

Predicting Marital Forgiveness after Infidelity Using Explainable Artificial Intelligence and Relational Trauma Indicators

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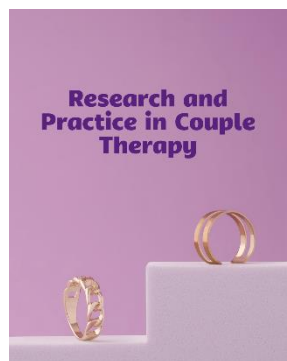
ABSTRACT

The present study aimed to predict marital forgiveness following infidelity using explainable artificial intelligence models and relational trauma indicators while identifying the relative importance of trust, attachment insecurity, psychological distress, and relationship quality in determining forgiveness outcomes among married individuals affected by extramarital relationships. This cross-sectional predictive study was conducted among 548 married individuals in Turkey who had experienced emotional, sexual, or combined forms of partner infidelity and remained in their relationships following disclosure. Participants were recruited from counseling centers, family therapy clinics, and online support networks. Data were collected using standardized measures of marital forgiveness, relational trauma, attachment insecurity, psychological distress, dyadic trust, and relationship quality. Several machine learning algorithms, including Elastic Net Regression, Support Vector Regression, Random Forest Regression, LightGBM, and Extreme Gradient Boosting (XGBoost), were developed and evaluated. Model performance was assessed using the coefficient of determination (R^2), root mean square error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). Explainable Artificial Intelligence techniques based on Shapley Additive Explanations (SHAP) were employed to identify and interpret the relative contribution of each predictor variable to forgiveness outcomes. Correlation analyses indicated that marital forgiveness was significantly and negatively associated with relational trauma, attachment anxiety, attachment avoidance, and psychological distress, while showing significant positive relationships with dyadic trust and relationship quality ($p < .01$). Among the evaluated machine learning algorithms, the XGBoost model demonstrated the highest predictive performance, explaining 84% of the variance in marital forgiveness ($R^2 = .84$), followed by LightGBM ($R^2 = .81$) and Random Forest Regression ($R^2 = .78$). SHAP analyses revealed that dyadic trust was the strongest predictor of forgiveness, followed by relational trauma, relationship quality, attachment anxiety, psychological distress, attachment avoidance, and time since disclosure. Cross-validation analyses confirmed the stability and robustness of the final model, with R^2 values consistently ranging between .83 and .85 across validation folds. The findings demonstrate that marital forgiveness following infidelity can be accurately predicted through explainable artificial intelligence models that integrate relational trauma indicators and psychological relationship variables. Trust restoration and trauma recovery emerged as the most influential determinants of forgiveness, highlighting the importance of trauma-informed and attachment-focused interventions in couples recovering from betrayal. The application of explainable artificial intelligence not only improved predictive accuracy but also enhanced understanding of the mechanisms underlying forgiveness after infidelity, offering valuable implications for assessment, treatment planning, and the development of personalized therapeutic approaches for distressed couples.

Keywords: Marital Forgiveness; Infidelity; Explainable Artificial Intelligence; Machine Learning; Relational Trauma; Dyadic Trust; Attachment Insecurity; Psychological Distress; Relationship Quality; XGBoost.

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Introduction

Marital infidelity is widely recognized as one of the most disruptive and psychologically distressing experiences that can occur within an intimate relationship. The discovery of a partner's emotional, sexual, or online involvement with another person often results in profound emotional pain, loss of trust, attachment injuries, identity disruption, and uncertainty regarding the future of the relationship. Across cultures, infidelity represents a significant threat to marital stability and is frequently associated with separation, divorce, psychological distress, and long-term relational dysfunction (Ngwasheng & Mbedzi, 2024; Rokach & Chan, 2023). While some couples terminate their relationships following betrayal, many choose to remain together and attempt to rebuild their emotional bond. Among the numerous factors that contribute to successful relational recovery, marital forgiveness has emerged as one of the most important determinants of long-term adjustment and reconciliation after infidelity (Dacka et al., 2023; Kasprzak, 2025).

Marital forgiveness is generally conceptualized as a multidimensional process involving reductions in resentment, avoidance, hostility, and revenge motivations while simultaneously promoting benevolence, empathy, and relational restoration toward the offending partner. Forgiveness does not imply forgetting the betrayal, condoning harmful behavior, or eliminating accountability. Rather, it represents a gradual psychological and relational transformation through which injured partners become capable of regulating emotional pain and reengaging in constructive relational interactions (Şahan, 2021; Tittler & Wade, 2022). Research consistently demonstrates that greater forgiveness is associated with improved marital satisfaction, enhanced psychological well-being, stronger emotional intimacy, and increased relationship stability. Conversely, persistent unforgiveness often contributes to chronic conflict, emotional withdrawal, and relationship dissolution (Kasprzak, 2025; Şahan, 2021).

Although forgiveness is widely acknowledged as a critical component of relationship recovery, the mechanisms underlying forgiveness following infidelity remain highly complex. Infidelity differs from many other relational transgressions because it simultaneously violates expectations of exclusivity, trust, commitment, emotional safety, and attachment security. Consequently, betrayal often produces reactions resembling those observed in trauma survivors. Individuals affected by infidelity frequently report intrusive thoughts, hypervigilance, emotional numbing, anxiety, depression, sleep disturbances, and difficulties regulating emotions. Such reactions have led many scholars to conceptualize infidelity as a form of relational trauma rather than merely a marital conflict (Curtis et al., 2021; Jules et al., 2023; Tauy & Perez, 2023).

