

Predicting Marital Satisfaction Using Random Forest Based on Attachment, Communication, Intimacy, and Conflict Indicators

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Article Info

Article type:

Original Article

How to cite this article:

Maldonado, J., & Patel, K. (2026). Predicting Marital Satisfaction Using Random Forest Based on Attachment, Communication, Intimacy, and Conflict Indicators. *Applied Family Therapy Journal*, 7(4), 1-18.

<http://dx.doi.org/10.61838/kman.afjt.6353>



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ABSTRACT

Objective: This study aimed to predict marital satisfaction among married adults in Canada using Random Forest regression based on attachment, communication, intimacy, and conflict indicators.

Methods and Materials: This cross-sectional predictive study was conducted on 646 married adults residing in Canada. Participants completed the Couples Satisfaction Index-16, Experiences in Close Relationships-Revised questionnaire, Communication Patterns Questionnaire-Short Form, Personal Assessment of Intimacy in Relationships scale, and selected dimensions of the Revised Conflict Tactics Scales. The predictor set included attachment anxiety and avoidance, constructive communication, mutual avoidance, demand-withdraw communication, emotional, social, sexual, intellectual, and recreational intimacy, negotiation, and psychological aggression. Random Forest regression was used to predict continuous marital satisfaction scores. The dataset was divided into training and independent test subsets using an 80:20 ratio, and hyperparameters were optimized through five-fold cross-validation. Predictive performance was evaluated using R^2 , mean absolute error, mean squared error, and root mean squared error. Permutation importance and partial dependence analyses were used to interpret predictor contributions and nonlinear patterns.

Findings: The Random Forest model demonstrated strong predictive performance, with an R^2 of .91 in the training set, .76 in five-fold cross-validation, and .78 in the independent test set. Test-set prediction error was MAE = 5.06, MSE = 43.52, and RMSE = 6.60. Emotional intimacy showed the greatest permutation importance, followed by constructive communication, attachment anxiety, sexual intimacy, psychological aggression, attachment avoidance, negotiation, and demand-withdraw communication. Partial dependence analyses indicated that higher emotional intimacy, constructive communication, sexual intimacy, and negotiation were associated with higher predicted marital satisfaction, whereas attachment anxiety, psychological aggression, attachment avoidance, and demand-withdraw communication were associated with lower predicted satisfaction.

Conclusion: Marital satisfaction can be predicted with substantial accuracy using a multidimensional Random Forest model, with emotional intimacy and constructive communication emerging as the strongest positive predictors and attachment insecurity and destructive conflict as the principal negative predictors.

Keywords: Marital Satisfaction, Random Forest, Attachment, Communication, Intimacy, Marital Conflict, Machine Learning

1. Introduction

Marital satisfaction is a multidimensional evaluation of the perceived quality, stability, emotional fulfillment, and functional adequacy of a marital relationship. It reflects not only the extent to which partners feel content with their marriage, but also how successfully they manage emotional closeness, communication, conflict, mutual expectations, sexual relations, role distribution, and adaptation to internal and external stressors. High marital satisfaction has consistently been associated with healthier relational functioning, stronger emotional security, greater family cohesion, and more adaptive coping, whereas persistent marital dissatisfaction may contribute to emotional disengagement, chronic conflict, relational instability, and deterioration in broader family functioning. Contemporary relationship research therefore increasingly conceptualizes marital satisfaction as an emergent outcome of interacting intrapersonal and interpersonal processes rather than the product of a single isolated variable. From this perspective, the quality of a marriage is shaped by how partners regulate emotions, communicate needs, respond to disagreement, maintain intimacy, interpret one another's behavior, and activate attachment-related expectations in situations involving vulnerability or stress (Adhikari & Shilpa, 2025; Mohamad et al., 2022). This multidimensional understanding has important methodological implications because conventional linear models may not fully represent the complex, conditional, and potentially nonlinear relationships among the psychological and relational processes that contribute to marital satisfaction.

The significance of marital satisfaction extends beyond the couple itself because marital functioning is embedded within the broader family system. The emotional climate of the marital relationship may influence parenting practices, family organization, coparenting, and children's socioemotional development. Research has shown that fathers' marital satisfaction can form an important link between coparenting processes and adolescent developmental outcomes, illustrating how couple-level functioning can extend into parent-child and peer-related domains (Ji et al., 2023). Similarly, parental marital quality has been associated with children's social-emotional competence through pathways involving parent-child and sibling relationships (Xiao, 2024). Family functioning is also closely connected to marital adjustment and relational experiences within the family of origin, emphasizing the interdependence of spousal and broader family processes

(Ashraf et al., 2024). These findings indicate that identifying the determinants of marital satisfaction is relevant not only to couple well-being but also to family health and intergenerational functioning. Preventive and promotive approaches to couple mental health have consequently gained increased attention, with relationship-enrichment models emphasizing early recognition of maladaptive patterns, strengthening of interpersonal skills, and enhancement of relational resources before severe distress develops (Suresh et al., 2025). A predictive approach capable of detecting the most informative combination of relational indicators may therefore provide practical value for screening, intervention planning, and preventive family services.

Attachment theory offers one of the most influential frameworks for understanding individual differences in marital functioning. Adult attachment patterns represent relatively stable expectations concerning emotional availability, closeness, support, rejection, abandonment, and dependence within intimate relationships. Individuals with greater attachment security generally experience intimacy and dependence as safe and manageable, whereas attachment anxiety is characterized by heightened concerns about rejection, abandonment, and insufficient partner responsiveness, and attachment avoidance is associated with discomfort with dependence, vulnerability, and emotional closeness. These patterns can influence how spouses perceive ambiguous interpersonal situations, seek or resist support, regulate distress, respond to conflict, and interpret their partner's behavior. Empirical evidence supports a close association between adult romantic attachment and relationship satisfaction (Hasim et al., 2023). Studies specifically examining marital relationships have also shown that attachment patterns are systematically associated with marital satisfaction, indicating that secure attachment tends to correspond with more satisfying relationships, whereas insecure attachment configurations may create vulnerability to dissatisfaction (Shinde et al., 2023). Attachment styles have likewise been identified as relevant to marital stability, particularly because insecure patterns may intensify maladaptive reactions to perceived rejection, relational threat, or insufficient emotional availability (Okonkwo, 2024).

The influence of attachment on marriage, however, does not appear to operate through a simple direct pathway. Attachment tendencies shape multiple dyadic processes through which satisfaction is either maintained or undermined. For example, attachment patterns and

interpersonal schemas have demonstrated both actor and partner effects in marital adjustment, indicating that one spouse's relational expectations can influence not only his or her own functioning but also the partner's experience of the relationship (Uluyol & Özen-Çiplak, 2024). Similarly, dyadic coping has been identified as an important mechanism linking attachment orientations with intimacy, demonstrating that attachment-related vulnerabilities may alter the way partners jointly manage stress and emotional demands (Wendolowska et al., 2022). In the transition to parenthood, common dyadic coping has also been found to mediate associations between attachment styles and marital satisfaction, reinforcing the idea that attachment is translated into relationship outcomes through interpersonal regulatory processes (Kuswanto et al., 2024). Attachment is further related to emotional regulation and relational outcomes in couple therapy, suggesting that partners' attachment-based responses to emotional activation can strongly influence relationship interactions (Ibrahim et al., 2023). Research focusing on marital intimacy has similarly demonstrated associations among attachment styles, attachment-related representations, self-differentiation, and intimacy (Ghasemi, 2023), while attachment styles, maladaptive schemas, and patterns of love have been used to predict intimacy in married individuals (Afshin et al., 2024). Taken together, these findings suggest that attachment indicators are likely to contribute substantial predictive information regarding marital satisfaction, but their influence should be examined alongside other relational processes.

