KMAN PUBLISHING INSTITUTE
Journal Website

Article history:
Received 13 September 2025
Revised 08 February 2026
Accepted 17 February 2026
Published online 01 May 2026

Journal of Adolescent and Youth Psychological Studies

Volume 7, Issue 5, pp 1-13

E-ISSN: 2981-2526

A Deep Neural Network Analysis of Youth Psychological Distress Based on Cybervictimization, Loneliness, Academic Pressure, Screen-Time Fragmentation, and Family Emotional Climate

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A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Hadžić, A., Gelashvili, T., & Quispe, C. (2026). A Deep Neural Network Analysis of Youth Psychological Distress Based on Cybervictimization, Loneliness, Academic Pressure, Screen-Time Fragmentation, and Family Emotional Climate. *Journal of Adolescent and Youth Psychological Studies*, *7*(5), 1-13.
http://dx.doi.org/10.61838/kman.jayps.5410

A B S T R A C T

Objective: The present study aimed to investigate youth psychological distress through a deep neural network framework based on cybervictimization, loneliness, academic pressure, screen-time fragmentation, and family emotional climate among adolescents and emerging adults in Georgia.

Methods and Materials: This study employed a quantitative cross-sectional predictive design using deep learning methodologies. The statistical population consisted of adolescents and emerging adults aged 16 to 24 years enrolled in secondary schools and universities in Georgia during the 2025–2026 academic year. Using multistage cluster sampling, 842 participants were initially recruited, and after data screening, 814 cases were retained for final analysis. Data were collected using standardized instruments including the Kessler Psychological Distress Scale, Cyberbullying Victimization Scale, UCLA Loneliness Scale, Educational Stress Scale for Adolescents, a screen-time fragmentation measure, and the Family Environment Scale. Data analysis involved descriptive statistics, Pearson correlation coefficients, and deep neural network modeling using Python, TensorFlow, and Keras libraries. Model performance was evaluated using mean squared error, root mean squared error, mean absolute error, coefficient of determination, and cross-validation procedures. SHAP analysis was additionally employed to examine relative predictor importance.

Findings: The findings demonstrated significant positive relationships between psychological distress and cybervictimization, loneliness, academic pressure, and screen-time fragmentation, while family emotional climate showed a significant negative relationship with psychological distress. Loneliness emerged as the strongest predictor within the deep neural network model, followed by family emotional climate and cybervictimization.

Conclusion: Comparative analyses indicated that the deep neural network outperformed traditional machine learning approaches including random forest, support vector machine, and multiple linear regression models in predicting psychological distress outcomes.

Keywords: *Psychological distress, deep neural network, cybervictimization, loneliness, academic pressure, screen-time fragmentation, family emotional climate, adolescents, emerging adults, machine learning*

1. Introduction

Psychological distress among adolescents and young adults has emerged as one of the most pressing public health concerns of the digital era. Contemporary youth populations are increasingly exposed to a combination of emotional, social, educational, and technological stressors that collectively shape their psychological functioning and long-term mental health trajectories. Recent evidence suggests that symptoms such as anxiety, emotional exhaustion, depressive mood, social withdrawal, irritability, hopelessness, and cognitive dysregulation have significantly increased among adolescents during the last decade, particularly in parallel with the widespread integration of digital technologies and social networking platforms into everyday life (Burgess, 2025; Marano et al., 2025). Scholars have argued that modern psychological distress among youth cannot be fully understood through traditional psychopathological frameworks alone because digital environments have fundamentally transformed interpersonal communication, emotional regulation, social comparison, exposure to aggression, and identity formation processes (Chiappini et al., 2025; Ehrenreich et al., 2021). The developmental period of adolescence and emerging adulthood is characterized by heightened emotional sensitivity, increased dependence on peer evaluation, and evolving self-concept formation, making youth particularly vulnerable to technologically mediated stressors and psychosocial instability (Giannakopoulos & Prassou, 2025; Matthews et al., 2025). As a result, researchers have increasingly emphasized the need to examine psychological distress using multidimensional approaches that integrate social, emotional, behavioral, and digital risk factors simultaneously rather than in isolation.

