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Modeling Risk-Taking Behaviors Based on Brain-Behavioral Systems and Emotion Regulation: The Mediating Role of Perceived Social Support in Junior High School Female Students

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ABSTRACT

Risk-taking behaviors during adolescence are major concerns for mental health and academic functioning and have adverse consequences for individuals and society. This study aimed to model the relationships of brain-behavioral systems and emotion regulation with the tendency toward risk-taking behaviors, with perceived social support as a mediator, among female junior high school students. This descriptive-correlational study used structural equation modeling and included 318 female students in grades 7–9 at schools in Babolsar County during the 2023–2024 academic year (1402–1403 in the Iranian calendar), selected through multistage cluster random sampling. The research instruments comprised the Armstrong Risk Behavior Questionnaire, the Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet et al., Carver and White's BIS/BAS Scales, and Gross and John's Emotion Regulation Questionnaire. Data were analyzed using partial least squares structural equation modeling (PLS-SEM) in SPSS version 27 and SmartPLS version 4. Brain-behavioral systems ($\beta = -0.287$, $T = 5.068$), emotion regulation ($\beta = -0.260$, $T = 4.972$), and social support ($\beta = -0.246$, $T = 4.176$) had significant negative direct effects on risk-taking behaviors. The indirect effects of brain-behavioral systems ($\beta = -0.085$, $T = 3.485$) and emotion regulation ($\beta = -0.110$, $T = 3.688$) through social support were also significant ($p < 0.05$ for all paths). The model demonstrated satisfactory fit, reliability, convergent validity, and predictive power. Perceived social support partially mediates the relationships of brain-behavioral systems and emotion regulation with risk-taking behaviors. Preventive programs focusing on strengthening family and peer social support networks, alongside training in emotion regulation strategies, are recommended to reduce risk-taking behaviors among female students.

Keywords: Risk-taking behavior; Brain-behavioral system; Emotion regulation; Social support; Adolescence

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Introduction

Adolescence is a critical developmental period characterized by rapid and interconnected biological, cognitive, emotional, and social transformations that substantially influence behavioral choices, interpersonal relationships, identity development, and adaptation to environmental demands. Although increasing independence, novelty seeking, exploration, and experimentation constitute normative aspects of adolescent development, these tendencies may also increase vulnerability to behaviors that threaten psychological, physical, educational, and social well-being. Risk-taking behaviors encompass a broad range

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of actions through which adolescents expose themselves to potentially harmful consequences in pursuit of immediate reward, emotional relief, social acceptance, excitement, or experimentation. Such behaviors may include substance use, aggression, unsafe sexual activity, rule-breaking, dangerous driving, and other forms of impulsive or hazardous conduct. Their emergence cannot be adequately explained by a single psychological characteristic because adolescent risk-taking develops within a complex system in which neurobehavioral sensitivities, cognitive-emotional capacities, family conditions, peer relationships, and perceived access to supportive resources interact with one another. Accordingly, contemporary research increasingly approaches risk-taking as a multidimensional phenomenon whose explanation requires the simultaneous consideration of vulnerability and protective processes. Evidence among adolescent populations indicates that individual tendencies toward risk-taking are associated not only with personality and behavioral dispositions but also with the quality of social relationships and the extent to which adolescents perceive themselves as supported, accepted, and protected within their interpersonal environment (1). This multidimensional perspective is particularly relevant for female adolescents in junior high school because early adolescence represents a transitional stage in which increasing sensitivity to peers and social evaluation occurs alongside continuing dependence on family relationships and still-developing capacities for self-regulation.

One important framework for understanding individual differences in adolescent risk-taking is the brain-behavioral systems perspective, which conceptualizes behavior in terms of motivational systems governing sensitivity to reward and punishment. Within this framework, behavioral activation processes facilitate approach toward potentially rewarding stimuli, whereas behavioral inhibition processes contribute to caution, conflict detection, sensitivity to punishment, and avoidance of potentially adverse consequences. Individual differences in the relative sensitivity of these systems may therefore shape how adolescents respond to opportunities involving novelty, excitement, immediate gratification, or possible negative outcomes. During adolescence, heightened reward responsiveness and increasing motivational salience of social and emotional stimuli can coincide with comparatively immature regulatory capacities, creating conditions in which immediate rewards may exert disproportionate influence over behavior. Research has consequently examined brain-behavioral systems as important predictors of risk-taking. Abedinzadeh et al. demonstrated that brain-behavioral systems were meaningfully associated with risk-taking among secondary school students within a model that also incorporated dark personality characteristics and the mediating role of thought control ability, suggesting that neurobehavioral sensitivities do not operate in isolation but are linked with higher-order psychological regulatory processes (2). Similarly, Moghadami Choobkhaluei et al. developed a model of adolescents' tendency toward risk-taking based on brain-behavioral systems and showed that parenting styles could operate as mediating mechanisms, indicating that the behavioral expression of underlying neuropsychological sensitivities may be modified by the relational environment in which adolescents develop (3). These findings support a framework in which brain-behavioral systems constitute an important biological or temperamental foundation of risk-taking while leaving substantial room for emotional and interpersonal factors to modify their behavioral consequences.

Further evidence suggests that the relationship between brain-behavioral functioning and risk-taking may depend partly on the adolescent's capacity to regulate cognition, emotion, and action. Mozaffari examined

adolescent risk-taking in relation to brain-behavioral systems and executive functions while considering emotion regulation and hedonism as mediating variables, thereby emphasizing that behavioral sensitivity to reward or punishment is embedded within broader regulatory processes (4). From this perspective, heightened responsiveness to incentives does not inevitably produce maladaptive behavior; rather, the behavioral outcome may depend on whether adolescents are capable of evaluating consequences, managing emotional arousal, delaying immediate gratification, and mobilizing effective coping strategies. This distinction is important because it shifts the explanatory focus from deterministic interpretations of neurobehavioral sensitivity toward a transactional model in which biological predispositions interact with modifiable psychological and social resources. Rahimi likewise proposed an integrative model linking brain-behavioral systems and emotion regulation to risk-taking behaviors through perceived social support among female junior high school students, highlighting the theoretical value of examining these domains simultaneously rather than as independent predictors (5). Such an approach is consistent with the broader biopsychosocial understanding of adolescent behavior because it recognizes that vulnerability arising from motivational sensitivity may be strengthened, weakened, or redirected through regulatory abilities and interpersonal support.

