Vitamin D Supplementation and Slowing Biological Aging: Insights from Epigenetic Clocks in the Precision Aging Network (PAN)

Ishaan Ranjan | PI: Dr. Bonnie LaFleur | **Mentor:** Jordan Pilch | University of Arizona KEYS Research Program

Background: Biological aging can be estimated using DNA-methylation "epigenetic clocks," which capture molecular aging beyond chronological (birthday) age. Low vitamin D has been linked to faster cellular aging in observational work, but it's unclear whether vitamin D supplementation is associated with slower biological aging in community cohorts especially in cross-sectional comparisons.

Objective: To evaluate whether vitamin D supplementation status is associated with epigenetic aging measures in the Precision Aging Network (PAN), while accounting for covariates.

Methods: Using PAN data (N=428), we compared vitamin D supplement users (Yes: N=59) to non-users (No: N=369). Biological aging was assessed using three epigenetic clocks: Horvath 2013, AltumAge, and DunedinPACE. I performed end-to-end computational analysis in R/Python, including data cleaning/standardization and figure generation. Associations were evaluated using multivariable linear regression, adjusting for relevant covariates including sex, BMI, and education (and additional health/demographic factors where appropriate). We also examined the relationship between chronological age and each clock.

Results: Chronological age showed a strong positive relationship with epigenetic age measures (e.g., Horvath 2013 correlated strongly with chronological age), while DunedinPACE exhibited weaker correlation consistent with its interpretation as a "pace" measure rather than a cumulative age estimate. In adjusted models, epigenetic aging differences were statistically associated with sex, BMI, and education, showing consistent patterns across the three clocks. In contrast, vitamin D supplementation was not statistically significantly associated with lower epigenetic age or slower pace of aging in this cross-sectional sample. So, the main objective was inconclusive.

Conclusion: In this PAN snapshot, vitamin D supplementation status did not show a significant association with epigenetic aging across three clocks, whereas sex, BMI, and education were consistently related to biological aging measures. These findings highlight limitations of cross-sectional observational supplementation data (e.g., unknown duration/dose, self-report, residual confounding) and motivate longitudinal analyses to test whether vitamin D supplementation influences within-person changes in biological aging over time.

Keywords: epigenetic clocks; biological aging; vitamin D; DunedinPACE; Horvath 2013; AltumAge; PAN; regression