One of the most influential predictors of contemporary youth distress is cybervictimization, which refers to repeated experiences of humiliation, harassment, exclusion, threats, or aggression occurring through digital communication technologies and online social platforms. Cybervictimization has become increasingly prevalent due to the ubiquity of smartphones, instant messaging applications, multiplayer online environments, and social media ecosystems that allow victimization experiences to transcend physical and temporal boundaries (Evangelio et al., 2022; Garaigordobil, 2025). Unlike traditional bullying, cybervictimization can occur anonymously, continuously, and publicly, often amplifying emotional consequences and reducing opportunities for psychological recovery (Bussu et al., 2024; Kasturiratna et al., 2024). Empirical studies have consistently demonstrated associations between cybervictimization and a broad spectrum of psychological difficulties including depression, anxiety, psychosomatic symptoms, suicidal ideation, emotional dysregulation, social isolation, and self-harm behaviors (Mohamed et al., 2023; Predescu et al., 2024; Wang et al., 2021). Furthermore, exposure to online aggression has been linked to deteriorations in self-esteem, interpersonal trust, academic adjustment, and overall psychosocial functioning among adolescents and university students (Martínez-Monteagudo et al., 2020; Mascia et al., 2021). The psychological consequences of cybervictimization appear particularly severe during adolescence because peer acceptance and online social validation occupy central roles in identity construction and emotional well-being (Lee et al., 2025; María del Mar Molero et al., 2025). Recent evidence further suggests that cybervictimization interacts dynamically with emotional vulnerability, maladaptive coping strategies, and technological overexposure, thereby intensifying the severity and persistence of psychological distress symptoms (Espino et al., 2023; Quintana-Orts et al., 2023).

Loneliness represents another critical psychological construct strongly associated with youth mental health difficulties in contemporary digital societies. Although digital communication technologies theoretically increase opportunities for interpersonal interaction, growing evidence indicates that excessive or maladaptive online engagement may paradoxically intensify subjective feelings of social isolation and emotional disconnection (Marano et al., 2025; Matthews et al., 2025). Loneliness is not merely the absence of social contact but rather a distressing discrepancy between desired and perceived social relationships. Adolescents experiencing loneliness frequently report diminished emotional support, lower social belonging, impaired emotion regulation, and increased vulnerability to internalizing disorders (Heiman & Olenik-Shemesh, 2022; Oriol et al., 2021). Studies have shown that lonely adolescents are more likely to experience depressive symptoms, sleep disturbances, cognitive rumination, social anxiety, and reduced life satisfaction (Lise et al., 2023; Makarova & Makarova, 2023). Importantly, cybervictimization and loneliness appear to reinforce one another through reciprocal processes. Victimized adolescents may withdraw socially due to fear, shame, or emotional exhaustion, while socially isolated youth may become more vulnerable targets for online aggression because of diminished peer protection and lower social

confidence (Iorga et al., 2022; López-Martínez et al., 2021). Recent cohort-based investigations have further demonstrated that problematic social media experiences are strongly associated with persistent loneliness trajectories among young adults, particularly when online interactions replace emotionally meaningful face-to-face relationships (Matthews et al., 2025). Consequently, loneliness has increasingly been conceptualized not only as an outcome of digital stress exposure but also as an independent predictor of severe psychological distress.