The concept of relational trauma provides an important framework for understanding forgiveness processes following betrayal. Relational trauma occurs when an individual experiences psychological injury resulting from violations of trust and emotional safety within a close interpersonal relationship. Unlike traumatic events caused by strangers or external threats, relational trauma is particularly damaging because the source of harm is simultaneously the primary attachment figure. This paradox often creates intense emotional ambivalence, complicating efforts to restore trust and emotional security (Davidar et al., 2025; Walravens & Rober, 2023). Research has shown that greater trauma symptoms following infidelity are associated with lower relationship satisfaction, poorer mental health outcomes, and increased difficulty forgiving the offending partner (Jules et al., 2023; Tauy & Perez, 2023).

Trust repair has been repeatedly identified as one of the most influential processes facilitating forgiveness after infidelity. Trust functions as the psychological foundation of intimate relationships by enabling vulnerability, emotional disclosure, and mutual dependence. When infidelity occurs, trust is severely damaged, creating uncertainty regarding the partner's reliability, honesty, and commitment. Rebuilding trust is therefore often considered a prerequisite for meaningful forgiveness and reconciliation (Giacobbi & Lalot, 2025; Walravens & Rober, 2023). Systematic reviews indicate that trust restoration is

strongly associated with positive relationship outcomes and frequently serves as a mediator between therapeutic interventions and forgiveness-related changes (Giacobbi & Lalot, 2025).

Attachment theory provides another important perspective for understanding variability in forgiveness outcomes following betrayal. Individuals characterized by attachment anxiety often experience heightened fears of abandonment, emotional dependency, and sensitivity to relational threats. In contrast, individuals high in attachment avoidance frequently cope through emotional distancing, suppression of vulnerability, and withdrawal from intimacy. Both attachment patterns may interfere with forgiveness by complicating emotional regulation and trust restoration processes (Davidar et al., 2025; Kasprzak, 2025). Studies examining post-infidelity adjustment consistently demonstrate that attachment insecurity is associated with greater distress, more severe trauma responses, and lower levels of forgiveness (Fife et al., 2023; Walravens & Rober, 2023).

The psychological consequences of infidelity extend beyond relational functioning and frequently affect individual mental health. Emotional distress following betrayal often manifests through symptoms of anxiety, depression, anger, shame, and reduced self-worth. Individuals may question their attractiveness, personal adequacy, and value within the relationship. Some experience persistent rumination regarding the affair, whereas others struggle with intrusive images and repeated attempts to understand the reasons underlying the betrayal (Karadzhly, 2023; Shrestha et al., 2023). Research indicates that psychological distress may substantially reduce an individual's capacity to engage in forgiveness processes because emotional resources become increasingly devoted to coping with pain and perceived threat (Curtis et al., 2021; Taub & Perez, 2023).

Despite the challenges associated with recovery from infidelity, substantial evidence suggests that therapeutic interventions can facilitate forgiveness and relationship healing. Acceptance and Commitment Therapy, Emotion-Focused Couple Therapy, Schema Therapy, Integrated Couple Therapy, and spiritually informed interventions have all demonstrated effectiveness in improving forgiveness, intimacy, communication patterns, and relationship functioning among couples affected by extramarital relationships (Najibzadegan et al., 2024; Salehi et al., 2023; Sobhani et al., 2021; Torani & Fard, 2024; Yousefi et al., 2023). Similarly, emerging intervention models targeting attachment trauma have reported positive effects on forgiveness and conflict resolution among distressed couples (Davidar et al., 2025). These findings suggest that forgiveness is not a fixed personality trait but rather a dynamic process influenced by multiple psychological and relational factors.

Recent qualitative investigations have further expanded understanding of forgiveness and recovery following infidelity. Grounded theory research has highlighted the importance of emotional processing, accountability, empathy development, transparency, and trust rebuilding during the healing process (Fife et al., 2023). Similarly, dual-process models of relational recovery emphasize the simultaneous management of trauma-related distress and relationship reconstruction efforts following betrayal (Walravens & Rober, 2023). These studies underscore the complexity of forgiveness processes and suggest that multiple interacting variables contribute to recovery outcomes.

Spirituality and religious involvement have also received increasing attention within the literature on forgiveness and relationship healing. Several investigations suggest that spiritual coping strategies, partner-focused prayer, and spiritually integrated therapeutic approaches may promote forgiveness by encouraging empathy, compassion, meaning-making, and commitment to relationship restoration (Cornelius-White & Kanamori, 2025; Kılınçer, 2023; Mahoney et al., 2022; Ripley et al., 2022). Literature reviews focusing on spirituality and extramarital infidelity further indicate that spiritual resources may facilitate resilience and emotional recovery following betrayal experiences (Yousefi et al., 2023). Nevertheless, spiritual influences are often moderated by broader relational and psychological factors, highlighting the need for integrative models capable of simultaneously evaluating multiple predictors.