Communication represents another central dimension of marital functioning because the quality of interaction determines how effectively partners express needs, disclose emotions, negotiate expectations, solve problems, and coordinate everyday life. Communication is not simply the frequency of verbal exchange; it includes emotional responsiveness, validation, listening, clarity, reciprocity, constructive problem solving, and the ability to communicate during disagreement without escalating hostility. Poor communication may contribute to misunderstanding, emotional distance, withdrawal, criticism, and unresolved conflict, whereas adaptive communication can strengthen intimacy, mutual understanding, and collaborative coping. Studies examining interpersonal communication in marriage have identified a range of antecedents that shape communication quality and ultimately influence relationship functioning (Kamal et al., 2023). More recent evidence indicates that communication may affect couple satisfaction partly through intimacy,

demonstrating that the effects of communication quality extend beyond direct conversational processes and influence the emotional bond between partners (Seo et al., 2025). Such findings are particularly important because communication patterns may interact with attachment orientations. An anxiously attached individual may interpret limited responsiveness as rejection and intensify demands for reassurance, whereas an avoidantly attached spouse may respond to emotional pressure through withdrawal. These reciprocal patterns can create self-reinforcing cycles in which communication difficulties magnify attachment insecurity and, in turn, undermine marital satisfaction.

Intimacy constitutes another major component of marital satisfaction and includes emotional, psychological, sexual, intellectual, social, and recreational dimensions of closeness. Emotional intimacy involves the perception that one can safely disclose thoughts and feelings, receive understanding, and experience meaningful emotional connection with a partner. Sexual intimacy incorporates both physical closeness and the broader relational meaning associated with sexual expression, mutual responsiveness, and sexual satisfaction. Intellectual and social intimacy reflect shared interests, communication, companionship, and participation in meaningful interpersonal experiences. Stable and satisfying marriages are often distinguished from distressed relationships by the presence of emotional safety, reciprocal understanding, affection, mutual respect, and sustained closeness (Nazemi et al., 2023). In contrast, sexual dissatisfaction may become a substantial source of relational strain, particularly among couples managing demanding work and family responsibilities (Dargahi et al., 2022). Relationship interventions targeting emotional connection have been shown to improve intimacy, adjustment, forgiveness, and other relational outcomes among couples experiencing serious relational challenges (Torani & Fard, 2024). Emotionally focused interventions have also demonstrated beneficial effects on marital harmony, forgiveness, and sexual assertiveness among maladjusted couples (Behrang et al., 2022). These findings reinforce the idea that intimacy is not merely an outcome of marital satisfaction but may itself function as an important predictive feature within a broader relational system.

Conflict is equally unavoidable in intimate relationships, but the manner in which conflict is managed may distinguish adaptive marriages from distressed ones. Constructive disagreement can provide opportunities for clarification, negotiation, boundary setting, and relational growth, whereas hostile, coercive, avoidant, or psychologically

aggressive conflict can progressively erode trust and emotional security. Because conflict behaviors vary across cultural and interpersonal contexts, reliable assessment of different conflict strategies is essential for understanding their relationship with marital outcomes. Measurement research on romantic partner conflict has emphasized the multidimensional nature of conflict and the need to distinguish constructive and destructive strategies rather than treating conflict as a unitary construct (Farooq et al., 2024). Intervention studies have further shown that relationship education programs can reduce marital conflict while improving sexual satisfaction, indicating that conflict patterns are modifiable and closely tied to broader dimensions of marital quality (Radpour et al., 2023). Conflict may also become particularly damaging when partners experience emotional flooding, a state of intense physiological and psychological arousal that reduces the capacity for constructive communication and emotional regulation during interpersonal confrontation (Castillo-López et al., 2024). Conversely, interpersonal mindfulness may buffer the negative effects of conflict on marital intimacy, suggesting that awareness, emotional regulation, and nonreactivity can alter the consequences of marital disagreement (Dehghanidowlatabadi et al., 2025). These findings suggest that marital conflict should be represented through both constructive and maladaptive indicators when predicting marital satisfaction.

Modern intimate relationships are also influenced by emerging social and technological stressors that may interact with established attachment, communication, intimacy, and conflict processes. One increasingly studied example is partner phubbing, in which attention to a smartphone interrupts or displaces interpersonal engagement with one's partner. Meta-analytic evidence indicates that partner phubbing is associated with a range of antecedents and adverse relational consequences, reflecting how technology-related attentional disruptions may weaken perceived responsiveness, intimacy, and relationship quality (Ni et al., 2025). Such processes are important because they demonstrate that marital satisfaction is sensitive not only to stable psychological characteristics but also to everyday patterns of interaction and responsiveness. Periods of major external stress can similarly expose relational strengths and vulnerabilities. Research applying strength-and-strain perspectives to romantic relationships in the context of COVID-19 has highlighted how relationship resources and stressors may simultaneously shape relational outcomes (Adhikari & Shilpa, 2025). These observations support a

systems-oriented approach in which marital satisfaction is understood as the result of dynamically interacting risk and protective factors rather than the isolated effect of any one relational characteristic.

Relationship instability can also emerge when emotional connection, trust, and relational boundaries deteriorate. Infidelity represents one of the most disruptive experiences within committed relationships, and research has identified multiple emotional and psychological factors associated with relationship infidelity, including unmet emotional needs, dissatisfaction, relational disconnection, and difficulties in emotional regulation (Shrestha et al., 2023). The presence of extramarital involvement can profoundly alter intimacy, forgiveness, attachment security, and perceived relationship stability, although therapeutic approaches focused on emotional processing and relational restructuring may facilitate recovery (Torani & Fard, 2024). More broadly, the distinction between satisfying and dissatisfying marriages appears to involve differences across multiple domains rather than a single deficit, including emotional connection, coping, conflict, communication, and shared relational meaning (Nazemi et al., 2023). This multidimensional pattern further suggests that predictive research should move beyond conventional models that estimate a fixed linear coefficient for each variable independently of the others.

Traditional statistical methods remain valuable for testing hypotheses concerning specific associations, but they may have limitations when the objective is to predict marital satisfaction from a relatively large set of correlated relational indicators. Attachment anxiety and avoidance may interact with communication styles; communication may influence satisfaction differently depending on intimacy; conflict may have disproportionate effects at higher levels of psychological aggression; and the protective effect of constructive communication may plateau once adequate communication has already been established. Such threshold effects, nonlinear relationships, and higher-order interactions are difficult to capture without explicitly specifying them in conventional regression models. Machine-learning approaches offer an alternative by focusing on out-of-sample prediction and allowing complex patterns to emerge from the data. Random Forest is particularly suitable because it combines many decision trees generated from resampled observations and predictor subsets, thereby capturing nonlinearities and interactions while reducing the instability associated with single-tree models. In other areas of behavioral and health research,

machine-learning methods are increasingly used to identify influential predictors from multidimensional data, and their application to couple and family research provides an opportunity to move from explanatory association toward empirically evaluated prediction.

