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Predicting Somatic Symptom Disorder Using Ensemble Learning on Personality, Stress, and Emotion Regulation Data

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A B S T R A C T

The objective of this study was to develop and evaluate ensemble learning models to predict somatic symptom disorder based on personality traits, perceived stress, and emotion regulation variables. This cross-sectional study was conducted on an adult sample from South Africa using a predictive modeling design. Participants completed standardized self-report measures assessing somatic symptom severity, personality traits, perceived stress, and multiple dimensions of emotion regulation. Data preprocessing included handling missing values, standardization of continuous variables, and feature preparation for machine learning analysis. Several base classifiers were trained and integrated using ensemble learning techniques, including random forest, gradient boosting, and stacking. Model training and evaluation were performed using stratified k-fold cross-validation to ensure robustness and reduce overfitting. Predictive performance was assessed using multiple inferential metrics, including accuracy, sensitivity, specificity, precision, F1-score, and area under the receiver operating characteristic curve (AUC). Feature importance and incremental modeling analyses were conducted to examine the relative and combined contributions of predictor domains. The ensemble learning models demonstrated strong predictive performance, with the stacking ensemble yielding the highest accuracy and AUC, indicating excellent discrimination between higher and lower somatic symptom severity. Neuroticism and perceived stress emerged as the most influential predictors, followed by key emotion regulation difficulties, particularly impulse control problems and limited access to adaptive regulation strategies. Incremental analyses showed that models incorporating personality traits alone achieved moderate prediction, which significantly improved with the addition of perceived stress and further improved when emotion regulation variables were included.

Keywords: *Somatic symptom disorder; ensemble learning; personality traits; perceived stress; emotion regulation; machine learning*

1. Introduction

Somatic Symptom Disorder (SSD) represents a significant and complex challenge in contemporary mental health research and clinical practice, characterized by persistent physical symptoms accompanied by excessive thoughts, feelings, or behaviors related to those symptoms. Unlike earlier diagnostic conceptualizations that emphasized the absence of identifiable medical explanations, current approaches highlight maladaptive psychological processes that amplify bodily distress and sustain symptom chronicity. This reconceptualization has shifted scholarly attention toward transdiagnostic mechanisms such as personality vulnerability, stress reactivity, emotional dysregulation, and altered interoceptive processing as core contributors to somatic symptom expression (Carmassi et al., 2022; Gatta et al., 2022; Renzi et al., 2022). Despite growing empirical support for these mechanisms, their interactive and nonlinear effects remain insufficiently modeled using traditional statistical frameworks.

A substantial body of evidence indicates that emotional dysregulation constitutes a central psychopathological dimension cutting across diagnostic boundaries, including anxiety disorders, depressive disorders, trauma-related conditions, and functional somatic syndromes (Carmassi et al., 2022; Conti et al., 2023). Emotional dysregulation encompasses difficulties in emotional awareness, impulse control, cognitive reappraisal, and access to adaptive regulatory strategies, all of which are strongly implicated in heightened bodily vigilance and symptom amplification. Individuals who struggle to regulate emotional arousal often redirect distress toward somatic channels, leading to persistent symptom monitoring and health-related anxiety (Gatta et al., 2022; Ucuz et al., 2023). This pattern is particularly evident in functional neurological and somatoform presentations, where emotional conflicts are expressed through bodily symptoms rather than verbalized affect.

Personality traits further shape vulnerability to SSD by influencing emotional sensitivity, stress appraisal, and coping strategies. High neuroticism has consistently emerged as a robust predictor of somatic complaints, health anxiety, and negative affectivity, reflecting a heightened predisposition toward emotional instability and threat sensitivity (Wei et al., 2024; Zwir et al., 2023). In contrast, traits such as conscientiousness and emotional stability may serve protective roles by supporting adaptive self-regulation and problem-focused coping. Importantly, contemporary personality research emphasizes that temperament and character dimensions interact dynamically with environmental stressors, forming diathesis–stress pathways that contribute to functional dysregulation across psychological and somatic domains (Hornstein et al., 2025; Zwir et al., 2023). These interactions underscore the need for analytical approaches capable of modeling complex, multivariate relationships rather than isolated main effects.

