participants performed 36 trials of a loop course. The loop course includes 15 meters of walking straight while encountering a ramp/step or step/ramp followed by a DGI-m task. Single and progressive lens glasses were switched every nine trials.

The DGI-m consists of nine walking tasks. These include: walking at normal speed, changing speeds, turning the head horizontally while walking, turning the head vertically, walking then pivoting, stepping over a shoebox and diagonal long box, stepping around cones, and stepping on and off a platform. Figures 3 illustrates the shoebox task. All nine tasks are scored by a trained rater. Scoring is based on a zero through five scale. A zero indicates the individual could not walk 20 feet without assistance and contained severe gait deviations or imbalance. A five indicates gait was a good speed, no evidence of imbalance, and a normal pattern. A perfect score is equivalent to 45.

MCA was conducted by applying 36 motion capture markers on participant's joint landmarks. MCA was used to measure toe clearance while walking up the ramp/step or step/ramp. The order of ramp and step was randomized. Step heights consisted of 3 inch and 6 inch. Figure 4 illustrates the 6 inch step/ramp. MCA was analyzed using the Cortex 2.0.0 software.

Figure 3: Participant performing Task 6 of the DGI; Stepping over an obstacle.



Figure 4: Participant performing the 6 inch step/ ramp trial.



## Results

When comparing progressive lens glasses to single lens glasses, there is an increase in toe clearance during the step up trials. Toe clearance was measured by the vertical lifting of the foot ( $r = 0.99$ ). In Figure 5 toe clearance is higher in both steps for bifocal lenses. Higher toe clearance indicates that the individual was using a cautious strategy for foot placement to reduce trip risk. This indicates that young novice wearers adapt a similar strategy for stepping when wearing multifocal lenses as older adults (Elliott, 2010).

Figure 5:

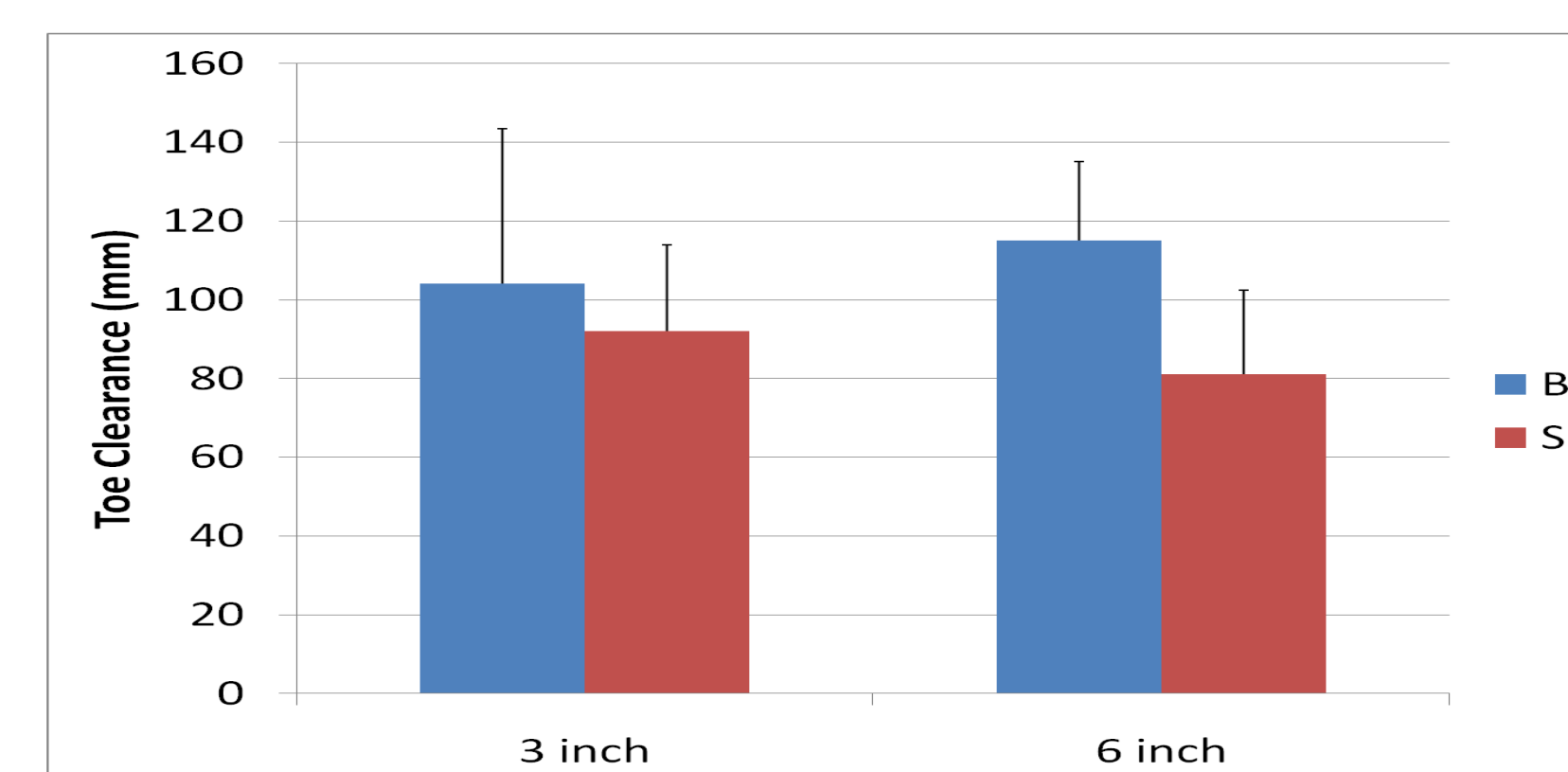


Figure 6 compares the DGI-m scores of single lens and bifocal lens trials. The bar graph shows a decrease in scores for bifocal lens trials.

Figure 6:

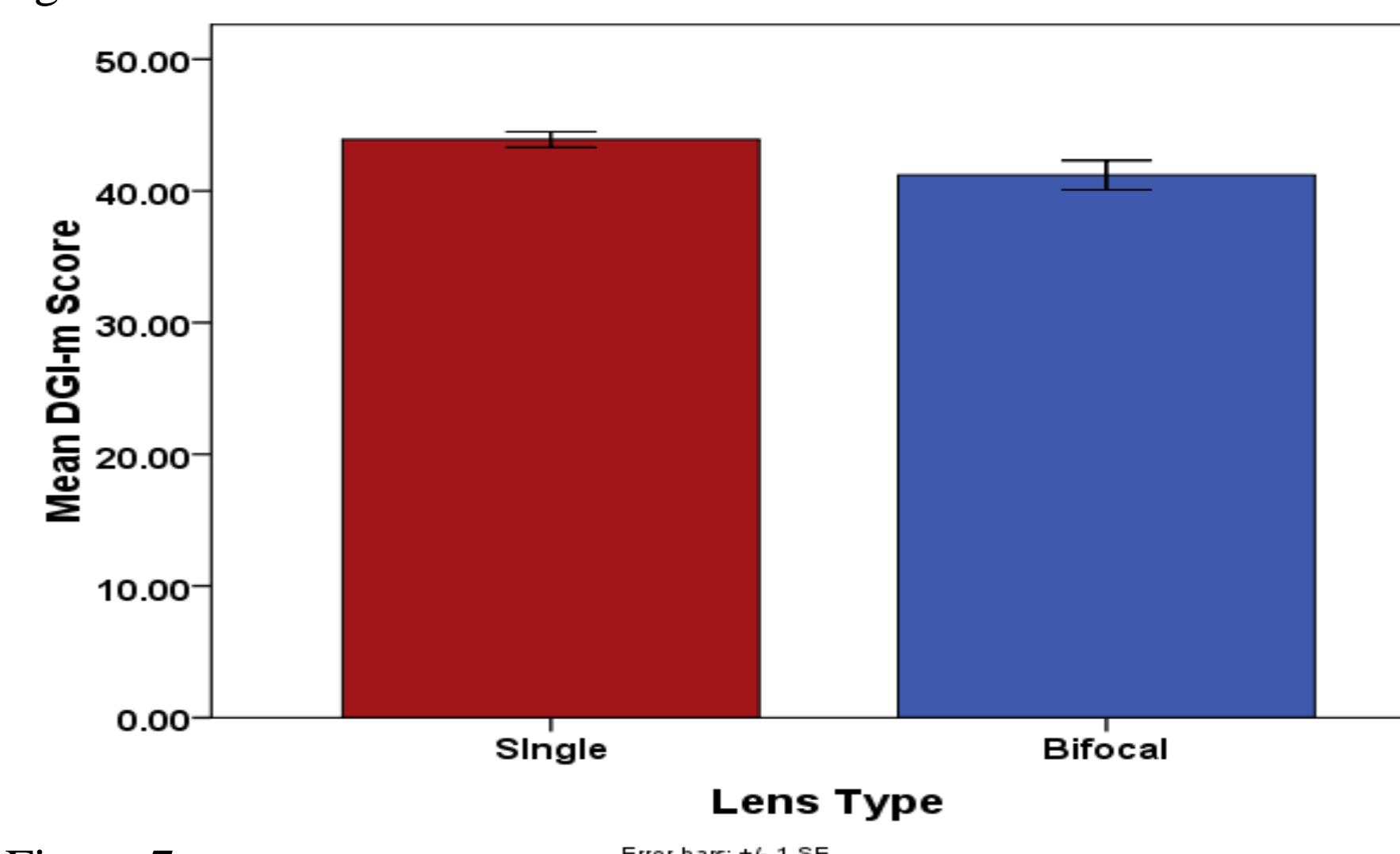


Figure 7:

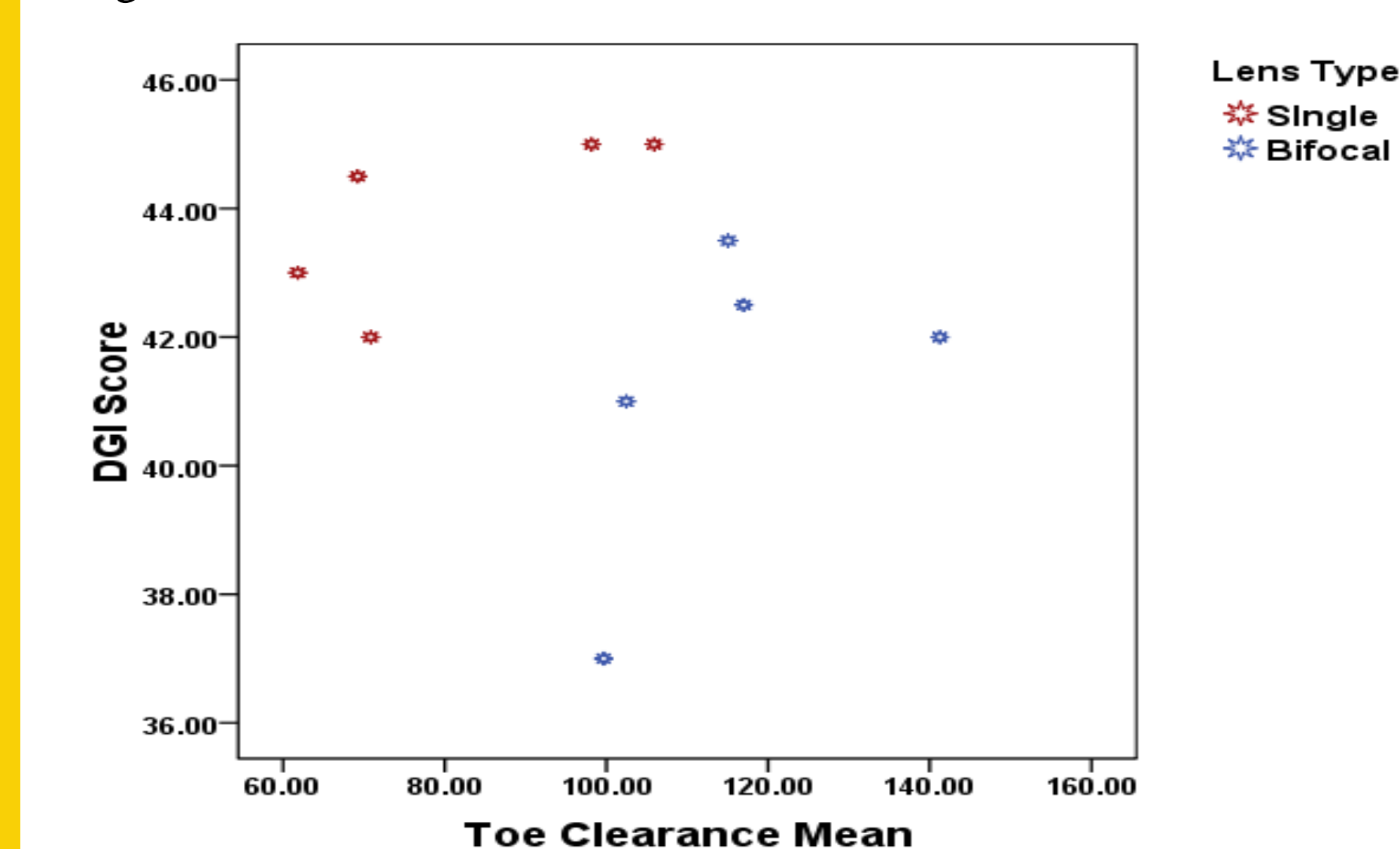


Figure 7 shows the correlation between DGI-m and toe clearance scores for bifocal and single lens trials. Participants wearing bifocal lens overall had lower DGI-m scores and higher toe variance.