The value of such an approach is especially evident when the predictors are theoretically interdependent. Attachment insecurity can shape emotional regulation and interpersonal responses (Ibrahim et al., 2023); dyadic coping can transmit attachment effects to marital satisfaction (Kuswanto et al., 2024); communication can influence satisfaction through intimacy (Seo et al., 2025); mindfulness can modify associations between conflict and intimacy (Dehghanidowlatabadi et al., 2025); and conflict regulation can influence whether disagreement becomes constructive or destructive (Castillo-López et al., 2024). A model that simultaneously incorporates these indicators may therefore reveal a hierarchy of predictive importance that cannot be inferred from isolated correlations. It may also clarify whether relational variables substantially outperform demographic characteristics such as age or duration of marriage in predicting individual differences in satisfaction. This distinction has practical relevance because relational variables are more directly modifiable through psychoeducation, couple therapy, communication training, attachment-focused interventions, and conflict-management programs (Radpour et al., 2023; Suresh et al., 2025).

Although prior studies have examined attachment and marital satisfaction (Hasim et al., 2023; Shinde et al., 2023), attachment and intimacy (Ghasemi, 2023), attachment and marital adjustment (Uluyol & Özen-Çıplak, 2024), communication and couple satisfaction (Seo et al., 2025), conflict and intimacy (Dehghanidowlatabadi et al., 2025), relational interventions and marital outcomes (Behrang et al., 2022; Radpour et al., 2023), and the broader psychological conditions associated with satisfying and distressed relationships (Nazemi et al., 2023), comparatively less attention has been given to integrated predictive modeling in which attachment, communication, multidimensional intimacy, and conflict indicators are evaluated simultaneously using a nonlinear machine-learning framework. This represents an important gap because marital satisfaction likely emerges from the combined configuration of these relational processes rather than from independent additive effects. A Random Forest model can address this gap by estimating out-of-sample predictive performance, ranking predictors according to their contribution to prediction, and examining nonlinear

response patterns. Such an approach is compatible with contemporary views of couple functioning as a dynamic system in which vulnerabilities and protective factors interact over time and across contexts.

Accordingly, the aim of the present study was to predict marital satisfaction among married adults in Canada using Random Forest regression based on attachment, communication, intimacy, and conflict indicators and to determine the relative predictive importance of these relational factors.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a quantitative, cross-sectional predictive design to develop and evaluate a machine-learning model for predicting marital satisfaction based on attachment, communication, intimacy, and marital conflict indicators. The study population consisted of married adults residing in Canada. A total of 684 participants were initially recruited through online community advertisements, social media platforms, family and relationship-related organizations, university mailing lists, and community networks distributed across several Canadian provinces. After data screening, 38 participants were excluded because of incomplete questionnaires, patterned responding, or failure to meet the eligibility criteria, resulting in a final analytical sample of 646 married adults. Participants were eligible for inclusion if they were at least 18 years of age, were legally married at the time of participation, had been married for at least one year, were currently living with their spouse, were able to read and understand English, and were residing in Canada. Individuals who reported being separated, undergoing divorce proceedings, or having completed less than 80% of the study questionnaires were excluded from the analysis. Recruitment was conducted using convenience and purposive sampling, with efforts made to obtain variation in age, duration of marriage, educational level, employment status, and geographic location. Participation was voluntary, and all respondents received an electronic information sheet describing the purpose of the study, confidentiality procedures, the voluntary nature of participation, and their right to discontinue participation without penalty. Electronic informed consent was obtained before access to the questionnaires was granted. No personally identifying information was included in the analytical dataset, and responses were stored using anonymous participant codes.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and relevant Canadian guidelines for research involving human participants. The primary outcome variable was marital satisfaction, while attachment characteristics, marital communication, intimacy, and conflict indicators constituted the predictor variables used in the Random Forest model.

2.2. Measures

Marital satisfaction was assessed using the Couples Satisfaction Index-16 (CSI-16), a 16-item self-report measure designed to evaluate an individual's overall level of satisfaction with an intimate relationship. The instrument assesses global relationship satisfaction as well as perceived quality, happiness, and functioning of the marital relationship. Items are rated using different response formats depending on the item, and item scores are summed to obtain a total marital satisfaction score, with higher scores representing greater satisfaction. The CSI-16 has demonstrated strong psychometric properties in studies of married and partnered adults and provides a sensitive measure of individual differences in relationship satisfaction. In the present study, the continuous total CSI-16 score was retained as the dependent variable for predictive modeling rather than transforming marital satisfaction into arbitrary categorical groups, thereby preserving the maximum amount of information available for Random Forest regression.

Adult attachment characteristics were measured using the Experiences in Close Relationships–Revised questionnaire (ECR-R). The ECR-R consists of 36 items designed to assess two primary dimensions of attachment in romantic relationships: attachment anxiety and attachment avoidance. Attachment anxiety reflects concerns regarding rejection, abandonment, and insufficient availability or responsiveness from the partner, whereas attachment avoidance reflects discomfort with closeness, emotional dependence, and interpersonal intimacy. Participants rated each item on a seven-point Likert-type scale ranging from strong disagreement to strong agreement. Following reverse scoring of relevant items, mean scores were calculated separately for attachment anxiety and attachment avoidance, with higher values representing stronger manifestations of the corresponding insecure attachment dimension. The two continuous dimensional scores were incorporated into the machine-learning analysis because dimensional attachment indices retain greater variability than categorical

classifications such as secure, anxious, or avoidant attachment and are therefore more suitable for prediction.

Marital communication was evaluated using the Communication Patterns Questionnaire–Short Form (CPQ-SF), which measures interaction patterns commonly occurring when couples encounter relationship problems. The instrument assesses constructive communication as well as dysfunctional interaction patterns involving mutual avoidance and demand-withdraw behavior. Participants indicated the extent to which each communication pattern characterized interactions between themselves and their spouses. Higher constructive communication scores indicated greater mutual discussion, emotional expression, negotiation, and collaborative problem solving, whereas higher demand-withdraw and avoidance scores reflected less adaptive communication processes. Constructive communication, mutual avoidance, and demand-withdraw scores were entered separately into the predictive model so that potentially nonlinear associations between distinct communication styles and marital satisfaction could be detected.

Intimacy was assessed using the Personal Assessment of Intimacy in Relationships scale (PAIR). The instrument assesses perceived intimacy within close relationships across several relational domains, including emotional intimacy, social intimacy, sexual intimacy, intellectual intimacy, and recreational intimacy. Participants rated statements concerning the degree of closeness, understanding, emotional connection, shared experiences, personal disclosure, and mutual engagement experienced in their marital relationships. Higher scores indicated greater perceived intimacy. Domain-specific intimacy scores were retained rather than relying exclusively on a global intimacy score because different forms of intimacy may contribute differently to marital satisfaction and may interact with attachment and communication characteristics in nonlinear ways. The emotional, social, sexual, intellectual, and recreational intimacy dimensions were therefore entered as individual predictors in the Random Forest analysis.

Marital conflict was measured using the Revised Conflict Tactics Scales (CTS2), with emphasis on the dimensions relevant to the frequency and management of disagreements within intimate relationships. The instrument evaluates conflict-related behaviors including negotiation, psychological aggression, and other maladaptive responses occurring during partner disagreements. Because the purpose of the present study was predictive rather than diagnostic, conflict indicators were analyzed as continuous

measures reflecting the frequency or intensity of specific conflict-management patterns. Particular attention was given to constructive negotiation and psychologically aggressive conflict behaviors because these variables represent contrasting approaches to marital disagreement and were theoretically expected to contribute differently to marital satisfaction. Higher negotiation scores indicated more frequent use of reasoning, discussion, compromise, and constructive conflict resolution, whereas higher psychological aggression scores indicated greater use of hostile verbal or emotional responses during disagreements. Responses to all instruments were screened for missing data and response consistency before composite scores were calculated according to their respective scoring protocols.

