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Explainable AI Models for Identifying Personality-Driven Risk Factors in Psychosomatic Disorders

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A B S T R A C T

The objective of this study was to identify and transparently explain personality-driven risk factors associated with psychosomatic symptom severity using explainable artificial intelligence models. This cross-sectional study was conducted on an adult clinical sample recruited from psychosomatic and general health settings in Chile. Participants completed validated self-report instruments assessing personality traits, stress-related psychological variables, and psychosomatic symptom severity. After data preprocessing and standardization, multiple supervised machine learning models were developed to predict psychosomatic symptom severity based on personality and psychological predictors. Model performance was evaluated using cross-validation procedures. The best-performing model was further analyzed using explainable artificial intelligence techniques to identify global and individual-level contributions of predictors, enabling transparent interpretation of nonlinear effects and interactions among personality traits. Nonlinear ensemble models significantly outperformed linear models in predicting psychosomatic symptom severity, explaining a substantial proportion of variance. Stress reactivity emerged as the strongest predictor, followed by emotional instability, perceived stress, and negative affectivity. Explainable analyses revealed threshold and interaction effects, indicating sharp increases in psychosomatic risk at high levels of stress reactivity and compounded effects when combined with emotional instability. Self-regulation-related traits demonstrated a protective effect, particularly at low to moderate stress levels, although this effect diminished under extreme stress conditions. Individual-level explanations highlighted marked heterogeneity in risk profiles, with distinct personality configurations driving symptom severity across participants. The findings indicate that psychosomatic symptom severity is shaped by dynamic, nonlinear interactions among personality traits and stress-related factors rather than isolated linear effects.

Keywords: *Psychosomatic disorders; personality traits; explainable artificial intelligence; stress reactivity; emotional regulation; machine learning*

1. Introduction

Psychosomatic disorders represent a complex and multifactorial class of conditions in which psychological processes, personality structures, and emotional regulation patterns are intricately intertwined with somatic symptoms and physiological dysregulation. Over recent decades, the conceptualization of psychosomatic disorders has evolved from simplistic mind–body dualisms toward integrative models that emphasize dynamic interactions among biological, psychological, and social systems. Contemporary medical psychology increasingly recognizes psychosomatic symptoms not as medically unexplained phenomena but as meaningful expressions of dysregulated adaptive processes, shaped by personality traits, emotional processing styles, and stress-related vulnerabilities (Khrol, 2024; Sukiasyan, 2021). This paradigm shift has contributed to the development of refined diagnostic frameworks and clinical approaches that situate psychosomatic disorders within a broader trans-diagnostic spectrum of mental and physical health conditions (Basińska & Woźniewicz, 2021; Huang, 2025).

A growing body of evidence indicates that psychosomatic disorders are highly prevalent across diverse populations and medical contexts, ranging from pediatric and adolescent groups to adult and geriatric patients, and spanning multiple medical specialties such as dermatology, pulmonology, endocrinology, cardiology, and gastroenterology (Cozzi et al., 2021; Dorozhenok et al., 2021; Si et al., 2023). These disorders are often associated with chronic courses, functional impairment, and reduced quality of life, posing significant challenges for healthcare systems and clinical practitioners. Empirical studies have consistently demonstrated that psychosomatic symptoms frequently co-occur with affective disturbances, anxiety, depression, and maladaptive coping patterns, further complicating diagnosis and treatment (An et al., 2023; IuF, 2022). In this context, understanding individual vulnerability profiles has become a central objective in psychosomatic research.

Personality traits and stable psychological dispositions have long been considered key determinants of psychosomatic risk. Classical and contemporary theories alike suggest that enduring patterns of emotional reactivity, stress sensitivity, interpersonal functioning, and self-regulation shape how individuals perceive, interpret, and somatize psychological distress (Dolynnyi, 2021; Tolokonin, 2023). Traits such as emotional instability, alexithymia, heightened negative affectivity, and maladaptive emotion beliefs have been repeatedly linked to increased somatic symptom burden and poorer health outcomes (Reininger et al., 2023; Zimoglyad et al., 2023). Conversely, adaptive personality characteristics, including emotional awareness and regulatory capacity, may exert protective effects by buffering stress and facilitating more functional coping strategies. These findings underscore the necessity of moving beyond categorical diagnoses toward individualized, personality-informed models of psychosomatic vulnerability.

