Journal Website

Article history:
Received 07 January 2026
Revised 03 May 2026
Accepted 10 May 2026
Published online 01 July 2026

Iranian Journal of Neurodevelopmental Disorders

Volume 5, Issue 4, pp 1-11

E-ISSN: 2980-9681

Machine Learning Analysis of Adolescent Moral Development Using Empathy, Parenting Practices, and Prosocial Behavior

Nahid Yousefpour[1*]

1. Assistant Professor, Department of Educational Sciences and Psychology, Payame Noor University, Tehran, Iran

*** Corresponding author email address:** nahidyousefpour97@pnu.ac.ir

A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Yousefpour, N. (2026). Machine Learning Analysis of Adolescent Moral Development Using Empathy, Parenting Practices, and Prosocial Behavior. *Iranian Journal of Neurodevelopmental Disorders, 5*(4), 1-11.
https://doi.org/10.61838/kman.jndd.803

© 2026 the authors. Published by Iranian Association for Intelligence and Talent Studies, Tehran, Iran. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

A B S T R A C T

Purpose: The present study aimed to analyze and predict adolescent moral development using machine learning models based on empathy, parenting practices, and prosocial behavior among adolescents in Tehran.

Methods and Materials: This study employed a descriptive-correlational design with a machine learning predictive approach. The statistical population included adolescents enrolled in secondary schools in Tehran during the 2025–2026 academic year. Using multistage cluster random sampling, 412 adolescents were selected, of whom 398 participants met the inclusion criteria and completed the study instruments. Data collection tools included the Moral Development Scale, the Interpersonal Reactivity Index for empathy assessment, the Alabama Parenting Questionnaire, and the Prosocial Tendencies Measure. Descriptive statistics and Pearson correlation analyses were initially conducted using SPSS-27 software. Subsequently, machine learning analyses were performed using Python programming language. The predictive models included Random Forest, Support Vector Machine, Gradient Boosting, and Artificial Neural Network algorithms. Model performance was evaluated using accuracy, mean absolute error (MAE), root mean square error (RMSE), and coefficient of determination (R^2).

Findings: The results revealed significant positive correlations among empathy, parenting practices, prosocial behavior, and adolescent moral development ($p < .01$). Prosocial behavior demonstrated the strongest relationship with moral development ($r = .65$), followed by empathy ($r = .61$) and positive parenting practices ($r = .57$). Machine learning analyses indicated that the Gradient Boosting algorithm demonstrated the highest predictive performance with an accuracy of 0.91 and an R^2 value of 0.85, outperforming the Random Forest, Artificial Neural Network, and Support Vector Machine models. Feature importance analysis further showed that prosocial behavior had the greatest predictive contribution to moral development, followed by empathy and parenting practices.

Conclusion: The findings of the present study demonstrated that empathy, parenting practices, and prosocial behavior play substantial roles in adolescent moral development, with prosocial behavior emerging as the strongest predictor.

Keywords: *Adolescent Moral Development, Empathy, Parenting Practices, Prosocial Behavior*

1. Introduction

Moral development during adolescence has emerged as one of the most important areas of inquiry in developmental psychology, educational sciences, and behavioral research because adolescence represents a critical period for the formation of ethical reasoning, social identity, emotional regulation, and prosocial orientation. During this developmental stage, individuals experience rapid cognitive, emotional, and interpersonal transformations that significantly shape their capacity to distinguish right from wrong, engage in socially responsible behavior, and internalize moral values. Researchers have increasingly emphasized that moral development is not merely a cognitive process but rather a multidimensional phenomenon influenced by emotional sensitivity, social learning, family interactions, and broader cultural experiences (Maggi et al., 2022; Sultan & Khan, 2025). Contemporary developmental theories suggest that adolescents' moral functioning is closely linked to empathy, altruistic tendencies, parenting practices, and social interactions, all of which contribute to the emergence of prosocial and ethically guided behaviors (Carlo & Partoví, 2025; Padilla-Walker & Graaff, 2023).

Recent advances in developmental psychology have highlighted empathy as one of the central mechanisms underlying moral reasoning and prosocial engagement among adolescents. Empathy enables individuals to recognize and understand the emotional experiences of others, thereby facilitating compassionate responses, moral sensitivity, and socially constructive behavior. Empathic responsiveness has been associated with increased helping behavior, emotional regulation, and reduced aggression among adolescents (Eisenberg et al., 2024; Shafique et al., 2024). Scholars have argued that empathy serves as a bridge between moral cognition and actual moral conduct because adolescents who are capable of perspective-taking and emotional understanding are more likely to exhibit fairness, cooperation, and altruism in social contexts (I. et al., 2024; Silke et al., 2024). Moreover, empathy development is strongly affected by sociocultural environments and family systems, indicating that emotional competencies are shaped through continuous interaction with parents, peers, and educational institutions (Khalid et al., 2025; Sultan & Khan, 2025).

The relationship between empathy and prosocial behavior has attracted substantial scholarly attention in recent years. Prosocial behavior generally refers to voluntary actions intended to benefit others, including helping, sharing, cooperation, emotional support, and altruistic conduct. Developmental researchers have consistently demonstrated that adolescents with higher levels of empathy tend to display greater prosocial engagement and stronger moral orientations (Carlo, Knight, et al., 2022; Padilla-Walker & Graaff, 2023). Empathy promotes emotional connectedness and increases adolescents' motivation to respond positively to the needs of others, thereby strengthening social cohesion and moral responsibility (Morela et al., 2020; Shafique et al., 2024). In addition, prosocial behavior has been linked to positive psychosocial outcomes such as emotional well-being, social competence, and academic adjustment, whereas deficits in prosocial tendencies are often associated with behavioral problems and antisocial outcomes (Eisenberg et al., 2024; García et al., 2021).

