Can Sense of Coherence Protect the Body? Salutogenic Pathways to Physiological Stress

An AIM-AHEAD Bridge2AI AI-READI Project

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OBJECTIVE/PURPOSE

BACKGROUND

- Chronic stress contributes to the development of type 2 diabetes through the dysregulation of physiological systems, as reflected in **allostatic load** (AL): the cumulative wear and tear of the body.
- Salutogenesis focuses on health-promoting resources that foster resilience and support physiological balance, such as **Sense of Coherence (SOC).**
  - SOC reflects an individual's capacity to comprehend, manage, and find meaning in life's challenges.
  - Higher SOC has been associated to better coping, healthier behaviors, and improved health outcomes.
- Few studies have examined whether SOC predicts AL, particularly in adults at risk for type 2 diabetes.

PURPOSE

- This study investigates whether sense of coherence (using proxy measures derived from cognitive function, self-care behaviors, and positive affect was associated with lower AL using both regression and machine learning approaches.

RESEARCH QUESTIONS

- Are individual SOC components (comprehensibility, manageability, meaningfulness) and a composite SOC score associated with physiological stress (allostatic load index (ALI))?
- Do these associations persist after adjusting for age, education, and marital status?
- Can SOC and its components predict ALI using machine learning?

METHODOLOGY

DATA SOURCE

- AI-READI (n = 979)

MEASUREMENTS

- **Sense of Coherence**: standardized (z-score) cognitive function (MoCA), diabetes self-care, and positive affect (from CESD-10).
- **Physiological Stress:** Allostatic Load Index (ALI). Sum of 10 high risk biomarkers (BP, HR, Waist circumference, HDL-cholesterol, TG, glucose, CRP, urine albumin/creatinine ratio, NT-proBNP)
- Covariates: age, education, marital status

DATA ANALYSES

- Linear and negative binomial regressions to test the associations between SOC (components and composite) and ALI, adjusting for covariates. Effect sizes are interpreted as IRRs: values < 1:indicate protective effect.
- XGBoost regression: explore potential non-linear effects
- Performance model evaluated using R^2, Root Mean Square Error (RMSE), and Mean Absolute Error (MAE).
- Dataset was split into training and test sets using the recommended split from AI-READI. Used Cursor and RStudio

RESULTS

Better diabetes self-care, higher sense of coherence, and more education were modestly associated with lower physiological stress risk. However, overall predictive power for allostatic load was limited.

MODEL 1: INDIVIDUAL SOC COMPONENTS + COVARIATES

- **Higher diabetes self-care** (β = -0.17, p = 0.002) and **more education** (β = -0.07, p < 0.001) were associated with **lower ALI.**
- Cognitive function, positive affect, age, and marital status were not significant (R^2 = 0.062).
- Negative binomial results were consistent (IRR for self-care = 0.93; IRR for education = 0.97).

MODEL 2: COMPOSITE SOC SCORE + COVARIATES

- **Higher composite SOC** was associated with **lower ALI** (β = -0.22, p = 0.021), with **education** remaining significant (β = -0.07, p < 0.001; R^2 = 0.058).
- Negative binomial regression showed similar findings (IRR for composite SOC = 0.92; IRR for education = 0.97).

MACHINE LEARNING ANALYSIS

- XGBoost regression yielded poor predictive performance (R^2 = -0.47, RMSE = 2.08, MAE = 1.65). The negative R^2 indicates that XGBoost model did not outperform a simple mean prediction on the test set, suggesting that the included predictors have limited ability to predict ALI in this sample.
- **Feature importance**: Diabetes self-care, education, and age were top contributors, but SOC components did not substantially improve allostatic load index prediction.

CONCLUSIONS

- Better diabetes self-care and more years of education are robustly associated with lower allostatic load.
- A higher composite SOC score is also associated with lower ALI, independent of covariates.
- Cognitive function and positive affect/meaning were not significant predictors when covariates were included.
- Effect sizes are small but statistically significant for self-care, education, and composite SOC.
- XGBoost did not substantially improve ALI prediction beyond traditional regression, reinforcing the modest predictive value of SOC components and related covariates for physiological risk in this sample.

IMPLICATIONS

- Interventions to improve self-care and education may help reduce physiological stress risk, but allostatic load is likely influenced by additional unmeasured factors.
- Further research should explore additional psychosocial and environmental predictors, and test these relationships in broad range of populations.

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