Emotion regulation is one of the most important psychological processes through which adolescents manage internal states and respond adaptively to challenging situations. Emotion regulation refers to processes involved in influencing which emotions are experienced, when they occur, how intensely they are experienced, and how they are expressed or modified. Gross's influential conceptualization emphasizes that emotion regulation can occur at different points in the emotion-generative process and that regulatory strategies may have different consequences for affective experience, cognition, interpersonal functioning, and subsequent behavior (6). Cognitive reappraisal, for example, involves changing the interpretation of an emotionally relevant situation in ways that alter its emotional impact, whereas expressive suppression primarily involves inhibiting the external expression of an already-generated emotional response. These strategies can differ in their adaptiveness, psychological cost, and implications for behavior. During adolescence, effective emotion regulation is especially consequential because young people increasingly encounter emotionally charged interpersonal situations, academic pressures, autonomy conflicts, peer evaluation, and identity-related challenges. When adolescents are unable to tolerate, interpret, or regulate intense emotional states, risk-taking behaviors may function as short-term mechanisms for reducing distress, obtaining stimulation, escaping unwanted affect, restoring perceived control, or gaining social reinforcement. In contrast, adaptive regulatory strategies can increase the capacity to pause, reinterpret situations, consider alternatives, and resist impulsive responses when immediate emotional pressures are strong.

Empirical findings consistently connect emotion regulation with different forms of adolescent risk-taking. Ordoubadi and Mohammadi-Soureh reported that cognitive emotion regulation strategies were associated with risk-taking behaviors among adolescents and young people, reinforcing the proposition that the manner in which emotional experiences are cognitively managed has direct behavioral implications (7). Raeisi and Darakhshan Houre further examined cognitive emotion regulation within a structural framework and showed its relevance to adolescent risk-taking while incorporating metaphorical time perception as a mediating mechanism, illustrating that regulatory processes may influence risky choices through

adolescents' broader cognitive representations of consequences and temporal experience (8). Evidence from more specific forms of risk behavior also supports this relationship. Zare et al. found that cognitive emotion regulation strategies mediated the association between attachment styles and risky sexual behaviors, suggesting that interpersonal developmental experiences may influence risk not only directly but also through the regulatory strategies adolescents and young people develop for managing emotional activation (9). Noruzi and Janjani similarly demonstrated the importance of emotion regulation difficulty in explaining the relationships among attachment styles, anger rumination, and risk-taking behaviors in female adolescents, indicating that emotional dysregulation may serve as a central pathway through which relational and cognitive vulnerabilities become behaviorally expressed (10). In a broader adolescent health context, Singh found that emotion regulation difficulties, perceived parenting, and personality characteristics significantly predicted health-risk behaviors, further demonstrating that emotion regulation should be understood within an interpersonal and dispositional system rather than as an isolated intrapersonal skill (11).

The importance of interpersonal context is particularly evident when considering perceived social support. Perceived social support refers to an individual's belief that supportive resources are available from meaningful others when needed, including emotional reassurance, understanding, companionship, advice, and practical assistance. The distinction between objectively received support and perceived support is important because behavior may be influenced not only by the actual presence of family members, peers, or significant others but also by the adolescent's subjective confidence that these relationships are dependable and responsive. During adolescence, social networks undergo substantial reorganization. Family remains a major source of emotional security, behavioral guidance, and protection, while peer relationships become increasingly central to belonging, self-evaluation, identity, and everyday decision-making. Consequently, insufficient support, peer rejection, family conflict, or perceived isolation may increase vulnerability to maladaptive coping and affiliation with risk-promoting contexts, whereas reliable and emotionally responsive relationships may reduce risk through supervision, emotional buffering, adaptive modeling, and increased access to constructive coping alternatives. Zaaddahesh and Babakhani found a meaningful relationship between perceived social support and adolescents' risk-taking behaviors using canonical analysis, demonstrating that different dimensions of perceived interpersonal support are relevant to a broad pattern of risky conduct (12). More recently, Ghorbani et al. showed that social support, together with religiosity and peer rejection, contributed to the prediction of risk-taking behaviors among female secondary school students, underscoring the significance of the social environment specifically within female adolescent populations (1).

Perceived social support may be especially important because it can operate both as a direct protective factor and as a mechanism through which psychological vulnerabilities are translated into behavior. Adolescents who perceive adequate family and peer support may have greater opportunities to discuss distress, receive guidance, cognitively reframe difficult experiences, obtain reassurance, and seek alternatives to maladaptive behavior. In contrast, adolescents who experience themselves as unsupported may rely more heavily on internal coping resources precisely when those resources are under strain. This reasoning establishes a theoretically important connection between emotion regulation and social support. Mohammadi et al. examined cognitive emotion regulation strategies and risk-taking behaviors while

specifically considering perceived social support as a mediator, demonstrating that interpersonal support can help explain how regulatory processes are connected with risky behavior rather than functioning merely as an independent correlate (13). Such evidence suggests that the effectiveness of adolescents' emotion-regulatory functioning may partly depend on their relational context. Adolescents who can reappraise stressful situations and regulate emotional arousal may be more capable of maintaining supportive relationships, seeking help, and interpreting interpersonal interactions constructively; conversely, access to reliable support may itself facilitate more adaptive regulation by providing emotional security and reducing the intensity of perceived stress. Therefore, the association between emotion regulation and risk-taking is likely to involve reciprocal and interconnected social processes rather than a simple direct pathway.