The role of altruism and prosociality in adolescent development has become increasingly relevant in modern societies characterized by social diversity, technological transformation, and changing interpersonal relationships. Researchers have argued that altruistic actions reflect internalized moral standards and emotional maturity, making them important indicators of adolescent moral development (Carlo & Partoví, 2025; J. & Mahapatra, 2024). Contemporary evidence suggests that adolescents who engage in prosocial and altruistic behaviors demonstrate stronger emotional intelligence, more adaptive social functioning, and greater life satisfaction (Dewi et al., 2023; Kuzmenkova et al., 2021). Furthermore, prosociality appears to function as a protective factor against antisocial tendencies, delinquency, and emotional maladjustment (Botchkovar et al., 2025; Cardona-Isaza et al., 2023). Studies involving adolescent offenders have shown that reduced empathy and impaired prosocial tendencies are often associated with moral disengagement and problematic behavioral outcomes (Concha-Salgado et al., 2022; Gómez & Durán, 2024).

Parenting practices constitute another critical factor influencing adolescent moral development. Family interactions provide the earliest and most influential socialization context in which moral values, emotional regulation, and interpersonal norms are transmitted to children and adolescents. Parenting characterized by warmth, consistency, emotional responsiveness, and supportive discipline has been associated with higher empathy levels, stronger moral emotions, and greater prosocial behavior among adolescents (Carlo, García, et al., 2022; Dirham et al., 2024). Conversely, harsh, inconsistent,

E-ISSN: 2980-9681

or neglectful parenting practices may contribute to emotional dysregulation, reduced empathic concern, and increased antisocial tendencies (Liu, 2023; Matthys & Schutter, 2023). Longitudinal findings further indicate that positive parenting behaviors can facilitate the development of moral traits and prosocial orientations over time, particularly during early and middle adolescence (Carlo, Knight, et al., 2022).

Attachment theory and family systems perspectives also emphasize the importance of secure interpersonal relationships in the development of moral emotions and social competence. Adolescents who experience secure emotional attachment within the family environment are more likely to develop empathy, emotional stability, and constructive social relationships (Martins et al., 2021). Emotional security within the family facilitates adolescents' ability to regulate emotions, understand social expectations, and internalize moral values. Research has shown that adolescents raised in emotionally supportive environments exhibit higher levels of prosociality and moral responsibility compared with adolescents exposed to family conflict or emotional neglect (Jevtić & Milanović, 2021; Maiya et al., 2024). These findings suggest that parenting practices and family dynamics function as essential developmental foundations for adolescent morality and social behavior.

The study of moral development has also expanded into cross-cultural and multicultural contexts. Contemporary researchers increasingly acknowledge that empathy, altruism, and moral reasoning are shaped by cultural norms, social diversity, and collective values (Carlo, Hastings, et al., 2022; Khalid et al., 2025). Cultural experiences influence adolescents' perceptions of fairness, cooperation, and social responsibility, while diverse social environments may promote greater perspective-taking and empathic understanding. Studies examining adolescents from multicultural settings have demonstrated that exposure to cultural diversity can positively influence prosociality and moral cognition (Khalid et al., 2025; McGinley et al., 2020). Similarly, volunteering experiences and participation in socially meaningful activities have been associated with stronger prosocial values and moral engagement among adolescents and young adults (Kuzmenkova et al., 2021; Olmos-Gómez et al., 2023).

In recent years, developmental psychopathology research has further demonstrated that moral development and prosocial functioning are closely related to psychological adjustment and behavioral health. Adolescents with lower empathy levels and weaker prosocial orientations are more vulnerable to conduct problems, aggression, callous-unemotional traits, and antisocial behavior (Gómez & Durán, 2024; Matthys & Schutter, 2023). In contrast, prosocial tendencies appear to buffer against emotional and behavioral difficulties by promoting emotional connectedness and adaptive social functioning (Eisenberg et al., 2024). These findings underscore the importance of identifying psychosocial predictors of moral development during adolescence and designing interventions aimed at strengthening empathy and prosocial behavior.

At the same time, researchers have increasingly recognized the complexity and multidimensionality of moral development processes, leading to growing interest in advanced analytical approaches capable of capturing nonlinear and interactive relationships among psychological variables. Traditional statistical approaches have provided valuable insights into moral development; however, they may not fully explain the complex interplay among emotional, familial, and behavioral predictors. Consequently, machine learning methods have emerged as promising analytical tools in psychological and developmental research because they allow researchers to identify hidden patterns, multidimensional interactions, and predictive structures within large datasets (Guo et al., 2023; Nistor et al., 2024). Machine learning algorithms can analyze complex psychosocial variables simultaneously and generate highly accurate predictive models that may enhance understanding of adolescent developmental processes.

The integration of machine learning techniques into psychological science has expanded considerably in recent years, particularly in studies involving behavioral prediction, emotional functioning, and developmental outcomes. Machine learning models are capable of identifying relationships among variables that may remain undetected through conventional linear statistical analyses. Such approaches are especially valuable in the study of moral development because moral behavior emerges from dynamic interactions among emotional, cognitive, social, and familial processes (Botchkovar et al., 2025; Eisenberg et al., 2024). By applying predictive algorithms to variables such as empathy, parenting practices, and prosocial behavior, researchers may gain more comprehensive insights into the factors contributing to adolescent morality and ethical functioning.

Despite substantial progress in the literature, several important gaps remain. First, many previous studies have examined empathy, parenting practices, or prosocial behavior separately rather than investigating their combined

E-ISSN: 2980-9681

predictive role in adolescent moral development. Second, relatively few studies have integrated machine learning approaches into developmental psychology research focusing on adolescent morality. Third, the majority of existing studies have relied on traditional correlational analyses, limiting understanding of complex predictive interactions among psychosocial variables. Finally, there remains limited evidence regarding these relationships within non-Western and culturally diverse adolescent populations, highlighting the need for further empirical investigation.

