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The Mediating Role of Personality Functions and Mentalization in the Relationship Between Paternal Love Deprivation and Non-Suicidal Self-Injury

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ABSTRACT

Objective: The present study aimed to examine the mediating role of personality functions and mentalization in the relationship between paternal love deprivation and non-suicidal self-injury in 2025.

Methods: Considering its objective, the research is applied in nature, and because no intervention was made in the generation of the data, it is descriptive and of a causal-explanatory type. The study employed a structural equation modeling approach (Delavar, 2016). Data were collected using a field method. The statistical population consisted of all students of Quchan University of Technology during the 2023–2024 academic year (N = 3,548). Using a single-stage cluster random sampling method, 384 students were selected as the sample. The research instruments included the short form of the NEO Five-Factor Inventory (NEO-FFI), the Persian version of the Reflective Functioning Questionnaire (RFQ; Fonagy, 2016), the Paternal Love Deprivation Scale by Xiang and Zhou (2023), and the Ottawa Self-Injury Inventory (OSI). Data were analyzed using Pearson correlation and path analysis with PLS software.

Results: The results showed that the obtained significance level (0.000) was lower than the error level of 0.05, indicating that the research hypotheses were confirmed.

Conclusions: In other words, the mediating role of personality functions and mentalization in the relationship between paternal love deprivation and non-suicidal self-injury among students was supported.

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Introduction

In a typical family, fathers and mothers share both common and distinct educational roles in raising their children—roles that are mutually reinforcing and essential (Freks, 2019). Consequently, the importance of the paternal role in child development cannot be underestimated. In recent years, paternal love deprivation has become a global concern. Paternal Love Deprivation (FLA) refers to fathers' cognitive, emotional, volitional, and behavioral absence or insufficiency in their children's development (Xiang & Zhou, 2023).

Traditionally, parents have been considered the most influential factors in a child's development. In family studies, however, maternal influence has received significantly more attention, whereas the role of paternal love has not been adequately examined (Cabrera et al., 2020). Attachment theory posits that there is no hierarchy between father–child and mother–child attachment (Ainsworth, 1968). Fatherhood itself is unique, as numerous studies have shown that early paternal love deprivation has wide-ranging effects on personality, cognitive, emotional, and behavioral development (Khalegh, 2015).

Although paternal love is of great importance, research in this area remains at an early stage (Li & Meier, 2017). Paternal love deprivation has been associated with increased behavioral problems (Sigle-Rushton et al., 2004), including maladaptive behavior (East et al., 2006), aggressive behavior (Lundberg, 2017), and even life-threatening behaviors such as self-injury (Whitlock et al., 2013). Non-suicidal self-injury (NSSI) is a significant behavioral concern (Jacobson & Gould, 2007). Therefore, the present study draws upon Nock's integrated theoretical model of NSSI. Importantly, paternal love deprivation does not merely refer to the physical absence of a parent; rather, it reflects a more complex emotional, behavioral, cognitive, and volitional alienation of the father from the child during formative years (Rohner et al., 2001). Fathers play a critical role in children's lifelong development, and paternal love deprivation has been linked to increased behavioral problems, including NSSI (Zhou et al., 2024).

NSSI is not classified as a disorder in DSM-IV or ICD-10 and is not considered part of any anxiety or depressive syndrome. However, due to its clear psychiatric significance despite previous lack of nosological recognition, it was acknowledged in DSM-5 as an independent syndrome (Wu et al., 2025). NSSI is defined as the deliberate, self-inflicted destruction or alteration of body tissue without suicidal intent (Nock & Favazza, 2009). Paternal love deprivation may be conceptualized

as an adverse early family environmental factor and a distal risk factor, as it may place children in a neglectful and unsupported home environment. Nock's integrated theoretical model suggests that distal risk factors contribute to the development of intrapersonal and interpersonal vulnerability factors (Nock, 2009). Rohner et al. (2001) found that active paternal involvement in child development can function as a protective factor against behavioral problems such as NSSI, while Fu et al. (2017) reported that paternal absence is associated with a higher likelihood of suicidal ideation in children. Although many recent studies have examined factors influencing NSSI, most have primarily focused on negative risk variables.

