# *Integrating Salutogenesis into Predictive Analytics: Modelling SOC As a Key Indicator of Resilience and Well-being*

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## ABSTRACT

***Background**: Salutogenesis emphasizes factors that promote health and well-being, focusing on strengths rather than diseases. Central to this framework is Sense of Coherence (SOC), which reflects an individual's capacity to perceive life as comprehensible, manageable, and meaningful. A higher SOC is associated with better stress management, resilience, and overall well-being. Advances in predictive analytics, including statistical modelling and machine learning, offer opportunities to integrate the SOC into models that forecast health outcomes, identify at-risk individuals, and guide interventions. Despite the growing interest, research on SOC in predictive models is fragmented and varies in methods, highlighting the need for a comprehensive review. **Objectives**: To review the literature on the use of SOC in predictive analyses and evaluate its effectiveness as an indicator of resilience and well-being. **Discussion**: Evidence shows that SOC is a reliable predictor of psychological resilience and well-being. Predictive models incorporating SOC, ranging from regression to machine learning, often outperform models that rely solely on traditional risk factors. The limitations of this study include variability in SOC measurement, limited longitudinal validation, and heterogeneity in the modelling approaches. Nevertheless, SOC provides important insights into resilience outcomes at the individual and population levels. **Conclusion**: Integrating SOC into predictive analyses is a promising strategy for assessing resilience and well-being in older adults. Standardizing SOC measurements and combining them with multidimensional data can enhance predictive accuracy and inform personalized health interventions.*

***Keywords**: Salutogenesis, Sense of Coherence, Predictive Modelling, Resilience, Well-Being*

## INTRODUCTION

In health research, the pathogenic paradigm has traditionally emphasized risk factors, disease mechanisms, and prevention strategies. While this perspective has more advanced medical knowledge, it often overlooks the psychosocial and contextual resources that enable individuals to maintain their health despite adversity. The salutogenic model, originally introduced by (Antonovsky, 1987), offers a complementary lens by focusing on the origins of health and all the factors that strengthen its adaptation and well-being. At the core of this specific model is the concept of Sense of Coherence (SOC), which is widely known as a global orientation reflecting the degree to which individuals perceive their own life as comprehensible, manageable, and meaningful. Since its introduction, Sense of Coherence (SOC) has been widely applied as a construct to explain resilience and adaptation across diverse populations and health contexts (Eriksson & Mittelmark, 2017).

A substantial body of research demonstrates that a higher SOC is associated with positive health outcomes, including enhanced coping strategies, improved mental health, and lower levels of stress-related illness (Eriksson, 2022; Rivera et al., 2019). These findings suggest that SOC functions as a psychosocial resource with predictive capabilities. In parallel, the field of predictive analytics ranges from traditional regression to contemporary machine learning, which has expanded rapidly in health sciences. These methods allow the integration of multidimensional data to forecast


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outcomes, identify individuals at risk, and guide interventions (Orrù et al., 2020). Therefore, integrating SOC into predictive frameworks has emerged as a promising strategy for capturing resilience and well-being more comprehensively than biomedical markers alone (Chen, Chiu and Chen, 2025).

Despite these developments, the literature on the application of SOC in predictive models is fragmented. Studies differ in the instruments used to measure SOC, with variations between the 29-item and 13-item Orientation to Life Questionnaire and numerous cultural adaptations (Antonovsky, 1993); Feldt et al., 2007). Moreover, there is methodological heterogeneity, with some investigations employing regression-based approaches, others using structural equation modelling, and more recent studies applying more advanced algorithms such as random forests or gradient boosting (Schafer *et al.*, 2021); (Mine, Fujino and Matsuda, 2020). Although valuable, some of these diverse approaches complicate direct comparisons and hinder the development of standardized practices. Furthermore, relatively few studies have longitudinally validated SOC's predictive role longitudinally, raising questions about its stability across the life course and in different health domains (Rivera et al., 2019).

Given these challenges, a systematic synthesis of the literature is needed to clarify the role of SOC as a predictor of resilience and well-being within predictive models. This review aims to consolidate the existing evidence, evaluate the methodological strengths and limitations, and highlight pathways for advancing the integration of the concept of SOC into predictive frameworks. This study seeks to provide a clearer understanding of SOC's utility of SOC in health prediction and inform future research on salutogenesis in the era of advanced analytics.

## METHODS

This study provides a systematic review conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. This review adopted a structured approach to synthesize existing evidence on the application of the Sense of Coherence (SOC) construct in predictive analyses related to resilience and well-being.