Considering the growing importance of moral development in adolescence, the increasing relevance of empathy and prosociality in modern societies, and the emerging utility of machine learning techniques in psychological science, the present study aimed to analyze adolescent moral development using machine learning models based on empathy, parenting practices, and prosocial behavior among adolescents in Tehran.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a descriptive-correlational design with a predictive modeling approach based on machine learning algorithms. The primary objective was to analyze and predict adolescent moral development using empathy, parenting practices, and prosocial behavior as predictor variables. The statistical population consisted of adolescents enrolled in secondary schools in Tehran during the 2025–2026 academic year. Using multistage cluster random sampling, 412 adolescents were selected from different educational districts of Tehran. After screening for incomplete questionnaires and outliers, data from 398 participants were retained for final analysis. Inclusion criteria included being between 13 and 18 years of age, enrollment in a secondary educational institution, willingness to participate in the study, and completion of informed consent forms by both adolescents and their parents. Exclusion criteria included incomplete questionnaire responses and evidence of random response patterns. Ethical considerations were observed throughout the study, and participants were assured that all collected information would remain confidential and would be used solely for research purposes.

2.2. Measures

The Moral Development Scale was used to assess adolescents' level of moral development. This instrument was originally developed by Gibbs et al. in 1992 based on cognitive-developmental theories of morality. The scale consists of 30 items designed to evaluate dimensions of moral reasoning, moral judgment, and ethical decision-making. Responses are scored using a five-point Likert scale ranging from strongly disagree to strongly agree, with higher scores indicating more advanced levels of moral development. Several items are reverse scored to reduce response bias. Previous studies have reported satisfactory psychometric properties for the scale, including acceptable construct validity and internal consistency coefficients above 0.80. The validity and reliability of the instrument have also been confirmed in adolescent populations in different cultural contexts.

Empathy was measured using the Interpersonal Reactivity Index developed by Mark H. Davis in 1983. This instrument contains 28 items distributed across four subscales, including perspective taking, empathic concern, fantasy, and personal distress. Each subscale consists of seven items rated on a five-point Likert scale ranging from does not describe me well to describes me very well. Higher scores indicate greater empathic tendencies. The scale has been widely used in psychological and developmental studies involving adolescents and has demonstrated strong convergent validity with social and emotional functioning measures. Previous research has reported Cronbach's alpha coefficients ranging from 0.71 to 0.83 for the subscales, and the reliability and validity of the instrument have been confirmed in numerous international and regional studies.

Parenting practices were assessed using the Alabama Parenting Questionnaire developed by Shelby S. Shelton, Frick, and Wootton in 1996. The questionnaire includes 42 items measuring several parenting dimensions, including positive involvement, supervision and monitoring, positive discipline techniques, inconsistent discipline, and corporal punishment. Participants responded to the items using a five-point Likert scale ranging from never to always. Higher scores in positive parenting dimensions reflect healthier parenting practices, whereas higher scores in negative dimensions indicate maladaptive parenting behaviors. Previous studies have demonstrated satisfactory factorial validity and reliability for the instrument across adolescent samples. Internal consistency coefficients for the subscales have generally ranged from 0.67 to 0.86, and its applicability

E-ISSN: 2980-9681

in family and developmental psychology research has been consistently supported.

Prosocial behavior was measured using the Prosocial Tendencies Measure developed by Gustavo Carlo and Randall in 2002. The instrument contains 23 items evaluating multiple dimensions of prosocial tendencies, including public, anonymous, dire, emotional, compliant, and altruistic prosocial behaviors. Responses are rated on a five-point Likert scale ranging from strongly disagree to strongly agree. Higher scores represent greater engagement in prosocial behaviors and social helping tendencies. The instrument has demonstrated good psychometric characteristics in adolescent and young adult populations, with reported Cronbach's alpha values above 0.70 for most subscales. Previous investigations have confirmed the construct validity, criterion validity, and reliability of the measure in different cultural settings.

2.3. Data Analysis

Data analysis was conducted using Python programming language and SPSS-27 software. Initially, descriptive statistics including mean, standard deviation, skewness, and kurtosis were calculated for all study variables. Pearson correlation coefficients were computed to examine bivariate relationships among variables. Prior to implementing machine learning analyses, data preprocessing procedures including missing value treatment, normalization, and outlier detection were performed. Several supervised machine learning algorithms were employed to predict adolescent moral development, including Random Forest, Support Vector Machine, Gradient Boosting, and Artificial Neural Network models. The dataset was randomly divided into training and testing subsets using an 80/20 split procedure. Model performance was evaluated using multiple indices including accuracy, mean squared error, root mean square error, mean absolute error, and coefficient of determination (R^2). Feature importance analysis was also conducted to identify the relative contribution of empathy, parenting practices, and prosocial behavior variables in predicting moral development. Cross-validation techniques were applied to minimize overfitting and improve model generalizability. Statistical significance in conventional analyses was considered at $p < 0.05$.

3. Findings and Results

A total of 398 adolescents participated in the study, including 207 females (52.01%) and 191 males (47.99%). The mean age of participants was 15.84 years (SD = 1.47), with an age range between 13 and 18 years. Regarding educational level, 132 participants (33.17%) were studying in the first grade of secondary school, 139 participants (34.92%) in the second grade, and 127 participants (31.91%) in the third grade. In terms of parental educational status, 41.21% of fathers and 38.94% of mothers held university degrees. Furthermore, 68.09% of participants reported living in two-parent households, while 31.91% reported other family structures. Preliminary examination of the data indicated that skewness and kurtosis values for all study variables were within the acceptable range of ±2, confirming the normal distribution of the variables and the suitability of the data for parametric and machine learning analyses.