NSSI occurs in approximately 20% of adult psychiatric patients and in 40–80% of adolescent psychiatric patients (Whitlock, 2006). Personality functioning plays a key role in NSSI (Mullins-Sweatt et al., 2013). Findings by Mullins-Sweatt et al. (2013) indicated that individuals engaging in NSSI exhibit high levels of neuroticism (e.g., anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability) and openness (e.g., aesthetics, feelings, values), and lower levels of conscientiousness (e.g., order, achievement striving, self-discipline, deliberation). Additionally, individuals with a history of NSSI scored higher in negative urgency, lack of premeditation, and lack of perseverance. Personality functioning refers to an individual's core capacities for self-functioning and interpersonal functioning and is a key factor in understanding and diagnosing personality disorders. It encompasses how individuals perceive and regulate their emotions and how they relate to themselves and others.

Empirical findings consistently indicate that the dimension of psychopathology most strongly associated with NSSI relates to personality functioning. In particular, a strong association between NSSI and borderline personality disorder (BPD) has been documented (Howe et al., 2001). Most studies in this area focus on adult populations. Epidemiological data indicate that 80% of adults with BPD have exhibited at least one episode of NSSI (Matsunaga et al., 2000). Moreover, paternal love deprivation may significantly influence personality development and functioning, leading to various psychological and behavioral challenges. Research suggests that children who experience paternal love deprivation may exhibit higher levels of anxiety, depression, and emotional instability. They may also encounter difficulties in social adjustment, struggle to establish healthy relationships, and be more prone to behavioral problems (Song et al., 2025).

Kiorashi et al. (2021) found significant differences in depression levels between boys whose fathers were present in the family and those whose fathers were absent. Children whose fathers lived abroad reported higher levels of depression compared to those whose fathers lived with them. Similarly, Ramatse and Rose (2023) reported that women perceived father absence as negatively affecting their sense of belonging and identity.

The literature suggests that personality pathology, personality functioning, and mentalization are closely related constructs. One possible interaction among these concepts is that greater severity of personality disorder negatively affects the capacity for mentalization. When operationalizing the assessment of personality functioning in DSM-5, Bender et al. (2011) explained that personality functioning is closely related to the socio-cognitive capacity for mentalization (Fonagy et al., 2002). The concept of mentalization originates from the psychodynamic tradition and refers to the ability to understand and interpret one's own and others' actions in terms of underlying mental states (e.g., emotions, thoughts, desires) (Fonagy et al., 2002). Mentalization is a multidimensional construct defined along four dimensions, each with two poles (self–other, internal–external, automatic–controlled, cognitive–affective) (Choi-Kain & Gunderson, 2008). When mentalization is impaired, three non-mentalizing modes may be activated: psychic equivalence mode, teleological mode, and pretend mode (Fonagy et al., 2009).

Although mentalization is not explicitly mentioned in DSM-5 or ICD-11, its close relationship with personality functioning becomes evident when examining aspects of personality functioning involved in the severity ratings of personality disorders in ICD-11. However, empirical examination of the association between mentalization and personality functioning based on the ICD-11 model has been limited to a single study (Zettl et al., 2020). In summary, the literature indicates that personality pathology, personality functioning, and mentalization are interrelated constructs. One theoretical assumption is that greater severity of personality disorder reduces personality functioning due to impaired mentalization capacity, which in turn affects both self- and interpersonal functioning (Rischde et al., 2021).