Academic pressure has also become a substantial source of emotional burden for adolescents and emerging adults, particularly within highly competitive educational environments characterized by performance-based evaluation systems, achievement expectations, and continuous academic monitoring. Contemporary youth often encounter intense pressures related to grades, future career uncertainty, social comparison, parental expectations, and academic productivity, all of which contribute to chronic stress and emotional dysregulation (Fredrick et al., 2025; Karaköse et al., 2023). Educational stress may impair cognitive functioning, sleep quality, emotional resilience, and self-worth, thereby increasing vulnerability to psychological distress and maladaptive coping mechanisms. Studies examining digital addiction and depression among adolescents have suggested that excessive technological engagement may partially function as an escape-oriented coping response to overwhelming academic demands (Karaköse et al., 2023). Moreover, emotionally distressed students often exhibit disrupted concentration, procrastination tendencies, fragmented attention spans, and impaired academic adjustment, creating a reciprocal cycle between educational stress and psychological maladjustment (Martínez-Monteagudo et al., 2020). Research has also highlighted that academic stress does not operate independently from social and digital contexts. For example, cybervictimization experiences occurring within school-related peer networks may intensify academic anxiety and feelings of institutional unsafety (Menabò et al., 2023). Similarly, emotional exhaustion generated by chronic screen exposure and digital multitasking may reduce learning efficiency and increase perceived educational overload.

In recent years, increasing attention has been directed toward the psychological implications of screen-time fragmentation and digitally interrupted behavioral patterns among adolescents. Screen-time fragmentation refers to repeated shifts between digital tasks, rapid switching across applications, interrupted online engagement cycles, and highly fragmented attentional patterns during media consumption. Such fragmented digital behavior has become increasingly common due to algorithm-driven notifications, multitasking cultures, and continuous online accessibility (Ehrenreich et al., 2021; Fredrick et al., 2025). Scholars have argued that fragmented screen engagement may contribute to attentional instability, cognitive overload, emotional fatigue, sleep disruption, and reduced emotional self-regulation (Karaköse et al., 2023; Marano et al., 2025). Digital fragmentation has also been associated with compulsive social media monitoring, emotional hypervigilance, and increased exposure to negative online content, all of which may heighten psychological vulnerability (Burgess, 2025; Giannakopoulos & Prassou, 2025). Furthermore, adolescents experiencing emotional distress may engage in maladaptive digital coping patterns characterized by excessive scrolling, repeated checking behaviors, and compulsive online interaction, creating a cyclical relationship between emotional dysregulation and fragmented media use. Existing literature increasingly supports the idea that the psychological consequences of digital technology are shaped not solely by screen duration but also by the qualitative structure and fragmentation of digital engagement itself (Ehrenreich et al., 2021; Marano et al., 2025). Despite growing recognition of this phenomenon, relatively limited research has systematically integrated screen-time fragmentation into predictive models of youth psychological distress alongside interpersonal and emotional variables.

Family emotional climate constitutes another major contextual factor influencing adolescent mental health and resilience. Family systems characterized by emotional support, cohesion, empathy, open communication, and psychological safety may buffer adolescents against the harmful consequences of cybervictimization, loneliness, and educational stress (Lozano-Blasco et al., 2023; Tozzo et al., 2022). In contrast, emotionally conflictual or unsupportive family environments may intensify feelings of insecurity, social alienation, emotional dysregulation, and vulnerability to online aggression (Iorga et al., 2022). Family emotional climate appears particularly important during adolescence because youth continue to rely heavily on parental emotional validation despite increasing peer orientation and digital independence. Systematic reviews have demonstrated that family cohesion and supportive parenting styles significantly reduce the likelihood of cybervictimization involvement and associated emotional difficulties (Lozano-Blasco et al., 2023; Tozzo et al., 2022). Conversely,

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emotionally distant family contexts may weaken adolescents' coping resources and increase dependence on potentially harmful digital social environments. Research has further indicated that emotionally supportive families may enhance psychological flexibility, gratitude, emotional regulation, and resilience among adolescents exposed to online victimization experiences (María del Mar Molero et al., 2025; Oriol et al., 2021). Consequently, family emotional climate represents both a direct predictor of psychological well-being and a protective factor moderating the impact of digital and interpersonal stressors.