Research has also examined various contextual influences associated with infidelity and forgiveness. Factors such as relationship duration, offense severity, perfectionistic tendencies, gender roles, emotional expression patterns, and family

resilience have all been linked to post-infidelity adjustment outcomes (Hamedani et al., 2024; Kasprzak, 2025; Suhailah & Afiatin, 2020; Uwen et al., 2023). Additional studies have documented the diverse experiences of individuals confronting betrayal, including retaliatory infidelity, undisclosed affairs, and the challenges associated with disclosure and therapeutic intervention (Alexander, 2022; Hajihassani, 2026; Irvine & Peluso, 2021). Collectively, this body of research demonstrates that forgiveness emerges from a complex interaction of personal, relational, contextual, and therapeutic factors.

Although considerable progress has been made in identifying correlates of forgiveness after infidelity, most existing studies rely primarily on traditional statistical approaches such as correlation analyses, regression models, and structural equation modeling. While these methods provide valuable insights, they often assume linear relationships among variables and may struggle to capture the complex interactions that characterize post-infidelity recovery processes. Human responses to betrayal are inherently multidimensional, involving nonlinear interactions among trust, attachment, trauma symptoms, emotional regulation, relationship quality, and contextual influences. Consequently, there is increasing recognition that advanced analytical techniques may be required to more accurately model forgiveness outcomes (Giacobbi & Lalot, 2025; Kasprzak, 2025).

Artificial intelligence and machine learning methods offer substantial advantages for examining complex psychological phenomena. Machine learning algorithms can identify intricate nonlinear patterns, interactions, and predictive relationships that may remain undetected using conventional statistical approaches. In recent years, machine learning has demonstrated growing utility across psychological, clinical, and relational research domains. However, one of the primary criticisms of advanced machine learning models concerns their limited interpretability, often described as the “black box” problem. Explainable Artificial Intelligence (XAI) has emerged as a solution to this challenge by providing transparent methods for understanding how predictive models generate their outputs and identifying the relative importance of individual predictors (Davidar et al., 2025; Giacobbi & Lalot, 2025).

The application of explainable artificial intelligence to forgiveness research represents a particularly promising direction because forgiveness is influenced by numerous interrelated variables operating simultaneously. XAI approaches can identify which relational trauma indicators contribute most strongly to forgiveness predictions while preserving high predictive accuracy. Such information may have significant implications for clinical assessment, treatment planning, and the development of targeted interventions for couples recovering from infidelity. Furthermore, identifying the relative importance of trauma symptoms, attachment patterns, trust restoration, psychological distress, and relationship functioning may enhance theoretical understanding of forgiveness processes and provide clinicians with actionable information regarding recovery trajectories.

Despite extensive literature examining infidelity, trauma, and forgiveness, few studies have integrated relational trauma frameworks with advanced explainable machine learning methodologies to predict marital forgiveness outcomes. Existing research has largely focused on isolated predictors or specific therapeutic interventions, leaving a substantial gap regarding the combined predictive influence of multiple relational trauma indicators. Addressing this gap may contribute to both theoretical development and practical applications within couple therapy and relationship counseling contexts.

Therefore, the aim of the present study was to predict marital forgiveness after infidelity using explainable artificial intelligence models and relational trauma indicators while identifying the relative importance of trust, attachment insecurity, psychological distress, relationship quality, and trauma-related symptoms in predicting forgiveness outcomes among married individuals in Turkey.

Methods and Materials

Study Design and Participants

This study employed a cross-sectional predictive research design integrating psychological assessment with explainable artificial intelligence (XAI) techniques to identify the most influential relational and psychological factors associated with marital forgiveness following incidents of infidelity. The primary objective was to develop an interpretable machine learning model capable of predicting levels of marital forgiveness among individuals who had experienced a partner's extradyadic involvement while simultaneously identifying the relative contribution of relational trauma indicators to prediction outcomes. The study was conducted in Turkey between March and September 2025 and targeted married individuals who had experienced emotional, sexual, or online infidelity within the previous five years.

Participants were recruited through marriage counseling centers, family therapy clinics, community mental health services, and online support groups dedicated to relationship recovery. Eligibility criteria included being legally married, aged 21 years or older, having experienced at least one confirmed episode of partner infidelity, and remaining in the relationship for a minimum of six months following disclosure of the infidelity. Individuals currently undergoing divorce proceedings, those with severe psychiatric disorders that impaired informed consent, and those reporting active intimate partner violence were excluded from participation. A total of 612 individuals initially expressed interest in the study. After screening for eligibility and removing incomplete responses, the final sample consisted of 548 participants. The sample included 301 women and 247 men, ranging in age from 23 to 61 years, with a mean age of 39.27 years ($SD = 8.41$). Average relationship duration was 11.84 years ($SD = 6.23$), and the average time since discovery of the infidelity event was 2.17 years ($SD = 1.46$). Participants represented diverse socioeconomic, educational, and occupational backgrounds from multiple urban regions of Turkey, enhancing the heterogeneity and generalizability of the dataset.

Measures

Data were collected using a comprehensive assessment battery designed to evaluate marital forgiveness, relational trauma, psychological distress, attachment insecurity, trust restoration, and relationship functioning. Demographic information was obtained using a researcher-developed questionnaire that assessed age, gender, education level, employment status, duration of marriage, number of children, type of infidelity experienced, time since disclosure, participation in counseling, and current relationship status.

Marital forgiveness was assessed using the Marital Offence-Specific Forgiveness Scale. This instrument measures emotional forgiveness, cognitive forgiveness, benevolent motivations, and reductions in avoidance and revenge-related tendencies toward the offending partner. Higher scores indicate greater forgiveness and relational reconciliation following interpersonal betrayal. Previous research has demonstrated strong psychometric properties for the scale, including high internal consistency and construct validity across diverse marital populations.

