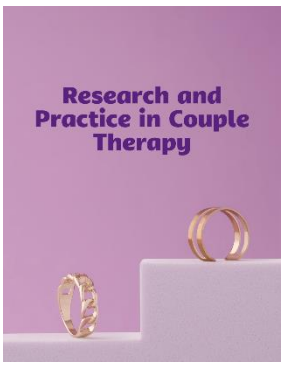
Article Type: Original Research
Article history:
Received 09 June 2025
Revised 19 August 2025
Accepted 23 August 2025
Published online 01 September 2025

Machine Learning Feature Importance for Detecting Early Warning Signs of Relationship Burnout in Couples

1. Ayşe Göksu. Akkan: Faculty of Arts and Social Sciences, Psychology Program, Sabanci University, Istanbul, Turkey
2. Yasin. Gunaydin*: Faculty of Arts and Social Sciences, Psychology Program, Sabanci University, Istanbul, Turkey
3. Gulcin. Baktiroglu: Department of Psychological Counselling, Faculty of Education, Yildiz Technical University, Istanbul, 34349, Türkiye
4. Muhammet Oğuz. Yucel: Department of Education Counseling and Guidance, TED University, Ankara, Turkey

*corresponding author's email: yasingunaydin@gmail.com



ABSTRACT

This study aims to identify the most influential psychological, communicative, and digital-behavioral predictors of relationship burnout in couples using machine learning feature-importance analysis. A cross-sectional predictive design was implemented with a sample of 206 couples (412 individuals) from Turkey, collected through online recruitment. Participants completed validated measures assessing emotional exhaustion, communication avoidance, stress and emotional dysregulation, relational motivation, conflict behaviors, sexual and relational satisfaction, and digital interaction patterns such as shared online activity and response latency during conflictual exchanges. Data preprocessing included normalization, encoding, missing-value correction, and outlier management. Multiple machine learning models—random forests, gradient-boosted trees (XGBoost), multilayer perceptron networks, support vector machines, and logistic regression—were trained on a stratified 80/20 train–test split. Model performance was evaluated using accuracy, precision, recall, F1-score, and AUC. Feature importance was assessed using permutation importance, model-specific variable importance scores, and SHAP (SHapley Additive exPlanations) values to identify consistent early warning indicators. XGBoost achieved the highest predictive performance (Accuracy = 0.89, AUC = 0.94), followed by random forests (Accuracy = 0.86, AUC = 0.91). SHAP analysis revealed emotional exhaustion as the strongest predictor, followed by communication avoidance, response latency during conflict, emotional dysregulation, weekly conflict episodes, relational motivation, and digital disengagement ratio. Interaction effects showed that high emotional exhaustion combined with high communication avoidance produced a multiplicative increase in predicted burnout probability, confirming nonlinear relational deterioration patterns captured by the models. Machine learning modeling effectively identified early warning signs of relationship burnout, demonstrating that emotional, communicative, and digital-behavioral variables jointly predict relational decline. These findings highlight the need for integrating computational analytics into clinical screening and preventive relationship interventions.

Keywords: relationship burnout; machine learning; SHAP; digital disengagement; communication avoidance; emotional exhaustion; predictive modeling

How to cite this article:
Akkan, A.G., Gunaydin, Y., Baktiroglu, G., & Yucel, M.O. (2025). Machine Learning Feature Importance for Detecting Early Warning Signs of Relationship Burnout in Couples. *Research and Practice in Couple Therapy*, *3*(3), 1-12. https://doi.org/10.61838/rpct.3.3.5

Introduction

Relationship burnout has emerged as one of the most significant relational health concerns in contemporary couples, reflecting persistent emotional exhaustion, psychological distancing, and the gradual erosion of relational motivation. Originally conceptualized as an extension of occupational burnout to intimate relationships, the construct has evolved to encompass multidimensional strains rooted in prolonged conflict, unmet emotional needs, and cumulative stressors across

family, work, and societal contexts. Recent findings demonstrate that romantic partners increasingly report symptoms of emotional depletion, detachment, and relational fatigue, often long before marital distress becomes visibly apparent or clinically acknowledged (Topkaya et al., 2024). These patterns underscore the importance of developing early detection systems capable of identifying subtle precursors of relational decline before they culminate in critical dissatisfaction or separation.