A similar mediating logic can be extended to brain-behavioral systems. Neurobehavioral sensitivity may shape the way adolescents experience reward, punishment, novelty, and interpersonal feedback, but social contexts can determine which opportunities for behavioral expression are available and how strongly these sensitivities translate into action. Adolescents characterized by greater reward responsiveness may be especially sensitive to peer approval and socially reinforced novelty, whereas those with stronger behavioral inhibition may be more attentive to rejection, punishment, or threat. Supportive family and peer environments may provide structure, monitoring, emotionally meaningful reinforcement, and adaptive channels for excitement and autonomy, thereby reducing the likelihood that neurobehavioral tendencies manifest as harmful risk-taking. Conversely, weak support or maladaptive peer networks may amplify risk by increasing the motivational value of peer acceptance, immediate rewards, or compensatory behavior. Research into parenting provides indirect support for this proposition. Moghadami Choobkhaluei et al. identified parenting styles as a mediating factor in the relationship between brain-behavioral systems and risk-taking tendencies, suggesting that biological sensitivities are behaviorally expressed through relational pathways (3). Likewise, Abedinzadeh et al. demonstrated mediation through thought control ability, indicating that the effects of brain-behavioral systems may be transmitted through intervening psychological processes rather than only through direct effects (2). Taken together, these studies justify extending the investigation from separate mediators toward a model in which perceived social support represents a plausible social mechanism connecting neurobehavioral characteristics with adolescent risk-taking.

Despite this growing literature, several limitations remain in existing evidence. First, many studies have examined only selected pairs of variables, such as emotion regulation and risk-taking, social support and risk-taking, or brain-behavioral systems and risk-taking, without integrating biological, psychological, and social constructs within the same explanatory model. Second, studies that have investigated mediation have frequently focused on mechanisms such as thought control ability, parenting styles, hedonism, executive functioning, time perception, or emotion regulation itself rather than examining perceived social support as a common interpersonal pathway connecting both brain-behavioral systems and emotion regulation with risky behavior (2, 4, 8). Third, developmental stage and gender deserve greater attention. Research findings from university students or older adolescents cannot automatically be generalized to junior high school students, whose dependence on family support, sensitivity to peers, regulatory capacities, and opportunities for risk-taking differ substantially. Similarly, evidence concerning female adolescents warrants focused investigation because their social relationships, exposure to peer evaluation, emotion-regulatory patterns, and culturally structured behavioral opportunities may differ from those of male adolescents. Studies

specifically examining female students have demonstrated that emotion regulation difficulties, social relationships, peer rejection, and other psychosocial factors are relevant to risk-taking, but these variables have not always been modeled alongside neurobehavioral systems (1, 10). Thus, a more integrated model is needed to clarify how these different levels of explanation operate simultaneously during early adolescence.

The conceptual integration of brain-behavioral systems, emotion regulation, and perceived social support is also important for prevention. If risk-taking is viewed solely as a consequence of relatively stable neurobehavioral dispositions, intervention possibilities may appear limited; however, if its association with biological sensitivity is partly transmitted or modified through regulatory and social resources, meaningful preventive targets become identifiable. Emotion-regulation skills can be strengthened through psychological and school-based interventions, and social support can be enhanced through family communication, peer-network development, supportive teacher relationships, and systematic school programs. Evidence that cognitive emotion regulation strategies influence risk-taking indicates that regulatory competencies are potentially modifiable protective processes (7), while evidence linking perceived social support with adolescent risk behavior indicates that strengthening interpersonal resources may have broad preventive value (12). Moreover, Singh's findings regarding the joint contributions of emotion regulation difficulties, perceived parenting, and personality characteristics suggest that effective prevention should not isolate individual skills from the environment in which those skills are developed and exercised (11). Recent modeling work has similarly moved toward integrated explanations in which biological sensitivity, emotional regulation, and interpersonal resources are treated as complementary components rather than competing explanations of risk (5). Such a model is theoretically consistent with the multifactorial nature of adolescent development and practically relevant to school psychologists, counselors, families, and educational policymakers seeking to identify points of intervention before risky patterns become consolidated.

Accordingly, the present study aimed to model risk-taking behaviors based on brain-behavioral systems and emotion regulation, with the mediating role of perceived social support, among female junior high school students.

Methods and Materials

Study Design and Participants

This applied study used a descriptive-correlational design based on structural equation modeling. The statistical population comprised all female junior high school students in grades 7, 8, and 9 attending schools in Babolsar County during the 2023–2024 academic year. Multistage cluster random sampling was used: Babolsar was divided into northern, southern, eastern, and western areas; two schools were randomly selected from each area, and two classes were randomly selected from each school. A total of 342 students entered the study. After incomplete questionnaires were excluded, data from 318 participants were analyzed (mean age = 13.87 years, SD = 0.82, range = 12–16 years). Inclusion criteria were informed consent from students and their parents, age 12–16 years, and the absence of learning disorders, hyperactivity, or severe separation anxiety. Incomplete responses constituted the exclusion criterion.

Data Collection Tools

Four instruments were used to collect data: the Armstrong Risk Behavior Questionnaire (1), comprising 15 items with a score range of 0–30; the Multidimensional Scale of Perceived Social Support developed by Zimet et al. (6) (MSPSS), comprising 12 items across the three dimensions of family, friends, and significant others; Carver and White's BIS/BAS Scales (3), comprising 24 items assessing behavioral inhibition and behavioral activation, the latter with three subscales; and Gross and John's Emotion Regulation Questionnaire (4), comprising 10 items across the two subscales of cognitive reappraisal and expressive suppression.