A demographic questionnaire was additionally administered to collect information regarding participants' age, gender, educational attainment, employment status, duration of marriage, number of children, and province or territory of residence. Duration of marriage and age were retained as potential contextual predictors in exploratory models because they could contribute to variation in marital satisfaction independently of the principal psychological and relational indicators. The principal predictive feature set, however, consisted of attachment anxiety, attachment avoidance, constructive communication, mutual avoidance, demand-withdraw communication, emotional intimacy, social intimacy, sexual intimacy, intellectual intimacy, recreational intimacy, negotiation, and psychological aggression.

2.3. Data Analysis

Data analysis was conducted using Python with the pandas, NumPy, scikit-learn, and related statistical libraries. Preliminary analyses involved examination of missing values, response completeness, score distributions, implausible values, and potential univariate outliers. Descriptive statistics, including means, standard deviations, minimum and maximum values, were calculated for the principal continuous variables. Internal consistency of multi-item instruments and subscales was evaluated using Cronbach's alpha, with coefficients of .70 or greater considered indicative of acceptable reliability. Pearson correlation coefficients were calculated during the preliminary statistical stage to describe conventional linear associations among marital satisfaction and the principal attachment, communication, intimacy, and conflict indicators. These correlations were used for descriptive

interpretation rather than for determining which variables would be retained in the machine-learning model, because Random Forest can capture nonlinear associations and complex interactions that may not be adequately represented by bivariate linear correlations.

Random Forest regression was used as the primary predictive modeling technique, with the continuous marital satisfaction score serving as the target variable. Random Forest was selected because it is a nonlinear ensemble-learning algorithm capable of modeling complex relationships, higher-order interactions, and threshold effects while requiring fewer restrictive distributional assumptions than conventional linear regression. The algorithm generates multiple decision trees from bootstrap samples of the training observations and combines their predictions to reduce variance and improve predictive stability. The dataset was randomly divided into training and testing subsets using an 80:20 allocation, corresponding to approximately 80% of observations for model development and 20% for independent evaluation. A fixed random seed was specified to ensure reproducibility. All observations belonging to the test dataset were withheld during model training and hyperparameter optimization to prevent information leakage and overly optimistic estimates of predictive performance.

Hyperparameter optimization was conducted within the training dataset using five-fold cross-validation. The parameters considered during tuning included the number of trees, maximum tree depth, minimum number of observations required to split an internal node, minimum number of observations required in a terminal leaf, and the number or proportion of predictor variables considered at each split. Candidate configurations were evaluated according to cross-validated prediction error, and the combination yielding the lowest root mean squared error was selected as the final model specification. Because tree-based models do not require variables to be standardized to a common metric, predictor standardization was not performed for the primary Random Forest model. The fitted model was subsequently applied to the previously unseen test dataset.

Predictive performance was evaluated using the coefficient of determination (R^2), mean absolute error (MAE), root mean squared error (RMSE), and mean squared error (MSE). R^2 was used to estimate the proportion of variation in marital satisfaction explained by model predictions, while MAE represented the average absolute deviation between observed and predicted marital

satisfaction scores. RMSE was additionally reported because it places greater weight on relatively large prediction errors. Performance estimates obtained for the training and testing datasets were compared to evaluate potential overfitting. Cross-validation performance was also examined to determine whether the predictive accuracy of the model remained reasonably stable across different subsets of participants.

Predictor importance was examined using permutation importance to determine the relative contribution of attachment, communication, intimacy, and conflict indicators to the model's predictive performance. Permutation importance was preferred as the principal interpretation procedure because impurity-based importance in Random Forest models may favor predictors with particular distributional characteristics or larger numbers of potential splitting points. For each predictor, values were randomly permuted in the test data while all other variables were retained unchanged, and the resulting decrease in model performance was calculated. Greater deterioration in predictive accuracy following permutation indicated greater predictive importance. Partial dependence analyses were subsequently used for the most influential predictors to investigate the direction and possible nonlinear form of their relationships with predicted marital satisfaction. These analyses made it possible to identify whether changes in characteristics such as attachment anxiety, constructive communication, emotional intimacy, or marital conflict were associated with gradual, threshold-based, or nonlinear changes in predicted marital satisfaction.

To evaluate the robustness of the findings, model stability was examined across repeated resampling procedures, and the ranking of influential predictors was compared across resampled models. Potential multicollinearity among predictors was inspected descriptively; however, highly correlated predictors were not automatically excluded because Random Forest does not depend on the same independence assumptions as ordinary least squares regression and because conceptually related relational variables may contain distinct predictive information. Statistical tests conducted as part of the preliminary conventional analyses were interpreted using a two-tailed significance level of $p < .05$. Machine-learning model evaluation, however, was based primarily on out-of-sample

predictive accuracy, cross-validation performance, error metrics, and predictor importance rather than null-hypothesis significance testing.

3. Findings and Results

The final analytical sample consisted of 646 married adults residing in Canada. Participants ranged in age from 22 to 69 years, with a mean age of 41.37 years ($SD = 10.26$). Of the participants, 331 (51.24%) identified as women, 302 (46.75%) as men, and 13 (2.01%) identified as another gender or preferred not to report their gender. The mean duration of marriage was 12.84 years ($SD = 9.31$), with marital duration ranging from 1 to 43 years. Regarding educational attainment, 74 participants (11.46%) had completed high school or an equivalent qualification, 126 (19.50%) held a college or technical diploma, 251 (38.85%) held a bachelor's degree, 156 (24.15%) held a master's degree, and 39 (6.04%) held a doctoral or professional degree. In terms of employment status, 456 participants (70.59%) were employed full-time, 86 (13.31%) were employed part-time, 39 (6.04%) were self-employed, 25 (3.87%) were unemployed, and 40 (6.19%) were students, retired, or otherwise outside the paid labor force. A total of 431 participants (66.72%) reported having at least one child, whereas 215 (33.28%) reported having no children. The geographical distribution of participants reflected several Canadian regions: 238 participants (36.84%) resided in Ontario, 143 (22.14%) in Quebec, 89 (13.78%) in British Columbia, 78 (12.07%) in Alberta, 54 (8.36%) in Manitoba or Saskatchewan, and 44 (6.81%) in Atlantic Canada or other provinces and territories. Preliminary examination of the data indicated no substantial violations that would preclude subsequent analyses. Missing responses were minimal and were addressed during the data-screening stage before scale scores were calculated. No predictor demonstrated a pattern of extreme dispersion sufficient to warrant removal, and the distributional characteristics of the variables were considered acceptable for descriptive and correlational analyses. Because Random Forest regression does not require multivariate normality or linear associations among predictors and the outcome, all theoretically specified attachment, communication, intimacy, and conflict indicators were retained for predictive modeling.