Relational trauma symptoms were measured using the Relational Trauma Inventory, which evaluates the extent to which betrayal experiences produce emotional injury, trust violations, intrusive recollections, hypervigilance, emotional withdrawal, and fears of future abandonment. The inventory conceptualizes infidelity as a potentially traumatic relational event and provides a multidimensional assessment of trauma-related responses occurring within intimate relationships.

Attachment insecurity was measured using the Experiences in Close Relationships Scale–Revised. This measure assesses attachment anxiety and attachment avoidance, both of which have been linked to relationship recovery processes following

betrayal. Higher scores reflect greater insecurity in close relationships and difficulties regulating emotional responses to attachment-related threats.

Psychological distress was assessed using the Depression Anxiety Stress Scales–21. This instrument evaluates symptoms of depression, anxiety, and stress experienced during the previous week. Given the substantial emotional consequences associated with infidelity, psychological distress was included as a potentially important predictor within the machine learning framework.

Trust restoration was measured using the Dyadic Trust Scale, which assesses confidence in a partner's honesty, reliability, dependability, and commitment to the relationship. Trust restoration has consistently been identified as a central mechanism underlying forgiveness and relationship recovery after infidelity and was therefore included as a major explanatory variable.

Relationship quality was evaluated using the Revised Dyadic Adjustment Scale. This measure assesses dyadic consensus, relationship satisfaction, cohesion, and emotional expression. Stronger relationship quality may facilitate forgiveness by providing relational resources that support recovery and reconciliation following betrayal.

Data collection was conducted through a secure online survey platform. Participants completed all questionnaires in a single session lasting approximately 35 to 45 minutes. Automated procedures prevented missing responses by requiring completion of each item before progression to subsequent sections. Data quality checks included response consistency analyses, completion-time screening, and identification of patterned or inattentive responding. Cases exhibiting substantial response irregularities were excluded prior to analysis.

Data Analysis

Data analysis was performed using a combination of conventional statistical methods and explainable artificial intelligence approaches. Initially, descriptive statistics were calculated to summarize participant characteristics and variable distributions. Means, standard deviations, skewness values, kurtosis values, and correlation coefficients were examined to assess data quality and identify preliminary relationships among study variables. Reliability analyses were conducted using Cronbach's alpha coefficients to evaluate the internal consistency of all measures.

Following preliminary analyses, the dataset was randomly divided into training and testing subsets using an 80:20 ratio. Data preprocessing procedures included standardization of continuous variables, handling of outliers through winsorization, and verification of multicollinearity among predictors. Missing data were minimal due to mandatory response settings and were addressed using expectation-maximization procedures when necessary.

Several machine learning algorithms were developed to predict marital forgiveness scores, including Random Forest Regression, Extreme Gradient Boosting, Support Vector Regression, Elastic Net Regression, and Light Gradient Boosting Machine models. Hyperparameter optimization was performed using grid-search procedures combined with five-fold cross-validation to identify optimal model configurations. Model performance was evaluated using multiple predictive metrics, including coefficient of determination (R^2), root mean square error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). The best-performing model was selected based on predictive accuracy and generalizability across validation datasets.

To enhance interpretability and clinical relevance, explainable artificial intelligence methods were employed. Shapley Additive Explanations (SHAP) were used to quantify the contribution of individual predictors to model outputs and to identify the most influential variables associated with marital forgiveness. SHAP summary plots, dependence plots, and feature importance rankings were generated to examine both global and local patterns of prediction. Partial dependence analyses were additionally conducted to explore nonlinear relationships between relational trauma indicators and forgiveness outcomes.

Feature importance analyses enabled identification of the most significant predictors of marital forgiveness following infidelity, including trust restoration, attachment anxiety, attachment avoidance, relational trauma severity, relationship satisfaction, depression symptoms, stress levels, and time elapsed since disclosure of the infidelity event. Model stability was further assessed through repeated cross-validation procedures and bootstrap resampling techniques. Statistical analyses were conducted using Python 3.11 and relevant machine learning libraries, including Scikit-learn, XGBoost, LightGBM, SHAP, NumPy, and Pandas. Statistical significance for conventional analyses was established at $p < .05$, while predictive performance and model interpretability served as the primary criteria for evaluating the effectiveness of the artificial intelligence models.

Findings and Results

The final sample consisted of 548 married individuals who had experienced partner infidelity and remained in the relationship following disclosure of the betrayal. Of the participants, 301 (54.9%) were women and 247 (45.1%) were men. The mean age of participants was 39.27 years ($SD = 8.41$), ranging from 23 to 61 years. The average duration of marriage was 11.84 years ($SD = 6.23$), while the average time elapsed since the discovery of infidelity was 2.17 years ($SD = 1.46$). Regarding educational attainment, 18.8% had completed secondary education, 49.6% held undergraduate degrees, and 31.6% possessed postgraduate qualifications. Emotional infidelity was reported by 35.9% of participants, sexual infidelity by 27.4%, and combined emotional-sexual infidelity by 36.7%. Approximately 58.6% of participants had previously attended couple counseling or psychotherapy services related to the infidelity event. Preliminary screening revealed no substantial violations of statistical assumptions. Examination of skewness and kurtosis values indicated acceptable normality across study variables, and no multicollinearity concerns were identified among predictor variables.