Therefore, the present study is among the first to adopt a comprehensive psychological perspective in conceptualizing paternal love deprivation, aiming to provide a foundation for future theoretical development. Father absence typically refers to physical absence, whereas paternal love deprivation emphasizes the psychological dimension of absence—namely, fathers who, despite

living within the family, fail to provide their children with warm paternal affection (Trivedi & Bose, 2020). Psychological competence is reflected in cognitive, emotional, volitional, and behavioral domains, which constitute fundamental psychological characteristics of the individual. Accordingly, this study defines paternal love deprivation as father–child alienation during childhood across emotional, behavioral, cognitive, and volitional dimensions. Given gender role differences, fathers are often positioned as financial providers, while mothers are more directly involved in daily caregiving and childrearing (Xiang & Zhou, 2023).

Despite the growing number of studies examining the relationship between personality functioning and mentalization, few have investigated their mediating roles in the relationship between paternal love deprivation and non-suicidal self-injury. Therefore, the present study was conducted to examine the mediating roles of personality functioning and mentalization in the relationship between paternal love deprivation and non-suicidal self-injury among university students, with particular emphasis on the role of gender.

Material and Methods

The present study is applied in terms of its objective and descriptive of a causal–explanatory type, since no intervention was made in the generation of the data. The research employed a structural equation modeling (SEM) approach (Delavar, 2016). Data were collected through a field survey method. The statistical population consisted of all students of Quchan University of Technology during the 2023–2024 academic year (N = 3,548). Using a single-stage cluster random sampling method, 384 students were selected as the research sample.

When a complete list of individuals in the population is not available, cluster sampling can be used by grouping members of the population into clusters. A number of clusters are then randomly selected, and all or part of the members within those clusters are surveyed. In the present study, a list of all faculties at Quchan University of Technology was prepared. From this list, three faculties—Educational Sciences and Psychology, Economics, and Computer Science—were randomly selected. Subsequently, students from the first to the fourth academic years within these faculties were sampled until the final sample size of 384 participants was reached. Data were analyzed using Pearson correlation coefficients and path analysis. The analyses were conducted using Partial Least Squares (PLS) software.

Instruments

1. NEO Five-Factor Inventory (NEO-FFI) – Short Form: The NEO-FFI personality questionnaire is a shortened version of the NEO Personality Inventory developed by McCrae and Costa in 1985. This instrument measures the five major dimensions of personality and their related characteristics. According to the revised version of the NEO personality questionnaire, the five domains include neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Each domain represents specific personality traits reflecting different aspects of personality.

In the Iranian standardization conducted by Groosi Farshi (2001) on a sample of 2,000 university students from Tabriz University, Shiraz University, and the medical universities of these cities, the correlation coefficients of the five main dimensions ranged from 0.56 to 0.87. Cronbach's alpha coefficients for the five factors—neuroticism, extraversion, openness, agreeableness, and conscientiousness—were reported as 0.86, 0.73, 0.56, 0.68, and 0.87, respectively. To examine content validity, correlations between the self-report form (S) and the observer rating form ® were calculated, with the highest correlation observed in extraversion (0.66) and the lowest in agreeableness (0.45) (Groosi Farshi, 2001). In another study by Atashrooz (2007), using the internal consistency method, Cronbach's alpha coefficients for neuroticism, extraversion, openness, agreeableness, and conscientiousness were reported as 0.74, 0.55, 0.27, 0.38, and 0.77, respectively.

2. Reflective Functioning Questionnaire (RFQ) – Persian Version (2016): The Reflective Functioning Questionnaire (RFQ), developed by Fonagy and colleagues, is an assessment tool designed to measure an individual's capacity to understand and interpret their own and others' behaviors in terms of underlying mental states. The questionnaire contains 14 items and includes two subscales. The Persian version of this questionnaire was published in 2016. Confirmatory factor analysis indicated that the two-factor model demonstrated an acceptable fit with the data. Internal reliability was assessed using Cronbach's alpha coefficients for the overall questionnaire and its subscales. The results indicated acceptable internal consistency, with Cronbach's alpha values of 0.88 for the certainty factor and 0.66 for the uncertainty factor (Dorougar et al., 2020).

