# Pickleball Biomechanics: The Machine Learning Advantage

**PURPOSE:** Pickleball is emerging as an important injury topic due to its ease of play, exercise benefits, and rapid growth among seniors.[1] However, senior pickleball injuries are increasing rapidly while senior tennis injuries have remained flat.[2] Little is known about pickleball-specific movements and their effects on the lower extremity injury risk. Because movements involve the complex interplay of intrinsic and extrinsic factors, determining which variables best predict injury risk is critical to risk reduction. A known method for solving complex and high-dimensional data is machine learning. Therefore, the goal was to investigate the effects of an acute static stretching on ankle biomechanics using machine learning.

**RESEARCH QUESTION**: The purpose of this study was to answer the question: do biomechanical subgroups, based on pre- and post-pickleball movement ankle range of motions, emerge with distinct demographic profiles?

**METHODOLOGY**: 29 participants, aged 18-80, who were recreationally active and had played pickleball at least once were recruited. Participants completed two separate days of testing for baseline and experimental measurements. The experimental protocol included an 8-minute stretching session targeting the gastrocnemius and soleus muscles of each leg. A custom Google Colab script was created to identify natural groupings and trends within participant data by applying dimensionality reduction with t-SNE, clustering with K-means, and validating the predictability of clusters using logistic regression.

**FINDINGS:** We hypothesized that distinct biomechanical subgroups, identified through clustering analysis of pre- and post-pickleball ankle range of motion data, would be characterized by distinct profiles of key ankle range of motion features, such as dorsiflexion / plantarflexion variables. This was correct and identified the passive range of motion of the ankle in dorsiflexion position, with the right leg extended, measured on the baseline day before motion capture as the most significant feature. This serves as a robust indicator of flexibility for cluster analysis highlighting the importance of prior ankle flexibility. The model achieved a F1 score of 0.902 indicating the model is capturing important relationships between ankle biomechanics and demographics Additionally, a Silhouette score of 0.43 was achieved and suggests a moderate level of separation between the clusters identified by the K-means algorithm. While the clusters are not perfectly distinct, they exhibit a reasonable level of separation which can warrant further investigation.

**CONCLUSION**: The results of this study help us target variables that may put athletes at the greatest risk of Achilles tendon injury. Understanding these injury risk factors highlights the importance of further researching pickleball maneuvers as the sport is expected to exponentially increase. Such information would help provide guidance and education of injury prevention for novice players. For future projects, this process could be repeated with a larger data set as it was not computationally expensive.

**REFERENCES**

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