Table 1

Descriptive Statistics, Internal Consistency, and Correlations of the Main Study Variables

Variable	M	SD	Cronbach's α	Correlation with Marital Satisfaction (r)
Marital satisfaction	58.42	14.37	.94	1.000
Attachment anxiety	3.41	1.19	.92	-.61***
Attachment avoidance	3.26	1.14	.91	-.58***
Constructive communication	16.83	4.27	.87	.66***
Mutual avoidance	8.24	3.11	.83	-.49***
Demand-withdraw communication	9.11	3.46	.85	-.53***
Emotional intimacy	18.76	4.08	.90	.72***
Social intimacy	16.94	3.91	.84	.52***
Sexual intimacy	17.31	4.36	.88	.63***
Intellectual intimacy	17.06	3.74	.85	.55***
Recreational intimacy	15.88	3.86	.82	.46***
Negotiation	13.72	3.34	.86	.57***
Psychological aggression	6.18	3.27	.89	-.60***

As shown in Table 1, all study instruments and subscales demonstrated satisfactory to excellent internal consistency, with Cronbach's alpha coefficients ranging from .82 for recreational intimacy to .94 for marital satisfaction. The strongest positive bivariate relationship with marital satisfaction was observed for emotional intimacy ($r = .72, p < .001$), indicating that participants who reported greater emotional closeness, mutual understanding, and emotional connection with their spouses tended to report substantially higher marital satisfaction. Constructive communication was also strongly and positively associated with marital satisfaction ($r = .66, p < .001$), followed by sexual intimacy ($r = .63, p < .001$), negotiation ($r = .57, p < .001$), intellectual intimacy ($r = .55, p < .001$), social intimacy ($r = .52, p < .001$), and recreational intimacy ($r = .46, p < .001$). In contrast, attachment anxiety demonstrated a strong negative association with marital satisfaction ($r = -.61, p < .001$),

suggesting that greater concerns regarding rejection, abandonment, and partner unavailability were associated with lower levels of satisfaction in marriage. Psychological aggression was similarly negatively associated with marital satisfaction ($r = -.60, p < .001$), while attachment avoidance ($r = -.58, p < .001$), demand-withdraw communication ($r = -.53, p < .001$), and mutual avoidance ($r = -.49, p < .001$) also showed statistically significant negative associations. Collectively, these findings indicated that both relational resources and relational vulnerabilities were closely associated with marital satisfaction at the bivariate level. Nevertheless, the magnitude of the correlations did not determine inclusion in the predictive model, as Random Forest regression was used specifically to identify nonlinear effects, conditional patterns, and interactions among variables that may not be adequately represented by conventional linear correlations.

Table 2

Predictive Performance of the Random Forest Regression Model

Evaluation Dataset	R ²	MAE	MSE	RMSE
Training set	.91	3.18	18.92	4.35
Five-fold cross-validation	.76	5.28	46.79	6.84
Independent test set	.78	5.06	43.52	6.60

Table 2 presents the predictive performance of the optimized Random Forest regression model. The model demonstrated strong explanatory and predictive performance across the training, cross-validation, and independent test datasets. In the training dataset, the model produced an R² of .91, indicating that approximately 91% of the variance in observed marital satisfaction scores was

reproduced by the fitted ensemble model. The corresponding MAE was 3.18, the MSE was 18.92, and the RMSE was 4.35. As expected, predictive performance was lower when the model was evaluated on observations not directly used for fitting. Across five-fold cross-validation within the training sample, the mean R² was .76, with an MAE of 5.28 and an RMSE of 6.84. Most importantly, when the final

optimized model was applied to the independent test subset, it achieved an R^2 of .78, indicating that approximately 78% of the variance in marital satisfaction was predicted in previously unseen participants. The test-set MAE of 5.06 indicated that the average absolute difference between observed and predicted marital satisfaction scores was slightly more than five scale points, while the RMSE of 6.60 indicated relatively limited dispersion of prediction errors. The similarity between cross-validation performance and independent test-set performance provided evidence that the

model generalized consistently beyond the training observations. Although the training R^2 was higher than the test R^2 , the magnitude of the difference was not considered indicative of severe overfitting because the independent test performance remained strong and closely corresponded to the cross-validated results. The findings therefore supported the suitability of the Random Forest model for predicting marital satisfaction from multidimensional indicators of attachment, communication, intimacy, and conflict.

Table 3

Permutation Importance of Predictors in the Random Forest Model

Rank	Predictor	Mean Decrease in Test R^2 After Permutation	Relative Importance (%)
1	Emotional intimacy	.113	18.4
2	Constructive communication	.091	14.8
3	Attachment anxiety	.076	12.4
4	Sexual intimacy	.067	10.9
5	Psychological aggression	.061	9.9
6	Attachment avoidance	.054	8.8
7	Negotiation	.043	7.0
8	Demand-withdraw communication	.035	5.7
9	Intellectual intimacy	.026	4.2
10	Social intimacy	.020	3.3
11	Mutual avoidance	.014	2.3
12	Recreational intimacy	.009	1.5
13	Duration of marriage	.004	0.7
14	Age	.001	0.2

The permutation-importance analysis presented in Table 3 demonstrated that emotional intimacy was the most influential predictor of marital satisfaction. Random permutation of emotional intimacy reduced test-set R^2 by .113, corresponding to 18.4% of the total relative predictive importance. This result indicated that disrupting information concerning emotional closeness and perceived emotional connection produced the largest deterioration in model performance. Constructive communication ranked second, accounting for 14.8% of relative importance, followed by attachment anxiety at 12.4%. Sexual intimacy represented the fourth most influential predictor at 10.9%, whereas psychological aggression accounted for 9.9% of predictive importance. Attachment avoidance also contributed substantially to model prediction, with a relative importance of 8.8%. Negotiation accounted for 7.0%, and demand-withdraw communication accounted for 5.7%. Intellectual intimacy, social intimacy, mutual avoidance, and recreational intimacy showed smaller but still meaningful

contributions. In contrast, demographic-contextual variables had substantially lower predictive importance. Duration of marriage accounted for only 0.7% of the total relative importance and age for 0.2%, suggesting that the quality of emotional, communicative, intimate, and conflict-related processes was substantially more informative for predicting marital satisfaction than chronological characteristics of participants or their marriages. Importantly, permutation importance should not be interpreted as a causal coefficient or as indicating that a one-unit change in a predictor produces a fixed change in marital satisfaction. Rather, it represents the extent to which predictive accuracy deteriorated when information contained in a particular variable was disrupted while the remaining features were preserved. The findings therefore identified emotional intimacy, constructive communication, attachment insecurity, sexual intimacy, and psychologically aggressive conflict as the principal sources of predictive information within the multivariate model.