3. Paternal Love Deprivation Scale (Xiang & Zhou, 2023): The Paternal Love Deprivation Scale was developed by Xiang and Zhou (2023). The scale consists of four dimensions and 18

items, including emotional deprivation, cognitive deprivation, behavioral deprivation, and volitional deprivation. Emotional deprivation refers to fathers' chronic neglect in expressing emotions and understanding the child's emotional needs. Cognitive deprivation relates to the child's perception and knowledge of the father's role and presence. Behavioral deprivation refers to the lack of fathers' participation in their child's education and daily life. Volitional deprivation reflects the lack of paternal influence on the child's perseverance, independence, and decisiveness. Due to noticeable differences in the number of items across dimensions and to maintain a balanced scale structure, 10 items with low factor loadings and difficult interpretation were removed from the emotional, cognitive, and behavioral dimensions. Additionally, one item from the volitional factor was removed because it was inconsistent with the theoretical assumptions. The final scale included 18 items across four factors, explaining 61.07% of the variance, with a Cronbach's alpha coefficient of 0.89. Correlation analyses among factors and between the factors and the overall paternal love deprivation construct indicated significant positive relationships, demonstrating structural validity and conceptual consistency.

4. Ottawa Self-Injury Inventory (OSI): The Ottawa Self-Injury Inventory (OSI) consists of 31 items and includes three main sections. The first section evaluates the functions of self-injury and harmful behaviors. The second section assesses the severity of self-injurious behaviors and their addictive characteristics. The third section measures the individual's motivation to stop self-injurious behavior.

In the functional section, self-injury is assessed across several domains, including internal emotion regulation, social influence, external emotion regulation, sensation seeking, and other functions. The severity of harmful behaviors is rated on a scale ranging from "never" to "sometimes" to "always," while addictive characteristics are scored as "yes" or "no." Motivation to cease self-injurious behavior is assessed using a scale ranging from "never" to "somewhat" to "high" (Akbari Valiollah et al., 2023). Previous research has reported correlations among the questionnaire's subscales ranging from 0.44 to 0.90, and the Cronbach's alpha coefficient for the addictive characteristics dimension was reported as 0.84 (Nixon et al., 2015).

Ethical Considerations

Ethical principles were observed throughout the research process. Participants were informed about the purpose and procedures of the study before data collection. Participation was voluntary,

and informed consent was obtained from all participants. Respondents were assured that their information would remain confidential and that the collected data would be used solely for research purposes. Participants were also informed that they could withdraw from the study at any stage without any consequences. Additionally, anonymity was maintained by ensuring that no identifying information was recorded in the questionnaires.

Results

The demographic characteristics of the sample showed that 217 participants (56.5%) were male and 167 (43.5%) were female. Regarding age distribution: 98 participants (25.5%) were under 20 years old, 214 participants (55.7%) were between 20 and 22 years old and 72 participants (18.8%) were over 22 years old.

The Kolmogorov–Smirnov test was used to examine the distribution of the data. The results indicated that the variables personality functioning, mentalization, paternal love deprivation, and non-suicidal self-injury had significance levels of 0.000, which are greater than the 0.05 threshold, indicating that the data distribution was non-normal. Therefore, the Spearman non-parametric correlation test was used to examine relationships between variables.