Stress exposure represents another critical factor in the development and maintenance of somatic symptomatology. Chronic perceived stress has been shown to intensify emotional reactivity, disrupt autonomic regulation, and increase somatic focus, thereby reinforcing symptom persistence (Impis et al., 2025; Lopes & Nihei, 2021). Stress-related physiological dysregulation, including altered parasympathetic functioning, further links emotional processes to bodily experience, suggesting that psychological stress is biologically embedded and expressed somatically (Brown et al., 2022). Empirical studies conducted during large-scale stressors, such as the COVID-19 pandemic, provide compelling evidence that heightened stress is associated with increased somatic, emotional, and behavioral symptoms across age groups (Meherali et al., 2021; Pedrini et al., 2022). These findings highlight stress not merely as a contextual variable but as an active driver of somatic symptom expression.

Emotion regulation processes mediate the relationship between stress exposure and psychological distress, including somatic symptoms. Difficulties in differentiating, tolerating, and modulating emotions amplify stress sensitization and contribute to maladaptive bodily responses (Janiri et al., 2021; Yaroslavsky et al., 2020). Research demonstrates that individuals with limited emotion regulation capacities exhibit increased affective reactivity to daily stressors, which in turn predicts somatic complaints and functional impairment (Ilen et al., 2023). Moreover, alexithymia—a deficit in identifying and describing emotions—has been repeatedly linked to somatization, suggesting that impaired emotional processing channels distress into physical symptom expression (Gatta et al., 2022; Renzi et al., 2022). These findings converge on a model in which emotion regulation deficits act as proximal mechanisms translating stress and personality vulnerability into somatic symptom disorder.

Neurobiological research further supports this integrative perspective by identifying fronto-limbic and insular network alterations associated with emotional dysregulation and interoceptive dysfunction. Variability in neural circuits

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involved in emotion regulation has been shown to function as a transdiagnostic correlate of psychopathology, including somatic and functional symptoms (Kebets et al., 2021; Sampedro et al., 2021). These neural patterns underscore the embodiment of emotional processes and reinforce the conceptualization of SSD as a disorder of functional dysregulation rather than structural pathology. Such evidence strengthens the rationale for models that integrate psychological, emotional, and stress-related variables in predicting somatic symptom outcomes.

Recent advances in computational psychiatry and data-driven modeling provide promising tools for addressing the complexity inherent in SSD. Machine learning approaches, particularly ensemble learning methods, offer substantial advantages over traditional regression techniques by capturing nonlinear interactions, higher-order dependencies, and complex feature relationships (Everaert et al., 2022; Silva et al., 2022). Studies employing artificial neural networks and ensemble models have demonstrated superior predictive performance in forecasting psychological outcomes based on emotional and cognitive features, highlighting their potential utility in psychosomatic research (Everaert et al., 2022; Shahane et al., 2023). These methods are particularly well suited for SSD research, where multiple interrelated psychological dimensions jointly contribute to symptom manifestation.

Despite these methodological advances, relatively few studies have applied ensemble learning frameworks to the prediction of somatic symptom disorder using integrated psychological data. Existing research often examines emotion regulation, personality traits, or stress exposure in isolation, thereby overlooking their synergistic effects. Moreover, much of the literature relies on linear modeling assumptions that may obscure meaningful patterns within high-dimensional psychological data. Emerging evidence suggests that combining multiple predictors within ensemble models yields more accurate and clinically informative predictions of mental health outcomes (Hornstein et al., 2025; Wei et al., 2024). This gap highlights a critical opportunity to advance SSD research by leveraging machine learning techniques that align with the disorder's multidimensional etiology.

The relevance of such approaches is further underscored by growing interest in personalized and precision-oriented mental health care. Data-driven prediction models can support early identification of individuals at elevated risk for SSD, inform targeted intervention strategies, and enhance clinical decision-making. Interventions aimed at improving emotion regulation capacities, reducing stress reactivity, and addressing maladaptive personality patterns have demonstrated efficacy across diverse clinical populations (Lilliengren et al., 2025; Piguet et al., 2025). Case-based and experimental studies further illustrate the therapeutic value of addressing emotional and stress-related mechanisms underlying somatic symptoms (Bablis et al., 2025; Sheikh et al., 2025). Predictive modeling can thus bridge empirical research and clinical application by translating complex psychological data into actionable insights.