Table 1

Descriptive Statistics and Correlation Matrix for Study Variables

Variables	Mean	SD	1	2	3	4
1. Moral Development	108.42	14.63	—			
2. Empathy	86.71	11.58	.61**	—		
3. Positive Parenting Practices	129.35	17.42	.57**	.49**	—	
4. Prosocial Behavior	91.84	12.76	.65**	.68**	.53**	—

Table 1 presents the descriptive statistics and Pearson correlation coefficients for the primary study variables. The findings demonstrated that adolescents reported relatively high levels of moral development, empathy, positive parenting practices, and prosocial behavior. Among the predictor variables, prosocial behavior showed the strongest positive correlation with moral development ($r = .65$, $p < .01$), indicating that adolescents who engaged more frequently in helping and cooperative behaviors also exhibited more advanced moral reasoning and ethical functioning. Empathy was also strongly associated with moral development ($r = .61$, $p < .01$), suggesting that emotional understanding and perspective-taking capacities play a significant role in adolescent moral growth. Positive parenting practices demonstrated a moderate-to-strong positive relationship with moral development ($r = .57$, $p <$

E-ISSN: 2980-9681

.01), indicating that supportive and consistent parental behaviors contribute substantially to adolescents' moral functioning. In addition, empathy was positively correlated with prosocial behavior ($r = .68$, $p < .01$), reflecting the interconnected nature of emotional responsiveness and socially constructive behavior during adolescence. The positive correlations among all predictor variables supported the conceptual framework of the study and provided preliminary evidence for the predictive modeling analyses conducted in subsequent stages.

Table 2

Performance Indicators of Machine Learning Models in Predicting Adolescent Moral Development

Model	Accuracy	MAE	RMSE	R^2
Random Forest	0.89	4.17	5.48	0.81
Support Vector Machine	0.84	5.31	6.74	0.73
Gradient Boosting	0.91	3.89	5.02	0.85
Artificial Neural Network	0.87	4.48	5.83	0.79

The findings presented in Table 2 indicate that all machine learning algorithms demonstrated acceptable predictive capability in estimating adolescent moral development based on empathy, parenting practices, and prosocial behavior variables. Among the evaluated models, the Gradient Boosting algorithm exhibited the strongest overall performance, achieving the highest accuracy rate (0.91) and the highest coefficient of determination ($R^2 = 0.85$), while simultaneously producing the lowest prediction errors (MAE = 3.89; RMSE = 5.02). These results indicate that the Gradient Boosting model was able to explain approximately 85% of the variance in adolescent moral development scores. The Random Forest model also showed substantial predictive power with an accuracy of 0.89 and an R^2 value of 0.81, suggesting that ensemble-based learning methods were particularly effective for modeling the complex relationships among the study variables. Although the Artificial Neural Network model demonstrated relatively strong performance, its prediction accuracy remained slightly lower than the ensemble methods. The Support Vector Machine model produced the weakest performance among the tested algorithms, with an R^2 value of 0.73 and comparatively higher prediction error values. Overall, the results confirmed that machine learning approaches can effectively identify psychological and familial predictors associated with adolescent moral development and provide accurate predictive models for developmental and behavioral outcomes.

Table 3

Feature Importance Values for Predicting Adolescent Moral Development in the Gradient Boosting Model

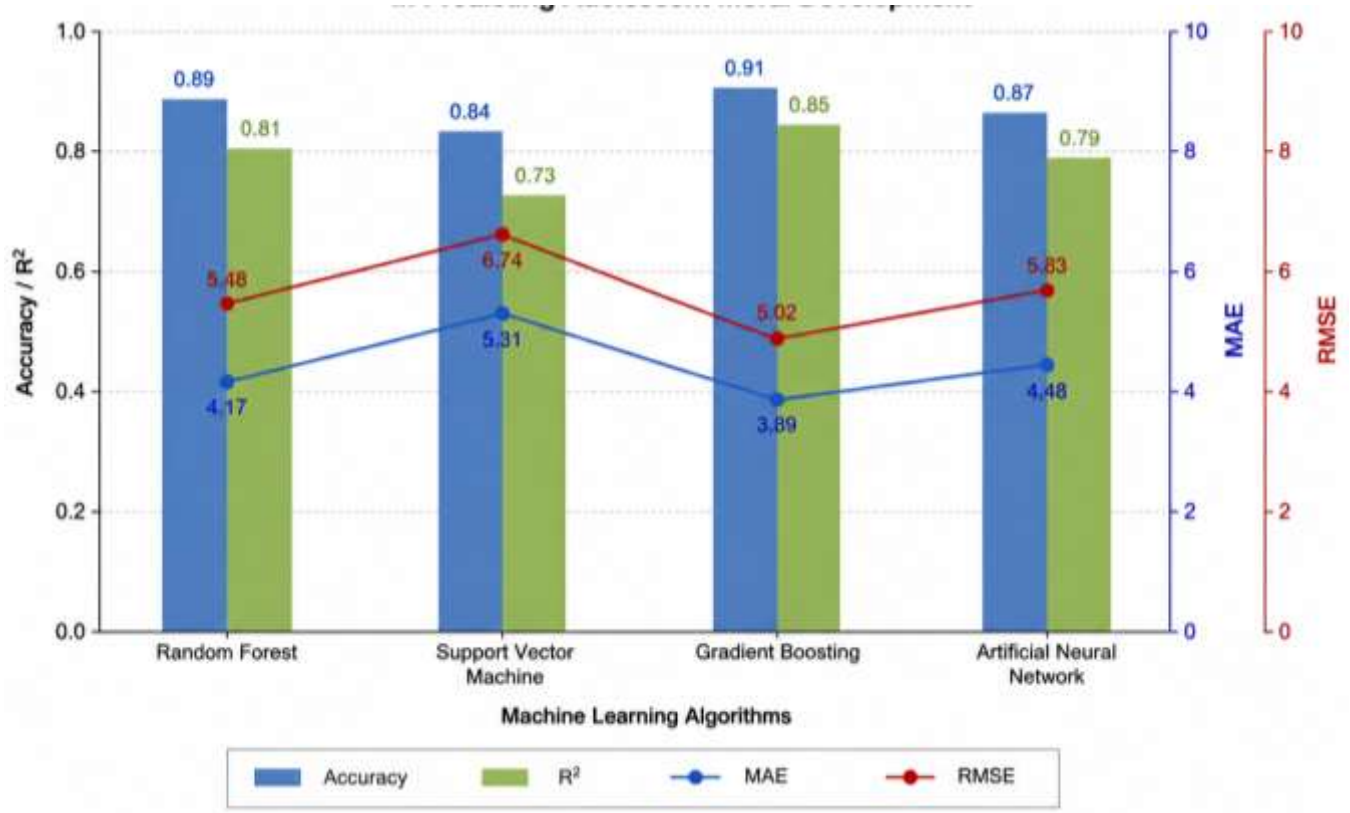
Predictor Variable	Importance Score
Prosocial Behavior	0.38
Empathy	0.34
Positive Parenting Practices	0.28

