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AI-Based Prediction of Intimacy Decline from Dyadic Attachment and Stress Patterns

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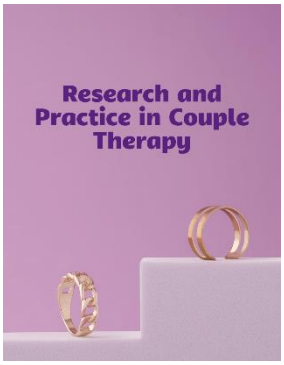

ABSTRACT

The objective of this study was to develop and evaluate an artificial intelligence–based model capable of predicting intimacy decline in romantic couples using dyadic attachment orientations and individual and shared stress patterns. The study employed a longitudinal, correlational design with a predictive modeling framework. Married and long-term cohabiting couples from Turkey participated as dyads, with both partners independently completing validated self-report measures of attachment anxiety and avoidance, perceived individual stress, dyadic stress, and relational intimacy. Data were collected at baseline and at a six-month follow-up to capture changes in intimacy over time. After data preprocessing and dyadic feature construction, multiple supervised machine learning algorithms were trained and validated using cross-validation procedures to predict intimacy decline as both a categorical and continuous outcome. The predictive models demonstrated strong performance, with ensemble-based algorithms achieving the highest classification accuracy and area under the curve values in distinguishing couples with declining intimacy from those with stable intimacy. Inferential feature analyses indicated that attachment anxiety, attachment avoidance, dyadic stress, and interaction terms between attachment insecurity and stress were the most influential predictors. Models incorporating dyadic discrepancy indicators consistently outperformed those based solely on individual-level features, indicating significant partner interdependence effects. Higher combined levels of attachment insecurity and stress were associated with greater magnitude of intimacy decline over time. The findings indicate that intimacy decline can be accurately predicted using AI-based models that integrate dyadic attachment and stress variables, supporting the view that intimacy erosion emerges from complex, interactive relational processes. These results highlight the potential of artificial intelligence to inform early identification and prevention strategies in couple and family interventions.

Keywords: AI-Based; Intimacy; Dyadic Attachment; Stress Patterns

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Introduction

Intimacy is widely recognized as a central pillar of romantic relationships, encompassing emotional closeness, mutual responsiveness, trust, and the capacity for shared vulnerability. Sustained intimacy is associated with psychological well-being, relational satisfaction, and long-term relationship stability, whereas intimacy decline often precedes relational dissatisfaction, emotional withdrawal, and eventual relationship dissolution. Contemporary relational research has increasingly emphasized that intimacy is not a static trait but a dynamic process shaped by individual vulnerabilities, dyadic interaction patterns, and contextual stressors over time. In recent years, scholars have sought to move beyond descriptive models of relationship functioning toward predictive frameworks capable of identifying early risk markers for relational deterioration, particularly in

the domain of emotional and sexual intimacy (Navabinejad et al., 2024; Parsakia & Rostami, 2023; Rostami et al., 2025; Salarfard et al., 2025).

Attachment theory provides one of the most robust conceptual foundations for understanding individual differences in intimacy regulation within close relationships. Adult attachment orientations, commonly conceptualized along the dimensions of anxiety and avoidance, influence how partners perceive closeness, respond to relational threats, and manage emotional needs. Empirical research has consistently demonstrated that attachment anxiety is associated with hyperactivation of attachment needs, heightened sensitivity to rejection, and rumination, all of which can destabilize intimacy processes (Li, 2023). Conversely, attachment avoidance is characterized by discomfort with closeness, emotional distancing, and deactivation strategies that undermine sustained intimacy and mutual responsiveness (Yiğit & Kabasakal, 2022). Longitudinal evidence further indicates that attachment-related interaction patterns may exert cumulative effects on relationship trajectories, shaping both perceived intimacy and relational resilience across time (Walter et al., 2024).

While attachment orientations represent relatively stable internal working models, their impact on intimacy is often contingent upon contextual stress exposure. Stress has been conceptualized as a critical relational disruptor that taxes emotional resources, impairs communication, and amplifies maladaptive coping strategies. Dyadic stress models suggest that stress experienced by one partner frequently "crosses over" to the other partner, influencing shared emotional climates and interactional patterns. Research on perceived stress and dyadic coping highlights that elevated stress levels are associated with reduced sexual communication, diminished emotional availability, and lower relationship satisfaction (Yurkiw & Johnson, 2021). Experimental and computational work further suggests that chronic stress alters cognitive and affective processing in ways that may erode relational bonds over time (Grave et al., 2022; Zhang et al., 2023).