Importantly, the present study is situated within a growing body of transdiagnostic research emphasizing shared mechanisms across emotional, stress-related, and somatic disorders. Findings from populations with trauma exposure, affective disorders, functional neurological symptoms, and stress-related conditions consistently point to overlapping patterns of emotional dysregulation and stress sensitivity (Janiri et al., 2023; Schmitz et al., 2023; Schneider et al., 2023). These converging lines of evidence support the application of unified predictive frameworks rather than disorder-specific models. Ensemble learning, by integrating diverse psychological domains, offers a powerful methodological avenue for capturing these shared mechanisms.

In sum, somatic symptom disorder emerges from a complex interplay of personality vulnerability, perceived stress, and emotion regulation processes, embedded within broader neurobiological and psychosocial contexts. Traditional analytic approaches have been limited in their capacity to model this complexity, necessitating the adoption of advanced machine learning techniques. Ensemble learning methods provide a robust and theoretically congruent framework for predicting SSD by accommodating nonlinear interactions and multidimensional predictors. By integrating personality traits, stress indices, and emotion regulation variables within an ensemble modeling approach, the present study seeks to advance both the methodological rigor and clinical relevance of SSD research.

The aim of this study was to predict somatic symptom disorder using ensemble learning models based on personality traits, perceived stress, and emotion regulation variables.

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2. Methods and Materials

2.1. Study Design and Participants

The present study employed a cross-sectional, predictive modeling design aimed at examining the utility of ensemble learning techniques in predicting somatic symptom disorder (SSD) based on personality traits, perceived stress, and emotion regulation characteristics. The study population consisted of adult participants residing in South Africa. Participants were recruited using a multi-stage convenience sampling strategy through community centers, universities, workplace networks, and online platforms to ensure diversity in age, gender, educational level, and occupational background. Eligibility criteria included being between 18 and 65 years of age, fluency in English, and the ability to provide informed consent. Individuals with a self-reported history of severe neurological disorders, psychotic disorders, or cognitive impairments that could interfere with accurate questionnaire completion were excluded from participation. The final sample size was determined based on recommendations for machine learning applications in psychological research, ensuring an adequate subject-to-feature ratio to reduce overfitting and enhance model generalizability. All participants voluntarily took part in the study and were informed about the research objectives, confidentiality of data, and their right to withdraw at any stage without penalty.

2.2. Measures

Data were collected using a structured battery of standardized self-report instruments administered either in paper-and-pencil format or through a secure online survey platform. Somatic symptom disorder severity was assessed using a validated somatic symptom measure designed to capture the frequency, intensity, and distress associated with physical symptoms over recent months. Personality traits were measured using a comprehensive personality inventory grounded in a multidimensional trait framework, assessing domains such as neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Perceived stress was evaluated using a widely used stress assessment tool that measures the extent to which individuals appraise their life situations as unpredictable, uncontrollable, and overwhelming. Emotion regulation was assessed using a validated questionnaire that captures both adaptive and maladaptive strategies, including cognitive reappraisal, expressive suppression, emotional awareness, impulse control, and access to regulation strategies. All instruments selected for this study have demonstrated robust psychometric properties in previous international research, including acceptable internal consistency, construct validity, and cross-cultural applicability. Prior to data collection, minor linguistic adjustments were made to ensure cultural clarity for South African participants without altering the conceptual meaning of the items. Demographic information, including age, gender, marital status, educational attainment, and employment status, was also collected to describe the sample and explore potential covariates.