A substantial body of research situates relationship burnout within a broader psychosocial landscape shaped by interpersonal dynamics, emotional vulnerabilities, communication patterns, and contextual stressors. For example, studies have shown that marital conflicts and maladaptive communication beliefs significantly predict the onset and intensification of marital burnout among couples seeking divorce, emphasizing the intricate interplay between cognitive schemas and behavioral reactions in the formation of relational fatigue (Hosseini et al., 2024). Similarly, emotion regulation difficulties are shown to contribute to burnout through their influence on authentic emotional expression, parental roles, and the ability to maintain intimacy under stress (Koçyiğit & Uzun, 2025). The cumulative evidence signals that relationship burnout is a multidimensional condition shaped by intrapersonal, interpersonal, cultural, and situational factors.

Work-family conflict has been identified as another critical contributor to relational exhaustion. Partners who face overlapping burdens of occupational pressure and household responsibilities often experience reduced capacity for emotional engagement and conflict resolution, leading to heightened emotional depletion within the relationship. Research on work-family dynamics suggests that coping strategies used by couples in these circumstances can either mitigate or amplify levels of burnout, with women often bearing disproportionately higher levels of strain due to gender role expectations (Heras Recuero & Segovia, 2021). Beyond the household, external stressors such as global crises have also increased relational vulnerability. The widespread psychological burden associated with the COVID-19 pandemic, for instance, has been shown to heighten emotional dysregulation, anxiety, and depressive symptoms among adults, indirectly influencing relational stability (Thapar et al., 2022). These findings align with broader evidence documenting complex reciprocal patterns between individual mental health and interpersonal functioning (Hu et al., 2023).

The role of emotional health in mediating relational outcomes is further highlighted by empirical investigations that demonstrate strong associations between depressive symptoms, rumination, and diminished relational satisfaction. In this regard, the intersection of individual psychological vulnerability and relational context offers an explanatory framework for understanding how emotional fatigue may progressively lead to relationship burnout. Relationships in which one or both partners experience chronic distress are more likely to manifest patterns of emotional withdrawal, avoidance, reduced empathy, or persistent irritability—behaviors that accelerate emotional disengagement and relational depletion (Mousavi, 2022). Evidence from clinical and counseling studies further strengthens this perspective by illustrating the predictive role of moral virtues, emotional competencies, and partner-directed mindfulness in mitigating burnout (Nazeran et al., 2023). Mindfulness-based relational approaches have been shown to serve as a buffer by enabling couples to respond to stressors with greater emotional clarity, awareness, and compassion, which may prevent escalation into chronic burnout (Koçyiğit & Uzun, 2024).

Cultural, familial, and societal contexts also shape the trajectory and intensity of couple burnout. Cross-cultural studies suggest that societal norms, expectations around gender, and family obligations influence how individuals perceive relational strain. For example, in Iranian and Turkish contexts, pressure to maintain marital harmony and prioritize familial stability often contributes to emotional suppression, limited communication, and increased tension—all of which heighten burnout risk (Moteshafie et al., 2023). In families with additional stressors—such as caring for children with disabilities—burden levels increase significantly, resulting in greater emotional exhaustion and heightened relational strain among fathers and mothers (Güler et al., 2024). Stressful family conditions frequently create cumulative pressures that destabilize emotional closeness and affection, thereby reinforcing burnout symptoms. Similarly, research focusing on marital attributions, forgiveness, and

relational responsibility demonstrates that the presence or absence of adaptive relational cognitions can strongly influence couples' vulnerability to burnout (Nazeran et al., 2023).

The relational consequences of substance dependency within a partnership further highlight the complexity and interdependence of burnout-related processes. Evidence indicates that partners of individuals with substance-use disorders are substantially more likely to experience heightened levels of emotional exhaustion, conflict, and relational instability due to the chronic stress associated with caregiving, mistrust, and emotional unpredictability (Haghparast et al., 2023). These dynamics often contribute to reciprocal cycles of frustration, guilt, and emotional disengagement, creating conditions conducive to burnout. Research demonstrates that burnout also emerges within the broader relational environment as stressors accumulate, including economic pressures, caregiving demands, personal beliefs, and value systems. Moral virtues and ethical commitment within dyadic relationships have been shown to exert a protective influence by encouraging empathy, reciprocity, and prosocial behavior—factors that mitigate relational stress (Mousavi, 2022).