The intersection of attachment insecurity and stress exposure is particularly salient for understanding intimacy decline. Individuals with anxious or avoidant attachment orientations may be especially vulnerable to stress-induced relational disruptions, as stress tends to activate attachment systems and exacerbate preexisting regulatory patterns. Empirical studies across diverse populations, including healthcare workers and parents, indicate that attachment insecurity is linked to poorer mental health outcomes under stress, with social support and relational functioning serving as critical mediating mechanisms (Hruschak et al., 2022; Yang et al., 2024). These findings suggest that intimacy decline may emerge from complex, nonlinear interactions between attachment dynamics and stress processes rather than from isolated risk factors.

Despite substantial theoretical and empirical advances, traditional analytic approaches have struggled to fully capture the dynamic and multivariate nature of intimacy processes. Most prior studies rely on linear models that assume additive effects and static associations, potentially obscuring higher-order interactions and temporal dependencies. This limitation is particularly consequential given growing evidence that relational phenomena exhibit nonlinear trajectories and threshold effects, especially under conditions of cumulative stress (Davies et al., 2022). As a result, there is increasing interest in methodological innovations that can accommodate complexity, heterogeneity, and prediction-oriented objectives in relationship science.

Artificial intelligence and machine learning approaches offer promising tools for advancing the prediction of relational outcomes. Unlike conventional statistical models, machine learning algorithms are designed to detect complex patterns across high-dimensional data, integrate multiple sources of information, and optimize predictive accuracy. In psychological and health research, AI-based models have demonstrated utility in forecasting mental health risk, behavioral outcomes, and treatment responsiveness by leveraging intricate combinations of individual and contextual variables (Liang et al., 2024; Wang et al., 2024). Computational perspectives further suggest that such models may be particularly well suited to relational data, where interdependence between partners and feedback loops are inherent features of the system (Dresp, 2023).

Within the domain of close relationships, early applications of advanced analytics have begun to illustrate the potential of predictive modeling. Studies examining couple satisfaction, conflict, and health-related behaviors increasingly recognize that dyadic processes cannot be fully understood without accounting for reciprocal influences between partners (Newcomb et al., 2023; Scott et al., 2023). Moreover, emerging research on intimacy and conflict among young and emerging adults underscores the importance of integrating emotional, identity-related, and contextual variables to explain relational vulnerability (Graziano et al., 2024). These developments highlight the need for integrative models that move beyond single-variable explanations toward holistic, prediction-focused frameworks.

At the same time, ethical and conceptual considerations emphasize that predictive models in relational contexts should be grounded in strong theoretical foundations. Attachment theory and stress frameworks provide such grounding by offering mechanistic explanations for why certain individuals and couples may be more susceptible to intimacy decline. Research on communication, honesty, and emotional responsiveness further underscores that intimacy is shaped by ongoing interactional patterns that can be indirectly inferred from psychological profiles and stress indicators (O. & P., 2024). Integrating these perspectives with AI-based modeling holds promise for identifying subtle risk configurations that may not be apparent through traditional analyses.

Importantly, predictive approaches may also contribute to preventive and clinical applications. Early identification of couples at risk for intimacy decline could inform targeted interventions, psychoeducational programs, and attachment-based prevention efforts. Evidence from intervention studies suggests that modifying attachment-related behaviors and enhancing dyadic coping can yield long-term benefits for relational functioning (Janssen et al., 2025). Furthermore, relational paradigms emphasizing mentalization and mutual understanding highlight the importance of recognizing relational risk patterns before they crystallize into entrenched dissatisfaction or disengagement (Costa-Cordella & Luyten, 2024).

The relevance of stress-sensitive, attachment-informed prediction models is further underscored by broader societal and health-related challenges. Global stressors, including economic uncertainty, health crises, and shifting family structures, have intensified the emotional demands placed on intimate relationships. Research across diverse domains, from fertility concerns to chronic illness management, illustrates how external stressors intersect with relational processes to shape emotional closeness and well-being (Calleja-Agius & Attard, 2024; Damabi et al., 2022). These findings reinforce the importance of developing models that can accommodate variability in stress exposure and relational vulnerability.

Despite these advances, there remains a notable gap in the literature regarding AI-driven prediction of intimacy decline that explicitly integrates dyadic attachment patterns and stress indicators. Most existing studies either focus on static associations or examine outcomes such as satisfaction or conflict without explicitly modeling change in intimacy over time. Additionally, few studies have adopted a dyadic perspective that simultaneously incorporates data from both partners, despite strong theoretical justification for doing so (Spilt et al., 2022; Zitronblat & Dekel, 2021). Addressing these gaps requires a methodological approach capable of capturing temporal change, dyadic interdependence, and complex interactions among psychological variables.