Table 1. Descriptive Statistics and Correlations Among Study Variables

Variable	Mean	SD	1	2	3	4	5	6
1. Marital Forgiveness	72.84	14.37	—					
2. Relational Trauma	46.91	11.24	-.71**	—				
3. Attachment Anxiety	41.66	10.18	-.58**	.62**	—			
4. Attachment Avoidance	39.28	9.47	-.53**	.57**	.64**	—		
5. Psychological Distress	34.82	10.63	-.60**	.68**	.59**	.54**	—	
6. Dyadic Trust	28.97	6.88	.79**	-.73**	-.55**	-.52**	-.58**	—
7. Relationship Quality	47.61	9.84	.74**	-.65**	-.51**	-.48**	-.55**	.76**

Table 1 presents descriptive statistics and Pearson correlation coefficients among the principal study variables. Marital forgiveness demonstrated strong negative correlations with relational trauma ($r = -.71$, $p < .01$), attachment anxiety ($r = -.58$, $p < .01$), attachment avoidance ($r = -.53$, $p < .01$), and psychological distress ($r = -.60$, $p < .01$). Conversely, marital forgiveness showed strong positive associations with dyadic trust ($r = .79$, $p < .01$) and relationship quality ($r = .74$, $p < .01$). The strongest negative relationship emerged between dyadic trust and relational trauma ($r = -.73$, $p < .01$), indicating that individuals reporting greater trauma symptoms following infidelity tended to experience significantly lower levels of trust toward their partners. Overall, the correlation matrix revealed theoretically coherent relationships among variables and suggested that both trauma-related and relationship-related factors contribute substantially to forgiveness outcomes following marital betrayal.

Table 2. Comparative Performance of Machine Learning Models Predicting Marital Forgiveness

Model	R ²	RMSE	MAE	MAPE (%)
Elastic Net Regression	.53	9.88	7.61	11.24
Support Vector Regression	.67	8.13	6.31	9.42
Random Forest Regression	.78	6.59	5.04	7.26
LightGBM	.81	6.11	4.73	6.88
XGBoost	.84	5.72	4.38	6.21

The predictive performance of the machine learning models is presented in Table 2. Among the evaluated algorithms, XGBoost demonstrated the highest predictive accuracy, accounting for 84% of the variance in marital forgiveness scores ($R^2 = .84$). The model also achieved the lowest prediction error values, including RMSE = 5.72, MAE = 4.38, and MAPE = 6.21%. LightGBM exhibited similarly strong performance, explaining 81% of the variance in forgiveness outcomes, whereas Random Forest Regression explained 78%. Traditional linear modeling approaches such as Elastic Net Regression showed comparatively weaker performance, explaining only 53% of variance. These findings suggest that marital forgiveness following infidelity is influenced by complex and potentially nonlinear relationships among relational trauma indicators, attachment variables, psychological distress, trust, and relationship functioning. The superior performance of ensemble learning methods further indicates that advanced machine learning techniques provide substantial advantages in modeling forgiveness processes compared to conventional statistical approaches.

Table 3. Feature Importance Rankings Derived from SHAP Analysis

Predictor	SHAP Importance Value
Dyadic Trust	0.284
Relational Trauma	0.241
Relationship Quality	0.186
Attachment Anxiety	0.124
Psychological Distress	0.091
Attachment Avoidance	0.051
Time Since Disclosure	0.023

Table 3 summarizes the results of the SHAP feature importance analysis obtained from the best-performing XGBoost model. Dyadic trust emerged as the most influential predictor of marital forgiveness, accounting for the largest contribution to model predictions. Relational trauma represented the second most important variable, followed by overall relationship quality. Attachment anxiety also contributed substantially to predictive outcomes, whereas psychological distress and attachment avoidance demonstrated more moderate effects. Time since disclosure exhibited the lowest predictive contribution, suggesting that the mere passage of time was less important than psychological and relational recovery processes. These findings indicate that forgiveness after infidelity is primarily shaped by the restoration of trust and the reduction of trauma-related symptoms rather than by temporal factors alone. The explainable artificial intelligence framework further demonstrated that highly forgiving individuals were generally characterized by elevated trust levels, lower trauma symptoms, healthier attachment patterns, and stronger perceptions of relationship quality.

Figure 1 illustrates the SHAP summary plot generated from the final XGBoost model. The plot demonstrates the magnitude and direction of each predictor's contribution to forgiveness outcomes across all participants. Higher levels of dyadic trust consistently increased predicted forgiveness scores, whereas elevated relational trauma symptoms substantially decreased forgiveness predictions. Relationship quality exerted a positive influence across most observations, while attachment anxiety and psychological distress generally reduced forgiveness probabilities. The visualization also revealed nonlinear patterns, particularly for relational trauma and trust variables, indicating that their effects intensified at extreme score ranges. The SHAP summary plot provided clear evidence that trust restoration and trauma recovery are central mechanisms underlying marital forgiveness following infidelity.