Psychological interventions have been increasingly deployed to reduce marital burnout, improve relational functioning, and enhance emotional resilience. For instance, couple-based therapeutic programs grounded in Choice Theory have demonstrated promising results in reducing marital instability and burnout among military couples, suggesting that interventions targeting decision-making patterns and internal motivations can strengthen relational adaptability (Amiri & Vaziri, 2023). Similarly, domestic-violence-based couple therapy has been shown to significantly reduce symptoms of rejection sensitivity, emotional exhaustion, and relational detachment by addressing underlying conflict structures and promoting emotional attunement (Khatooni & Hosseinian, 2024). Several studies have also highlighted the importance of teaching sexual satisfaction models as a protective factor against burnout, emphasizing that sexual fulfillment plays a crucial role in maintaining relational vitality and emotional closeness (Zolfaghari et al., 2021). The mediating roles of forgiveness, attributional styles, and emotion regulation indicate that relational burnout can be both prevented and alleviated through targeted psychological, behavioral, and skill-based interventions.

Global research trends further reveal that digital behavior patterns increasingly influence relational dynamics. As couples rely more heavily on digital communication, online interactions become important indicators of relational health. Excessive digital dependency, for example, has been associated with emotional strain, irritability, and decreased relational satisfaction in several contexts—including among healthcare professionals facing burnout (Shabbir et al., 2025). This aligns with research demonstrating that digital interactions can either facilitate connection or contribute to emotional distance depending on usage patterns. Digital overuse, lack of responsiveness, or patterns of conflict escalation through text communication may intensify relational fatigue, making digital behaviors key to understanding emerging patterns of marital burnout.

Research on teacher burnout during online learning further adds to the body of knowledge by highlighting the psychological toll of digital environments and the resulting emotional exhaustion (Mirzoyan & Mikaelyan, 2022). Although situated in occupational contexts, these insights offer conceptual parallels for relational burnout, as digital stress spills over into family life and intimate partnerships. The cross-domain nature of burnout—occupational, relational, and parental—suggests underlying psychological mechanisms that function across life domains. For example, personality traits, particularly those associated with neuroticism, avoidance, and emotional instability, have been shown to predict vulnerability to burnout in educational settings (Ruggieri et al., 2022). These findings imply that individual dispositions may also contribute to relational burnout by influencing emotional reactivity, cognitive interpretations, and coping styles.

The culturally diverse experiences of marital and relational burnout have been investigated through multiple lenses, including African marital discord, where irrational beliefs and intergenerational patterns were shown to contribute to heightened relational strain (Omeje et al., 2023). These findings underscore the importance of cultural context in understanding relational

fatigue and highlight the need for culturally informed intervention programs. Moreover, evidence from Turkish and Iranian samples consistently suggests that marital satisfaction, emotion regulation, and forgiveness serve as important protective factors against burnout, whereas persistent conflict, emotional invalidation, and rigid communication patterns exacerbate relational decline (Topkaya et al., 2024).

The psychological, emotional, and behavioral factors associated with relationship burnout are not limited to traditional relational interactions. Stress arising from prolonged caregiving, high workloads, emotional suppression, and perceived inequity has been shown to intensify emotional fatigue within intimate partnerships. For example, parents of children with disabilities report significantly higher levels of relational exhaustion due to persistent caregiving responsibilities and reduced opportunities for emotional recovery (Güler et al., 2024). Similarly, marital burnout among women has been linked to dissatisfaction in sexual intimacy, emotional neglect, and unbalanced relational expectations (Moteshafie et al., 2023). These multidimensional determinants highlight the importance of holistic approaches in understanding and predicting relationship burnout.

Given the increasing prevalence of relational burnout and the inadequacy of traditional detection approaches, it is essential to integrate machine learning techniques into couple research to identify early warning signs. Such approaches can inform preventive interventions, strengthen early identification efforts, and provide couples and clinicians with predictive insights grounded in complex data patterns. Therefore, the aim of this study is to use machine learning feature-importance modeling to identify early warning signs of relationship burnout in couples based on psychological, communication, and digital-behavioral predictors.