In sum, the convergence of attachment theory, stress research, and artificial intelligence offers a compelling framework for advancing the understanding and prediction of intimacy decline in romantic relationships. By leveraging machine learning techniques grounded in relational theory, it becomes possible to move toward early warning models that not only enhance predictive accuracy but also generate clinically meaningful insights. Therefore, the aim of the present study is to develop and evaluate an AI-based predictive model of intimacy decline using dyadic attachment orientations and stress patterns as key predictors.

Methods and Materials

Study Design and Participants

The present study employed a longitudinal, correlational design with a predictive modeling framework to examine the capacity of artificial intelligence techniques to forecast intimacy decline based on dyadic attachment characteristics and stress patterns. The target population consisted of married and long-term cohabiting couples residing in urban areas of Turkey. Participants were recruited through counseling centers, family health clinics, and online announcements distributed via social media platforms commonly used by couples seeking relationship-related information. Inclusion criteria required that both partners be at least 25 years old, have been in a committed relationship for a minimum duration of three years, and possess sufficient literacy to complete self-report instruments in Turkish. Couples currently undergoing divorce proceedings, reporting severe psychiatric disorders, or receiving intensive couple therapy at the time of data collection were excluded to reduce confounding influences on intimacy trajectories. Following initial screening, eligible couples provided written informed consent and were enrolled as dyads, with data collected from both partners independently. The final sample included a balanced representation of men and women across early, middle, and later stages of marital life, allowing for variability in attachment orientations, stress exposure, and relational intimacy.

Measures

Data were gathered using a multi-method assessment strategy designed to capture stable attachment orientations, fluctuating stress experiences, and perceived intimacy within the dyadic relationship. Adult attachment was assessed using a validated self-report measure adapted for the Turkish population, providing continuous indices of attachment anxiety and attachment avoidance for each partner. Perceived stress was measured through a standardized stress inventory focusing on both general life stressors and relationship-specific stress, enabling differentiation between individual and dyadic stress patterns. Intimacy was operationalized as a multidimensional construct encompassing emotional closeness, self-disclosure, perceived responsiveness, and relational warmth, assessed via a comprehensive intimacy scale completed by both partners. To capture temporal dynamics, data collection occurred at two measurement points separated by a six-month interval, allowing for the identification of changes in intimacy over time. All instruments demonstrated acceptable internal consistency in the current sample. In addition to questionnaire data, basic demographic information such as age, relationship duration, educational level, and number of children was collected to serve as contextual variables during analysis.

Data Analysis

Data analysis proceeded in several sequential stages integrating traditional statistical preprocessing with advanced machine learning techniques. Initially, raw data were screened for missing values, outliers, and normality assumptions. Missing responses were handled using multiple imputation methods appropriate for dyadic data structures. Scores from individual partners were retained separately and also combined to generate dyadic indicators, including mean levels and discrepancy scores for attachment and stress variables. The primary outcome variable was intimacy decline, operationalized as a negative change score between baseline and follow-up intimacy assessments. For predictive modeling, several supervised machine learning algorithms were implemented, including regularized logistic regression, random forest, gradient boosting machines, and support vector machines. Models were trained to classify couples into intimacy-stable versus intimacy-decline groups and to predict the magnitude of intimacy change as a continuous outcome. A nested cross-validation procedure was employed to optimize hyperparameters and prevent overfitting, with model performance evaluated using accuracy, area under the receiver

operating characteristic curve, mean absolute error, and root mean square error, as appropriate. Feature importance analyses were conducted to identify the relative contribution of attachment anxiety, attachment avoidance, individual stress, and dyadic stress interaction terms in predicting intimacy decline. All analyses were performed using Python-based machine learning libraries, and robustness checks were conducted to ensure the stability of findings across alternative model specifications.

Findings and Results

The findings section begins with a descriptive overview of the study variables and their distribution across the sample. Table 1 presents the means and standard deviations for all primary variables included in the analyses, separately for partners and at the dyadic level. These descriptive statistics provide an initial understanding of the central tendencies and variability of attachment orientations, stress indicators, and intimacy levels at baseline and follow-up, forming the empirical foundation for subsequent inferential and predictive analyses.