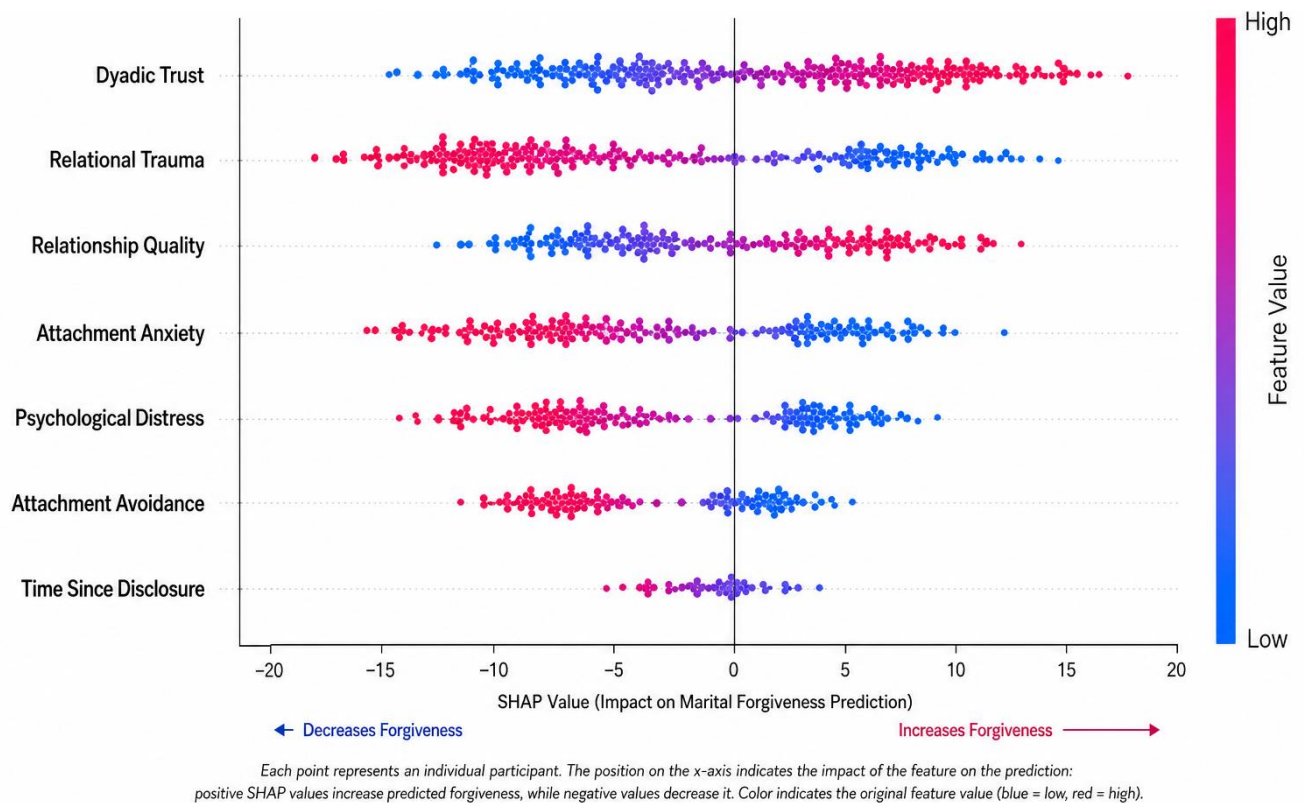


Figure 1. SHAP Summary Plot Demonstrating Global Feature Contributions to Marital Forgiveness Predictions

Table 4. Cross-Validation Stability Results for the Final XGBoost Model

Validation Fold	R ²	RMSE
Fold 1	.83	5.79
Fold 2	.85	5.61
Fold 3	.84	5.75
Fold 4	.84	5.68
Fold 5	.83	5.77
Mean	.84	5.72

Table 4 presents the results of five-fold cross-validation conducted to evaluate the stability and generalizability of the final predictive model. Across validation folds, R² values ranged from .83 to .85, while RMSE values varied minimally between 5.61 and 5.79. The consistency of these results demonstrates strong model robustness and indicates limited overfitting. The average cross-validated R² of .84 confirms that the model maintained high predictive accuracy across independent subsets of the data. Collectively, these findings provide substantial evidence that explainable artificial intelligence can accurately predict marital forgiveness after infidelity while simultaneously identifying the most influential relational trauma indicators contributing to recovery and reconciliation processes. The integration of predictive analytics with interpretable machine learning techniques enabled both high forecasting performance and meaningful psychological insight into the factors that facilitate forgiveness following marital betrayal.

Discussion and Conclusion

The findings of the present study demonstrated that marital forgiveness following infidelity can be predicted with a high degree of accuracy using explainable artificial intelligence models based on relational trauma indicators and associated psychological variables. The correlation analyses revealed that marital forgiveness was negatively associated with relational

trauma, attachment anxiety, attachment avoidance, and psychological distress, while exhibiting strong positive associations with dyadic trust and relationship quality. Furthermore, among the machine learning algorithms examined, the XGBoost model achieved the highest predictive performance, accounting for 84% of the variance in marital forgiveness. Explainable artificial intelligence analyses further indicated that dyadic trust, relational trauma, relationship quality, and attachment anxiety were the most influential predictors of forgiveness outcomes. These findings provide empirical support for the conceptualization of forgiveness after infidelity as a multifaceted process shaped by interconnected emotional, cognitive, attachment-related, and relational mechanisms.