The feature importance analysis derived from the Gradient Boosting model demonstrated that prosocial behavior was the strongest predictor of adolescent moral development, with an importance score of 0.38. This finding suggests that adolescents who frequently engage in helping, cooperative, and altruistic behaviors are more likely to demonstrate advanced moral reasoning and ethical decision-making capacities. Empathy emerged as the second most influential predictor, with an importance value of 0.34, indicating that emotional understanding, empathic concern, and perspective-taking substantially contribute to moral developmental processes during adolescence. Positive parenting practices also contributed significantly to the predictive model, with an importance score of 0.28, highlighting the role of supportive, consistent, and emotionally responsive parenting in fostering adolescents' moral competencies. Although all three variables meaningfully contributed to the model, the findings indicate that interpersonal and socially oriented behaviors had comparatively greater predictive power than family-related variables alone. These results support developmental theories emphasizing the interaction between emotional competencies, social behavior, and family environment in shaping moral functioning during adolescence.

E-ISSN: 2980-9681

Figure 1

Comparative Performance of Machine Learning Algorithms in Predicting Adolescent Moral Development



The graphical comparison of machine learning algorithms illustrated that ensemble-based models, particularly Gradient Boosting and Random Forest, consistently outperformed other algorithms across all evaluation indicators. The figure demonstrated lower prediction errors and higher explained variance values for these models relative to the Support Vector Machine and Artificial Neural Network models. The visual pattern further highlighted the stability and efficiency of Gradient Boosting in modeling multidimensional psychological and behavioral variables. In addition, the figure showed relatively small differences between the top-performing models, suggesting that multiple machine learning techniques may be suitable for predicting adolescent moral development when theoretically relevant psychosocial variables are included. Overall, the visual findings reinforced the statistical results reported in the previous tables and provided additional evidence regarding the robustness of machine learning methods in developmental psychology research.

4. Discussion and Conclusion

The present study aimed to analyze adolescent moral development using machine learning models based on empathy, parenting practices, and prosocial behavior among adolescents in Tehran. The findings demonstrated that all study variables were positively and significantly associated with moral development, with prosocial behavior emerging as the strongest predictor, followed by empathy and positive parenting practices. Furthermore, the machine learning analyses revealed that the Gradient Boosting model demonstrated the highest predictive accuracy among the tested algorithms, indicating that moral development in adolescence can be effectively predicted through multidimensional psychosocial variables. Overall, the findings emphasized the interconnected role of emotional responsiveness, family dynamics, and socially constructive behavior in shaping adolescent moral functioning.

One of the major findings of the study was the significant positive relationship between empathy and adolescent moral development. Adolescents with higher levels of empathy demonstrated more advanced moral reasoning, stronger

E-ISSN: 2980-9681

ethical sensitivity, and greater engagement in socially responsible behavior. This finding is consistent with previous developmental and social psychological research emphasizing the central role of empathy in moral cognition and moral action (Eisenberg et al., 2024; Sultan & Khan, 2025). Empathy enables adolescents to recognize the emotional experiences of others, which subsequently increases feelings of compassion, fairness, and interpersonal responsibility. From a developmental perspective, empathy contributes to the internalization of moral standards because emotionally responsive adolescents are more likely to consider the consequences of their behavior on others and avoid harmful actions.

The findings also align with the work of (Shafique et al., 2024) and (I. et al., 2024), who reported that empathic responsiveness significantly predicts prosocial orientation and social adjustment among adolescents and university students. Adolescents who are capable of perspective-taking and emotional understanding may develop stronger interpersonal bonds and exhibit more cooperative and altruistic behavior. Furthermore, the current findings support the argument proposed by (Silke et al., 2024) that empathy is influenced not only by individual emotional capacities but also by social experiences, environmental opportunities, and relational contexts that facilitate compassionate responding. Therefore, empathy should be considered both a developmental competency and a socially cultivated process that contributes substantially to moral functioning.

Another important finding of the present study was the strong predictive role of prosocial behavior in adolescent moral development. Prosocial behavior emerged as the strongest predictor in the machine learning model, indicating that adolescents who frequently engage in helping, sharing, cooperation, and supportive social interactions exhibit more advanced moral functioning. This result is consistent with previous studies demonstrating that prosocial tendencies represent observable manifestations of internalized moral values and ethical reasoning (Carlo & Partoví, 2025; Padilla-Walker & Graaff, 2023). Prosocial actions may strengthen adolescents' moral identity because repeated engagement in socially constructive behavior reinforces empathy, responsibility, and social connectedness.