Data Analysis

The study began after a letter of introduction was obtained from the university and the necessary permissions were secured. Before completing the questionnaires, students received explanations of the study objectives, the confidentiality of their information, and their complete freedom to withdraw at any stage. Research ethics were observed in accordance with the guidelines of the American Counseling Association and the American Psychological Association.

Data were analyzed at descriptive and inferential levels. Descriptive statistics included frequencies, percentages, means, standard deviations, skewness, and kurtosis. For inferential analysis, bivariate relationships were first examined using Pearson's correlation test, and the hypotheses were then tested using partial least squares structural equation modeling (PLS-SEM) (21). This approach was implemented in two stages: evaluation of the measurement model (factor loadings, composite reliability, and convergent validity) and evaluation of the structural model (path coefficients, T statistics, and fit indices). Bootstrapping was used to test the significance of indirect paths. All analyses were conducted at an alpha level of 0.05 using SPSS version 27 and SmartPLS version 4.

Before testing the structural model, the necessary assumptions for structural equation modeling were examined. The normality of the data distributions was assessed using skewness and kurtosis indices. Based on the acceptable range of –2 to 2 (20), all study variables exhibited acceptably normal distributions (Table 1). The sample size of 318 also satisfied the rule of thumb requiring at least ten times the number of paths entering any construct. Multicollinearity among predictor variables was assessed using the variance inflation factor (VIF). A VIF below 3 indicates no multicollinearity, values between 3 and 5 indicate minor multicollinearity, and values above 5 indicate severe multicollinearity among variables.

Findings and Results

The study included 318 female students with a mean age of 13.87 years (SD = 0.82). Of these, 42.8% (n = 136) were in grade 7, 34.6% (n = 110) were in grade 8, and 22.6% (n = 72) were in grade 9.

Table 1. Descriptive statistics for the study variables (mean, standard deviation, skewness, and kurtosis)

Variable	Mean	SD	Skewness	Kurtosis
Risk-taking behaviors — Level 1	1.47	0.70	−0.42	−0.20

Risk-taking behaviors — Level 2	2.60	1.09	−0.87	0.30
Risk-taking behaviors — Level 3	1.50	0.72	0.49	0.13
Social support — Family	2.10	1.09	−0.05	1.12
Social support — Friends	2.88	1.27	−1.24	0.03
Social support — Significant others	2.52	0.74	−0.60	0.51
Emotion regulation — Cognitive reappraisal	3.08	1.06	−0.68	−0.28
Emotion regulation — Expressive suppression	3.09	1.13	0.84	−0.24
Brain-behavioral system — Behavioral inhibition	2.64	0.78	−0.67	−0.62
Brain-behavioral system — Reward responsiveness	2.59	0.82	−0.92	−0.45
Brain-behavioral system — Drive	2.63	0.85	−0.98	−0.45
Brain-behavioral system — Fun seeking	2.35	0.76	−0.69	0.06
Total risk-taking behavior score	72.62	19.01	0.23	0.20

Pearson's correlation analysis showed that risk-taking behaviors were significantly and negatively associated with all components of social support, emotion regulation, and brain-behavioral systems ($p < 0.01$; Table 2).

Table 2. Pearson correlation coefficients between the study components and risk-taking behaviors

Component	Correlation coefficient (r)
Family (social support)	−0.870**
Friends (social support)	−0.553**
Significant others (social support)	−0.730**
Cognitive reappraisal (emotion regulation)	−0.702**
Expressive suppression (emotion regulation)	−0.677**
Behavioral inhibition (brain-behavioral system)	−0.600**
Reward responsiveness (brain-behavioral system)	−0.623**
Drive (brain-behavioral system)	−0.516**
Fun seeking (brain-behavioral system)	−0.799**

** Correlation is significant at the 0.01 level.

Factor loadings for the risk-taking behavior scale items ranged from 0.75 to 0.86, and those for the brain-behavioral system ranged from 0.70 to 1.00 ($p < 0.01$ for all), indicating satisfactory fit of the measurement model.

Table 3. Cronbach's alpha, composite validity (rho_a), composite reliability (rho_c), and average variance extracted (AVE)

Variable	Cronbach's alpha	Composite validity (rho_a)	Composite reliability (rho_c)	AVE
Risk-taking behaviors	0.96	0.96	0.96	0.65
Family	0.92	0.92	0.94	0.81
Friends	0.92	0.93	0.95	0.82
Significant others	0.80	0.81	0.87	0.63
Cognitive reappraisal	0.90	0.91	0.93	0.68
Expressive suppression	0.87	0.87	0.91	0.72
Behavioral inhibition	0.91	0.92	0.93	0.68
Reward responsiveness	0.86	0.87	0.90	0.65
Drive	0.84	0.85	0.89	0.68
Fun seeking	0.74	0.74	0.83	0.56

As shown in Table 3, Cronbach's alpha and composite reliability values exceeded 0.70 for all variables, and average variance extracted (AVE) values exceeded 0.50 for all variables. Thus, the reliability and convergent validity of the measurement model were confirmed (22)(20). Discriminant validity was also

examined and confirmed using the Fornell–Larcker criterion and a multitrait–multimethod matrix: the square root of the AVE for each construct exceeded its correlations with the other latent constructs in the model.

Table 4. Variance inflation factors (VIFs) for the model's predictor paths

Path	VIF
Emotion regulation → Social support	1.487
Emotion regulation → Risk-taking behaviors	1.889
Social support → Risk-taking behaviors	1.999
Brain-behavioral system → Social support	1.487
Brain-behavioral system → Risk-taking behaviors	1.727

As shown in Table 4, all VIF values were below 3 and, in most cases, close to 1. Therefore, no harmful multicollinearity was observed among the model's predictor variables, and the assumption of no multicollinearity for path analysis was satisfied (19). The structural model is presented in Figures 1 and 2 in terms of standardized path coefficients and significance values (p values), respectively.