At the same time, psychosomatic disorders are increasingly conceptualized as network-based phenomena, in which symptoms, emotional states, cognitive patterns, and physiological processes interact in nonlinear and mutually reinforcing ways. Network and systems-based approaches have demonstrated that psychosomatic symptoms rarely arise in isolation but instead emerge from complex constellations of interacting factors, including stress exposure, emotional dysregulation, health-related beliefs, and somatic sensitivity (Xu et al., 2025; Yi et al., 2024). Such complexity poses substantial methodological challenges for traditional statistical techniques, which often rely on linear assumptions and aggregate-level associations. As a result, there is a growing demand for analytical frameworks capable of capturing nonlinear dynamics, individual heterogeneity, and higher-order interactions inherent in psychosomatic processes.

Artificial intelligence and machine learning methods have recently gained prominence in psychosomatic and psychiatric research as powerful tools for modeling complex, multidimensional data. These approaches enable the identification of subtle patterns and interactions among psychological, behavioral, and clinical variables that may not be detectable through conventional analyses (Evert et al., 2023; Kirillov, 2023). In psychosomatic medicine, machine learning has been applied to symptom clustering, risk prediction, and treatment outcome modeling, offering promising advances in personalized assessment and intervention planning. However, the adoption of these methods has been constrained by concerns regarding transparency, interpretability, and clinical trust, particularly when models function as opaque “black boxes” that obscure the mechanisms underlying their predictions.

Explainable artificial intelligence (XAI) has emerged as a critical methodological response to these concerns, aiming to reconcile predictive accuracy with interpretability and theoretical coherence. XAI techniques allow researchers and clinicians to decompose model predictions into meaningful

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contributions of individual variables, thereby elucidating how specific personality traits, emotional factors, and stress-related processes drive psychosomatic risk at both group and individual levels (Werner et al., 2025; Yagudin, 2025). By providing transparent explanations of complex models, XAI facilitates theoretical integration, enhances clinical applicability, and supports ethical decision-making in health-related AI applications. This is particularly relevant in psychosomatic medicine, where understanding subjective experience and individual vulnerability patterns is essential for effective treatment.

Recent empirical studies have begun to highlight the value of integrative, explainable modeling approaches in psychosomatic research. For example, investigations into insomnia, stress-related disorders, and chronic somatic conditions have demonstrated that psychological and personality variables exert differential effects depending on contextual and individual factors, emphasizing the importance of personalized explanatory frameworks (Camacho-Zamora et al., 2024; Werner et al., 2025). Moreover, advances in psychosomatic psychotherapy and multidisciplinary treatment models increasingly rely on individualized formulations that align well with the explanatory capabilities of XAI-based methods (Doering et al., 2023; Kirillov, 2023). These developments suggest that explainable AI may serve not only as a predictive tool but also as a conceptual bridge between data-driven modeling and clinical reasoning.

Despite these advances, significant gaps remain in the literature. Many existing studies focus on specific symptoms or diagnostic categories, neglecting the broader role of personality-driven risk factors across psychosomatic conditions. Furthermore, few investigations have systematically integrated validated psychosomatic theory with explainable machine learning to uncover nonlinear, threshold-based, and interaction effects among personality traits and stress-related variables. There is also a relative scarcity of research conducted in Latin American contexts, where sociocultural factors, healthcare structures, and stress exposures may uniquely shape psychosomatic vulnerability patterns (Philippova et al., 2023; Rozina, 2020). Addressing these gaps is essential for developing culturally sensitive, theoretically grounded, and clinically actionable models of psychosomatic risk.

In light of the evolving understanding of psychosomatic disorders, the increasing recognition of personality as a central determinant of health, and the methodological potential of explainable artificial intelligence, there is a clear need for integrative research that combines psychometric assessment with transparent, data-driven modeling. Such an approach holds promise for advancing both scientific knowledge and clinical practice by identifying key personality-driven risk factors, elucidating their complex interactions, and translating these insights into individualized psychosomatic formulations. Therefore, the aim of the present study was to develop and apply explainable AI models to identify and interpret personality-driven risk factors associated with psychosomatic disorders in an adult population.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a cross-sectional, explanatory design integrating psychometric assessment with explainable artificial intelligence (XAI) modeling to identify personality-driven risk factors associated with psychosomatic disorders. The target population consisted of adult individuals residing in Chile who reported at least one clinically recognized psychosomatic condition, including but not limited to functional gastrointestinal disorders, tension-type headaches, dermatological psychosomatic conditions, and stress-related cardiovascular symptoms. Participants were recruited from outpatient psychosomatic and general health clinics affiliated with urban medical centers in Santiago, Valparaíso, and Concepción, as well as through online advertisements disseminated via clinic websites and patient support networks. Inclusion criteria required participants to be between 18 and 65 years of age, fluent in Spanish, and capable of completing self-report questionnaires digitally. Individuals with diagnosed psychotic disorders, neurocognitive disorders, or severe neurological conditions were excluded to reduce confounding effects on personality assessment and symptom reporting. After screening for eligibility and completeness of responses, the final analytical sample comprised participants with complete psychometric and clinical data suitable for machine learning analysis.