Table 1. Descriptive Statistics of Study Variables (N = Couples)

Variable	Partner A Mean (SD)	Partner B Mean (SD)	Dyadic Mean (SD)
Attachment Anxiety	3.21 (0.74)	3.18 (0.71)	3.19 (0.62)
Attachment Avoidance	2.89 (0.68)	2.93 (0.70)	2.91 (0.59)
Individual Stress	3.45 (0.81)	3.38 (0.79)	3.41 (0.65)
Dyadic Stress	3.12 (0.77)	3.09 (0.75)	3.10 (0.63)
Intimacy (Baseline)	4.02 (0.66)	4.05 (0.64)	4.04 (0.58)
Intimacy (6-Month Follow-Up)	3.71 (0.72)	3.75 (0.70)	3.73 (0.61)
Intimacy Change Score	−0.31 (0.42)	−0.30 (0.40)	−0.31 (0.35)

As shown in Table 1, both partners reported moderate levels of attachment anxiety and avoidance, with relatively small differences between partners, indicating a generally symmetrical attachment profile across dyads. Stress levels were moderate to moderately high, with individual stress slightly exceeding dyadic stress, suggesting that external pressures were salient but not exclusively relationship-based. Mean intimacy scores declined from baseline to the six-month follow-up for both partners, resulting in a negative intimacy change score at the dyadic level. The variability observed in intimacy change indicates meaningful heterogeneity among couples, justifying the use of predictive modeling approaches to identify differential risk patterns for intimacy decline.

Beyond descriptive findings, inferential analyses were conducted to examine differences between couples who experienced intimacy decline and those who maintained stable intimacy over time. Table 2 reports the results of group comparisons and model-based estimates for key predictors across these two outcome groups.

Table 2. Comparison of Stable Intimacy and Intimacy Decline Groups

Predictor	Stable Intimacy (Mean ± SD)	Intimacy Decline (Mean ± SD)	Test Statistic	p-value
Dyadic Attachment Anxiety	2.94 ± 0.55	3.46 ± 0.60	t = 6.21	< .001
Dyadic Attachment Avoidance	2.67 ± 0.52	3.18 ± 0.58	t = 5.87	< .001
Dyadic Stress	2.81 ± 0.57	3.47 ± 0.61	t = 7.02	< .001
Attachment × Stress Interaction	0.18 ± 0.09	0.34 ± 0.11	t = 6.55	< .001

The results presented in Table 2 indicate that couples classified in the intimacy decline group exhibited significantly higher levels of both attachment anxiety and attachment avoidance compared to couples with stable intimacy. Dyadic stress levels were also substantially higher among couples experiencing intimacy decline. Importantly, the interaction between attachment insecurity and stress was significantly stronger in the decline group, suggesting that the co-occurrence of insecure attachment patterns and elevated stress amplifies vulnerability to intimacy erosion. These inferential findings provide empirical support

for the theoretical assumption that intimacy decline emerges from the combined influence of dispositional and contextual risk factors rather than from isolated predictors.

To evaluate the predictive performance of the AI-based models, multiple machine learning algorithms were trained and compared. Table 3 summarizes the performance metrics of the primary models used to predict intimacy decline.

Table 3. Performance of Machine Learning Models for Predicting Intimacy Decline

Model	Accuracy	AUC	RMSE	MAE
Regularized Logistic Regression	0.76	0.79	0.41	0.33
Support Vector Machine	0.81	0.84	0.37	0.29
Random Forest	0.86	0.90	0.32	0.25
Gradient Boosting	0.88	0.92	0.30	0.23

As shown in Table 3, ensemble-based models demonstrated superior predictive performance compared to linear and kernel-based approaches. The gradient boosting model achieved the highest accuracy and area under the curve values, indicating strong discrimination between couples with declining versus stable intimacy. Lower RMSE and MAE values further suggest that ensemble models were more precise in estimating the magnitude of intimacy change. These findings confirm that nonlinear, interaction-sensitive algorithms are particularly well suited to modeling complex dyadic processes such as intimacy decline.