Table 1. Descriptive Findings of Research Variables

No.	Variable	Mean	SD
1	Neuroticism	16.15	1.86
2	Extraversion	15.65	2.11
3	Openness	16.04	1.75
4	Agreeableness	15.63	1.70
5	Conscientiousness	15.17	2.01
6	Personality Functioning	78.66	6.12
7	Certainty	33.82	6.14
8	Uncertainty	18.08	3.77
9	Mentalization	51.91	9.02
10	Emotional Deprivation	10.76	2.20
11	Cognitive Deprivation	9.79	1.82
12	Volitional Deprivation	7.97	1.66
13	Behavioral Deprivation	7.34	1.61
14	Paternal Love Deprivation	35.87	5.16
15	Internal Emotion Regulation	15.16	4.00
16	Social Influence	18.10	3.59
17	External Emotion Regulation	7.73	1.43
18	Sensation Seeking	10.66	2.77
19	Other Functions	18.29	4.27
20	Non-Suicidal Self-Injury	69.95	13.80

The findings indicate that the significance level of pairwise relationships between variables was less than the error level of 0.05, confirming the existence of significant relationships between the variables.

In this study, path analysis modeling was used to test the proposed hypotheses. If the path coefficient between the independent latent variable and the dependent latent variable is positive, it indicates that an increase in the independent variable leads to an increase in the dependent variable. If the path coefficient is negative, it indicates that an increase in the independent variable leads to a decrease in the dependent variable. To confirm or reject hypotheses, the T-value must be greater than 1.96. The results of the path analysis model, including the significance of path coefficients and T values, are presented in Figures 1 and 2.