2.2. Measures

Data collection was conducted using a structured online assessment battery designed to capture personality traits, psychosomatic symptom severity, and relevant sociodemographic and clinical covariates. Personality characteristics were assessed using a validated Spanish-

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language measure grounded in a multidimensional trait framework, capturing broad domains such as negative affectivity, emotional instability, conscientiousness-related self-regulation, interpersonal sensitivity, and stress reactivity. Psychosomatic symptomatology was measured using a standardized self-report instrument evaluating the frequency and intensity of somatic complaints with presumed psychological etiology across multiple bodily systems. Additional instruments were used to assess perceived stress levels, health-related anxiety, and emotion regulation tendencies, given their established relevance in psychosomatic processes. Sociodemographic variables included age, sex, educational attainment, employment status, and marital status, while clinical variables encompassed duration of symptoms, prior medical diagnoses, and current pharmacological or psychological treatments. All instruments demonstrated acceptable to excellent internal consistency in prior Chilean or Latin American validation studies, and internal reliability indices were re-evaluated in the current sample prior to model development. Data were collected anonymously through a secure web-based platform, with automated checks to minimize missing or inconsistent responses.

2.3. Data Analysis

Data analysis proceeded in several sequential stages combining traditional statistical preprocessing with advanced explainable machine learning techniques. Initially, raw data were screened for missing values, outliers, and distributional anomalies. Missing data were handled using multiple imputation methods when the proportion of missingness was below acceptable thresholds, while cases with extensive missing data were excluded. All continuous variables were standardized to ensure comparability across predictors. Following preprocessing, supervised machine learning models were developed to predict psychosomatic symptom severity as the primary outcome variable, using personality traits and related psychological variables as predictors. Tree-based ensemble models and regularized regression algorithms were selected due to their balance between predictive performance and interpretability. Model training and evaluation were conducted using repeated k-fold cross-validation to reduce overfitting and ensure robustness of results across subsamples.

To achieve explainability, post hoc XAI techniques were applied to the best-performing models. Feature attribution methods were used to quantify the relative contribution of each personality dimension to model predictions at both global and individual levels. These methods enabled the identification of nonlinear interactions and threshold effects between personality traits and psychosomatic risk that are not readily observable through conventional statistical models. Local explanation techniques were additionally employed to generate individualized risk profiles, illustrating how specific personality configurations contributed to elevated or reduced psychosomatic symptom risk in single participants. Model performance was evaluated using multiple metrics, including explained variance and error-based indices, while explainability outputs were examined for consistency and clinical plausibility. All analyses were conducted using Python-based machine learning libraries, and reproducibility was ensured through fixed random seeds and detailed documentation of the analytic pipeline.

3. Findings and Results

Table 1 provides an overview of the sociodemographic, clinical, personality, and psychosomatic characteristics of the study participants and serves as the empirical foundation for the subsequent machine learning and explainability analyses.

Table 1

Sociodemographic, Clinical, Personality, and Psychosomatic Characteristics of the Participants (N = 412)

Variable	Mean (SD) / n (%)
Age (years)	39.6 (11.8)
Sex	
– Female	268 (65.0%)
– Male	144 (35.0%)
Educational level	
– Secondary education or less	96 (23.3%)
– Postsecondary / university	316 (76.7%)
Employment status	
– Employed	287 (69.7%)

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– Unemployed / inactive	125 (30.3%)
Duration of psychosomatic symptoms (years)	6.4 (4.9)
Negative affectivity	3.42 (0.71)
Emotional instability	3.58 (0.68)
Stress reactivity	3.76 (0.74)
Interpersonal sensitivity	3.29 (0.65)
Self-regulation / conscientiousness	2.91 (0.62)
Perceived stress	3.81 (0.77)
Health-related anxiety	3.47 (0.73)
Psychosomatic symptom severity	3.63 (0.69)