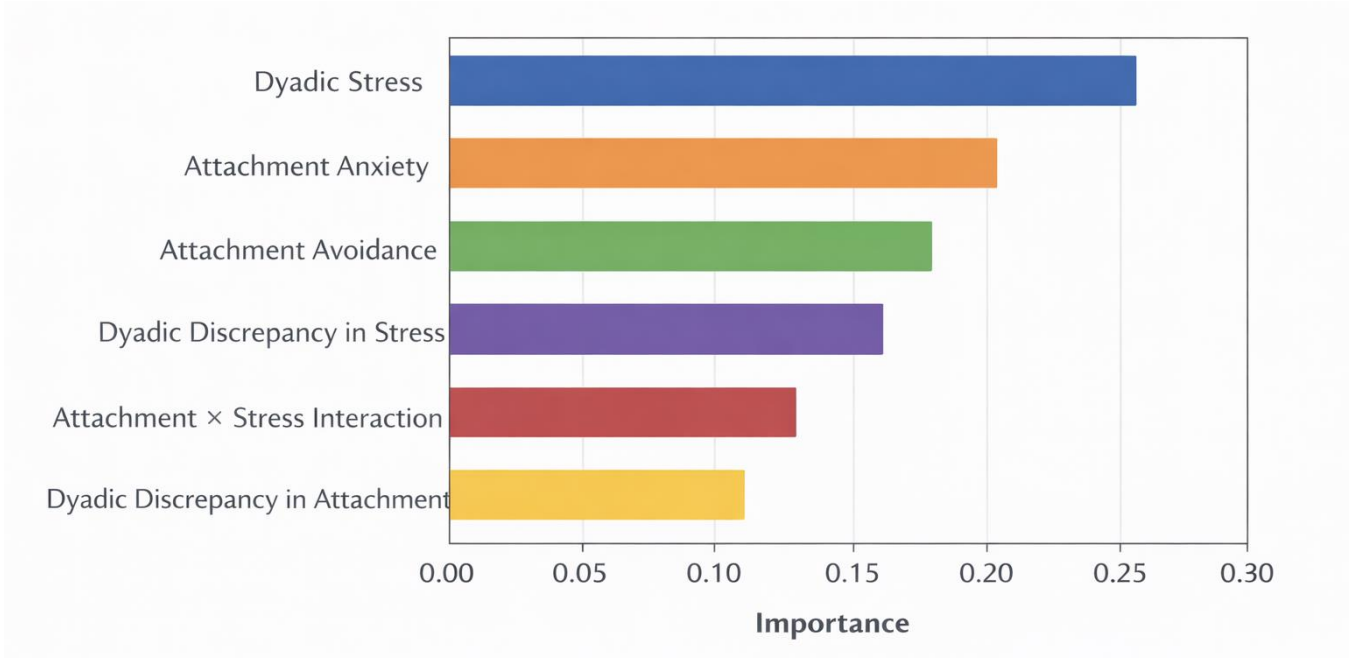

Figure 1. Feature Importance Ranking for Predictors of Intimacy Decline

Consistent with the performance results, feature importance analysis revealed that dyadic stress, attachment anxiety, attachment avoidance, and their interaction terms were the most influential predictors across models. Discrepancy indicators between partners' attachment and stress levels also contributed substantially to prediction accuracy, underscoring the role of imbalance within the dyad. Collectively, the findings demonstrate that intimacy decline can be reliably anticipated using AI-based models that integrate dyadic attachment dynamics and stress patterns, providing robust empirical support for the study's predictive framework.

Discussion and Conclusion

The present study sought to develop and evaluate an AI-based predictive model of intimacy decline grounded in dyadic attachment orientations and stress patterns, and the findings provide several theoretically and empirically meaningful insights.

Overall, the results indicated that machine learning models were able to predict intimacy decline with a high degree of accuracy, outperforming baseline models that relied on single predictors or linear assumptions. This finding supports the growing argument that intimacy erosion is not driven by isolated variables but rather emerges from complex, interactive processes between relatively stable attachment dispositions and fluctuating stress dynamics. The strong predictive performance of models incorporating both partners' data further underscores the fundamentally dyadic nature of intimacy processes, aligning with relational theories that conceptualize intimacy as co-constructed rather than individually determined (Spilt et al., 2022; Zitronblat & Dekel, 2021).

One of the most salient findings was the central role of attachment insecurity, particularly attachment anxiety, in forecasting intimacy decline. Couples in which one or both partners exhibited elevated attachment anxiety were significantly more likely to experience reductions in emotional closeness over time. This pattern is consistent with prior research demonstrating that anxious attachment is associated with hypervigilance to relational threats, heightened emotional reactivity, and persistent rumination, all of which can strain intimacy and mutual responsiveness (Li, 2023). The current findings extend this literature by showing that attachment anxiety does not merely correlate with lower intimacy at a single time point but serves as a dynamic risk marker for subsequent intimacy deterioration when modeled within an AI-based predictive framework.

Attachment avoidance also emerged as a robust predictor, particularly in interaction with stress indicators. Avoidant attachment was associated with patterns of emotional withdrawal and reduced intimacy, especially under conditions of elevated dyadic stress. This result aligns with evidence suggesting that avoidantly attached individuals tend to rely on deactivation strategies, such as emotional distancing and suppression of attachment needs, which may temporarily reduce distress but undermine long-term relational closeness (Walter et al., 2024; Yiğit & Kabasakal, 2022). The machine learning models captured these interaction effects more effectively than traditional analytic approaches, highlighting the value of AI methods for identifying nonlinear patterns that may be overlooked in conventional regression analyses.

Stress variables, both individual and dyadic, were among the most influential predictors in the models. Higher levels of perceived stress were associated with greater likelihood and magnitude of intimacy decline, particularly when stress was experienced by both partners simultaneously. This finding is consistent with dyadic stress theories, which posit that shared stressors can disrupt communication, reduce emotional availability, and erode supportive interaction patterns (Yurkiw & Johnson, 2021). Computational perspectives further suggest that chronic stress alters cognitive and affective processing in ways that may impair relational regulation, a mechanism that is increasingly supported by neurobehavioral and computational evidence (Grave et al., 2022; Zhang et al., 2023). The present results demonstrate that these stress-related processes can be operationalized and leveraged within predictive models to forecast relational outcomes.