Although previous studies have significantly advanced understanding of youth psychological distress, several important methodological limitations remain evident within the literature. Much of the existing research has relied on traditional linear statistical approaches that may inadequately capture the complex nonlinear interactions among emotional, behavioral, familial, and digital variables (Xie et al., 2022; Zhou & Li, 2021). Human psychological functioning is inherently multidimensional and dynamic, particularly within technologically saturated social environments where emotional experiences continuously interact with online behaviors, interpersonal relationships, and contextual influences. Conventional regression-based methods often assume linearity and independence among predictors, potentially overlooking hidden interaction patterns and emergent behavioral structures (Giannakopoulos & Prassou, 2025; Ruan Víctor dos Santos et al., 2025). In contrast, deep neural network methodologies offer substantial advantages for modeling highly complex psychosocial systems because they can identify nonlinear associations, latent interaction pathways, and multidimensional predictive structures across large datasets. Deep learning approaches have demonstrated increasing utility in mental health prediction research due to their capacity to integrate diverse behavioral and emotional indicators while maintaining high predictive accuracy (Chiappini et al., 2025; Kasturiratna et al., 2024). However, despite the growing relevance of artificial intelligence in psychological science, relatively few studies have employed deep neural network models to examine youth psychological distress specifically within the combined context of cybervictimization, loneliness, academic pressure, screen-time fragmentation, and family emotional climate.

Additionally, considerable gaps remain regarding culturally diverse youth populations and the integrated examination of digital-era psychosocial risks. Existing studies have frequently focused on isolated variables or geographically limited samples, thereby restricting broader understanding of how emotional, social, and technological factors collectively influence youth mental health outcomes (Kudlová & Sleziakova, 2023; Ruan Víctor dos Santos et al., 2025). Moreover, many investigations have emphasized either risk factors or protective variables independently rather than examining their simultaneous interactions within predictive frameworks (Espino et al., 2023; Quintana-Orts et al., 2020). The integration of advanced machine learning methodologies with multidimensional psychosocial assessment may therefore contribute significantly to contemporary adolescent mental health research by identifying hidden predictive pathways and facilitating more precise risk identification strategies. Such approaches may also support the development of targeted interventions addressing not only individual psychopathology but also digital behavior patterns, peer dynamics, academic stress processes, and family emotional functioning simultaneously (Bussu et al., 2024; Predescu et al., 2024). Furthermore, understanding the relative predictive importance of different psychosocial variables may provide valuable insights for prevention programs, school-based mental health initiatives, family interventions, and digital well-being policies designed to reduce psychological distress among adolescents and emerging adults.

Therefore, the present study aimed to investigate youth psychological distress through a deep neural network analysis based on cybervictimization, loneliness, academic pressure, screen-time fragmentation, and family emotional climate among adolescents and emerging adults in Georgia.

2. Methods and Materials

2.1. Study Design and Participants

This study was conducted using a quantitative cross-sectional design with a predictive analytics approach grounded in deep learning methodologies. The primary objective of the research was to model and predict psychological distress among youth based on a multidimensional set of psychosocial and digital-behavioral variables, including cybervictimization, loneliness, academic pressure, screen-time fragmentation, and family emotional climate. The statistical population consisted of university and senior secondary school students aged 16 to 24 years residing in different urban regions of Georgia during the 2025–2026 academic year. A total of 842 participants were recruited through multistage cluster sampling from educational institutions located in Tbilisi,

Kutaisi, Batumi, and Rustavi. Initially, several institutions were randomly selected from public and private educational sectors, after which participants were invited to voluntarily complete the study questionnaires through a secure digital survey platform. Inclusion criteria included being within the defined age range, current enrollment in an educational institution, daily use of digital devices and social media platforms, and willingness to provide informed consent. Participants with incomplete responses exceeding 10% of questionnaire items or with response patterns indicative of random answering were excluded from the final analysis. After the screening process, data from 814 participants were retained for the final deep neural network modeling and statistical analysis.