Table 4

Partial Dependence Estimates for the Most Influential Predictors of Marital Satisfaction

Predictor	Low-Level Predicted Marital Satisfaction	Moderate-Level Predicted Marital Satisfaction	High-Level Predicted Marital Satisfaction	General Pattern
Emotional intimacy	46.82	58.73	67.41	Strong positive nonlinear increase
Constructive communication	49.16	59.37	65.88	Positive increase with upper-level plateau
Attachment anxiety	66.21	58.12	46.93	Strong negative nonlinear decrease
Sexual intimacy	50.74	59.21	65.09	Positive increase
Psychological aggression	65.37	57.44	47.28	Strong negative decrease
Attachment avoidance	64.18	57.96	49.34	Negative nonlinear decrease
Negotiation	52.13	59.64	64.27	Positive increase
Demand-withdraw communication	63.26	57.88	50.41	Negative increase in dissatisfaction

The partial dependence results in Table 4 provided additional information regarding the direction and functional form of relationships identified by the Random Forest model. Emotional intimacy exhibited the most pronounced positive pattern. Participants represented at relatively low levels of emotional intimacy had an average predicted marital satisfaction score of 46.82, compared with 58.73 at moderate levels and 67.41 at relatively high levels. The increase was particularly marked between low and moderate levels, suggesting that moving from limited emotional closeness toward a moderate level of emotional connection was associated with a substantial increase in predicted satisfaction. Constructive communication followed a similar positive pattern, with predicted marital satisfaction increasing from 49.16 at low levels to 59.37 at moderate levels and 65.88 at high levels. However, the curve flattened at the upper range, indicating diminishing incremental gains once constructive communication had already reached relatively high levels. Attachment anxiety showed the opposite pattern. Predicted marital satisfaction decreased from 66.21 among participants with relatively low attachment anxiety to 58.12 at moderate levels and 46.93 at

high levels, indicating that elevated fears of abandonment and relationship insecurity were associated with especially pronounced reductions in predicted marital satisfaction. Sexual intimacy demonstrated a positive relationship, with predicted scores rising from 50.74 to 65.09 across low to high levels. Psychological aggression was associated with one of the steepest negative gradients, with predicted marital satisfaction declining from 65.37 at low levels to 47.28 at high levels. Attachment avoidance was similarly associated with progressively lower predictions, declining from 64.18 to 49.34. Negotiation demonstrated a positive relationship, whereas demand-withdraw communication showed a clear negative pattern. These findings confirmed that the Random Forest model did not merely distinguish variables according to overall importance but also identified theoretically coherent nonlinear response patterns. The strongest improvements in predicted marital satisfaction were associated with emotional intimacy, constructive communication, sexual intimacy, and negotiation, whereas the most substantial reductions were associated with attachment anxiety, psychological aggression, attachment avoidance, and demand-withdraw communication.

Figure 1

Observed Versus Random Forest-Predicted Marital Satisfaction Scores in the Independent Test Set

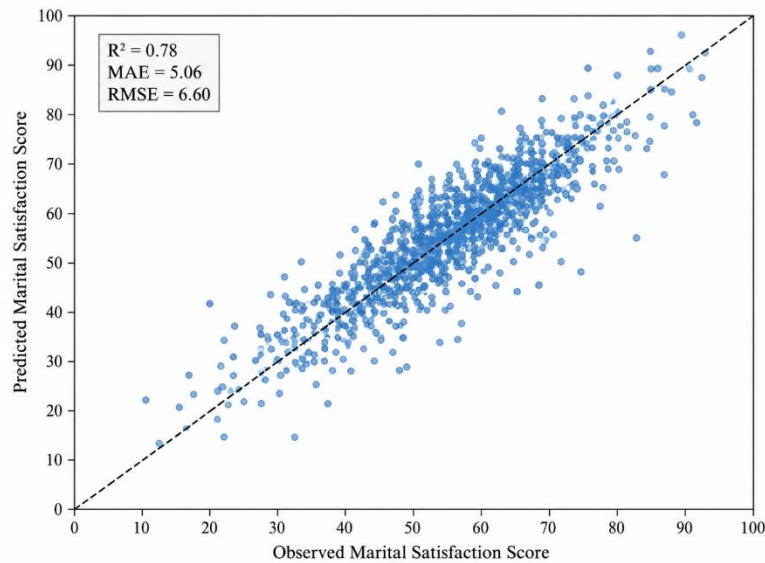


Figure 1 illustrates the correspondence between observed marital satisfaction scores and the values generated by the optimized Random Forest model for participants in the independent test dataset. The predicted scores followed the observed values closely across most of the distribution, with observations generally clustering near the line representing perfect agreement between observed and predicted scores. Prediction errors were relatively limited in the middle range of marital satisfaction, where the largest proportion of the sample was concentrated. Somewhat greater dispersion was evident toward the extreme lower and upper ends of the outcome distribution, reflecting the common tendency of ensemble regression models to generate more conservative predictions for relatively uncommon extreme values. Nevertheless, no systematic pattern of severe overprediction or underprediction was apparent. Participants with low observed marital satisfaction generally received low predicted scores, while those with moderate and high observed satisfaction were correspondingly assigned higher predicted values. This visual pattern was consistent with the quantitative test-set performance reported in Table 2, particularly the R^2 of .78 and RMSE of 6.60, and provided further evidence that the model captured a substantial proportion of individual differences in marital satisfaction among previously unseen participants.

Taken together, the findings indicated that marital satisfaction could be predicted with a relatively high degree of accuracy using a multidimensional combination of attachment, communication, intimacy, and conflict indicators. Emotional intimacy emerged as the strongest

individual source of predictive information, followed by constructive communication, attachment anxiety, sexual intimacy, psychological aggression, and attachment avoidance. The findings also demonstrated that relational quality variables substantially outperformed age and duration of marriage in predictive importance. The partial dependence analyses further suggested that these associations were not uniformly linear. In particular, improvements in emotional intimacy and constructive communication appeared to produce particularly large gains in predicted marital satisfaction at lower and moderate levels before becoming less pronounced at the upper end of the respective distributions. Conversely, increasing attachment anxiety and psychologically aggressive conflict were associated with increasingly lower predicted satisfaction, with the largest deterioration occurring when these risk indicators reached relatively elevated levels. The convergence of descriptive correlations, out-of-sample model performance, permutation importance, and partial dependence patterns provided a coherent predictive profile in which emotional connection, constructive interpersonal exchange, secure attachment-related functioning, and effective conflict management represented the central features distinguishing higher from lower levels of marital satisfaction.

4. Discussion

The present study investigated the prediction of marital satisfaction among married adults in Canada using a

Random Forest regression model based on attachment, communication, intimacy, and conflict indicators. The findings demonstrated that the model achieved strong predictive performance, accounting for approximately 78% of the variance in marital satisfaction in the independent test sample. This level of out-of-sample performance suggests that marital satisfaction can be predicted with considerable accuracy when multiple relational dimensions are examined simultaneously rather than independently. The permutation-importance results further indicated that emotional intimacy was the strongest predictor of marital satisfaction, followed by constructive communication, attachment anxiety, sexual intimacy, psychological aggression, attachment avoidance, negotiation, and demand-withdraw communication. The partial dependence analyses showed theoretically coherent nonlinear patterns: marital satisfaction increased with emotional intimacy, constructive communication, sexual intimacy, and negotiation, whereas it decreased as attachment anxiety, psychological aggression, attachment avoidance, and demand-withdraw communication increased. Demographic variables, particularly age and duration of marriage, showed substantially lower predictive importance than relational variables. Overall, these findings support a multidimensional and interaction-oriented conceptualization of marital satisfaction in which emotional closeness, security, communication quality, and conflict regulation jointly differentiate more satisfying from less satisfying marriages.

The particularly strong role of emotional intimacy represents one of the central findings of the study. Emotional intimacy showed the highest correlation with marital satisfaction and was also ranked first in permutation importance, indicating that information about emotional closeness contributed more to the predictive accuracy of the Random Forest model than any other individual feature. This finding is consistent with previous evidence emphasizing intimacy as a central organizing feature of successful marital relationships. Research comparing satisfying and dissatisfied marriages has shown that stable and satisfying relationships are characterized by emotional closeness, mutual understanding, perceived responsiveness, and a stronger sense of connection between partners (Nazemi et al., 2023). Similarly, attachment-related processes and self-differentiation have been associated with marital intimacy, suggesting that the capacity to maintain emotional closeness while preserving a coherent sense of self contributes to healthier intimate functioning (Ghasemi, 2023). The present findings also align with evidence showing that attachment

styles, maladaptive schemas, and love-related patterns can significantly predict marital intimacy (Afshin et al., 2024). Taken together, these studies support the interpretation that intimacy is not merely a secondary feature of satisfactory marriages, but rather a central mechanism through which partners experience emotional security, acceptance, validation, and relational fulfillment.