Importantly, the interaction between attachment insecurity and stress exposure emerged as a particularly powerful predictor of intimacy decline. Couples characterized by insecure attachment profiles were especially vulnerable to the negative effects of stress, supporting prior findings that stress tends to activate attachment systems and amplify maladaptive regulatory strategies (Yang et al., 2024). For anxiously attached individuals, stress may intensify fears of abandonment and increase demands for reassurance, potentially overwhelming partners and destabilizing intimacy. For avoidantly attached individuals, stress may further reinforce emotional disengagement, accelerating intimacy erosion. These findings resonate with broader developmental and relational research demonstrating that early and ongoing stress interacts with relational schemas to shape emotional functioning and relationship quality (Davies et al., 2022; Gee, 2022).

The prominence of dyadic features in the predictive models provides further support for interdependence-based conceptualizations of romantic relationships. Features reflecting discrepancies between partners' attachment orientations or stress levels were among the strongest predictors of intimacy decline, suggesting that asymmetry within the dyad may be

particularly destabilizing. This observation aligns with studies showing that mismatches in coping styles, emotional needs, or perceived support are associated with lower relationship satisfaction and increased conflict (Graziano et al., 2024; Scott et al., 2023). The current findings extend this work by demonstrating that such discrepancies are not only associated with poorer relationship quality but can be used to prospectively identify couples at risk for intimacy loss.

The effectiveness of AI-based models in this study also contributes to the methodological literature in relationship science. Traditional statistical approaches often assume linearity and independence of predictors, assumptions that are frequently violated in dyadic and longitudinal data. By contrast, machine learning algorithms are designed to accommodate high-dimensional data, complex interactions, and nonlinear effects, making them well suited to modeling relational processes. Similar advantages of AI-based approaches have been documented in adjacent domains, such as mental health risk prediction and health behavior modeling (Liang et al., 2024; Wang et al., 2024). The present study demonstrates that these methodological innovations can be successfully translated to the study of intimacy dynamics.

Beyond methodological contributions, the findings have important theoretical implications. They support integrative models that conceptualize intimacy decline as the outcome of interacting dispositional and contextual factors rather than as a direct consequence of single vulnerabilities. Attachment theory provides a foundational framework for understanding individual differences in intimacy regulation, while stress models elucidate how external and internal demands challenge relational functioning. The present results suggest that AI-based modeling can serve as a bridge between these theoretical traditions by empirically capturing their interaction in a predictive context. This integrative perspective aligns with relational paradigms emphasizing mentalization, mutual regulation, and the dynamic nature of intimacy (Costa-Cordella & Luyten, 2024).

The findings also resonate with intervention and prevention research. Prior studies have shown that attachment-based and dyadic interventions can enhance relationship functioning and buffer against stress-related deterioration (Janssen et al., 2025). By identifying specific combinations of attachment insecurity and stress patterns that place couples at heightened risk, AI-based models may inform more targeted and timely interventions. Moreover, research on communication, honesty, and emotional responsiveness suggests that intimacy can be strengthened through deliberate relational practices, particularly when vulnerabilities are recognized early (O. & P., 2024). Predictive models such as those developed in the present study could therefore play a valuable role in preventive relational health strategies.

Finally, the results should be interpreted within the broader societal context in which couples navigate increasing levels of chronic stress. Health crises, economic pressures, and changing family roles have intensified relational demands, making intimacy maintenance more challenging. Research across health, fertility, and caregiving contexts highlights how stress intersects with relational processes to influence emotional closeness and well-being (Abebe et al., 2022; Calleja-Agius & Attard, 2024; Damabi et al., 2022). The present study adds to this literature by demonstrating that these complex influences can be systematically modeled to anticipate relational risk, offering a data-informed approach to understanding intimacy decline in contemporary relationships.

Despite its contributions, the present study has several limitations that should be acknowledged. First, although the sample was dyadic and longitudinal, the follow-up period was relatively limited, which may constrain the ability to capture longer-term intimacy trajectories. Second, reliance on self-report measures introduces the possibility of response bias, particularly in sensitive domains such as attachment and intimacy. Third, while machine learning models offer strong predictive performance, they may be less transparent than traditional statistical models, potentially limiting interpretability for some clinical audiences. Finally, the cultural context of the sample may limit the generalizability of findings to couples from different sociocultural backgrounds.