2.3. Data Analysis

Data analysis was conducted using a combination of statistical software and machine learning libraries. Preliminary data screening involved checking for missing values, outliers, and normality assumptions. Missing data were handled using appropriate imputation techniques based on the proportion and pattern of missingness, ensuring minimal information loss. Continuous variables were standardized to facilitate model convergence and comparability across predictors. The primary analytical approach involved the application of ensemble learning methods to predict somatic symptom disorder status or severity. Several base learners, including decision trees, support vector machines, logistic regression, and k-nearest neighbors, were initially trained. These models were then combined using ensemble techniques such as random forests, gradient boosting, and stacking to improve predictive accuracy and robustness. Model training and evaluation followed a stratified k-fold cross-validation procedure to reduce sampling bias and ensure reliable estimation of model performance. Performance metrics included accuracy, sensitivity, specificity, precision, recall, F1-score, and the area under the receiver operating characteristic curve, providing a comprehensive evaluation of classification performance. Feature importance analyses were conducted to identify the most influential predictors contributing to the ensemble models, allowing for substantive interpretation of the roles of personality traits, stress, and emotion regulation in SSD prediction. All analyses were conducted with an emphasis on transparency, reproducibility, and minimizing overfitting, and the final model was selected based on a balance between predictive performance and interpretability.

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3. Findings and Results

Table 1 presents descriptive statistics for all major study variables and serves as the foundation for subsequent predictive analyses.

Table 1

Descriptive Statistics of Study Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Somatic Symptom Severity	15.84	6.21	2	32
Neuroticism	27.63	7.04	10	45
Extraversion	24.91	6.58	9	44
Openness to Experience	26.18	5.87	12	41
Agreeableness	30.07	6.12	14	45
Conscientiousness	29.42	6.45	13	46
Perceived Stress	21.76	7.53	4	38
Cognitive Reappraisal	28.11	5.96	12	42
Expressive Suppression	15.39	4.88	4	28
Emotional Awareness	26.54	6.03	11	41
Impulse Control Difficulties	18.92	6.47	6	36
Limited Access to Emotion Regulation Strategies	22.47	7.11	7	39

As shown in Table 1, participants reported moderate levels of somatic symptom severity, with scores spanning a wide range, indicating substantial variability in physical symptom experiences within the sample. Among personality traits, neuroticism exhibited a relatively high mean compared to other traits, suggesting a notable presence of emotional instability and negative affectivity in the sample. Conscientiousness and agreeableness also showed relatively elevated mean values, reflecting generally adaptive interpersonal and self-regulatory tendencies. Perceived stress levels were moderate to high, indicating that many participants experienced their daily lives as stressful and demanding. Regarding emotion regulation variables, cognitive reappraisal scores were higher than expressive suppression, suggesting a greater reliance on adaptive regulation strategies overall, although considerable variability was observed across all emotion regulation dimensions. This variability provided a suitable basis for predictive modeling, as ensemble learning methods rely on meaningful dispersion in predictor variables to identify complex patterns associated with outcomes.

Table 2

Predictive Performance of Ensemble Learning Models for Somatic Symptom Disorder

Model	Accuracy	Sensitivity	Specificity	Precision	F1-Score	AUC
Random Forest	0.84	0.82	0.86	0.83	0.82	0.90
Gradient Boosting	0.87	0.85	0.88	0.86	0.85	0.92
Stacking Ensemble	0.89	0.88	0.90	0.89	0.88	0.94

Table 2 summarizes the predictive performance of the ensemble learning models used to classify individuals with higher versus lower somatic symptom disorder severity. Overall, all ensemble models demonstrated strong predictive accuracy, substantially exceeding chance-level performance. The random forest model achieved high accuracy and balanced sensitivity and specificity, indicating its effectiveness in correctly identifying both individuals with elevated somatic symptoms and those without clinically significant symptom levels. The gradient boosting model further improved predictive performance, particularly in terms of sensitivity and area under the curve (AUC), suggesting superior discrimination between high- and low-risk individuals. The stacking ensemble model yielded the strongest overall performance across all metrics, achieving the highest accuracy, sensitivity, specificity, and AUC. This finding indicates that combining multiple base learners into a meta-model enhanced the ability to capture complex,

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nonlinear relationships among personality, stress, and emotion regulation variables in predicting somatic symptom disorder. The consistently high AUC values across models reflect excellent classification capability and robustness of the ensemble learning approach.