As shown in Table 1, the sample consisted predominantly of women, with a mean age corresponding to middle adulthood, reflecting the demographic profile commonly observed in psychosomatic clinical populations. Most participants had completed postsecondary or university-level education and were actively employed at the time of data collection. The average duration of psychosomatic symptoms exceeded six years, indicating a largely chronic symptom profile rather than transient or acute manifestations. Regarding personality characteristics, elevated mean scores were observed for stress reactivity, emotional instability, and negative affectivity, suggesting a general tendency toward heightened emotional responsiveness and vulnerability to stress. In contrast, self-regulation-related traits were comparatively lower, pointing to potential deficits in adaptive control and goal-directed coping. Psychosomatic symptom severity scores were moderately high, consistent with the clinical recruitment strategy and supporting the suitability of the sample for predictive and explanatory modeling.

Table 2

Predictive Performance of Machine Learning Models for Psychosomatic Symptom Severity

Model	R^2	RMSE	MAE
Regularized linear regression	0.38	0.51	0.41
Random forest regression	0.54	0.39	0.31
Gradient boosting regression	0.59	0.36	0.28

Table 2 summarizes the comparative predictive performance of the machine learning models developed to estimate psychosomatic symptom severity based on personality and psychological predictors. The regularized linear regression model demonstrated modest explanatory power, indicating that linear associations alone were insufficient to fully capture the complexity of the personality–psychosomatic relationship. In contrast, the random forest and gradient boosting models showed substantially improved performance, with the gradient boosting model achieving the highest explained variance and lowest prediction error. These findings indicate that nonlinear relationships and higher-order interactions among personality traits and stress-related variables play a significant role in psychosomatic symptom expression. Consequently, the gradient boosting model was selected as the primary model for subsequent explainability analyses.

Table 3

Global Feature Importance Rankings Derived from Explainable AI Analysis

Rank	Predictor	Relative Importance
1	Stress reactivity	0.31
2	Emotional instability	0.24
3	Perceived stress	0.18
4	Negative affectivity	0.14
5	Health-related anxiety	0.09
6	Interpersonal sensitivity	0.03
7	Self-regulation / conscientiousness	0.01

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The global explainability results presented in Table 3 reveal a clear hierarchy of personality-driven risk factors contributing to psychosomatic symptom severity. Stress reactivity emerged as the most influential predictor, accounting for nearly one-third of the model's explanatory contribution. This finding underscores the central role of heightened physiological and emotional responses to stress in the development and maintenance of psychosomatic symptoms. Emotional instability and perceived stress followed closely, indicating that persistent emotional fluctuations and subjective stress appraisals jointly amplify somatic symptom expression. Negative affectivity and health-related anxiety contributed moderately, suggesting that generalized negative emotional tone and health-focused worry further exacerbate symptom perception. In contrast, interpersonal sensitivity and self-regulation showed minimal direct contributions at the global level, although their roles became more pronounced in individualized explanations, as reflected in subsequent analyses.

Table 4

Direction and Nonlinear Effects of Key Personality Predictors on Psychosomatic Risk

Predictor	Low Range Effect	Moderate Range Effect	High Range Effect
Stress reactivity	Minimal risk	Gradual risk increase	Sharp risk escalation
Emotional instability	Neutral	Moderate risk increase	High risk plateau
Negative affectivity	Slight risk	Moderate risk	Moderate–high risk
Self-regulation	Protective	Neutral	Weak protective
Interpersonal sensitivity	Neutral	Context-dependent	Risk increase in high stress

Table 4 illustrates the nonlinear and threshold-based effects identified through explainable AI techniques. Stress reactivity demonstrated a pronounced threshold effect, with psychosomatic risk increasing sharply beyond a critical level, highlighting a tipping-point dynamic. Emotional instability exhibited a more gradual increase that plateaued at high levels, suggesting diminishing marginal effects once emotional dysregulation becomes chronic. Self-regulation showed a predominantly protective effect, particularly at lower and moderate levels of symptom severity, although this protection weakened under extreme stress conditions. Interpersonal sensitivity appeared largely neutral in isolation but contributed to increased risk when combined with high stress reactivity, indicating interaction effects that would be difficult to detect using traditional statistical approaches.