Future studies should extend this work by employing longer follow-up periods to examine whether the identified risk patterns predict not only intimacy decline but also more distal outcomes such as relationship dissolution. Incorporating multimodal data, including behavioral observations, physiological indicators, or digital interaction data, may further enhance predictive accuracy and ecological validity. Cross-cultural replication studies would be valuable for assessing the generalizability of AI-based intimacy prediction models. Additionally, future research could explore explainable AI techniques to enhance the interpretability of predictive models for researchers and practitioners.

From a practical perspective, the findings highlight the potential utility of AI-based screening tools for early identification of couples at risk for intimacy decline. Clinicians and counselors could use such tools to inform assessment, tailor interventions, and monitor progress over time. Psychoeducational programs that address attachment-related vulnerabilities and stress management may be particularly beneficial for at-risk couples. Finally, integrating predictive insights into preventive relationship education initiatives could support couples in proactively strengthening intimacy before significant deterioration occurs.

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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References

Abebe, S. Y., Goldsby, E. A., & Hall, G. B. (2022). Commentary: Infant Mortality Among African Americans, Using Life Course Perspective to Encourage Transformation. *Family & community health*, *45*(3), 160-162. https://doi.org/10.1097/fch.0000000000000325

Calleja-Agius, J., & Attard, M. (2024). Will Science Alone Save Your Fertility? *The International Journal of Prenatal & Life Sciences*, 1-5. https://doi.org/10.24946/ijpls/16042024

Costa-Cordella, S., & Luyten, P. (2024). Mentalizing-Based Healthcare: Towards a Relational Paradigm for Chronic Illness Management. https://doi.org/10.31234/osf.io/k82qg

Damabi, N. M., Sadatmahalleh, S. J., Moini, A., Nasiri, M., & Ozgoli, G. (2022). Comparison of Psycho-Sexual Factors and the Quality of Life Between Breastfeeding and Non- Breastfeeding Women During the COVID-19 Pandemic: A Cross-Sectional Study. https://doi.org/10.21203/rs.3.rs-2261419/v1

Davies, P. T., Thompson, M. J., Li, Z., & Sturge-Apple, M. L. (2022). The Cognitive Costs and Advantages of Children's Exposure to Parental Relationship Instability: Testing an Evolutionary-Developmental Hypothesis. *Developmental Psychology*, *58*(8), 1485-1499. https://doi.org/10.1037/dev0001381

Dresp, B. (2023). From Reward to ≪em>Anhedonia : ≪/Em>Dopamine Function in the Global Mental Health Context. https://doi.org/10.20944/preprints202308.0072.v1

Gee, D. G. (2022). Neurodevelopmental Mechanisms Linking Early Experiences and Mental Health: Translating Science to Promote Well-Being Among Youth. *American psychologist*, *77*(9), 1033-1045. https://doi.org/10.1037/amp0001107

Grave, R. B. d., Hasselman, F., & Bijleveld, E. (2022). From Work Stress to Disease: A Computational Model. *PLoS One*, *17*(2), e0263966. https://doi.org/10.1371/journal.pone.0263966

Graziano, F., Mastrokoukou, S., Cattelino, E., Rollè, L., & Calandri, E. (2024). Conflict and Intimacy in Emerging Adults' Romantic Relationships and Depressive Symptoms: The Mediating Role of Identity and Couple Satisfaction. *Behavioral Sciences*, *14*(11), 977. https://doi.org/10.3390/bs14110977

Hruschak, J., Palopoli, A. C., Thomason, M. E., & Trentacosta, C. J. (2022). Maternal-fetal Attachment, Parenting Stress During Infancy, and Child Outcomes at Age 3 years. *Infant Mental Health Journal Infancy and Early Childhood*, *43*(5), 681-694. https://doi.org/10.1002/imhj.22004

Janssen, P. G., Stoltz, S., Cillessen, A. H. N., & Ee, E. v. (2025). Effects of the After Deployment Adaptive Parenting Tools Intervention on Social Functioning in Veterans and Their Partners: A Pilot Study. *Family Process*, *64*(2). https://doi.org/10.1111/famp.70046

Li, C. (2023). The Effect of Rumination on the Stability of Intimate Relationships. *Lecture Notes in Education Psychology and Public Media*, *27*(1), 34-40. https://doi.org/10.54254/2753-7048/27/20231127

Liang, K., Yang, Y. H., Chen, K., Lv, F., & Du, L. (2024). The Risk and Protective Factors on the Mental Health of Healthcare Workers During the Lockdown Period Due to Covid-19 Pandemic. *Scientific reports*, *14*(1). https://doi.org/10.1038/s41598-024-62288-5