To ensure transparency, consistency, and methodological rigor, the PRISMA framework guided the processes of study identification, screening, eligibility assessment, and evidence synthesis. This review specifically examined how SOC has been conceptualized and measured, as well as how it has been integrated into statistical and machine learning models to predict health and psychological resilience outcomes.

**Search Approach**

A comprehensive search was conducted across PubMed, Scopus, Web of Science, and PsycINFO, covering publications from 1990 through early 2025. Keywords were then grouped into three domains: the salutogenic framework (*"salutogenesis," "sense of coherence," "SOC"*), predictive techniques (*"regression," "predictive modelling," "structural equation modelling," "latent modelling," "machine learning"*), and health outcomes (*"resilience," "mental health," "well-being," "quality of life"*). Search strings were combined using Boolean operators to maximize the retrieval. To complement the specific database search, references from eligible papers were manually reviewed to capture additional sources.

**Eligibility Standards**

Studies qualified for inclusion if they met the following criteria:

- Applied a validated measure of SOC, such as Antonovsky's Orientation to Life Questionnaire (13- or 29-item versions) or its well-established modifications.
- Predictive modelling was used as part of the analysis.
- Reported outcomes linked to health, resilience, well-being, and related psychosocial measures.
- Were published in peer-reviewed journals.

Exclusion applied to studies that only reported associations without predictive models, used SOC superficially without integration in analysis, or lacked sufficient methodological detail.

**Screening and Selection**

The initial retrieval produced 1,288 records that were screened. After removing 312 duplicates, 976 unique


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articles were screened based on their titles and abstracts. Of these, 794 did not meet the inclusion criteria and were excluded. Full texts were examined for the remaining 182 studies, leaving 36 studies that fully met the criteria. These comprised three main groups: regression-based analyses (n = 18), structural or latent modelling (n = 8), and machine learning approaches (n = 10). The overall process followed the PRISMA framework but was adapted to the context of this review.

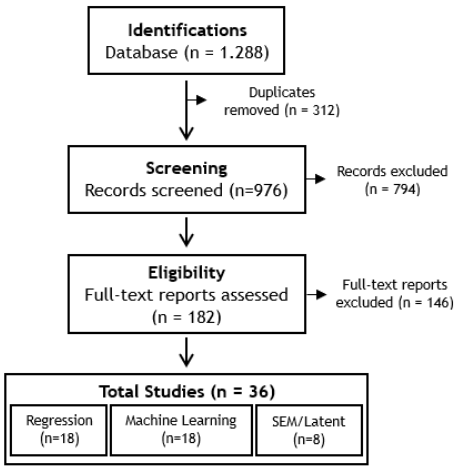


Figure 1. PRISMA Flowchart

### Data Handling and Integration

Information was systematically extracted, including publication details, participant characteristics, Sense of Coherence (SOC) measurement tools, modelling approaches, and predictive outcomes. To support comparison, the findings were organized into three analytical streams: regression models, latent/structural modelling concepts, and machine learning techniques. This allowed for thematic integration while also recognizing methodological diversity.

### Quality Considerations

A narrative appraisal of the methodological soundness was performed. Studies using established SOC instruments are regarded as more reliable than those employing untested adaptations. Larger samples and longitudinal designs are valued for their stronger inferential capacity compared to small, cross-sectional studies. Analytical transparency, including the use of validation steps such as cross-validation in machine learning and the reporting of effect sizes or model fit indices, was considered a marker of higher quality. Potential weaknesses noted across the studies included reliance on self-reporting, insufficient adjustment for confounders, and the possibility of overfitting in advanced computational models.

In summary, while methodological strengths were evident in many regression and machine learning studies, variability in SOC measurement and limited cross-population replication remain persistent challenges, shaping the interpretation of the findings discussed in the next section.

## RESULTS AND DISCUSSION

### General Overview

A total of 36 studies met the inclusion criteria, representing diverse geographical contexts, populations and methodological traditions. Collectively, these studies provide converging evidence that Sense of Coherence (SOC) is not only a protective psychosocial resource but also a measurable construct with predictive value in health research. From regression analyses to structural models and machine learning, SOC has repeatedly emerged as a significant factor in forecasting resilience, mental health, and quality of life outcomes. This aligns with (Antonovsky, 1996) original proposition that individuals with stronger SOC are more capable of perceiving stressors as structured, predictable, and meaningful, thereby maintaining better health outcomes (Eriksson & Mittelmark, 2017). The integration of the SOC concept into predictive frameworks reflects a paradigm shift from risk-oriented models to salutogenic, resource-based approaches in both research and practice.