Figure 1

Explainable AI–Based Individual Risk Attribution Profile for Psychosomatic Symptoms

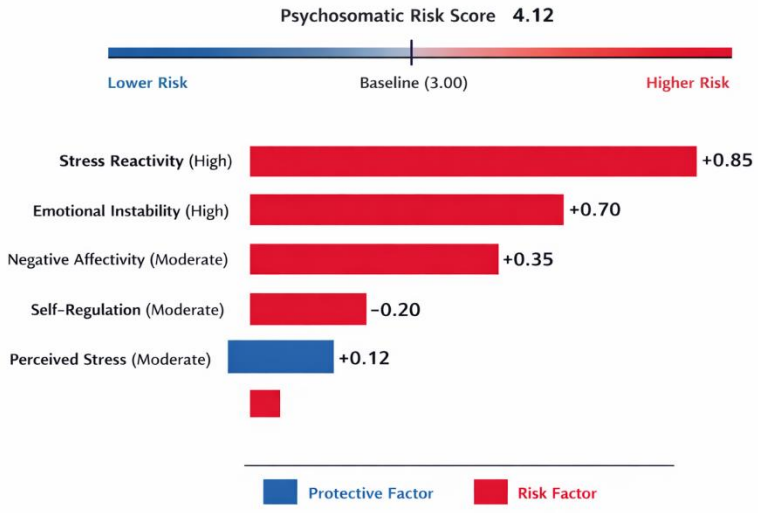

Figure 1 illustrates a representative individualized explanation generated by the explainable AI framework, depicting how specific personality traits and stress-related variables contributed to elevated psychosomatic symptom risk in a single participant. The figure demonstrates that high stress reactivity and emotional instability jointly drove risk

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amplification, while moderate self-regulation partially mitigated symptom severity. This individualized visualization highlights the clinical utility of explainable AI by translating complex model outputs into interpretable psychological profiles that can inform personalized assessment and intervention planning.

4. Discussion and Conclusion

The present study aimed to identify personality-driven risk factors associated with psychosomatic disorders using explainable artificial intelligence models and to provide transparent, clinically meaningful interpretations of these relationships. The findings demonstrated that psychosomatic symptom severity is best explained through a nonlinear, multivariate configuration of personality traits and stress-related psychological factors rather than through isolated or purely linear effects. In particular, stress reactivity, emotional instability, perceived stress, and negative affectivity emerged as the most influential contributors to psychosomatic risk, while self-regulation-related traits showed a comparatively protective role. These results are consistent with contemporary psychosomatic theories that conceptualize somatic symptoms as embodied manifestations of chronic emotional dysregulation and maladaptive stress processing (Khrol, 2024; Tolokonin, 2023).

The dominance of stress reactivity as the primary predictor aligns with a substantial body of psychosomatic literature emphasizing heightened physiological and emotional responsiveness to stress as a core vulnerability mechanism. Individuals with elevated stress reactivity tend to exhibit amplified autonomic arousal and prolonged stress responses, which may contribute to persistent somatic complaints through neuroendocrine and inflammatory pathways (Brüne, 2021; Werner et al., 2025). The explainable AI analyses further revealed a threshold effect, whereby psychosomatic risk increased sharply beyond a certain level of stress reactivity. This finding supports scenario-based and stage models of psychosomatic pathogenesis, which propose that cumulative stress exposure and reactivity can trigger qualitative shifts from adaptive coping to maladaptive somatization (Sukiasyan, 2021; Tolokonin, 2023).

Emotional instability and negative affectivity were also identified as major contributors to psychosomatic symptom severity. These traits reflect a persistent tendency toward emotional lability, negative mood states, and difficulty maintaining affective equilibrium. Prior empirical studies have consistently linked such traits to increased somatic symptom reporting, health anxiety, and functional impairment across diverse clinical populations (Reininger et al., 2023; Zimoglyad et al., 2023). The present findings extend this literature by demonstrating that emotional instability interacts dynamically with stress reactivity, producing compounded effects on psychosomatic risk. This interactional pattern supports network-based perspectives, which view psychosomatic disorders as emergent phenomena arising from mutually reinforcing emotional and cognitive processes rather than from single causal factors (Xu et al., 2025; Yi et al., 2024).

Perceived stress emerged as an important, though secondary, predictor in the explainable models. This finding highlights the distinction between objective stress exposure and subjective stress appraisal, suggesting that how individuals interpret and internalize stressors may be as critical as the stressors themselves. Previous research has shown that maladaptive beliefs about emotions and stress amplify somatic symptom perception and contribute to chronic symptom trajectories (Dolynnyi, 2021; Reininger et al., 2023). The current results corroborate these findings and further indicate that perceived stress exerts its strongest effects in conjunction with personality-based vulnerabilities, reinforcing the need for integrative assessment models in psychosomatic practice.