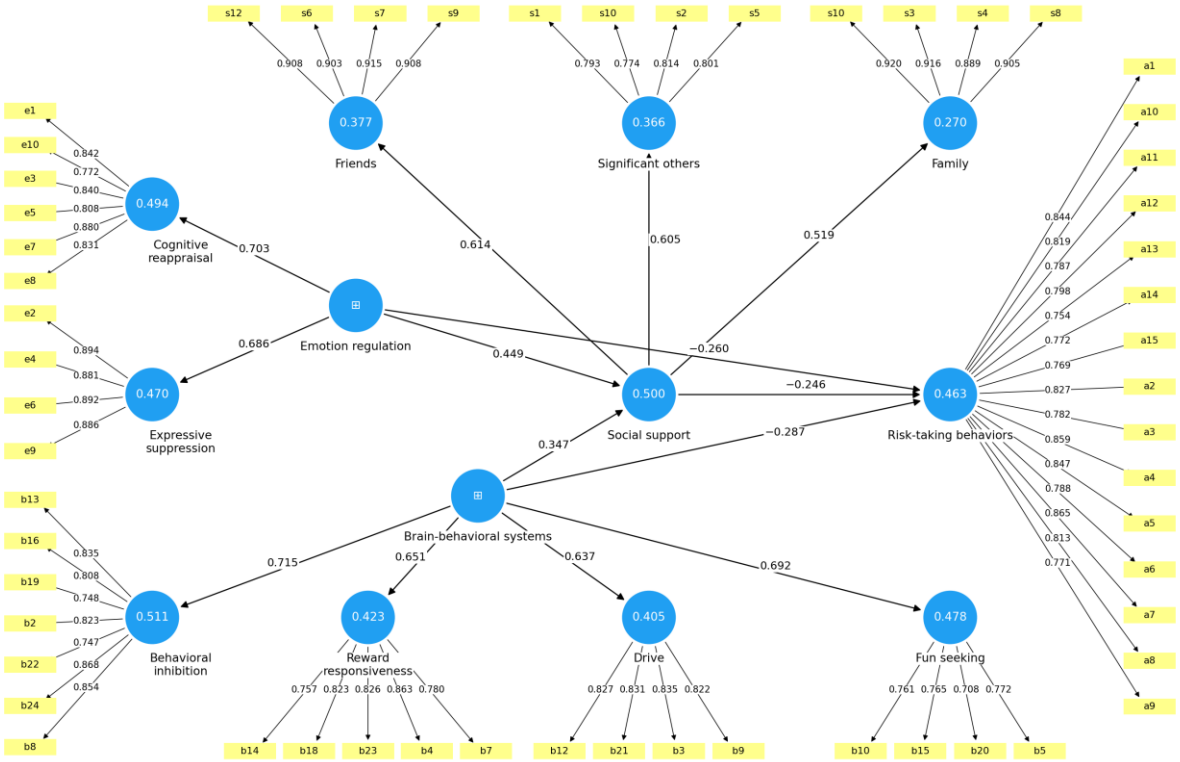


Figure 1. Research model with standardized path coefficients (structural model assessment)

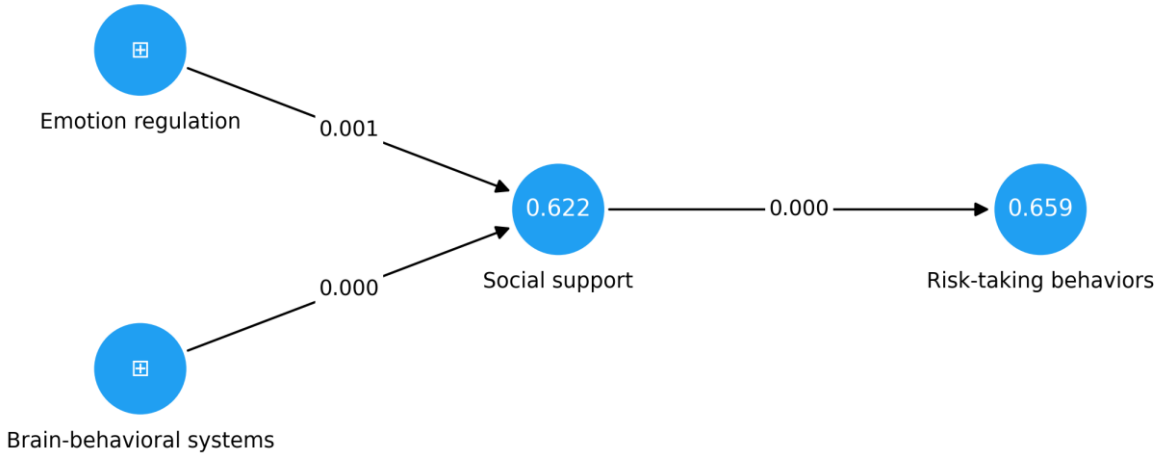


Figure 2. Significance values (p values) of the research structural model

Table 5. Coefficients of determination (R^2) and predictive relevance (Q^2) for the study's endogenous variables

Endogenous variable	R^2	Adjusted R^2	Q^2 (predictive)
Risk-taking behaviors	0.463	0.458	0.426
Social support	0.500	0.497	0.494
Family	0.287	0.284	0.309
Friends	0.377	0.375	0.370
Significant others	0.936	0.364	0.376
Cognitive reappraisal	0.494	0.492	0.491
Expressive suppression	0.470	0.469	0.468
Behavioral inhibition	0.511	0.510	0.508
Reward responsiveness	0.423	0.421	0.418
Drive	0.405	0.403	0.400
Fun seeking	0.478	0.477	0.473

R^2 values for the dependent variables fall within the satisfactory range of 0.287–0.511, indicating adequate explanatory power of the model. Q^2 values were also greater than zero for all variables, indicating satisfactory predictive fit of the proposed structural model.

The hypothesis-testing results, including standardized path coefficients and T statistics, with bootstrapping for indirect paths, are presented in Table 6.