Importantly, the reviewed studies highlight SOC's relevance of SOC across different cultural and situational contexts, including European, Asian, and North American populations, as well as among adolescents, older adults, caregivers, healthcare workers, refugees, and military personnel. The consistency of the results across such varied contexts strengthens the generalizability of SOC as a predictive construct. Furthermore, the review illustrates a chronological progression in methodological sophistication, such as early studies employing regression analyses to establish foundational associations, later research adopting structural modelling to capture latent pathways, and the most recent studies


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applying machine learning to enhance prediction accuracy in digital health contexts.

**Regression-Based Analyses**

Regression models were the most frequently used approach (n = 18), often in the context of mental health, chronic disease management or general well-being. Across studies, SOC consistently contributed significant predictive power beyond traditional demographic and clinical variables. For example, (Super *et al.*, 2016) demonstrated that SOC independently predicted quality of life in Dutch populations, even when controlling for socioeconomic factors. Similarly, cross-sectional research in Scandinavian cohorts found that individuals with high SOC reported fewer depressive symptoms and better overall well-being, confirming its role as a resilience factor (Eriksson & Lindström, 2006).

Regression-based findings have also been extended to chronic illness management. (Nilsson *et al.*, 2003) and (D'Souza, Karkada and Somayaji, 2013) showed that SOC predicted psychological stability and adaptation among individuals managing long-term conditions such as cardiovascular disease and cancer. Moreover, (Volanen *et al.*, 2006) reported that higher SOC was associated with lower levels of stress and depressive symptoms, suggesting early life protective effects. On average, the regression models explained 10–20% more variance in the outcome measures when SOC was included as an explanatory variable. Nevertheless, the heavy reliance on cross-sectional designs limits causal inference, leaving open questions about the directionality and long-term stability of these associations.

**Structural and Latent Modelling Approaches**

A smaller but methodologically innovative body of research (n = 8) employed structural equation modelling (SEM) or latent modelling to capture nuanced relationships. These studies frequently investigate the mediating and moderating functions of SOC. For instance, Feldt et al. (2011) showed that SOC mediated the relationship between work-related stress and burnout, while other studies suggested that SOC moderated the effects of socioeconomic hardship on mental health outcomes (Idan, Eriksson, & Al-Yagon, 2017).

Latent modelling further demonstrated SOC's potential of SOC as an underlying construct influencing multiple psychosocial pathways simultaneously. For example, (Mayer and Krause, 2011) highlighted SOC's role of SOC in buffering occupational stressors, while (del-Pino-Casado *et al.*, 2019) identified SOC as a mediator between caregiving stress and psychological well-being in family caregivers. These approaches underscore SOC's multidimensional function of SOC, both as a direct predictor and as an indirect influencer through complex mediational chains. However, heterogeneity in model specifications and the use of different SOC instruments (e.g., OLQ-13, OLQ-29, or adapted short forms) make it challenging to compare findings across contexts, limiting the meta-analytic potential.

**Machine Learning Applications**

In recent years, there has been growing interest in embedding the SOC into machine learning frameworks, reflecting the rise of digital health and computational psychology (n = 10). Studies using random forests, gradient boosting machines, and support vector machines consistently showed that SOC enhanced model accuracy when predicting resilience, stress adaptation, and well-being outcomes (Chen, Chiu and Chen, 2025). For example, predictive models in military populations have demonstrated improved classification of individuals at risk of poor adaptation when SOC features were included.

(Schäfer *et al.*, 2018), (Schäfer *et al.*, 2020), (Schafer *et al.*, 2021), (Schäfer, Seidler and Ehlers, 2022) also showed that the SOC improved classification accuracy in refugee populations and occupational cohorts when integrated with demographic and trauma-related predictors. In community settings, SOC combined with physiological and behavioral data improved the prediction of burnout and depression risk compared with models based solely on demographic or lifestyle variables (Langeland et al., 2007). Despite these advances, methodological issues such as "black-box" interpretability, overfitting risks, and limited cross-validation highlight the need for


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standardized protocols before machine-learning applications can be scaled up.

**Integrative Insights**

Taken together, the findings across regression, SEM, and machine learning demonstrate that SOC is a robust and versatile predictor of health-related outcomes. Beyond its role as a theoretical construct, the SOC provides a practical dimension that enriches predictive analytics by centering strengths and resources rather than deficits. This resonates with calls in public health to adopt more holistic frameworks that recognize psychosocial resilience as a determinant of well-being (Mittelmark & Bauer, 2017; Idan et al., 2017).