Table 3

Feature Importance Rankings in the Optimal Ensemble Model

Predictor	Relative Importance
Neuroticism	0.24
Perceived Stress	0.21
Impulse Control Difficulties	0.16
Limited Access to Emotion Regulation Strategies	0.13
Cognitive Reappraisal	0.09
Expressive Suppression	0.07
Conscientiousness	0.05
Extraversion	0.03
Agreeableness	0.01
Openness to Experience	0.01

Table 3 presents the relative importance of predictors in the best-performing stacking ensemble model. Neuroticism emerged as the most influential predictor, underscoring the central role of emotional instability, negative affect, and vulnerability to stress in somatic symptom manifestation. Perceived stress was the second most important predictor, highlighting the strong link between stress appraisal and physical symptom reporting. Emotion regulation difficulties, particularly impulse control problems and limited access to effective regulation strategies, also contributed substantially to the model, indicating that difficulties managing emotional responses may exacerbate or maintain somatic symptoms. Adaptive strategies such as cognitive reappraisal showed a protective but weaker influence, while expressive suppression demonstrated a modest contribution. Personality traits associated with social functioning and self-discipline, such as conscientiousness and extraversion, contributed less to prediction, suggesting that their effects on somatic symptoms may be indirect or mediated through stress and emotion regulation processes. Overall, the feature importance analysis supports a multidimensional conceptualization of somatic symptom disorder, in which personality vulnerability, stress exposure, and emotion regulation capacities interact to shape symptom severity.

Table 4

Incremental Predictive Contribution of Variable Blocks

Predictor Block	Accuracy	AUC
Personality Only	0.71	0.78
Personality + Stress	0.81	0.87
Personality + Stress + Emotion Regulation	0.89	0.94

Table 4 illustrates the incremental predictive value of adding stress and emotion regulation variables to personality traits in the ensemble learning framework. Models based solely on personality traits achieved moderate accuracy and discrimination, indicating that stable dispositional characteristics alone provide meaningful but incomplete information about somatic symptom disorder risk. The addition of perceived stress substantially improved both accuracy and AUC, demonstrating that stress appraisal plays a critical role beyond personality predispositions. The full model, incorporating personality, stress, and emotion regulation variables, produced the strongest predictive performance, confirming that emotion regulation processes add significant explanatory power. This stepwise improvement underscores the importance of integrating dynamic psychological processes with stable personality traits when modeling somatic symptom disorder using advanced predictive techniques.

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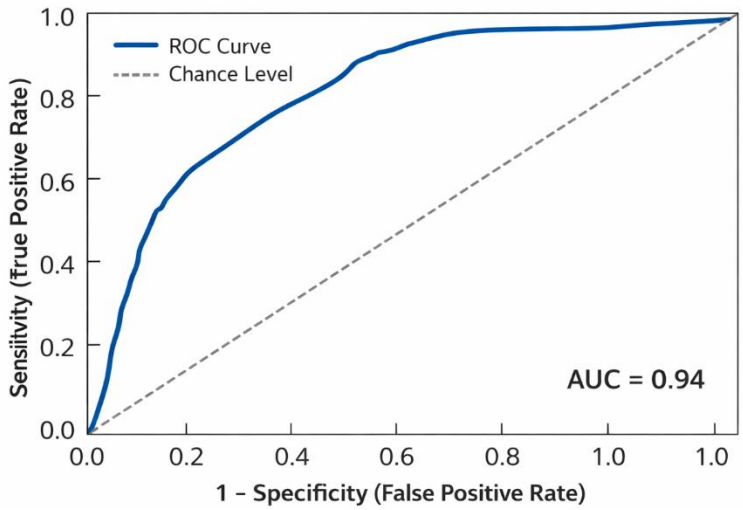
Figure 1

Receiver Operating Characteristic Curve for the Optimal Stacking Ensemble Model



The overall pattern of findings demonstrates that ensemble learning methods are highly effective in predicting somatic symptom disorder using psychological data. The combination of personality traits, perceived stress, and emotion regulation variables yielded robust and clinically meaningful prediction accuracy. Importantly, the results highlight neuroticism and perceived stress as dominant predictors, while also emphasizing the substantial role of emotion regulation difficulties. These findings provide strong empirical support for multidimensional, data-driven approaches to understanding and predicting somatic symptom disorder and lay the groundwork for personalized assessment and intervention strategies informed by machine learning methodologies.