Table 6. Results of the research hypothesis tests (path coefficients and T statistics)

Hypothesis	Path	Path coefficient (β)	T statistic	Result
H1	Brain-behavioral systems → Risk-taking behaviors (direct)	−0.287	5.068	Supported
H2	Emotion regulation → Risk-taking behaviors (direct)	−0.260	4.972	Supported
H3	Social support → Risk-taking behaviors (direct)	−0.246	4.176	Supported
H4	Brain-behavioral systems → Social support → Risk-taking behaviors (indirect)	−0.085	3.485	Supported
H5	Emotion regulation → Social support → Risk-taking behaviors (indirect)	−0.110	3.688	Supported

Since the T values for all paths fell outside the interval from −1.96 to 1.96, all five research hypotheses were supported.

Discussion and Conclusion

The present study examined a structural model of risk-taking behaviors based on brain-behavioral systems and emotion regulation, with perceived social support as a mediating variable, among female junior high school students. The findings showed that all proposed direct and indirect relationships were statistically significant. Specifically, brain-behavioral systems had a significant negative direct effect on risk-taking behaviors ($\beta = -0.287$, $T = 5.068$), emotion regulation had a significant negative direct effect on risk-taking behaviors ($\beta = -0.260$, $T = 4.972$), and perceived social support had a significant negative direct effect on risk-taking behaviors ($\beta = -0.246$, $T = 4.176$). Moreover, perceived social support significantly mediated the relationship between brain-behavioral systems and risk-taking behaviors ($\beta = -0.085$, $T = 3.485$) and the relationship between emotion regulation and risk-taking behaviors ($\beta = -0.110$, $T = 3.688$). The model also demonstrated satisfactory explanatory and predictive performance, with approximately 46% of the variance in risk-taking behaviors explained by the model and 50% of the variance in perceived social support explained by its predictors. These findings collectively support a multidimensional interpretation of adolescent risk-taking in which neurobehavioral sensitivities, emotional regulatory capacities, and interpersonal resources interact rather than operating independently.

The significant direct relationship between brain-behavioral systems and risk-taking behaviors indicates that individual differences in sensitivity to behavioral inhibition and activation are important in explaining adolescents' engagement in risky behavior. Within the scoring and structural configuration used in the present model, higher adaptive functioning across the brain-behavioral system construct was associated with lower risk-taking tendencies. Brain-behavioral systems influence how adolescents respond to cues of reward, punishment, novelty, threat, and anticipated consequences; therefore, differences in the balance between behavioral activation and inhibition may affect whether an adolescent approaches or avoids potentially hazardous situations. This finding is consistent with Abedinzadeh et al., who reported that brain-behavioral systems contributed to the prediction of risk-taking behaviors among secondary school students and that their effects could operate through psychological mechanisms such as thought control ability (2). It is also consistent with Mozaffari, who showed that brain-behavioral systems and executive functions were important predictors of adolescent risk-taking when emotion regulation and hedonism were considered as intervening processes (4). Similarly, Moghadami Choobkhaluei et al. demonstrated that brain-behavioral systems were associated with adolescents' tendency toward risk-taking and that parenting styles could mediate this association (3). The convergence of these findings suggests that neurobehavioral predispositions constitute an important foundation for risk-taking, but their behavioral consequences are shaped by cognitive, emotional, and relational processes.

This result can also be interpreted developmentally. Early adolescence is characterized by heightened responsiveness to emotionally and socially salient rewards at a time when regulatory and executive-control processes are still developing. An adolescent who is strongly oriented toward immediate reinforcement may therefore be more likely to choose short-term rewards despite longer-term consequences, particularly in peer contexts or emotionally charged situations. Conversely, stronger sensitivity to potential negative consequences and more effective behavioral inhibition may facilitate caution and avoidance of harmful actions. The findings of the present study therefore do not imply that brain-behavioral sensitivity produces risk-taking in a deterministic manner; rather, such sensitivity appears to create a dispositional context

within which environmental conditions and regulatory resources acquire greater importance. The model proposed by Rahimi similarly conceptualized risk-taking among female junior high school students as the result of interactions among brain-behavioral systems, emotion regulation, and perceived social support rather than as the consequence of any single predictor (5). This integrated perspective is especially important for preventive psychology because it suggests that even when relatively stable biological or temperamental sensitivities are present, modifiable emotional and social resources may still reduce the probability that these vulnerabilities are translated into risky behavior.

The second major finding was the significant negative direct effect of emotion regulation on risk-taking behaviors. This result indicates that more effective emotion regulation is associated with a lower tendency toward risky behavior among female adolescents. Emotion regulation allows individuals to monitor, interpret, modify, and express emotional responses in ways that are compatible with situational demands and longer-term goals. Gross emphasized that emotion regulation involves multiple processes occurring before and after emotional responses are fully generated and that strategies differ considerably in their consequences for psychological functioning (6). Cognitive reappraisal, for example, enables an individual to reinterpret the meaning of an emotionally provocative situation before the emotional response intensifies, whereas expressive suppression primarily involves controlling the observable expression of an already-developed emotional state. Adolescents who possess more adaptive regulatory capacities may therefore be better able to tolerate frustration, manage interpersonal conflict, delay impulsive reactions, and evaluate the consequences of their choices. In contrast, adolescents who have difficulty regulating emotional arousal may employ risky behaviors as immediate strategies for obtaining relief, stimulation, social validation, or escape from unpleasant internal experiences.