Figure 8:

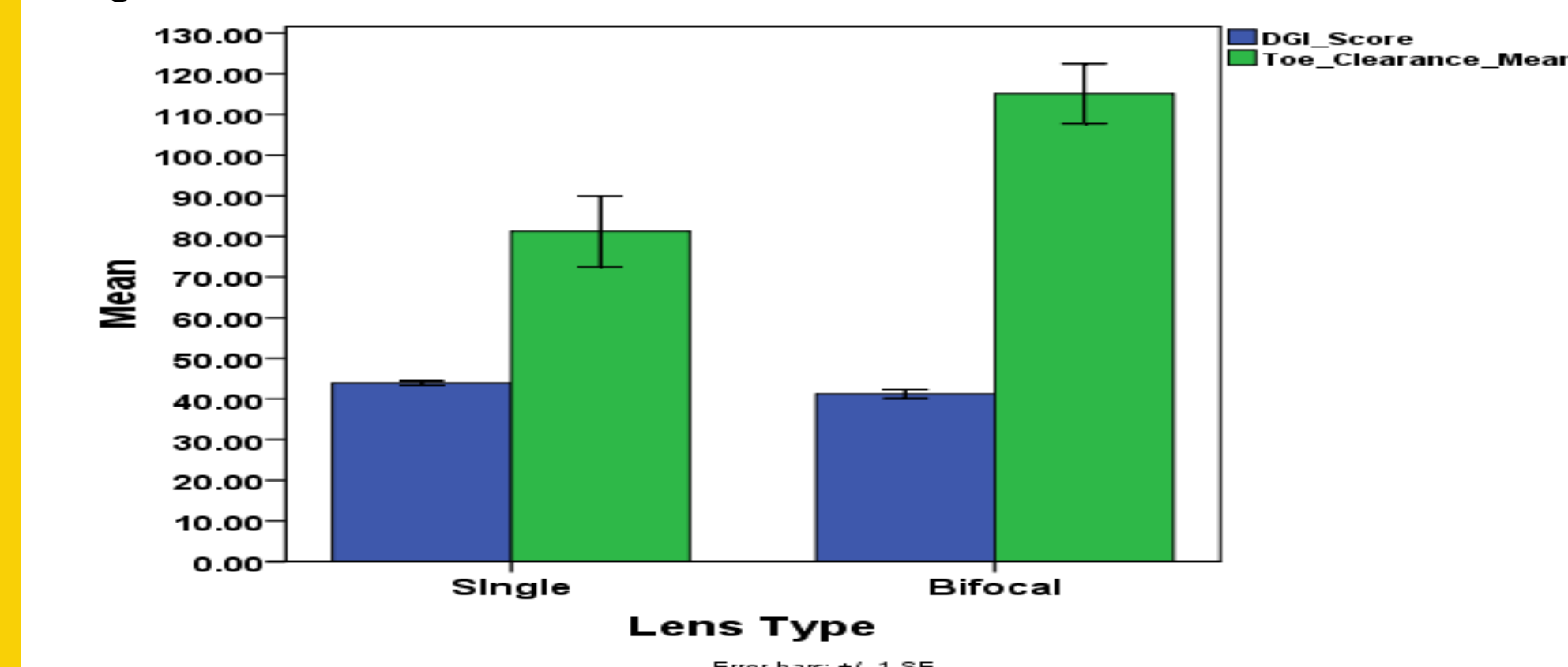


Figure 8 represents the comparison between toe clearance mean and DGI-m score for single and bifocal lenses. Toe clearance increases with the use of bifocal lenses while DGI-m score decrease. Single lens trials experience less variance and a higher DGI-m score.

## Discussion

Preliminary results of this pilot study reveals that multifocal lenses cause young, healthy adults to use a cautious strategy to prevent falls and near falls. Cautious strategies result in greater toe clearance variance and lower DGI-m scores. Similar cautious strategies are used by elderly multifocal wearers. Knowing that young, healthy adults perform the similarly eliminates fall risk variables such as poor health and balance impairments that are experienced in elderly individuals. Multifocal lenses are determined to be a fall risk factor that increases with age. Further study of this phenomenon will only strengthen the hypothesis that multifocal lenses are a fall risk factor.

## References

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