

Fuzzy Clustering Approach to Quantification of Allostatic Load

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Abstract

Purpose: Allostatic load (AL) refers to the cumulative burden of chronic stress and life events and results in multi-systemic physiological dysregulation. Periodontal Disease (PD) has been associated with various systemic diseases and is impacted by metabolic dysregulation. The aim of this research is to assess the relationship between AL and PD using unsupervised machine learning fuzzy methods.

Methods and Results: Data from the National Health and Nutrition Examination Survey (NHANES) 2011 was used. AL was measured using eleven biomarkers representing cardiovascular, inflammatory, and metabolic system functioning outcomes. A total of 1414 US adults aged 35 years and older were allocated to two fuzzy clusters, using the Gustafson, Kessel, and Babuska c-means type algorithm (GKB-FkM), the fuzzy k-means clustering algorithm. The cluster 1 presented more advantageous values for the allostatic load surrogate biomarkers. In both clusters, the membership degrees (MD) varied from 0.5 and 1.0, with an average of 0.7. The PD parameters' were compared between both clusters using GAMLSS models, yielding statistically significant differences ($p < 0.05$) for pocket probing depth (PPD) mean and maximum and clinical attachment loss (CAL) rate. The correlation coefficients between PD parameters and cluster 1 MD's ranged from -0.06 and -0.11 , being statistically significant. The association of PPD mean with cluster 1 MD's statistical significance did hold up after adjustment for age and gender.

Conclusion: The latent nature of AL together with the absence of an universally accepted AL score poses major difficulties when classification of individuals is needed and to correlate their allostatic burden with other conditions. We propose to tackle this issue using fuzzy clustering methods in combinations with GAMLSS models. This approach allowed us to find an association between AL and PD by measuring individuals AL through the membership grade to a cluster that's hold after adjustment for age and gender. This methodology appears to be promising to deal with variables that

results from a complex combination of surrogate endpoints, and which aggregation is difficult or impossible.

Keywords:

Allostatic load, Pperiodontal health, Fuzzy clustering, GAMLSS.

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