The present finding is strongly supported by previous research. Ordoubadi and Mohammadi-Soureh found that cognitive emotion regulation strategies were significantly related to risk-taking behaviors among adolescents and young people, demonstrating that the way emotional experiences are cognitively processed can influence behavioral choices (7). Raeisi and Darakhshan Houre also showed that cognitive emotion regulation strategies contributed to the prediction of adolescent risk-taking within a structural model involving metaphorical time perception (8). Their findings suggest that emotion regulation may affect risk-taking partly by shaping how adolescents represent consequences, future outcomes, and emotionally salient situations. Likewise, Zare et al. reported that cognitive emotion regulation mediated the relationship between attachment styles and risky sexual behavior, indicating that emotional regulatory processes can transmit the influence of broader relational experiences to specific forms of risk-taking (9). Noruzi and Janjani similarly demonstrated that difficulties in emotion regulation played a mediating role in relationships involving attachment styles, anger rumination, and risky behavior among female adolescents (10). Singh also identified emotion regulation difficulties as a significant predictor of adolescent health-risk behaviors alongside perceived parenting and personality variables (11). Together, these findings reinforce the interpretation that emotion regulation represents a central psychological mechanism through which adolescents manage pressures that might otherwise be expressed in maladaptive or hazardous behavior.

Another important result was the significant negative direct effect of perceived social support on risk-taking behaviors. Adolescents who perceived greater support from family, friends, and significant others were less likely to report risk-taking tendencies. This relationship is theoretically plausible because

perceived social support contributes to feelings of security, belonging, acceptance, and interpersonal availability. Supportive relationships can provide adolescents with opportunities to disclose problems, seek advice, receive emotional reassurance, and access practical assistance before stressful experiences are translated into maladaptive responses. At the same time, supportive families may provide supervision, consistent expectations, and behavioral guidance, while constructive peer relationships can offer social acceptance without requiring engagement in risky behavior. Zaaddahesh and Babakhani found significant relationships between perceived social support and multiple dimensions of adolescent risk-taking, supporting the role of interpersonal resources as protective factors (12). Ghorbani et al. similarly showed that social support, together with religiosity and peer rejection, predicted risk-taking behaviors among female secondary school students (1). These findings are particularly relevant to the present sample because they demonstrate that the social ecology of female adolescents can substantially influence vulnerability to risky behavior.

The protective role of perceived social support may be especially pronounced during early adolescence because this period involves a gradual shift in social orientation from predominantly family-centered relationships toward increasing peer involvement. Although peers become more influential, family relationships remain important sources of emotional security, behavioral monitoring, and decision-making guidance. When adolescents perceive that family members and significant others are responsive and available, they may be less dependent on risky peer approval or maladaptive behaviors as means of gaining belonging. Conversely, inadequate support may increase susceptibility to negative peer influence because adolescents may seek alternative sources of validation and social inclusion. The findings of Ghorbani et al. concerning social support and peer rejection are consistent with this interpretation, as both supportive and adverse interpersonal experiences contributed to adolescents' risk-taking tendencies (1). The findings of Mohammadi et al. also reinforce the importance of perceived social support by demonstrating its mediating role in the relationship between cognitive emotion regulation strategies and risk-taking behaviors among university students (13). Although their sample represented a later developmental stage, the similarity in the direction of associations suggests that perceived interpersonal support may function as a protective mechanism across different periods of youth development.

One of the most important findings of the present study was that perceived social support significantly mediated the relationship between brain-behavioral systems and risk-taking behaviors. This indirect effect indicates that part of the association between neurobehavioral functioning and risky behavior may be explained through adolescents' perceptions of their interpersonal support network. Brain-behavioral systems may influence how adolescents perceive and respond to social cues, reinforcement, rejection, approval, and punishment. Adolescents with particular patterns of activation or inhibition sensitivity may differ in their capacity to establish supportive relationships, seek assistance when distressed, or interpret social interactions as reassuring or threatening. At the same time, supportive family and peer environments may regulate the behavioral expression of neurobehavioral vulnerabilities by providing external structure and reinforcement for safer forms of behavior. This interpretation is consistent with Moghadami Choobkhaluei et al., who found that parenting styles mediated the relationship between brain-behavioral systems and risk-taking tendencies (3). Parenting style and perceived social support represent related but conceptually distinct aspects of adolescents' relational environments, and the consistency across these

findings suggests that interpersonal processes may be crucial pathways through which underlying neurobehavioral sensitivities are converted into actual behavior.

The mediating role of social support between brain-behavioral systems and risk-taking is also compatible with the findings of Abedinzadeh et al., who demonstrated that thought control ability mediated associations involving brain-behavioral systems and risk-taking behaviors (2). Taken together, the evidence suggests that brain-behavioral systems should not be conceptualized as isolated predictors. Their influence appears to be filtered through internal regulatory resources and external relational resources. Adolescents with heightened sensitivity to immediate rewards, for instance, may nevertheless avoid risky behavior when family relationships provide supervision, emotional connection, and consistent behavioral expectations. In contrast, the same motivational sensitivity may carry greater behavioral risk when adolescents experience weak support and seek reinforcement primarily from peers who normalize hazardous behavior. Mozaffari's findings concerning the roles of emotion regulation and hedonism in the relationship between brain-behavioral processes and adolescent risk-taking further support such a mediated interpretation (4). The present findings extend this literature by identifying perceived social support as another mechanism capable of linking neurobehavioral functioning with risk-taking.

The second significant indirect relationship showed that perceived social support mediated the association between emotion regulation and risk-taking behaviors. This finding suggests that effective emotion regulation may reduce risky behavior not only directly but also partly by strengthening adolescents' ability to perceive, obtain, or utilize interpersonal support. Adolescents capable of regulating anger, anxiety, frustration, and other intense emotions may communicate more effectively, experience fewer disruptive interpersonal conflicts, interpret social interactions less negatively, and seek help more constructively. These patterns may promote supportive family and peer relationships, which subsequently decrease the likelihood of risky behavior. Conversely, persistent emotion dysregulation may undermine relationships through withdrawal, impulsive reactions, conflict, or maladaptive communication, thereby reducing access to precisely the social resources that could protect against risk-taking. Mohammadi et al. directly support this interpretation, as they identified perceived social support as a mediator between cognitive emotion regulation strategies and risk-taking behaviors (13). The present study extends that evidence to younger female adolescents and demonstrates that this mediating pathway operates alongside the direct effect of emotion regulation.