The current findings are also supported by the studies of (Olmos-Gómez et al., 2023) and (Dewi et al., 2023), which reported that adolescents and young adults with higher prosocial tendencies demonstrate stronger emotional well-being, interpersonal competence, and moral responsibility. In addition, the findings correspond with research indicating that altruistic behaviors serve as protective factors against antisocial tendencies and behavioral maladjustment (Botchkovar et al., 2025; García et al., 2021). Adolescents who develop habitual patterns of helping and cooperation are more likely to internalize social norms and develop stable moral orientations. The findings additionally support the theoretical perspectives proposed by (Carlo, Hastings, et al., 2022) and (Carlo, García, et al., 2022), who emphasized the developmental significance of prosocial behavior across cultural and social contexts.

The positive association between parenting practices and moral development represents another important contribution of the study. Adolescents who reported more positive parenting experiences, including emotional support, supervision, consistency, and constructive discipline, demonstrated higher levels of moral development. This finding is consistent with social learning and attachment-based theories emphasizing the importance of family interactions in the development of emotional and moral competencies (Dirham et al., 2024; Martins et al., 2021). Positive parenting environments may facilitate adolescents' emotional security and moral internalization by providing supportive relational models and opportunities for social learning.

The findings correspond with the longitudinal evidence presented by (Carlo, Knight, et al., 2022), which demonstrated that parental use of supportive and rewarding practices contributes to the development of prosocial tendencies and moral traits among adolescents over time. Adolescents raised in emotionally responsive families are more likely to develop empathy, emotional regulation skills, and socially responsible behavior patterns. In contrast, ineffective parenting practices may hinder the development of moral sensitivity and increase vulnerability to emotional and behavioral problems (Liu, 2023; Matthys & Schutter, 2023). Therefore, family functioning appears to provide a critical developmental foundation for adolescent moral growth.

The findings also support broader developmental perspectives suggesting that moral development is not an isolated cognitive process but rather a multidimensional construct shaped through the interaction of emotional, behavioral, familial, and cultural influences. Research conducted by (Khalid et al., 2025) emphasized the importance of cultural diversity and social context in shaping adolescents' prosociality and moral understanding. Similarly, (McGinley et al., 2020) demonstrated that social integration experiences influence multidimensional

E-ISSN: 2980-9681

prosocial behaviors among adolescents. The present study extends these perspectives by demonstrating that emotional and social variables can collectively predict moral development with substantial accuracy through advanced computational methods.

The machine learning findings constitute one of the most significant aspects of the study. The results indicated that the Gradient Boosting model outperformed the other algorithms in predicting adolescent moral development. This finding suggests that the relationships among empathy, parenting practices, prosocial behavior, and moral functioning are highly interactive and nonlinear. Traditional statistical approaches may be insufficient for capturing these complex developmental dynamics, whereas machine learning techniques are capable of identifying hidden patterns and multidimensional predictive relationships. The superior performance of ensemble-based models such as Gradient Boosting and Random Forest indicates that adolescent moral development emerges from multiple interacting psychosocial mechanisms rather than isolated predictors.

The effectiveness of machine learning approaches observed in the present study is theoretically consistent with the complexity of developmental processes. Adolescence is characterized by rapid emotional, social, and cognitive changes, making behavioral outcomes highly dynamic and multifactorial. Consequently, predictive models capable of analyzing nonlinear interactions may provide more accurate and comprehensive explanations of adolescent behavior. The findings therefore support recent efforts to integrate computational methods into psychological and educational research in order to improve prediction accuracy and theoretical understanding of developmental phenomena.

The current results also contribute to the literature concerning moral disengagement and antisocial tendencies. Previous studies have shown that reduced empathy and impaired prosociality are associated with callous-unemotional traits, aggression, and delinquent behavior among adolescents (Concha-Salgado et al., 2022; Gómez & Durán, 2024). The present findings indirectly support these observations by demonstrating that empathy and prosocial behavior positively predict moral development. Adolescents who lack empathic sensitivity and prosocial orientation may struggle to internalize moral standards and regulate socially inappropriate behavior. This interpretation is also supported by the findings of (Cardona-Isaza et al., 2023), who highlighted the mediating role of rational decision-making between empathy and prosocial behavior among adolescent offenders.

Another important implication of the findings relates to educational and social interventions aimed at promoting adolescent moral development. The findings suggest that interventions designed to strengthen empathy, social cooperation, and positive parenting practices may significantly contribute to adolescents' ethical and psychosocial growth. Educational systems and family-based programs should therefore emphasize emotional education, perspective-taking, and cooperative social experiences as central components of adolescent development. The findings also align with the arguments proposed by (Fedorko, 2021) and (Jevtić & Milanović, 2021), who emphasized the importance of educational environments in promoting prosocial personality development and moral learning.

The study further supports theoretical models emphasizing the role of moral emotions in developmental adjustment. Researchers such as (Fitouchi et al., 2021) and (Maggi et al., 2022) have argued that emotions such as empathy, guilt, compassion, and shame function as regulatory mechanisms guiding moral behavior. Adolescents who possess stronger emotional awareness may be more capable of evaluating the social consequences of their actions and engaging in ethically responsible behavior. The present findings reinforce this perspective by demonstrating that emotional responsiveness significantly contributes to moral functioning and predictive accuracy.

Moreover, the findings concerning prosociality and altruistic tendencies are consistent with research demonstrating that adolescents' moral orientations are closely linked to social connectedness and interpersonal engagement (Morela et al., 2020; Nistor et al., 2024). Adolescents who participate in helping behaviors and socially constructive activities may develop stronger moral identities through repeated reinforcement of cooperative and compassionate values. These experiences likely strengthen emotional regulation and increase adolescents' sensitivity toward social norms and ethical expectations.