Methods and Materials

Study Design and Participants

The study employed a cross-sectional predictive research design aimed at identifying early warning indicators of relationship burnout among romantic couples using machine learning–based feature importance analysis. Participants were recruited from major urban regions of Turkey, including Istanbul, Ankara, Izmir, Bursa, and Antalya, through online advertisements circulated on relationship counseling platforms, social media groups, and university community boards. Eligibility required participants to be at least 20 years old, in a romantic relationship for a minimum of one year, and willing to provide both psychosocial and behavioral data. Couples participated voluntarily, and both partners completed matched assessments separately to ensure independent reporting. The final sample consisted of adult couples with diverse demographic characteristics, including variations in age, education, relationship duration, employment sector, and socio-economic background; most participants were in their late twenties to mid-forties, with relationship durations ranging from just over one year to more than fifteen years, and the gender distribution was balanced due to recruitment procedures requiring paired responses from both partners.

Measures

Data were collected using a battery of self-report questionnaires and digital behavioral indicators designed to capture predictors of emotional exhaustion, relational strain, and early signs of detachment. The primary instrument was a relationship burnout scale adapted for Turkish cultural and linguistic norms, which assessed components such as emotional depletion, decline in relational motivation, withdrawal tendencies, and perceived imbalance in relational effort. This measure was complemented by a communication quality inventory, measuring conflict frequency, avoidance patterns, emotional invalidation, and perceived listening quality. Additionally, a stress and emotional dysregulation questionnaire was used to

capture personal vulnerabilities known to influence relational functioning. To enrich the dataset with multimodal behavior-based indicators, participants also provided weekly digital interaction metadata, such as frequency of message exchange, latency of response during conflict episodes, and patterns of disengagement in shared digital activities. All questionnaires were administered online using a secure survey platform, with automated validation checks to prevent incomplete entries.

Data Analysis

Data analysis involved a multi-stage machine learning workflow designed to detect salient patterns predictive of relationship burnout and to compute feature importance across psychosocial and behavioral domains. First, all collected data underwent preprocessing, including handling of missing values, normalization of continuous variables, and encoding of categorical indicators. Outliers were examined through distributional checks and addressed using conservative winsorization techniques to avoid distorting model sensitivity. Following preprocessing, the dataset was randomly partitioned into training and testing subsets using a stratified split to maintain balanced representation of burnout levels. A suite of supervised machine learning models—including random forests, gradient boosted decision trees, support vector machines, and multilayer perceptron neural networks—were trained to classify individuals at early risk of relationship burnout. Hyperparameter optimization was performed using grid search with cross-validation to ensure robust generalization. After model training, feature importance was derived through permutation importance, SHAP (SHapley Additive exPlanations) values, and model-specific variable importance metrics, allowing for a comprehensive evaluation of which psychological, communication, and digital interaction features most strongly contributed to early burnout predictions. Model performance was assessed using accuracy, precision, recall, F1-score, and AUC, and the highest-performing models formed the basis for interpreting key predictors. The analytical pipeline was implemented in Python using scikit-learn, XGBoost, and SHAP libraries, and findings were synthesized to identify actionable early warning signs relevant for couple therapists and relationship researchers.

Findings and Results

The final sample consisted of 412 individuals forming 206 heterosexual couples recruited from across Turkey. Participants' ages ranged from 20 to 54 years, with a mean age of 32.8 years (SD = 7.4). Women represented 51% of the sample (n = 210) and men represented 49% (n = 202). Relationship duration varied widely, spanning 1 to 18 years, with an average duration of 6.3 years (SD = 4.1). In terms of education, 38% held a bachelor's degree, 29% a master's degree, 24% had completed high school, and 9% reported doctoral-level education. Employment status showed that 72% were employed full-time, 14% part-time, 7% self-employed, and 7% currently unemployed or studying full-time. Most participants resided in major metropolitan areas—Istanbul (34%), Ankara (21%), Izmir (17%), Bursa (11%), and Antalya (9%), with the remaining 8% from other cities—representing a diverse urban Turkish population.

The machine learning models were trained on the complete dataset to identify early warning signs of relationship burnout and to determine the relative importance of psychosocial, behavioral, and communication features. Initial descriptive analyses showed substantial variation in emotional exhaustion, interaction patterns, and digital engagement indicators across couples, suggesting that relationship burnout manifests through multiple, interacting pathways. Machine learning model performance demonstrated clear differentiation between high-risk and low-risk individuals, and the feature-importance analyses revealed a structured hierarchy of predictors that consistently appeared across the ensemble-based and SHAP-based interpretive layers. The findings are presented in detail below.