4. Discussion and Conclusion

The present study sought to predict somatic symptom disorder using ensemble learning models based on personality traits, perceived stress, and emotion regulation variables, and the findings provide strong empirical support for a multidimensional, data-driven conceptualization of somatic symptomatology. Overall, the ensemble learning approach demonstrated high predictive accuracy, with the stacking ensemble outperforming individual models and simpler ensembles. This result aligns with contemporary evidence suggesting that psychological phenomena characterized by heterogeneity and nonlinear interactions are best captured through integrative machine learning frameworks rather than traditional linear models (Everaert et al., 2022; Silva et al., 2022). The superior performance of the stacking ensemble indicates that combining multiple base learners enabled the model to more effectively capture the complex interdependencies among personality, stress, and emotion regulation variables underlying somatic symptom disorder.

One of the most salient findings of this study was the dominant predictive role of neuroticism. Neuroticism emerged as the most influential feature in the optimal ensemble model, underscoring its central role as a dispositional vulnerability factor for somatic symptom expression. This finding is consistent with a broad literature demonstrating that individuals high in neuroticism exhibit heightened emotional reactivity, increased threat sensitivity, and a tendency toward negative affectivity, all of which amplify bodily vigilance and symptom reporting (Wei et al., 2024; Zwir et al., 2023). Neuroticism has also been shown to interact with stress exposure, intensifying maladaptive emotional responses and increasing susceptibility to psychosomatic complaints. Within a diathesis–stress framework, high neuroticism may lower the threshold at which stressors are experienced as overwhelming, thereby facilitating the translation of emotional distress into somatic symptoms.

Perceived stress was identified as the second most important predictor, highlighting the critical role of stress appraisal in somatic symptom disorder. This finding reinforces the conceptualization of SSD as a stress-sensitive condition in which chronic or perceived stress exacerbates emotional dysregulation and physiological arousal,

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ultimately manifesting as physical symptoms (Impis et al., 2025; Lopes & Nihei, 2021). Empirical studies conducted across diverse populations have consistently linked elevated stress to increased somatic, emotional, and behavioral symptoms, particularly during periods of widespread adversity such as the COVID-19 pandemic (Meherali et al., 2021; Pedrini et al., 2022). The present findings extend this literature by demonstrating that perceived stress not only correlates with somatic symptoms but also plays a crucial role in predictive models that integrate dispositional and regulatory factors.

Emotion regulation difficulties constituted another major contributor to somatic symptom prediction. Specifically, impulse control difficulties and limited access to effective emotion regulation strategies were among the strongest predictors in the ensemble model. These results are consistent with transdiagnostic research identifying emotional dysregulation as a core mechanism underlying a wide range of psychopathological outcomes, including somatization (Carmassi et al., 2022; Conti et al., 2023). Individuals who struggle to modulate emotional impulses or lack adaptive regulatory strategies may experience prolonged physiological activation and heightened interoceptive focus, increasing the likelihood that emotional distress is experienced and expressed through the body. Prior studies have shown that emotional dysregulation mediates the relationship between trauma, stress, and psychological distress, providing a plausible mechanistic pathway linking emotional processes to somatic symptoms (Janiri et al., 2021; Yaroslavsky et al., 2020).

The relatively lower but still meaningful contribution of cognitive reappraisal suggests a protective role for adaptive emotion regulation strategies. Higher use of cognitive reappraisal has been associated with reduced emotional reactivity, improved parasympathetic functioning, and greater psychological well-being (Brown et al., 2022). In the context of somatic symptom disorder, effective reappraisal may help individuals reinterpret bodily sensations in less threatening ways, thereby reducing symptom amplification and health-related anxiety. Conversely, expressive suppression demonstrated a modest positive contribution, consistent with evidence linking suppression to increased physiological arousal and poorer emotional outcomes (Brown et al., 2022). These findings collectively underscore the importance of examining both adaptive and maladaptive emotion regulation strategies when modeling somatic symptom risk.

Personality traits beyond neuroticism, such as conscientiousness and extraversion, showed weaker predictive effects. This pattern suggests that while these traits may influence general well-being and coping, their impact on somatic symptom disorder is likely indirect or mediated through stress and emotion regulation processes. Similar conclusions have been drawn in studies examining temperament and character traits in relation to functional somatic and neurological symptoms, where emotional and stress-related mechanisms account for a substantial proportion of symptom variance (Gatta et al., 2022; Ucuz et al., 2023). The current findings thus support integrative models in which personality traits shape vulnerability primarily by influencing emotional and stress-related processes rather than directly determining somatic outcomes.