The partial dependence results further suggested that the association between emotional intimacy and predicted marital satisfaction was not strictly linear. The largest gain in predicted marital satisfaction occurred between relatively low and moderate levels of emotional intimacy, while the incremental increase became less pronounced at higher levels. This pattern may indicate that moving from emotional disconnection toward a functional level of emotional responsiveness produces especially large benefits for marital quality, whereas additional gains become progressively smaller once a sufficiently strong emotional bond has already been established. Such a result is compatible with emotionally focused conceptualizations of couple functioning, in which the restoration of emotional accessibility, responsiveness, and engagement is considered particularly important in distressed relationships. Empirical intervention studies have shown that emotionally focused couple therapy can improve intimacy, marital adjustment, forgiveness, and related relational outcomes (Torani & Fard, 2024). Emotion-focused treatment has also been associated with improvements in marital harmony, forgiveness, and sexual assertiveness among maladjusted couples (Behrang et al., 2022). These findings support the present study by suggesting that emotional connection is both highly predictive of marital satisfaction and potentially responsive to intervention.

Constructive communication emerged as the second most important predictor and demonstrated a strong positive relationship with marital satisfaction. This result indicates that couples who engage more frequently in mutual discussion, collaborative problem solving, emotional expression, negotiation, and reciprocal listening tend to experience higher levels of marital satisfaction. The finding is consistent with prior research identifying communication quality as a key antecedent of marital functioning (Kamal et al., 2023). Communication is particularly important because it provides the behavioral medium through which many other relational processes are expressed. Attachment needs are communicated through requests for closeness and reassurance; intimacy is maintained through disclosure and responsiveness; and conflict is resolved through negotiation

and mutual perspective-taking. Therefore, communication may function as a central relational pathway linking individual psychological tendencies with dyadic outcomes. This interpretation is strongly supported by evidence showing that intimacy mediates the relationship between communication and couple satisfaction, indicating that effective communication may contribute to satisfaction partly because it promotes greater closeness and emotional connection (Seo et al., 2025).

The observed nonlinear pattern for constructive communication is also noteworthy. Predicted marital satisfaction increased markedly from low to moderate levels of constructive communication, but the curve became less steep at higher levels. This may reflect a threshold process in which the absence of constructive communication is especially damaging, whereas once couples establish a sufficiently effective communication system, further increases provide smaller marginal benefits. This result illustrates one of the advantages of using Random Forest regression rather than relying exclusively on linear models. A conventional regression coefficient would summarize the association as a constant average effect across all values, whereas the present model suggested that the relational benefit of communication depends partly on its starting level. This finding also supports preventive approaches to couple care. Relationship-enrichment programs emphasizing communication, problem solving, and emotional responsiveness have been proposed as promotive and preventive strategies for strengthening relationships before severe distress develops (Suresh et al., 2025). The present findings suggest that such interventions may be particularly useful among couples exhibiting low baseline levels of constructive communication.

Attachment anxiety was the third most important predictor and showed a strong negative association with marital satisfaction. Participants with higher attachment anxiety were predicted to report substantially lower marital satisfaction, particularly at elevated levels of attachment insecurity. This finding is consistent with attachment theory and with previous research linking adult romantic attachment to relationship satisfaction (Hasim et al., 2023). Attachment anxiety is typically characterized by fears of abandonment, heightened sensitivity to signs of rejection, excessive reassurance seeking, and persistent concerns about a partner's availability. These tendencies can amplify ambiguity within marital interactions and may contribute to conflict escalation, emotional dependency, and difficulty regulating relational distress. Prior research has shown that

attachment patterns are associated with marital satisfaction (Shinde et al., 2023) and marital stability (Okonkwo, 2024). The present results extend this literature by demonstrating that attachment anxiety remains highly informative even when communication, intimacy, and conflict variables are simultaneously included in a nonlinear predictive model.

Attachment avoidance was also an important negative predictor, although its relative importance was somewhat lower than that of attachment anxiety. Higher attachment avoidance was associated with lower predicted marital satisfaction, which is theoretically consistent with the tendency of avoidantly attached individuals to minimize dependence, suppress emotional needs, and distance themselves during relational stress. Such patterns may interfere with intimacy and limit constructive communication during conflict. Previous research has demonstrated actor-partner relationships between adult attachment patterns, interpersonal schemas, and marital adjustment (Uluyol & Özen-Çıplak, 2024). Attachment orientations have also been linked to emotional regulation and relational outcomes in couples (Ibrahim et al., 2023). From a dyadic perspective, attachment-related effects may occur not only through an individual's internal experience but also through reciprocal interactions with the spouse. For example, withdrawal from an avoidant partner may increase anxiety in the other partner, producing a demand-withdraw cycle that further reduces satisfaction. This interpretation is consistent with evidence that dyadic coping mediates associations between attachment styles and marital satisfaction, particularly during demanding transitions such as parenthood (Kuswanto et al., 2024), and that attachment and dyadic coping jointly shape relational intimacy (Wendołowska et al., 2022).

Sexual intimacy also made a substantial contribution to prediction and was positively associated with marital satisfaction. This result underscores the importance of sexual and affectionate connection as one component of the broader marital bond. Sexual intimacy can reflect not only sexual behavior itself but also mutual responsiveness, desirability, trust, comfort with vulnerability, and emotional connection. Previous research has shown that sexual dissatisfaction can become a significant source of relational strain, particularly among dual-career couples facing competing personal and occupational demands (Dargahi et al., 2022). In contrast, interventions focused on relational enrichment and conflict reduction have been associated with improvements in sexual satisfaction (Radpour et al., 2023). Emotionally focused interventions have also demonstrated benefits for sexual

assertiveness and marital harmony (Behrang et al., 2022). The present finding therefore suggests that sexual intimacy contributes unique predictive information even after other forms of intimacy and communication have been considered, supporting the view that marital satisfaction is multidimensional and cannot be fully understood through emotional intimacy alone.

Psychological aggression was among the strongest negative predictors of marital satisfaction and showed one of the steepest declines in the partial dependence analysis. Participants reporting higher levels of psychologically aggressive conflict behaviors were predicted to experience markedly lower satisfaction. This result is consistent with research emphasizing the multidimensional nature of romantic conflict and the importance of distinguishing constructive disagreement from destructive behaviors (Farooq et al., 2024). Psychological aggression can include hostile criticism, humiliation, threats, contempt, verbal attacks, or coercive interpersonal responses, all of which can undermine emotional safety and trust. The negative effect of conflict may become especially pronounced when partners experience emotional flooding, in which intense arousal reduces the capacity for reflective communication and adaptive self-regulation (Castillo-López et al., 2024). Once conflict becomes emotionally overwhelming, partners may rely more heavily on attack, defensiveness, or withdrawal, reinforcing cycles of distress and dissatisfaction.