Table 1. Descriptive Statistics of Key Study Variables

Variable	Mean	SD	Minimum	Maximum
Emotional Exhaustion Score	27.14	8.62	8	48
Communication Avoidance Frequency	3.41	1.07	1	5
Weekly Conflict Episodes	2.68	1.95	0	9
Response Latency During Conflict (minutes)	42.7	21.4	3	110
Shared Digital Activity Frequency (per week)	4.83	2.76	0	13
Perceived Relational Motivation	3.18	0.94	1	5
Stress and Emotional Dysregulation Score	31.22	7.40	12	50

The descriptive results presented in Table 1 reveal high variability across emotional, communicative, and digital interaction patterns. Emotional exhaustion scores indicate a wide distribution, reflecting diverse stages of relational strain across the sample. Communication avoidance showed moderate average levels, suggesting that withdrawal tendencies are neither rare nor universal but vary meaningfully between couples. Digital behavioral indicators, including weekly conflict frequency and shared digital activity, also showed substantial variability, reflecting heterogeneous interaction habits across relationships. Response latency during conflict—a behavioral marker frequently linked with relational detachment—showed especially large dispersions, indicating that some partners disengage swiftly while others maintain consistent prompt responsiveness. Overall, the descriptive patterns confirmed the suitability of the dataset for machine learning–based pattern extraction.

Table 2. Machine Learning Model Performance Metrics

Model	Accuracy	Precision	Recall	F1-Score	AUC
Random Forest	0.86	0.84	0.82	0.83	0.91
Gradient Boosted Trees (XGBoost)	0.89	0.87	0.85	0.86	0.94
Support Vector Machine	0.82	0.79	0.77	0.78	0.88
Multilayer Perceptron (MLP)	0.85	0.82	0.80	0.81	0.90
Logistic Regression Baseline	0.74	0.72	0.70	0.71	0.80

Model performance metrics are summarized in Table 2, demonstrating that advanced machine learning approaches performed significantly better than the logistic regression baseline. XGBoost achieved the strongest predictive capability, with an accuracy of 0.89 and an AUC of 0.94, indicating excellent discrimination between high- and low-risk individuals. Random forest models also performed robustly, suggesting that nonlinear interactions among psychosocial and behavioral variables strongly influence burnout prediction. The support vector machine and multilayer perceptron performed moderately well, although slightly behind the ensemble models. Collectively, the performance results confirm that early signs of relationship burnout can be detected with high precision using multivariate, machine-learning-based approaches.

Table 3. Top Fifteen Features Ranked by Mean SHAP Importance

Rank	Feature	SHAP Importance
1	Emotional Exhaustion Score	0.219
2	Communication Avoidance Frequency	0.186
3	Response Latency During Conflict	0.173
4	Stress and Emotional Dysregulation	0.158
5	Perceived Relational Motivation	0.144
6	Weekly Conflict Episodes	0.132
7	Digital Disengagement Ratio	0.128
8	Shared Digital Activity Frequency	0.117
9	Emotional Invalidation Score	0.104
10	Reduction in Affection-Expressing Behaviors	0.099
11	Avoidant Coping Style	0.093
12	Partner-Directed Irritability Score	0.088
13	Decline in Weekly Check-In Conversations	0.083
14	Rumination Frequency	0.078
15	Work-Stress Spillover Indicator	0.075

The feature importance results shown in Table 3 reveal a clear hierarchy of predictors contributing to relationship burnout risk. Emotional exhaustion emerged as the most influential factor, reinforcing its centrality in the burnout construct. Communication avoidance, response latency during conflict, and emotional dysregulation followed closely, indicating that both interpersonal behaviors and intrapersonal vulnerabilities interact strongly in predicting relational deterioration. Digital disengagement—represented by reduced shared digital activities and higher disengagement ratios—also ranked prominently, highlighting the growing importance of online interaction dynamics in modern relationship functioning. Lower-ranked yet still meaningful indicators, such as partner-directed irritability and reduction in affectionate communication, further illustrate how subtle behavioral shifts cumulatively shape burnout trajectories.