Although the findings of the present study contribute substantially to the literature, several limitations should be acknowledged. First, the cross-sectional nature of the study limits the ability to establish causal relationships among empathy, parenting practices, prosocial behavior, and moral development. Second, the study relied on self-report measures, which may have been influenced by social desirability bias and subjective interpretation. Third, the participants were selected exclusively from adolescents in Tehran, which may limit the generalizability of the findings to adolescents from other cultural or socioeconomic

E-ISSN: 2980-9681

contexts. Additionally, although machine learning models demonstrated strong predictive accuracy, the inclusion of additional psychological, educational, and environmental variables may further improve prediction performance in future studies.

Future research should employ longitudinal and experimental designs to examine developmental changes in adolescent morality across different stages of adolescence. Researchers are also encouraged to investigate additional psychosocial variables such as emotional intelligence, peer relationships, school climate, digital media exposure, and cultural identity in relation to moral development. Comparative cross-cultural studies could provide further insight into how social and cultural contexts influence empathy, prosocial behavior, and moral reasoning. Moreover, future studies should continue integrating advanced machine learning approaches with developmental psychology frameworks to improve predictive precision and theoretical understanding of adolescent behavior.

From a practical perspective, the findings highlight the importance of implementing educational and family-based interventions aimed at strengthening empathy and prosocial behavior among adolescents. Schools should incorporate emotional learning programs, cooperative activities, and moral education curricula that encourage perspective-taking, compassion, and social responsibility. Parents should also receive guidance regarding supportive parenting strategies that promote emotional security, constructive discipline, and healthy communication with adolescents. Mental health professionals, educators, and policymakers may benefit from using machine learning-based assessment approaches to identify adolescents who may be at risk for impaired moral development or behavioral maladjustment and to design targeted preventive interventions accordingly.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

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

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

We hereby thank all individuals for participating and cooperating us in this study.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

References

Botchkovar, E. V., Antonaccio, O., Hughes, L. A., & Timmer, A. (2025). Why They Do It and Why They Don't: Self-Interest vs. Altruistic Tendencies as Explanations of Criminal Behavior. *European Journal of Criminology*, *22*(3), 452-477. https://doi.org/10.1177/14773708241310393

Cardona-Isaza, A. d. J., Barrón, R. G., & Montoya-Castilla, I. (2023). Empathy and Prosocial Behavior in Adolescent Offenders: The Mediating Role of Rational Decisions. *Sage Open*, *13*(4). https://doi.org/10.1177/21582440231202844

Carlo, G., García, P. S., Malonda, E., Mestre, A., Tur-Porcar, A., & Mestre, M. V. (2022). Longitudinal Paths Between Parents' Use of Rewards and Young Adolescents' Moral Traits and Prosocial Behaviors. *Journal of adolescence*, *94*(8), 1096-1107. https://doi.org/10.1002/jad.12086

Carlo, G., Hastings, P. D., Dicus, J. L., & Ugarte, E. (2022). Development, Culture, and Neurobiology of Moral Emotions in Ethnic/Racial Minority Children. 526-541. https://doi.org/10.1093/oxfordhb/9780198855903.013.2

Carlo, G., Knight, G. P., & Davis, A. N. (2022). Kindness Towards All: Prosocial Behaviors to Address U.S. Latinx Youth Social Inequities. 129-148. https://doi.org/10.1016/bs.acdb.2022.04.002

Carlo, G., & Partoví, R. (2025). Varieties of Altruistic Actions Across Development and Culture / <i>Variedades De Acciones Altruistas a Lo Largo Del Desarrollo Y Entre Culturas</I>. *Journal for the Study of Education and Development Infancia Y Aprendizaje*, *48*(1), 3-35. https://doi.org/10.1177/02103702241304926

Concha-Salgado, A., Ramírez, A. M., Pérez, B., Pérez-Luco, R., & García-Cueto, E. (2022). Moral Disengagement as a Self-Regulatory Cognitive Process of Transgressions: Psychometric Evidence of the Bandura Scale in Chilean Adolescents. *International journal of environmental research and public health*, *19*(19), 12249. https://doi.org/10.3390/ijerph191912249

Dewi, E. K., Santosa, T. T., & Rusmawati, D. (2023). The Relationship Between Gender, Age, and Prosocial Behavior in College Students. *Proc. Int. Conf. Of Psy. Stu.*, *4*, 87-95. https://doi.org/10.58959/icpsyche.v4i1.27

E-ISSN: 2980-9681

Dirham, I. F., Izzaty, R. E., & Nurmiati, N. (2024). The Effect of Authoritative Parenting and Self-Esteem on Prosocial Behavior in Adolescents in Palopo City. *Enrichment Journal of Multidisciplinary Research and Development*, *2*(7). https://doi.org/10.55324/enrichment.v2i7.162

Eisenberg, N., Zuffianò, A., & Spinrad, T. L. (2024). Are Prosocial Tendencies Relevant for Developmental Psychopathology? The Relations of Prosocial Behavior and Empathy-Related Responding to Externalizing Problems, Internalizing Problems, and Autism Spectrum Disorder. *Development and Psychopathology*, *36*(5), 2207-2217. https://doi.org/10.1017/s0954579424000063

Fedorko, V. (2021). Determination of Prosocial Behavior of Preschool-Aged Children in the Context of Preschool Education. https://doi.org/10.5507/vup.21.24459974

Fitouchi, L., André, J. B., & Baumard, N. (2021). Are There Really So Many Moral Emotions? Carving Morality at Its Functional Joints. https://doi.org/10.31234/osf.io/2phzt

García, P. S., Llorca, A., Malonda, E., & Mestre, M. V. (2021). Examining the Predictors of Prosocial Behavior in Young Offenders and Nonoffenders. *International Journal of Behavioral Development*, *45*(4), 299-309. https://doi.org/10.1177/0165025421995930

Gómez, A. S., & Durán, N. (2024). Association Between Callous-Unemotional Traits, Empathy, and Moral Disengagement Mechanisms in Juvenile Offenders. *Anuario de Psicología Jurídica*, *34*(2), 85-95. https://doi.org/10.5093/apj2023a7