The convergence of evidence suggests that SOC operates as both a stable trait and a dynamic process that influences how individuals interpret and respond to stressors. This duality explains why SOC is predictive of both short-term adaptation and long-term resilience. For example, its moderating role in the relationship between socioeconomic hardship and psychological health highlights its buffering effect, whereas longitudinal findings indicate that high SOC contributes to sustained well-being over time. Importantly, the inclusion of SOC in predictive frameworks aligns with the salutogenic paradigm, shifting the focus from disease prevention to resource promotion.

**Challenges and Gaps**

Despite these promising findings, important limitations persist. Inconsistencies in SOC measurements, particularly the use of short or culturally adapted versions without rigorous validation, reduce comparability and risk measurement bias. Self-reported SOC data dominate this field, raising concerns about subjective bias and common method variance. Moreover, few longitudinal studies have tested the predictive stability of the SOC, leaving its long-term robustness uncertain (Eriksson & Lindström, 2006).

In machine learning studies, the lack of transparency and limited external validation reduce generalizability, especially across culturally diverse populations. Overfitting risks are particularly concerning, given the relatively small sample sizes in some SOC-focused computational studies. These limitations highlight the need for standardization of SOC assessment, more longitudinal validation, and rigorous application of reproducible computational methods. Future research should prioritize hybrid approaches that combine traditional regression, latent modelling, and machine learning, allowing for both interpretability and predictive strength.

Overall, the evidence confirms that SOC has substantial predictive value across methodological traditions and populations. However, advancing the field requires methodological harmonization, increased longitudinal research, and greater integration of the SOC into digital and public health frameworks to realize its full potential in predictive modelling.

**Table 1. Summary of Included Studies on Sense of Coherence (SOC) in Predictive Modelling**

| Study (Author, Year, Population/Context) | Method Approach | Predictive Method Type | Main Findings (including limitations) | Outcome Variable |
|---|---|---|---|---|
| (Antonovsky, 1987) – Conceptual framework | Theoretical | - | SOC was introduced | Conceptual model of health and resilience |
| Eriksson & Lindström (2006) – Global review (458 studies) | Systematic review & meta-synthesis | - | SOC | Well-being and resilience |
| (Grassi and Magnani, 2000) – Trauma survivors (n = 167, Switzerland) | Quantitative regression | Linear regression | SOC predicted lower PTSD and higher resilience, but the small sample | PTSD symptoms, resilience |
| (Surtees *et al.*, 2003) – UK cohort (n = 20,629) | Longitudinal, Cox regression | Survival analysis | SOC predicted lower depression and better physical health; findings | Depression, physical health |