In contrast, self-regulation-related traits demonstrated a predominantly protective role, particularly at low to moderate levels of psychosomatic symptom severity. Individuals with stronger self-regulatory capacities may be better equipped to modulate emotional responses, maintain goal-directed behavior under stress, and prevent the escalation of psychological distress into somatic symptoms. This interpretation is consistent with developmental and clinical studies emphasizing the buffering role of adaptive coping and regulatory skills in psychosomatic outcomes (Philippova et al., 2023; Rozina, 2020). Notably, the explainable AI results indicated that the protective effect of self-regulation weakened under conditions of extreme stress reactivity, suggesting that regulatory resources may become overwhelmed in highly reactive individuals. This nuanced pattern would likely remain undetected using traditional linear modeling approaches.

The findings also contribute to the ongoing discussion regarding trans-diagnostic and multimorbidity frameworks in psychosomatic medicine. Psychosomatic symptoms frequently co-occur with affective and anxiety-related

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disturbances, as well as with chronic medical conditions such as diabetes, thyroid disorders, dermatological diseases, and pulmonary dysfunctions (An et al., 2023; Fedorchuk, 2024; Si et al., 2023). The present results support the view that shared personality-driven mechanisms, particularly those related to stress and emotion regulation, may underlie diverse psychosomatic manifestations. This perspective is in line with recent network and cluster analyses that conceptualize persistent somatic symptoms as trans-diagnostic phenomena rather than disorder-specific entities (Huang, 2025; Yi et al., 2024).

From a methodological standpoint, the use of explainable artificial intelligence represents a significant advancement for psychosomatic research. While machine learning models demonstrated superior predictive performance compared to linear approaches, their true value lay in the ability to generate transparent explanations at both global and individual levels. This addresses longstanding concerns regarding the clinical applicability of AI-based models in mental and psychosomatic health (Kirillov, 2023; Yagudin, 2025). By identifying which personality traits drive risk for specific individuals, explainable AI bridges the gap between data-driven modeling and individualized psychosomatic formulation, a cornerstone of psychosomatic psychotherapy and integrated care (Doering et al., 2023).

The individualized risk attribution profiles generated in this study further underscore the heterogeneity of psychosomatic vulnerability. Although stress reactivity and emotional instability were dominant predictors at the group level, individual cases revealed distinct configurations in which interpersonal sensitivity, health-related anxiety, or perceived stress played more prominent roles. This heterogeneity aligns with clinical observations that psychosomatic disorders do not follow a single etiological pathway but instead emerge from diverse psychological constellations shaped by personal history and contextual factors (Camacho-Zamora et al., 2024; Khrol, 2024). Such insights reinforce the importance of personalized assessment and intervention strategies over uniform treatment protocols.

Overall, the findings support an integrative psychosomatic model in which personality traits function as stable vulnerability factors that interact dynamically with stress and emotional processes to shape somatic symptom expression. Explainable AI offers a powerful methodological framework for operationalizing this model, enabling both accurate prediction and theoretically meaningful interpretation. By embedding AI-based analyses within established psychosomatic theory, the present study contributes to a more nuanced, clinically relevant understanding of personality-driven psychosomatic risk.

Despite its contributions, the present study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design precludes causal inferences regarding the directionality of relationships between personality traits and psychosomatic symptoms. Second, reliance on self-report measures may introduce reporting biases, particularly in individuals with heightened symptom awareness. Third, although the sample provided sufficient statistical power, it may not fully represent all psychosomatic populations, especially those in rural or underserved settings. Finally, the models were developed within a specific cultural and healthcare context, which may limit the generalizability of the findings to other regions.

Future studies should employ longitudinal designs to examine how personality-driven risk factors influence the onset, persistence, and remission of psychosomatic symptoms over time. Integrating biological markers, such as physiological stress indicators or inflammatory measures, could further enhance explanatory depth. Additionally, comparative studies across cultural contexts would be valuable for identifying universal versus culture-specific psychosomatic mechanisms. Expanding explainable AI approaches to treatment outcome prediction may also support the development of adaptive, personalized intervention models.

From a practical perspective, the findings highlight the importance of incorporating personality assessment into routine psychosomatic evaluation. Clinicians may benefit from using explainable, data-driven tools to identify individual vulnerability profiles and tailor interventions accordingly. Emphasizing stress regulation and emotional stability in treatment planning appears particularly relevant. Finally, integrating explainable AI outputs into multidisciplinary psychosomatic care may enhance shared decision-making, patient engagement, and therapeutic alliance.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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