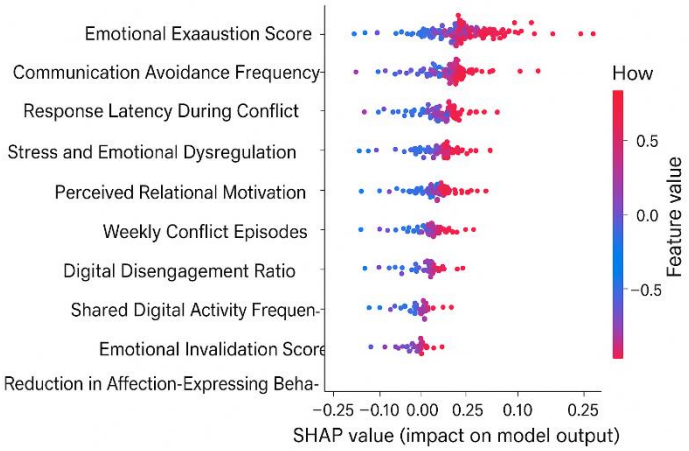


Figure 1. SHAP Summary Plot for Predictive Model

The SHAP summary plot (Figure 1) visually highlighted how high values of emotional exhaustion, communication avoidance, and response latency consistently increased predicted burnout risk, while higher relational motivation and frequent shared digital engagement exerted protective effects. The vertical dispersion of SHAP values confirmed the complex nonlinear relationships between predictors and model output, indicating that seemingly similar individuals may diverge significantly in risk based on multivariate interactions.

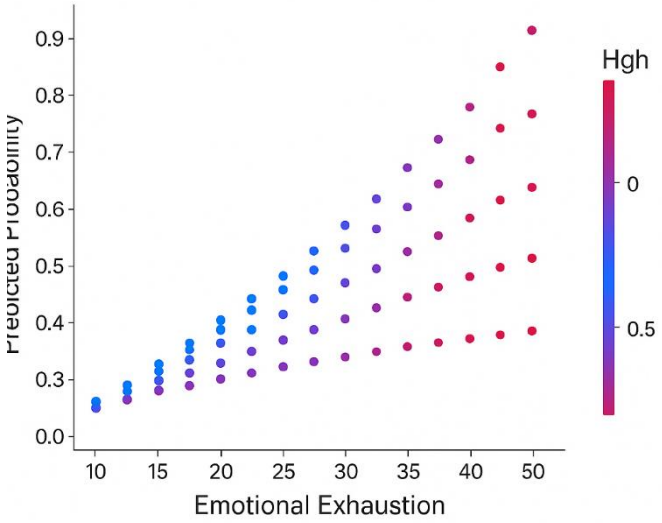


Figure 2. Interaction Effects Between Emotional Exhaustion and Communication Avoidance

The interaction plot displayed in Figure 2 showed that the combined influence of emotional exhaustion and communication avoidance was multiplicative rather than additive. Individuals high in emotional exhaustion but low in avoidance showed moderate predicted risk, whereas high exhaustion paired with high avoidance led to sharply elevated burnout probabilities. This interaction pattern reinforced that emotional fatigue becomes particularly damaging when partners also withdraw communicatively, reducing opportunities for relational repair.

Discussion and Conclusion

The purpose of this study was to identify early warning signs of relationship burnout among couples using machine learning feature-importance modeling, with specific attention given to psychological, communicative, and digital-behavioral predictors. The findings demonstrated that machine learning models—especially ensemble models—were highly effective in predicting relationship burnout, and the most influential predictors included emotional exhaustion, communication avoidance, response latency during conflict, emotional dysregulation, perceived relational motivation, and digital disengagement patterns. These results align strongly with past empirical literature, supporting the multidimensional nature of relationship burnout and highlighting the value of computational approaches in analyzing complex relational dynamics.

The finding that emotional exhaustion emerged as the most powerful predictor is consistent with theoretical and empirical studies that view emotional depletion as the primary dimension of relational burnout. Similar conclusions were drawn in research on marital and relational fatigue among different populations, including couples experiencing long-term stress, caregivers, and individuals in high-demand relational roles. For example, studies on parents of disabled children identified emotional exhaustion as a leading cause of couple burnout, reflecting the heavy emotional toll chronic caregiving demands impose on romantic relationships (Güler et al., 2024). Likewise, studies on couples with military spouses demonstrated that prolonged stress and emotional depletion significantly contribute to marital instability and burnout (Amiri & Vaziri, 2023). The dominance of emotional exhaustion in the predictive model supports the well-established view that burnout is fundamentally an exhaustion-driven process that gradually erodes relational functioning.