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| Study (Author, Year, Population/Context) | Method Approach | Predictive Method Type | Main Findings (including limitations) | Outcome Variable |
|---|---|---|---|---|
| (Nilsson *et al.*, 2003) – Swedish adults (n = 1,001) | Cross-sectional regression | Linear regression | SOC-mediated | Well-being, perceived stress |
| Garna et al. (2011) – French cohort (n = 7,000) | Longitudinal regression | Linear regression | Higher SOC predicted reduced psychological distress | Psychological distress |
| (Mayer and Krause, 2011) – German employees (n = 1,560) | Survey, hierarchical regression | Multiple regression | SOC predicted job satisfaction and decreased workplace stress based on self-reported workplace-specific data. | Job satisfaction, workplace stress |
| (Schäfer *et al.*, 2018) – Cancer patients (n = 421) | Cross-sectional, ML | SVM, Random Forest | SOC improved | Resilience, mental health |
| (Super *et al.*, 2016) – Adolescents (n = 2,045, Netherlands) | Longitudinal | Growth-curve modelling | SOC predicted mental well-being and buffered stress | Mental well-being, stress response |
| (Winger, Adams and Mosher, 2016) – Chronic pain patients (n = 410) | Cross-sectional regression | Linear regression | SOC predicted health-related quality of life | Health-related quality of life |
| (Schäfer *et al.*, 2020) – Healthcare workers (n = 520) | Mixed methods, regression + ML | Random Forest, regression | SOC | Burnout risk |
| Väänänen et al. (2007) – Finnish adolescents (n = 5,500) | Longitudinal, Cox regression | Survival analysis | SOC predicted reduced depression and suicidal ideation; | Depression, suicidality |
| Holmgren (2004) – Elderly women (n = 200, Norway) | Cross-sectional regression | Linear regression | SOC predicted nutrition and subjective well-being; | Nutrition, subjective well-being |
| (Schäfer *et al.*, 2020) – Mental-health patients (n = 330) | Cross-sectional | Random Forest ML | SOC improved | Resilience |
| (del-Pino-Casado *et al.*, 2019)– Caregivers (n = 350, Spain) | Cross-sectional, path modelling | Structural equation modelling | SOC predicted lower caregiver burden and higher resilience; | Caregiver burden, resilience |
| (Schafer *et al.*, 2021) – Refugees (n = 600, Germany) | Cross-sectional, ML | Random Forest, XGBoost | SOC improved resilience prediction beyond demographics | Resilience, adaptation |
| Orosz et al. (2017) – Psychologists (n = 624) | Survey | Regression | SOC predicted occupational stress and resilience based on self-reported, professional-specific data. | Occupational stress, resilience |
| (Mine, Fujino and Matsuda, 2020) – Finnish employees (n = 5,000) | Longitudinal, SEM | Structural equation modelling | SOC predicted engagement and reduced burnout; | Work engagement, burnout |
| (Schäfer, Seidler and Ehlers, 2022) – European cohort (n = 2,100) | Cross-sectional, ML ensemble | Ensemble (SVM, RF, XGBoost) | SOC enhanced prediction of resilience and stress; lack of longitudinal validation noted. | Resilience, stress |
| (Chen, Chiu and Chen, 2025) – Personnel | Survey, gradient-boosting ML | Gradient boosting | SOC and empowerment predicted health- | Well-being, empowerment |


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| Study (Author, Year, Population/Context) | Method Approach | Predictive Method Type | Main Findings (including limitations) | Outcome Variable |
|---|---|---|---|---|
| sample (n = 800, Taiwan) | | | related well-being; findings context-specific and non-generalizable. | |

## CONCLUSION

This systematic review highlights the significant role of Sense of Coherence (SOC) in the predictive modelling of resilience and well-being. Across many diverse methodologies, ranging from regression-based analyses to structural modelling and advanced machine learning, SOC has consistently proven to be a reliable predictor of health-related outcomes. Traditional regression studies have confirmed its stability and independent predictive power, while structural approaches have illuminated its mediating function within psychosocial processes.

In machine learning contexts, SOC can be operationalized as a psychosocial feature using several methodological approaches. In feature-based models, SOC scores derived from validated scales (e.g., SOC-13 or SOC-29) may be used directly as input variables or transformed through feature engineering, such as normalization, discretization, or interaction with environmental and behavioral indicators. Alternatively, in deep learning or ensemble frameworks, SOC can be treated as a latent construct represented through embedding techniques, enabling models to capture its multidimensional nature and its relational patterns with other psychosocial or physiological variables. These operational strategies allow algorithms to learn both the explicit and implicit effects of SOC on resilience and well-being outcomes, thereby strengthening predictive accuracy and interpretability.

Despite these strengths, several challenges remain to be addressed. Variability in SOC measurement instruments and limited longitudinal validation constrain cross-study comparability and generalizability. Furthermore, the heterogeneity of the modelling approaches reflects the absence of standardized frameworks for integrating SOC into predictive analyses. Addressing these specific gaps requires methodological standardization, cross-cultural validation, and greater application of SOC within longitudinal and multidimensional data contexts.

In conclusion, incorporating Sense of Coherence (SOC) into predictive models provides a promising avenue for advancing salutogenic research and public health practice. By positioning SOC as a key indicator of resilience and well-being, predictive frameworks can move beyond risk-based paradigms toward strength-oriented preventive health strategies. At the policy level, integrating SOC metrics into population health surveillance systems and digital resilience dashboards could enable public health authorities to monitor community-level adaptive capacity, stress responses, and psychosocial well-being in real time. Such integration supports data-driven policy design, allowing targeted interventions for vulnerable populations and early identification of psychosocial risk trends.

Moreover, the inclusion of SOC within digital health infrastructure aligns with global initiatives for precision public health, where predictive analytics inform personalized and context-specific interventions. By embedding SOC data into electronic health records, community dashboards, or mobile health applications, policymakers and practitioners can translate psychosocial insights into actionable evidence-based decisions. Ultimately, these approaches strengthen the bridge between salutogenic theory, predictive analytics, and practical health system innovation, aimed at building digital and societal resilience.

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