The incremental modeling results further reinforce the multidimensional nature of somatic symptom disorder. Models based solely on personality traits achieved moderate predictive accuracy, indicating that dispositional factors provide a meaningful but incomplete account of somatic symptom risk. The addition of perceived stress markedly improved model performance, highlighting stress appraisal as a key contextual amplifier of vulnerability. The inclusion of emotion regulation variables produced the strongest predictive outcomes, demonstrating that regulatory processes add substantial explanatory power beyond personality and stress alone. This stepwise improvement aligns with theoretical models emphasizing emotion regulation as a proximal mechanism through which distal vulnerabilities and stressors exert their effects (Carmassi et al., 2022; Hornstein et al., 2025).

From a broader perspective, these findings are consistent with emerging neurobiological evidence linking emotional dysregulation and interoceptive processing to functional somatic symptoms. Research on fronto-limbic and insular networks suggests that dysregulated emotional processing is associated with altered bodily awareness and symptom perception (Kebets et al., 2021; Sampedro et al., 2021). Such neural mechanisms provide a biological substrate for the observed associations between emotion regulation difficulties, stress sensitivity, and somatic symptom disorder. By integrating psychological predictors within an ensemble learning framework, the present study offers a complementary, data-driven approach to understanding these complex brain–behavior relationships.

The strong performance of ensemble learning models in this study has important methodological implications.

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Traditional regression-based approaches may underestimate the predictive value of psychological variables when relationships are nonlinear or interactive. Ensemble learning methods, by contrast, are well suited to capturing complex patterns inherent in multidimensional mental health data (Everaert et al., 2022; Shahane et al., 2023). The present findings demonstrate that such methods can yield clinically meaningful predictions of somatic symptom disorder, supporting their broader adoption in psychosomatic and clinical psychology research.

Taken together, the results of this study support a comprehensive, transdiagnostic framework for understanding somatic symptom disorder. Personality vulnerability, perceived stress, and emotion regulation difficulties interact in complex ways to shape somatic symptom expression, and ensemble learning models provide a powerful tool for capturing these interactions. These findings are consistent with a growing body of literature emphasizing shared emotional and stress-related mechanisms across psychopathological conditions, including trauma-related disorders, affective disorders, and functional neurological syndromes (Janiri et al., 2023; Schmitz et al., 2023; Schneider et al., 2023). By demonstrating the predictive utility of integrated psychological data, the present study advances both theoretical understanding and methodological practice in the study of somatic symptom disorder.

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design precludes causal inferences regarding the relationships among personality traits, stress, emotion regulation, and somatic symptom disorder. Second, reliance on self-report measures may introduce response biases, including social desirability and shared method variance. Third, although the sample was diverse, it was limited to adults residing in South Africa, which may constrain the generalizability of the findings to other cultural or clinical contexts. Finally, while ensemble learning models offer strong predictive performance, they may be less transparent than traditional statistical models, potentially limiting interpretability for some clinical applications.

Future research should employ longitudinal designs to examine causal pathways and temporal dynamics among personality, stress, emotion regulation, and somatic symptoms. Incorporating biological and behavioral indicators, such as physiological stress markers or ecological momentary assessment data, may further enhance predictive accuracy and theoretical insight. Comparative studies across cultural and clinical populations would also be valuable in assessing the generalizability of ensemble learning models. Additionally, future work could explore hybrid models that integrate machine learning with theory-driven approaches to balance predictive power and interpretability.

From a practical perspective, the findings highlight the importance of comprehensive assessment approaches that consider personality traits, stress levels, and emotion regulation capacities in individuals presenting with somatic symptoms. Clinicians may benefit from interventions that target emotion regulation skills and stress management alongside symptom-focused treatment. The use of data-driven predictive tools could support early identification of individuals at elevated risk for somatic symptom disorder and facilitate personalized intervention planning. Integrating such approaches into routine clinical practice may enhance treatment effectiveness and reduce the chronicity of somatic symptoms.

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

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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