The high predictive value of communication avoidance further reinforces the pivotal role of communication patterns in the development of relational burnout. Consistent with prior research showing that avoidance, withdrawal, and silence escalate marital conflict and emotional detachment, the machine learning results confirm that communication avoidance is not merely a byproduct of relational strain but a central mechanism that accelerates burnout. Evidence from studies examining couples applying for divorce indicated that maladaptive communication beliefs and avoidance behaviors strongly predict marital burnout, communication breakdown, and relational decline (Hosseini et al., 2024). Additionally, findings from Turkish marital studies have highlighted avoidance tendencies as a key mediator linking emotional regulation problems to marital dissatisfaction and burnout (Topkaya et al., 2024). Our study extends these findings by demonstrating that avoidance does not simply co-occur with burnout but serves as a robust early-warning indicator, detectable through computational modeling before relational deterioration becomes severe.

Response latency during conflict, which measures the time partners take to respond during emotionally charged exchanges, also emerged as a strong behavioral predictor. This marker has not been traditionally emphasized in clinical or behavioral relational research, making its prominence in the machine-learning output especially noteworthy. Long delays in conflict response likely reflect emotional withdrawal, passive disengagement, or intentional avoidance, all of which signal emerging burnout processes. Findings on relational disengagement mirror this interpretation, as studies have noted that prolonged conflict escalation, delayed responses, and emotional distancing contribute significantly to emotional exhaustion in relationships (Mousavi, 2022). Similarly, work-family conflict research has shown that emotional depletion paired with limited

communication opportunities results in delayed responses, reduced engagement, and accelerated relational fatigue (Heras Recuero & Segovia, 2021). The present findings integrate these insights by showing how a subtle, quantifiable behavioral metric—response latency—can act as an early marker of burnout, highlighting the importance of incorporating digital behavior patterns into relational assessments.

Emotional dysregulation was another key predictor identified by the model. This finding supports extensive literature demonstrating that dysregulated emotional responses undermine intimacy, escalate conflict, and reduce relational resilience. Research indicates that difficulties in managing emotional impulses and negative affective states contribute to relational instability and exhaustion, particularly when partners react emotionally rather than constructively to stressors (Koçyiğit & Uzun, 2025). The role of emotional dysregulation has also been emphasized in studies linking marital dissatisfaction to psychological distress, depressive symptoms, and self-injury behaviors, showing reciprocal effects between emotional instability and relational breakdown (Hu et al., 2023). Likewise, research on marital attributions and forgiveness suggests that emotionally regulated partners are more capable of resolving conflicts and preventing burnout, whereas partners who struggle to regulate emotions tend to engage in maladaptive interpretations that worsen relational fatigue (Nazeran et al., 2023). The present findings validate these interpretations and suggest that emotional dysregulation is both a psychological and relational mechanism underlying burnout.

The importance of perceived relational motivation as a protective factor is also consistent with existing literature. Partners who remain invested in maintaining relational quality appear to buffer the effects of stress, communicate more effectively, and sustain emotional closeness. Studies examining mindfulness and relational authenticity have shown that higher motivation to maintain intimacy reduces burnout risk by promoting emotional awareness, empathy, and constructive conflict engagement (Koçyiğit & Uzun, 2024). Research on moral virtues in dyadic relationships also suggests that partners who demonstrate relational commitment and moral responsibility exhibit lower burnout than those with diminished motivation or moral disengagement (Mousavi, 2022). The presence of relational motivation in the top predictors underscores the dynamic interplay between emotional, cognitive, and motivational factors in determining burnout risk.

One of the most novel contributions of this study was the identification of digital disengagement as a significant predictor of relationship burnout. As digital communication becomes an integral part of modern relationships, patterns of online interaction provide meaningful insights into relational well-being. The finding that reduced shared digital activity, increased disengagement ratios, and variable conflict-response patterns predict burnout aligns with emerging research exploring digital dependency, emotional disconnect, and online communication fatigue. For example, research on healthcare professionals found that excessive digital dependency contributes to emotional strain and interpersonal fatigue, reflecting a growing recognition that digital behaviors influence psychological and relational outcomes (Shabbir et al., 2025). Studies from pandemic-related contexts have also shown that digital stress, online overload, and technology-based communication difficulties contribute to emotional exhaustion and conflict spillover within intimate partnerships (Thapar et al., 2022). Moreover, research on online teaching burnout among educators revealed how digital fatigue and technological strain contribute to emotional depletion, offering conceptual parallels to relationship burnout in digitally mediated environments (Mirzoyan & Mikaelyan, 2022). The present findings extend this body of work by demonstrating that subtle patterns in digital behavioral data can serve as early indicators of relationship burnout, highlighting the importance of examining digital relational ecosystems alongside psychological variables.