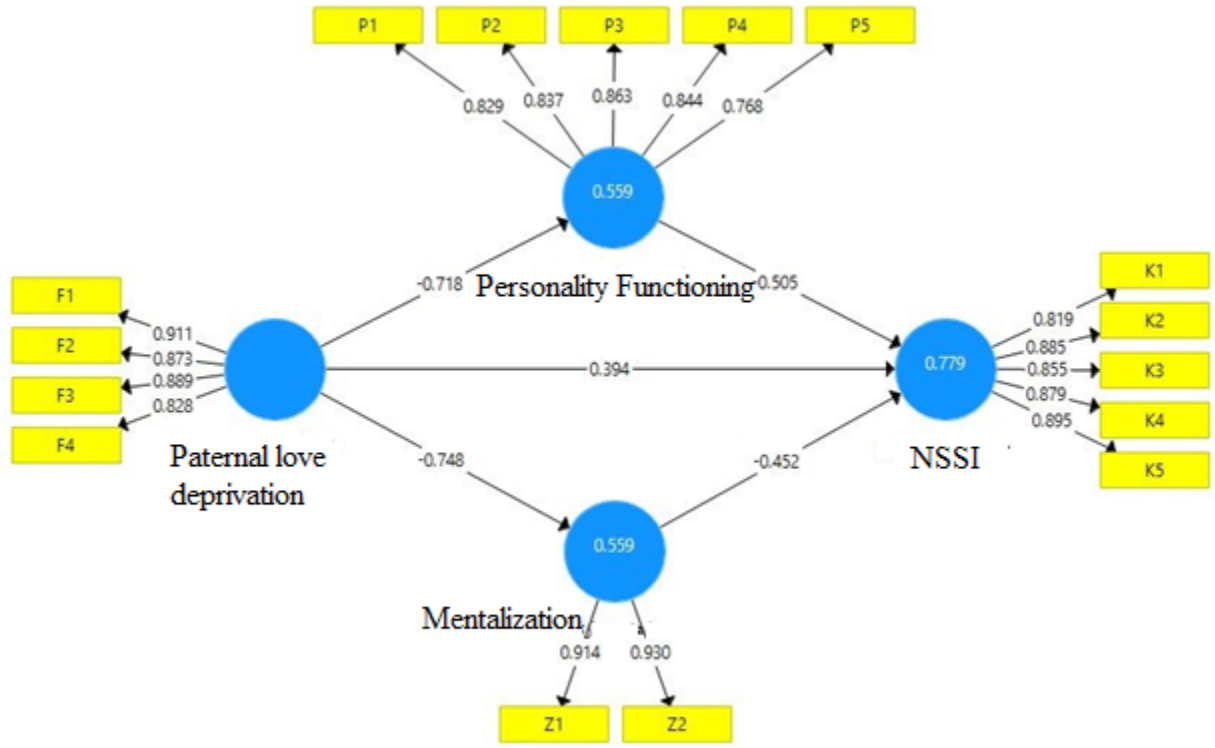

Figure 1. Path Coefficient Test

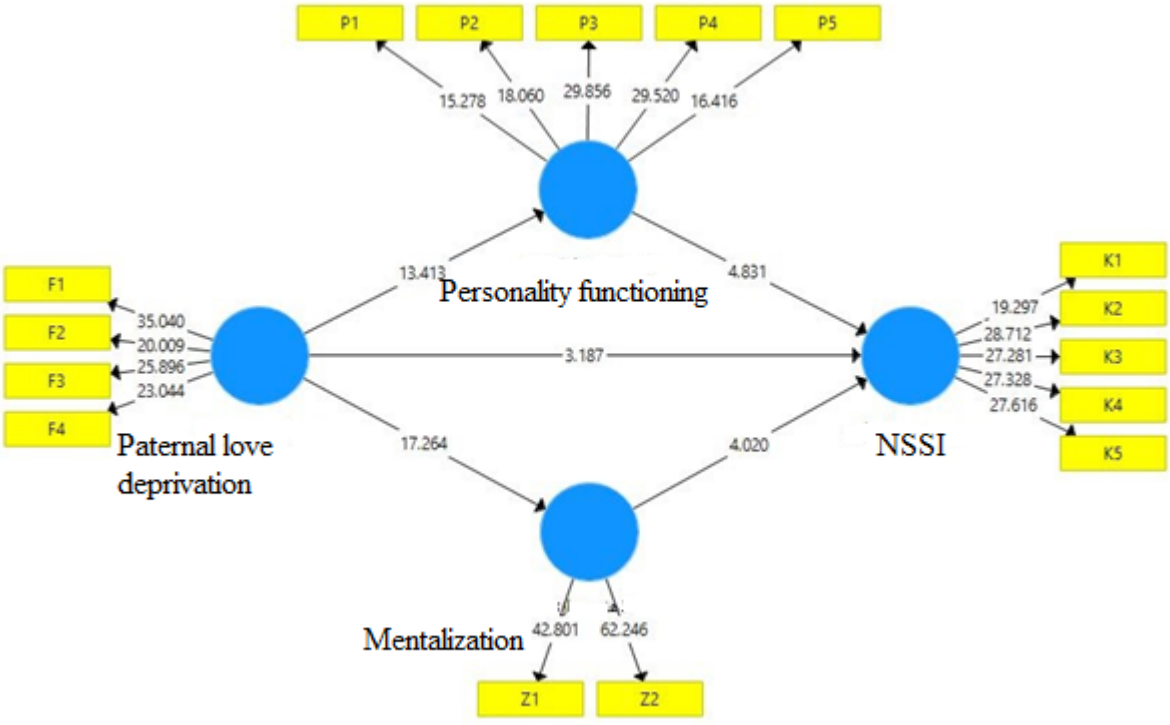

Figure 2. T-value Test

Factor Loading Test

The factor loading indicates the strength of the relationship between a latent variable (factor) and its observed variables. It shows how well the items measure their corresponding construct. Factor loading values range between 0 and 1: Below 0.30 → weak relationship (usually removed) 0.30 to 0.60 → acceptable, above 0.60 → highly desirable. The values obtained in Figure 1 indicate that the factor loadings of the constructs are highly satisfactory.

Reliability and Validity Test

Table 2. Reliability and Validity Values

Variable	Cronbach's Alpha	rho-A	Composite Reliability	Convergent Validity (AVE)
Non-Suicidal Self-Injury	0.917	0.918	0.938	0.752
Mentalization	0.824	0.830	0.919	0.850
Paternal Love Deprivation	0.898	0.900	0.929	0.767
Personality Functioning	0.886	0.887	0.916	0.687

Cronbach's alpha measures reliability and internal consistency. Values above 0.70 indicate acceptable reliability. As shown in the table, the alpha values for all variables are above 0.70, demonstrating acceptable reliability. Composite Reliability (CR) and rho-A are calculated using the ratio of construct variance to the sum of construct variance and measurement error variance.