This indirect pathway is also compatible with studies demonstrating that emotion regulation mediates relationships between earlier relational experiences and risky behavior. Zare et al. showed that cognitive emotion regulation strategies mediated the association between attachment styles and risky sexual behavior (9), while Noruzi and Janjani found that emotion regulation difficulty served as an intervening mechanism linking attachment-related and cognitive variables to risk-taking among female adolescents (10). These studies and the present findings can be viewed as describing interconnected components of a broader relational-regulatory system. Supportive relationships may facilitate emotional regulation, while effective emotional regulation may enhance adolescents' ability to maintain and benefit from supportive relationships. Both processes may ultimately reduce risky behavior. Singh's findings that emotion regulation difficulties and perceived parenting jointly predicted adolescent health-risk behavior further support the importance of considering regulatory and relational variables together rather than treating them as

independent domains (11). This reciprocal theoretical relationship may explain why perceived social support remained a significant mediator even after the direct association between emotion regulation and risk-taking was taken into account.

Overall, the pattern of direct and indirect findings supports a biopsychosocial interpretation of risk-taking among female junior high school students. Brain-behavioral systems represent a neurobehavioral level of vulnerability or protection; emotion regulation reflects a psychological self-regulatory level; and perceived social support represents an interpersonal and social-resource level. The significant direct effects indicate that each level contributes independently to explaining risk-taking, whereas the significant mediating effects show that these levels are also interconnected. This is consistent with Rahimi's proposed model integrating brain-behavioral systems, emotion regulation, social support, and risk-taking within the same framework (5). It also accords with a broader body of research indicating that adolescent risk-taking results from the convergence of dispositional sensitivity, regulatory competence, family processes, and social experiences rather than a single causal mechanism (2, 3, 11). The explanatory power observed for risk-taking behaviors further indicates that these constructs collectively account for a meaningful proportion of individual differences in adolescents' risky behavior. Importantly, the mediation findings also suggest that perceived social support functions as more than a background contextual characteristic; it constitutes an active explanatory mechanism through which individual vulnerabilities can be attenuated or expressed. Consequently, understanding adolescent risk-taking requires simultaneous attention to how young people respond to reward and punishment, how they manage emotional experiences, and whether they perceive their interpersonal environment as available, supportive, and dependable.

Several limitations should be considered when interpreting the findings. First, the study employed a cross-sectional descriptive-correlational design; therefore, although structural equation modeling permitted examination of theoretically specified direct and indirect relationships, causal or temporal conclusions cannot be established. Second, all primary variables were measured using self-report questionnaires, which may be affected by social desirability, recall error, response tendencies, and adolescents' willingness to disclose sensitive behaviors. This concern may be particularly relevant to risk-taking behaviors because some behaviors can be perceived as socially undesirable or inconsistent with school and family expectations. Third, the sample consisted exclusively of female junior high school students from Babolsar County, which restricts generalizability to male adolescents, older students, adolescents outside formal education, and populations in other geographical and sociocultural settings. Fourth, the study focused on a selected set of biological, psychological, and social variables and did not include other potentially influential factors such as socioeconomic status, parental monitoring, peer risk behavior, family conflict, school climate, impulsivity, executive functioning, mental health symptoms, or exposure to stressful life events. Finally, although perceived social support is psychologically meaningful, it reflects adolescents' subjective appraisal of support and does not necessarily correspond exactly to the amount, quality, or behavioral characteristics of support actually provided by family members, peers, and significant others.

Future studies should employ longitudinal designs to establish the temporal ordering of brain-behavioral systems, emotion regulation, perceived social support, and risk-taking behaviors and to determine whether changes in social support or emotional regulation predict subsequent changes in risky behavior. Replication with larger and more diverse samples, including boys, senior high school students, adolescents from rural

and urban communities, and participants from different cultural and socioeconomic backgrounds, would clarify the generalizability of the proposed model. Multi-informant and multimethod designs should also be considered by combining adolescent self-reports with parent and teacher assessments, behavioral tasks, observational measures, and where feasible, psychophysiological or neurocognitive indicators. Future models could examine additional mediators or moderators, including parenting practices, peer norms, impulsivity, executive functions, sensation seeking, resilience, school connectedness, self-control, and socioeconomic conditions. Researchers could also test whether family support, peer support, and support from significant others differ in their mediating effects rather than treating perceived social support only as a global construct. Experimental and intervention studies would be particularly valuable for determining whether deliberate improvement in emotion regulation or social support produces measurable reductions in risk-taking over time.

The findings have practical implications for schools, counselors, psychologists, and families working with adolescents. Screening programs in junior high schools could identify students who show elevated risk-taking tendencies, difficulties in emotional regulation, or patterns of behavioral sensitivity that may increase vulnerability. School-based prevention programs should include developmentally appropriate training in cognitive reappraisal, impulse control, emotional awareness, problem solving, and coping with interpersonal stress. Because perceived social support emerged as both a direct protective factor and a mediator, interventions should extend beyond individual adolescents and involve parents, teachers, and peer networks. Parent-training programs can strengthen supportive communication, emotional availability, consistent supervision, and nonpunitive guidance, while schools can create mentoring systems, peer-support programs, accessible counseling services, and psychologically safe environments in which students can seek help without stigma. Prevention strategies should also avoid labeling neurobehaviorally sensitive adolescents as inherently problematic; instead, biological and motivational characteristics can be used to identify students who may benefit from stronger regulatory and social resources. A coordinated approach combining early identification, emotion-regulation training, family support, positive peer relationships, and school-based psychological services is therefore likely to be more effective than interventions targeting risk-taking behavior alone.

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Authors' Contributions

All authors equally contributed to 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.

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