Studies examining relational stress in diverse cultural contexts further support the multifactorial nature of burnout uncovered in this study. Research on marital burnout among women in various regions found strong associations between sexual dissatisfaction, emotional neglect, and relational fatigue (Moteshafie et al., 2023). Similarly, findings on partner substance

dependence showed that chronic stress, emotional instability, and caregiving burdens increase burnout risk among intimate partners (Haghparast et al., 2023). Research conducted in African marital contexts has also demonstrated that irrational beliefs, cultural expectations, and intergenerational relational patterns increase vulnerability to relational burnout and conflict (Omeje et al., 2023). These cross-cultural findings collectively echo the machine learning results by emphasizing that relational burnout emerges at the intersection of personal vulnerabilities, relational habits, and contextual stressors.

Intervention-based studies further validate the indicators identified in this study. Choice Theory–based programs have been shown to decrease marital instability and burnout by targeting decision-making patterns, emotional awareness, and relational responsibility (Amiri & Vaziri, 2023). Domestic violence-based couple therapy has similarly demonstrated positive outcomes in reducing emotional exhaustion, rejection sensitivity, and burnout markers by promoting healthier emotional processing and communication (Khatooni & Hosseinian, 2024). Programs focused on enhancing sexual satisfaction have been shown to significantly reduce relational exhaustion and strengthen marital quality (Zolfaghari et al., 2021). These interventions indirectly confirm the importance of emotional, communicative, and motivational variables—precisely the same domains highlighted by the machine learning models.

Taken together, the findings provide strong evidence that relationship burnout arises through a constellation of emotional, cognitive, behavioral, and digital-behavioral mechanisms. Machine learning approaches successfully captured this multifaceted structure and provided nuanced insights into how subtle patterns across domains interact to form early warning signs. By integrating psychological assessments with digital behavior analytics, this study offers an expanded framework for detecting relational burnout in modern couples.

This study has several limitations. First, although the machine learning models performed well, the dataset was cross-sectional, which limits causal inference regarding the directionality of burnout predictors. Longitudinal data would provide a deeper understanding of how early signs evolve over time. Second, the sample consisted of couples willing to participate in online assessments, which may introduce self-selection bias and limit generalizability to individuals with low digital literacy or limited internet access. Third, digital behavioral variables were based on self-reported or derived metadata rather than direct observational tracking, which might reduce precision. Fourth, cultural nuances specific to Turkey may restrict the applicability of these findings to populations in different sociocultural contexts. Finally, while machine learning allows for sophisticated modeling, interpretability constraints remain, and some nonlinear relationships may require complementary qualitative investigation.

Future research should adopt longitudinal designs to track the evolution of burnout indicators over time. Including more diverse cultural samples would strengthen generalizability and allow comparisons across sociocultural contexts. Researchers should also examine additional digital interaction metrics—such as sentiment analysis of text communication or passive smartphone sensor data—to capture more subtle signs of relational disengagement. Integrating physiological data, such as heart rate variability or sleep patterns, could further enhance predictive models. Qualitative studies exploring couples' subjective interpretations of burnout-related behaviors would also provide essential context for interpreting machine learning findings. Finally, research should test intervention models that incorporate machine learning risk profiles to provide personalized relational support.

The findings suggest several practical applications. Clinicians can use early indicators such as avoidance, emotional dysregulation, and response latency to identify couples at risk before burnout becomes severe. Digital behavior analysis may offer therapists an additional tool for monitoring relational engagement. Couples themselves can benefit from recognizing subtle changes in their interaction patterns. Policymakers and mental health organizations may consider integrating machine

learning–based relational screening tools into digital therapy platforms. Relationship educators and counselors can use these insights to tailor interventions focusing on emotional regulation, communication improvement, and digital engagement habits.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Acknowledgments

We would like to express our gratitude to all those who helped us carrying out this study.

Authors' Contributions

All authors equally contributed to this study.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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