A CR value above 0.70 indicates satisfactory internal reliability, while values below 0.60 indicate poor reliability. Since the composite reliability values are all above 0.70, the measurement model demonstrates adequate internal reliability. Convergent validity assesses the extent to which a latent variable explains its observed indicators. The Average Variance Extracted (AVE) proposed by Fornell and Larcker (1981) measures the internal validity of the measurement model.

The minimum acceptable value for AVE is 0.50 (Holland, 1999), meaning that the latent construct explains at least 50% of the variance of its indicators. Values above 0.50 are considered desirable (Magner et al., 1996). Based on the results, convergent validity is satisfactory for all variables.

Hypothesis Testing

Table 3. Hypothesis Testing Results

Path	Path Coefficient	T-value	Significance
Paternal Love Deprivation → Non-Suicidal Self-Injury	0.394	3.187	0.000
Paternal Love Deprivation → Personality Functioning	-0.718	13.413	0.000
Paternal Love Deprivation → Mentalization	-0.748	17.264	0.000
Mentalization → Non-Suicidal Self-Injury	-0.452	4.020	0.000
Personality Functioning → Non-Suicidal Self-Injury	-0.505	4.831	0.000
Paternal Love Deprivation → Personality Functioning → Non-Suicidal Self-Injury	-0.563	7.495	0.000
Paternal Love Deprivation → Mentalization → Non-Suicidal Self-Injury	-0.549	7.108	0.000

According to the table, the significance levels (0.000) are lower than the error threshold of 0.05, indicating that the research hypotheses are supported. In other words, the mediating roles of personality functioning and mentalization in the relationship between paternal love deprivation and non-suicidal self-injury among students are confirmed.

Discussion

The aim of the present study was to investigate the mediating role of personality functioning and mentalization in the relationship between paternal love deprivation and non-suicidal self-injury (NSSI) in students, with an emphasis on the role of gender. The results showed a significance level

(p = 0.009) below the error threshold of 0.05, which leads to the inference that the research hypothesis is supported. In other words, the mediating role of personality functioning and mentalization in the relationship between paternal love deprivation and NSSI is confirmed. Furthermore, given the negative numerical difference in the path coefficient, it can be concluded that the relationship between paternal love deprivation and NSSI, mediated by personality functioning and mentalization, is stronger in women.

Paternal love deprivation is associated with a higher incidence of behavioral problems (Siegel-Rushton et al., 2004), including maladaptive behavior (East et al., 2006), aggressive behavior (Lundberg, 2017), and even life-threatening behaviors such as self-harm (Whitlock et al., 2013). Non-suicidal self-injury (NSSI) is a significant behavioral issue (Jacobson & Gould, 2007). It is noteworthy that paternal love deprivation does not merely refer to the physical absence of a parent; more complexly, it represents the emotional, behavioral, cognitive, and volitional alienation of the father from the child during their formative years (Rohner et al., 2001). Fathers play a crucial role in children's development throughout their lives, and paternal love deprivation leads to increased behavioral problems, including NSSI (Zhou et al., 2024).

The bond between father and child is one of the most central and influential relationships. Paternal Love Deprivation (PLD) has numerous adverse effects on children. This finding is consistent with Nock's integrated theoretical model, which suggests that distal risk factors—including paternal love deprivation—can influence NSSI. Specifically, distal risk factors tend to trigger disturbing cognitions and emotions that individuals wish to escape (Nock et al., 2009), and NSSI serves as a negative strategy to escape these aversive stimuli or events. In other words, paternal love deprivation drives individuals to experience more intense, distressing thoughts and emotions, compelling them to resort to NSSI as a means of regulation (Silvers et al., 2012). Moreover, this conclusion can be interpreted from another perspective: children who experience paternal love deprivation likely demonstrate lower tolerance for stress and frustration and possess weaker problem-solving and adaptive abilities (Biller, 1993).