Guo, Q., Li, S., Liang, J., Yu, X., & Lv, Y. (2023). Mindfulness May Be Associated With Less Prosocial Engagement Among High Intelligence Individuals. *Scientific reports*, *13*(1). https://doi.org/10.1038/s41598-023-31039-3

I., S., Kumari, J. M. U., Chauhan, R., S., H. K., Pandey, A., & T., S. (2024). Relationship Between Empathy and Prosocial Behavior. *International Journal for Multidisciplinary Research*, *6*(6). https://doi.org/10.36948/ijfmr.2024.v06i06.30999

J., S., & Mahapatra, M. (2024). Altruism, Social Maturity and Life Satisfaction Among Teenagers. *International Journal for Multidisciplinary Research*, *6*(3). https://doi.org/10.36948/ijfmr.2024.v06i03.19923

Jevtić, B., & Milanović, N. (2021). Teachers at Work – Developing a Prosocial Personality. *European Journal of Education and Pedagogy*, *2*(3), 73-79. https://doi.org/10.24018/ejedu.2021.2.3.117

Khalid, H., Valoojerdy, Z. K., Talwar, V., & Bosacki, S. (2025). The Role of Cultural Diversity in Adolescents' Theory of Mind (ToM) and Prosociality: A Review of the Literature. https://doi.org/10.21203/rs.3.rs-7357691/v1

Kuzmenkova, M., Veselova, E. K., Korzhova, E., Artemeva, V., & Dvoretskaya, M. Y. (2021). Moral and Emotional Characteristics of Students With Different Attitudes to Volunteering. 53-61. https://doi.org/10.15405/epsbs.2021.06.04.7

Liu, Y. (2023). The Symptomatology and Psychosocial Risk Factors in Developing Callous-Unemotional Trait During Childhood and Adolescence. *Lecture Notes in Education Psychology and Public Media*, *23*(1), 316-323. https://doi.org/10.54254/2753-7048/23/20230503

Maggi, S., Zaccaria, V., Breda, M., Romani, M., Aceti, F., Giacchetti, N., Ardizzone, I., & Sogos, C. (2022). A Narrative Review About Prosocial and Antisocial Behavior in Childhood: The Relationship With Shame and Moral Development. *Children*, *9*(10), 1556. https://doi.org/10.3390/children9101556

Maiya, S., Streit, C., & Kline, G. C. (2024). Sibling Relationship Qualities and Prosocial Behaviors in Asian Indian College Students: Intervening Roles of Family Respect Values and Empathy. *Journal of Social and Personal Relationships*, *43*(1), 141-161. https://doi.org/10.1177/02654075241298713

Martins, M. C., Santos, A. F., Fernandes, M. l., & Veríssimo, M. (2021). Attachment and the Development of Moral Emotions in Children and Adolescents: A Systematic Review. *Children*, *8*(10), 915. https://doi.org/10.3390/children8100915

Matthys, W., & Schutter, D. J. (2023). Moral Thinking and Empathy in Cognitive Behavioral Therapy for Children and Adolescents With Conduct Problems: A Narrative Review. *Clinical Child and Family Psychology Review*, *26*(2), 401-415. https://doi.org/10.1007/s10567-023-00429-4

McGinley, M., Davis, A. N., Carlo, G., Schwartz, S. J., Lorenzo-Blanco, E. I., Unger, J. B., Szapocznik, J., Báezconde-Garbanati, L., Soto, D. W., Rosiers, S. E. D., Villamar, J. A., & Lizzi, K. M. (2020). A Parallel Process Model of Integration and Multidimensional Prosocial Behaviors in Recent Immigrant U.S. Latinx Adolescents. *Psychological Reports*, *124*(3), 1237-1267. https://doi.org/10.1177/0033294120928268

Morela, E., Hatzigeorgiadis, A., Theodorakis, Y., Γούδας, M., & Elbe, A. M. (2020). Youth Sport Motivational Climate and Attitudes Toward Migrants' Acculturation: The Role of Empathy and Altruism. *Journal of Applied Social Psychology*, *51*(1), 32-41. https://doi.org/10.1111/jasp.12713

Nistor, G., Anghel, M., & Popa, M. (2024). Identifying the Prosocial Orientations That Influence Choice of University Studies in the Social Field for Sustainable Educational Integration. *Sustainability*, *16*(4), 1462. https://doi.org/10.3390/su16041462

Olmos-Gómez, M. d. C., Garzón, F. R., Azancot-Chocrón, D., & López-Cordero, R. (2023). Prosocial Behaviour Axioms and Values: Influence of Gender and Volunteering. *Psicologia Reflexão E Crítica*, *36*(1). https://doi.org/10.1186/s41155-023-00258-y

Padilla-Walker, L. M., & Graaff, J. V. d. (2023). Prosocial Behavior During Adolescence and the Transition to Adulthood. 559-572. https://doi.org/10.1037/0000298-034

Shafique, M., Firdos, S. S., & Imtiaz, M. (2024). Interplay Between Empathy and Pro-Social Behavior Among Undergraduate University Students. *Pakistan Journal of Humanities and Social Sciences*, *12*(2). https://doi.org/10.52131/pjhss.2024.v12i2.2142

Silke, C., Brady, B., Dolan, P., & Boylan, C. (2024). Empathy Rules, Maps and Paths: A Qualitative Exploration of the Factors That Facilitate or Inhibit Empathy and Prosocial Responding Among Youth. *Journal of Community Psychology*, *52*(2), 326-343. https://doi.org/10.1002/jcop.23106

Sultan, M. A., & Khan, N. (2025). Rethinking Empathy Development in Childhood and Adolescence: A Call for Global, Culturally Adaptive Strategies. *Frontiers in psychology*, *16*. https://doi.org/10.3389/fpsyg.2025.1575249

E-ISSN: 2980-9681