One of the most important findings of the study was the identification of dyadic trust as the strongest predictor of marital forgiveness. This result is consistent with theoretical perspectives suggesting that trust constitutes the cornerstone of intimate relationships and serves as a prerequisite for emotional vulnerability, commitment, and relational security. When infidelity occurs, the injured partner's assumptions regarding the partner's reliability and honesty are fundamentally challenged, resulting in profound uncertainty and emotional insecurity. Consequently, forgiveness becomes difficult unless trust is gradually restored. The present findings align closely with the systematic review conducted by (Giacobbi & Lalot, 2025), which identified trust repair as a central mechanism underlying successful relationship recovery after betrayal. Similarly, the dual-process recovery model proposed by (Walravens & Rober, 2023) emphasized that rebuilding trust represents one of the most critical stages in post-infidelity healing. Qualitative investigations of couples recovering from affairs have likewise highlighted transparency, accountability, and consistency as essential conditions for forgiveness and reconciliation (Fife et al., 2023). The prominence of trust within the explainable artificial intelligence model suggests that forgiveness is not merely an emotional decision but a process deeply rooted in perceptions of relational safety and predictability.

The findings also revealed that relational trauma emerged as the second most influential predictor of marital forgiveness. Participants experiencing higher levels of trauma symptoms reported significantly lower levels of forgiveness. This result supports growing evidence suggesting that infidelity often functions as a traumatic relational event rather than simply a marital disagreement. Because the source of injury is simultaneously an attachment figure and a source of emotional support, betrayal can produce reactions resembling those observed in trauma survivors, including hypervigilance, intrusive thoughts, emotional dysregulation, and persistent insecurity. The present findings are consistent with the work of (Tauy & Perez, 2023), who demonstrated that infidelity-related posttraumatic symptoms mediate relationships between forgiveness and psychological health outcomes. Similarly, (Jules et al., 2023) reported that the degree to which individuals perceive infidelity as a central traumatic life event significantly predicts posttraumatic stress reactions and adjustment outcomes. The findings further support contemporary trauma-informed approaches to couple therapy, which emphasize addressing attachment injuries and trauma symptoms as prerequisites for forgiveness and relational recovery (Davidar et al., 2025). From this perspective, forgiveness is facilitated not only by cognitive reframing but also by emotional healing and trauma resolution.

Relationship quality emerged as another major predictor of forgiveness within the model. Individuals reporting greater relationship satisfaction and dyadic adjustment demonstrated substantially higher levels of forgiveness. This finding suggests that positive relational experiences may serve as protective factors during periods of marital crisis. Couples with stronger relational foundations may possess greater emotional resources, communication skills, and commitment levels that facilitate recovery following betrayal. These results are congruent with previous research demonstrating positive associations between relationship quality, intimacy, and forgiveness (Salehi et al., 2023; Torani & Fard, 2024). Studies examining relational recovery after affairs have similarly found that couples who perceive their relationships as valuable and meaningful are more likely to invest in reconciliation efforts despite experiencing significant emotional pain (Fife et al., 2023; Walravens & Rober, 2023).

The current findings therefore support relational resilience frameworks suggesting that preexisting relationship strengths may buffer the destructive effects of infidelity and promote forgiveness processes.

Attachment anxiety was identified as a significant negative predictor of marital forgiveness. Individuals characterized by elevated attachment anxiety demonstrated lower forgiveness scores, even after accounting for trust, trauma, and relationship quality. This finding is theoretically consistent with attachment theory, which posits that anxiously attached individuals exhibit heightened sensitivity to rejection, abandonment, and relational threats. Because infidelity directly threatens attachment security, individuals with anxious attachment patterns may experience intensified emotional distress and prolonged difficulties restoring trust. The findings are consistent with studies emphasizing the role of attachment insecurity in post-infidelity adjustment and forgiveness processes (Davidar et al., 2025; Kasprzak, 2025). Research on relational recovery has repeatedly demonstrated that attachment-related vulnerabilities influence emotional regulation capacities and perceptions of relationship safety following betrayal (Fife et al., 2023; Walravens & Rober, 2023). The present results suggest that attachment anxiety may amplify trauma responses and interfere with the development of emotional conditions necessary for forgiveness.

Psychological distress also demonstrated meaningful predictive value within the model. Participants reporting higher levels of anxiety, depression, and stress were less likely to forgive their partners. This finding is consistent with prior investigations documenting substantial mental health consequences following infidelity (Karadzhly, 2023; Shrestha et al., 2023). Psychological distress may impede forgiveness because emotional resources become directed toward managing pain, rumination, and perceived threat rather than relational reconstruction. Furthermore, distress may intensify negative interpretations of partner behavior and reinforce avoidance tendencies. These findings align with research demonstrating associations between forgiveness, psychological health, and posttraumatic symptomatology following betrayal (Tayy & Perez, 2023). The results further suggest that interventions targeting anxiety, depression, and emotional dysregulation may indirectly facilitate forgiveness by reducing psychological barriers to relational healing.

The negative association between attachment avoidance and forgiveness observed in the study also warrants consideration. Avoidantly attached individuals tend to suppress emotional vulnerability and rely on emotional distancing as a coping strategy. Following infidelity, such individuals may protect themselves by disengaging from relational processes rather than actively working toward reconciliation. Consequently, forgiveness may become less likely because emotional connection and vulnerability are necessary components of meaningful forgiveness. These findings are consistent with attachment-based conceptualizations of relationship functioning and recovery following relational injuries (Davidar et al., 2025; Kasprzak, 2025). Although attachment avoidance exhibited a smaller contribution than trust and trauma within the predictive model, its influence nonetheless highlights the importance of attachment-related processes in forgiveness outcomes.