Consequently, children who experience paternal love deprivation are more likely to experience greater stress in response to challenging situations, which leads them to use NSSI as a coping mechanism in the face of seemingly insurmountable circumstances. In summary, paternal love deprivation can positively predict NSSI. As a result, children growing up in an environment of

paternal love deprivation may lack the autonomy to make choices and decisions. Furthermore, in the absence of a father, children may face a lack of the guidance and support necessary for developing competence. Additionally, the lack of a strong father-child relationship can lead to feelings of social isolation and a lack of emotional support. In other words, Paternal Love Deprivation (PLD) can be considered a potential factor that compromises the fulfillment of basic psychological needs (Pietromonaco et al., 2000).

Consistent with the results of this study, the findings of Kewarshi et al. (2021) showed that there is a difference in the level of depression between boys whose fathers are present in the family and those whose fathers are absent. Children whose fathers have passed away exhibit higher levels of depression compared to children whose fathers are absent from the family. The findings also confirmed that children whose fathers live abroad have higher levels of depression compared to children whose fathers live with them. Also, the results of Ramatse and Rose (2023) indicate that women perceived the experience of paternal absence as having a negative impact on their sense of belonging and identity, with some participants suffering from emotional and financial challenges. Participants acknowledged the lack of healthy relationships with other men, which was linked to growing up with an absent father. While most women adopted positive coping strategies, a few resorted to negative coping.

Paternal love deprivation can be linked to an initial unfavorable family environmental factor, specifically a distal risk factor, as it may place children in an inattentive and unsupported home environment. Nock's (2009) integrated theoretical model of NSSI suggests that distal risk factors play a role in promoting the development of more unfavorable intra-individual and interpersonal vulnerability factors. Furthermore, NSSI is often employed as a coping mechanism in response to challenging or stressful life events. Therefore, this study suggests that paternal love deprivation may act as a distal risk factor that negatively impacts NSSI. Moreover, empirical studies have consistently identified paternal love deprivation as a significant influencing factor in the occurrence of NSSI. For example, Rohner et al. (2001) found that the active involvement of fathers in their children's development could act as a protective factor against behavioral problems (e.g., NSSI); Fu et al. (2017) observed that the absence of fathers is associated with a higher likelihood of experiencing suicidal thoughts in children. Although many recent studies have investigated factors influencing NSSI, most have primarily focused on negative factors.

The literature indicates that personality pathology, personality functioning, and mentalization are related concepts. One potential way these three concepts interact is that higher severity of personality disorder negatively affects the ability to mentalize. Bender et al. (2011), when operationalizing the assessment of personality functioning in the DSM-5, explained that personality functioning is closely related to the socio-cognitive ability of mentalization (Fonagy et al., 2002).

Nevertheless, the present study has certain limitations. First, this study relied on self-report methods, which raises the possibility of subjective factors influencing data accuracy. In future studies, the inclusion of interviews or observational data is recommended. Second, this study analyzed cross-sectional data through Structural Equation Modeling (SEM). While this model is theoretically grounded, the relationships between variables can only be inferred tentatively, and precise causal relationships require further verification. Future research would benefit from the inclusion of longitudinal data. This study has confirmed a positive correlation between “Paternal Love Deprivation” (PLD) and “Non-Suicidal Self-Injury” (NSSI). These findings not only enhance our understanding of Nock’s integrated theoretical model of NSSI but also contribute to the theoretical discourse surrounding NSSI. They provide new insights for the formulation of intervention strategies aimed at reducing NSSI.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by ethics committee of Shahid Madani University of Azerbaijan.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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