At the same time, the findings showed that negotiation was positively associated with marital satisfaction, confirming that conflict itself is not necessarily harmful; rather, the manner in which conflict is managed is crucial. Couples who use discussion, compromise, reasoning, and collaborative problem solving appear better able to prevent disagreement from eroding relationship quality. This interpretation is supported by intervention research demonstrating that preventive and relationship-enrichment programs can reduce marital conflict while improving other areas of couple functioning (Radpour et al., 2023). It is also consistent with findings showing that interpersonal mindfulness can moderate the relationship between marital conflict and marital intimacy (Dehghanidowlatabadi et al., 2025). Mindful awareness may reduce automatic reactivity during disagreement and thereby facilitate more constructive responses. Accordingly, the simultaneous negative importance of psychological aggression and positive importance of negotiation in the present model highlights the importance of distinguishing destructive from constructive conflict strategies.

Demand-withdraw communication and mutual avoidance also predicted lower marital satisfaction, although their relative importance was lower than that of emotional intimacy, constructive communication, or attachment insecurity. These patterns may represent dyadic regulatory strategies used when partners are unable to manage emotional activation effectively. In demand-withdraw cycles, one partner intensifies requests, criticism, or emotional pursuit while the other disengages or avoids the interaction. Such cycles can become self-perpetuating, especially when they correspond with anxious and avoidant attachment tendencies. Communication difficulties may therefore function as the behavioral expression of underlying attachment insecurity. Previous research on adult attachment, emotional regulation, and relational outcomes supports this interpretation (Ibrahim et al., 2023), while evidence concerning actor-partner effects suggests that one partner's interpersonal schema can influence both partners' marital adjustment (Uluyol & Özen-Çıplak, 2024). The present results therefore reinforce the value of understanding marital satisfaction as a dyadic system in which attachment, communication, intimacy, and conflict processes are mutually interconnected.

Another important finding was that relational variables substantially outperformed age and duration of marriage in predictive importance. This suggests that marital satisfaction is determined less by how old partners are or how long they have been married than by how they function within the relationship. Although developmental stage and marital duration may shape the context in which relationship processes occur, they appear to provide relatively limited predictive information once direct measures of emotional closeness, communication, attachment, and conflict are available. This result is compatible with strength-and-strain perspectives that emphasize the dynamic balance between relational resources and stressors rather than fixed demographic characteristics (Adhikari & Shilpa, 2025). It is also consistent with broader models of positive relationships that emphasize adaptive interpersonal processes and positive relational orientations (Mohamad et al., 2022). From a clinical perspective, this is encouraging because many of the strongest predictors identified in the model are potentially modifiable.

The strong performance of the Random Forest model further supports the usefulness of machine-learning approaches in marital research. The independent test-set R^2 of .78 indicates that the model generalized well to participants not used during training, while the similarity

between cross-validation and test performance suggests that the results were not solely attributable to overfitting. The advantage of Random Forest in this context lies in its capacity to model nonlinear relationships and interactions without requiring these patterns to be prespecified. This is especially relevant because the present findings indicated that several predictors showed threshold-like or diminishing-return patterns. The relational consequences of emotional intimacy, communication, and attachment insecurity therefore may not be uniform across their entire distributions. Such complexity is consistent with contemporary couple research, in which relationship satisfaction is increasingly understood as the product of interdependent and context-sensitive processes rather than a simple additive outcome.

5. Conclusion

The findings may also be understood within the broader context of contemporary relationship challenges. Modern couples face stressors related to work, parenting, digital technology, and changing expectations regarding emotional availability. Meta-analytic evidence concerning partner phubbing, for example, indicates that digital distraction is associated with adverse relational consequences and may interfere with perceived responsiveness and intimacy (Ni et al., 2025). These emerging stressors may interact with the core relational processes identified in the present study. A partner who is already attachment-anxious may interpret digital disengagement as rejection, while poor communication may make it more difficult to negotiate technology boundaries. Similarly, relational disruptions such as infidelity are closely tied to emotional disconnection, unmet relational needs, and psychological processes affecting trust and commitment (Shrestha et al., 2023). The current predictive framework therefore has potential relevance beyond routine marital functioning because attachment, intimacy, communication, and conflict represent foundational dimensions through which diverse relational challenges may influence satisfaction.

6. Limitations & Suggestions

The present findings should be interpreted in light of several limitations. First, the cross-sectional design prevents conclusions regarding temporal or causal direction. Although the Random Forest model predicted marital satisfaction with high accuracy, predictive importance does not establish that a particular variable causes changes in

marital satisfaction. For example, low intimacy may contribute to dissatisfaction, but dissatisfaction may also reduce emotional or sexual intimacy. Second, the study relied on self-report measures, which may be affected by social desirability, recall bias, shared method variance, or participants' current emotional state. Third, only one member of each marital dyad participated, meaning that partner effects and discrepancies in partners' perceptions could not be directly modeled. Fourth, although the sample included participants from several Canadian regions, convenience and purposive recruitment may limit population representativeness, particularly with regard to linguistic, cultural, socioeconomic, and minority-group diversity. Fifth, the Random Forest model was evaluated using an internal train-test procedure rather than an entirely independent external cohort, and its predictive performance may therefore differ in other populations or clinical settings. Finally, the selected predictors were theoretically broad but not exhaustive; variables such as personality, financial stress, parenting burden, mental health symptoms, infidelity history, partner phubbing, work-family conflict, and socioeconomic strain were not included and could provide additional predictive information.

Future research should employ longitudinal and dyadic designs to examine how attachment, communication, intimacy, conflict, and marital satisfaction influence one another across time. Studies that recruit both spouses would allow actor-partner interdependence to be integrated with machine-learning prediction and could clarify whether one partner's attachment insecurity or conflict behavior predicts the other partner's satisfaction. External validation should also be conducted using independent samples from different Canadian provinces and from culturally diverse populations to assess model transportability. Future studies could compare Random Forest with alternative algorithms such as gradient boosting, elastic-net regression, support vector machines, and neural networks to determine whether predictive accuracy can be improved without sacrificing interpretability. Incorporating additional contextual predictors, including parenting stress, economic strain, digital-device interference, mental health, relationship transitions, and social support, could further strengthen prediction. Longitudinal machine-learning models may also be used to predict clinically meaningful outcomes such as substantial deterioration in satisfaction, separation risk, or response to couple interventions.

In practice, the findings suggest that couple assessment and intervention should prioritize modifiable relational

processes rather than relying heavily on demographic characteristics. Screening protocols could place particular emphasis on emotional intimacy, constructive communication, attachment-related anxiety and avoidance, sexual intimacy, psychologically aggressive conflict, negotiation, and demand-withdraw patterns. Couple therapists and family practitioners may benefit from using these domains to identify relational strengths and vulnerabilities early in treatment. Intervention programs should emphasize increasing emotional accessibility and responsiveness, strengthening constructive communication, improving conflict negotiation, reducing psychologically aggressive interaction, and helping partners recognize attachment-driven responses during periods of stress. Preventive relationship-education programs could similarly use these domains to identify couples who may benefit from early support before severe dissatisfaction develops. Machine-learning models should not replace clinical judgment, but they may provide an additional decision-support tool for identifying relational patterns that warrant closer assessment and for tailoring interventions toward the combination of factors most strongly associated with marital satisfaction in a particular couple.

Acknowledgments

We would like to express our appreciation and gratitude to all those who cooperated in carrying out this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

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.

Authors' Contributions

All authors have equally contributed to the research process and the development of the manuscript.

Declaration

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

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