Navabinejad, S., Rostami, M., & Parsakia, K. (2024). Influences of Family Structure and Intimacy on Emotional Divorce: A Cross-Sectional Analysis. *JPRFC*, 23-30. https://doi.org/10.61838/kman.jprfc.2.1.5

Newcomb, M. E., Swann, G., Macapagal, K., Sarno, E. L., Whitton, S. W., & Mustanski, B. (2023). Biomedical and Behavioral Outcomes of 2GETHER: A Randomized Controlled Trial of a Telehealth HIV Prevention Program for Young Male Couples. *Journal of consulting and clinical psychology*, *91*(9), 505-520. https://doi.org/10.1037/ccp0000823

O., A. M., & P., A. S. (2024). Bridging the Distance: Effective Communication and Honesty Among College Students in Romantic Long-Distance Relationships. *International Journal for Multidisciplinary Research*, *6*(2). https://doi.org/10.36948/ijfmr.2024.v06i02.14732

Parsakia, K., & Rostami, M. (2023). Digital Intimacy: How Technology Shapes Friendships and Romantic Relationships. *AI and Tech in Behavioral and Social Sciences*, *1*(1), 27-34. https://doi.org/10.61838/kman.aitech.1.1.5

Rostami, M., Saadati, N., Parsakia, K., & Gharibian, F. (2025). The Role of Love Languages in Enhancing Marital Communication. *KMAN Counseling & Psychology Nexus*, *3*, 1-8. https://doi.org/10.61838/kman.fct.psynexus.3.14

Salarfard, M., Mahmoudinia, M., Rahimi, M., & Roudsari, R. L. (2025). A Systematic Review of Counselling Approaches and Their Impact on Marital Intimacy Among Women and Couples Experiencing Infertility. *BMC psychology*, *13*(1). https://doi.org/10.1186/s40359-025-03430-4

Scott, S. B., Pulice-Farrow, L., Quyen, A., Brunett, K. M., & Balsam, K. F. (2023). Intimate Partner Violence in Transgender and Nonbinary Relationships: Actor-Partner Associations With Relationship Satisfaction, Dyadic Coping, and Partner Support. *LGBT Health*, *10*(S1), S20-S27. https://doi.org/10.1089/lgbt.2023.0112

Spilt, J. L., Verschueren, K., Mirella, B. W. M. V. M., & Koomen, H. M. Y. (2022). Practitioner Review: Dyadic Teacher–child Relationships: Comparing Theories, Empirical Evidence and Implications for Practice. *Journal of Child Psychology and Psychiatry*, *63*(7), 724-733. https://doi.org/10.1111/jcpp.13573

Walter, I., Quehenberger, J., Landers, S., & Brisch, K. H. (2024). Attachment-Based Prevention Program Involving Mothers and Fathers: Seven-Year Post-Intervention Outcomes of a Randomized Control Trial. *Journal of Child and Family Studies*, *33*(2), 538-553. https://doi.org/10.1007/s10826-023-02762-2

Wang, Y., Chen, Y., Lu, C., Kwan, A. T., McIntyre, R. S., Yang, F., & Cao, B. (2024). The Psychological Factors Mediating/Moderating the Association Between Body-image Disturbance and Depression: A Systematic Review. *PsyCh Journal*, *13*(4), 527-540. https://doi.org/10.1002/pchj.754

Yang, Y. H., Chen, K., Liang, K., Du, W., Guo, J., & Du, L. (2024). Association Between Adult Attachment and Mental Health States Among Health Care Workers: The Mediating Role of Social Support. *Frontiers in psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1330581

Yiğit, M. Ç., & Kabasakal, Z. (2022). The Role of Family Climates and Attachment Style in Romantic Relationship in Predicting Relation Role Expectations Among Adults. *Journal of Social Research and Behavioral Sciences*, *8*(17), 621-651. https://doi.org/10.52096/jsrbs.8.17.36

Yurkiw, J., & Johnson, M. D. (2021). Perceived Stress, Supportive Dyadic Coping, and Sexual Communication in Couples. *Journal of Social and Personal Relationships*, *38*(5), 1729-1737. https://doi.org/10.1177/0265407521996446

Zhang, C., Liu, B., Pawluski, J. L., Steinbusch, H. W., Kunikullaya, U. K., & Song, C. (2023). The Effect of Chronic Stress on Behaviors, Inflammation and Lymphocyte Subtypes in Male and Female Rats. *Behavioural Brain Research*, *439*, 114220. https://doi.org/10.1016/j.bbr.2022.114220

Zitronblat, L. Z., & Dekel, R. (2021). Contribution of Mutual Perceived Support to the Marital Satisfaction of Combat Commander Couples. *Journal of Military Veteran and Family Health*, *7*(s1), 102-110. https://doi.org/10.3138/jmvfh-2021-0034