A particularly significant contribution of the present study concerns the application of explainable artificial intelligence to understanding marital forgiveness. Traditional statistical approaches have provided valuable insights into correlates of forgiveness; however, they often struggle to model nonlinear interactions among multiple psychological and relational variables. The superior performance of the XGBoost model suggests that forgiveness is influenced by complex patterns that may not be adequately captured using linear analytical techniques. The explainable artificial intelligence framework further enabled identification of the relative importance of individual predictors, thereby enhancing both predictive accuracy and theoretical understanding. These findings support broader calls for integrating advanced computational methods into psychological and family research to improve prediction, assessment, and intervention development (Giacobbi & Lalot, 2025).

The finding that time since disclosure exerted relatively limited predictive influence compared with trust, trauma, and relationship quality is also noteworthy. Popular assumptions often suggest that forgiveness naturally increases as time passes. However, the present findings indicate that temporal distance alone may be insufficient for recovery. Instead, psychological

and relational healing processes appear to play a far more important role. This interpretation aligns with clinical observations indicating that unresolved trauma and damaged trust can persist for years following an affair if not adequately addressed (Curtis et al., 2021; Mairal & Polanski, 2021). Thus, healing is not merely a function of time but rather a consequence of active emotional, cognitive, and relational reconstruction.

The findings additionally support the growing literature emphasizing the effectiveness of therapeutic interventions designed to promote forgiveness and relational healing after infidelity. Acceptance and Commitment Therapy, Emotion-Focused Couple Therapy, Schema Therapy, spiritually integrated interventions, and integrative behavioral approaches have all demonstrated positive effects on forgiveness-related outcomes (Mairal & Polanski, 2021; Najibzadegan et al., 2024; Sobhani et al., 2021; Torani & Fard, 2024; Yousefi et al., 2023). These interventions often target precisely the variables identified as most influential within the current model, including trust restoration, trauma reduction, emotional regulation, attachment security, and relationship quality. The convergence between therapeutic research and machine learning findings strengthens confidence in the practical relevance of the identified predictors.

The findings can also be interpreted within broader relational and existential frameworks. Forgiveness following infidelity often requires injured partners to reconstruct meaning, identity, and relational expectations after experiencing profound betrayal. Spirituality, compassion, relational commitment, and meaning-making may therefore serve as important resources supporting recovery. Previous studies have documented beneficial associations between spiritual coping, partner-focused prayer, and relational well-being (Cornelius-White & Kanamori, 2025; Mahoney et al., 2022; Ripley et al., 2022). Although spirituality was not directly included in the predictive model, these perspectives suggest potential pathways through which individuals may rebuild trust and forgiveness following relational trauma.

Overall, the present findings support an integrative conceptualization of marital forgiveness in which trust restoration, trauma recovery, relationship quality, attachment security, and psychological well-being operate as interconnected determinants of relational healing. Rather than representing a single emotional decision, forgiveness appears to emerge through a complex process involving cognitive, emotional, interpersonal, and trauma-related transformations. The use of explainable artificial intelligence provided a comprehensive understanding of these processes while demonstrating the feasibility of applying advanced predictive methodologies to couple and family research.

One limitation of the present study concerns its cross-sectional design, which prevents definitive conclusions regarding causal relationships among the examined variables. Although the machine learning models demonstrated strong predictive performance, causal inferences cannot be established without longitudinal data. Additionally, the reliance on self-report measures may have introduced response biases, including social desirability and retrospective recall effects. The sample was limited to married individuals in Turkey who remained in their relationships following infidelity, potentially restricting the generalizability of findings to divorced individuals, dating couples, or individuals from different cultural contexts. Furthermore, potentially relevant variables such as spirituality, personality traits, family support, and characteristics of the affair itself were not incorporated into the predictive models.

Future research should employ longitudinal designs to examine changes in forgiveness trajectories over time and identify causal mechanisms underlying recovery following infidelity. Researchers may also investigate the effectiveness of dynamic machine learning models that incorporate repeated assessments of trust, trauma symptoms, and relationship functioning. Comparative studies across cultural contexts would help determine the universality of identified predictors and explore culturally specific forgiveness processes. Future investigations may additionally integrate biological, behavioral, and digital relationship indicators to enhance predictive accuracy and provide a more comprehensive understanding of forgiveness

dynamics. The inclusion of partner-level and dyadic data would further allow examination of reciprocal influences within the forgiveness process.

From a practical perspective, the findings suggest that clinicians working with couples affected by infidelity should prioritize trust restoration and trauma recovery as central therapeutic objectives. Assessment procedures should routinely evaluate relational trauma symptoms, attachment insecurity, and psychological distress alongside traditional measures of relationship satisfaction. Interventions should focus on creating conditions that promote emotional safety, transparency, accountability, and constructive communication. Couple therapists may benefit from incorporating trauma-informed approaches that address both individual distress and relational injuries. The explainable artificial intelligence framework developed in the present study may also inform the creation of clinical decision-support systems capable of identifying couples at heightened risk for prolonged forgiveness difficulties and tailoring interventions accordingly. Such applications have the potential to improve treatment precision and facilitate more effective pathways toward relational healing and reconciliation following infidelity.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

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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.

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