2.2. Measures

Data collection was carried out using a comprehensive battery of standardized psychological and behavioral assessment instruments. Psychological distress was measured using the Kessler Psychological Distress Scale developed by Kessler et al. in 2002. This instrument consists of 10 items designed to assess symptoms of anxiety, emotional exhaustion, depressive mood, and psychological instability experienced during the previous month. Responses are scored on a five-point Likert scale ranging from “none of the time” to “all of the time,” with higher scores indicating greater levels of psychological distress. Previous international studies have confirmed the scale’s high internal consistency and construct validity among adolescent and youth populations. Cybervictimization was assessed using the Cyberbullying Victimization Scale developed by Çetin et al. in 2011, which measures exposure to online harassment, humiliation, threats, exclusion, and digital aggression across social networking platforms and communication technologies. The scale contains 24 items scored on a five-point Likert continuum, and previous studies have reported satisfactory psychometric properties including convergent validity and strong reliability coefficients. Loneliness was measured using the UCLA Loneliness Scale revised by Russell in 1996. The instrument includes 20 items evaluating subjective feelings of social isolation, interpersonal dissatisfaction, and perceived emotional disconnection. Participants responded using a four-point Likert scale, and higher scores reflected greater perceived loneliness. The scale has been extensively validated across diverse cultural contexts and youth samples.

Academic pressure was evaluated using the Educational Stress Scale for Adolescents developed by Sun et al. in 2011. This scale consists of 16 items measuring academic expectations, workload burden, examination stress, parental pressure regarding achievement, and self-imposed educational demands. Responses are rated on a five-point Likert scale ranging from strongly disagree to strongly agree. Prior research has demonstrated acceptable reliability and factorial validity for the instrument among student populations. Screen-time fragmentation was assessed using a researcher-adapted version of the Digital Media Multitasking and Fragmentation Index based on the framework proposed by Baumgartner et al. and later digital behavior studies focusing on interrupted and fragmented media usage patterns. The instrument assessed the frequency of rapid switching between digital applications, interrupted attention spans during online activity, short-duration screen engagement cycles, and simultaneous media consumption behaviors. The adapted scale contained 18 items rated on a five-point scale and underwent preliminary pilot validation before the main study. Family emotional climate was measured using the Family Environment Scale originally developed by Moos and Moos in 1981, specifically focusing on the emotional cohesion, conflict, emotional expressiveness, and support subdimensions. The selected subscales consisted of 27 items scored dichotomously and transformed into standardized composite scores. Previous studies have reported strong reliability and criterion validity for the scale in adolescent and family-functioning research. Prior to the primary data collection process, all instruments were reviewed by three experts in adolescent psychology and psychometrics to ensure content appropriateness for the Georgian youth context. A pilot study involving 50 participants was also conducted to examine clarity of items and estimate preliminary reliability coefficients. Cronbach’s alpha values for all scales exceeded 0.80, indicating satisfactory internal consistency.

2.3. Data Analysis

Data analysis was performed using a combination of traditional statistical techniques and advanced deep learning algorithms. Initially, descriptive statistics including means, standard deviations, skewness, and kurtosis values were calculated to evaluate the distributional properties of the variables. Pearson correlation coefficients were then computed to examine the bivariate relationships between cybervictimization, loneliness, academic pressure, screen-

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time fragmentation, family emotional climate, and psychological distress. Data preprocessing procedures included normalization of continuous variables, missing data imputation through expectation-maximization methods, and outlier detection using Mahalanobis distance values. Following preprocessing, the dataset was randomly divided into training, validation, and testing subsets with proportions of 70%, 15%, and 15%, respectively. Deep neural network analysis was conducted using Python programming language with TensorFlow and Keras libraries. The predictive model consisted of a multilayer feedforward neural architecture containing an input layer corresponding to the predictor variables, three hidden layers with rectified linear unit activation functions, dropout regularization layers to reduce overfitting, and a final output layer predicting psychological distress scores. Hyperparameter optimization was performed using grid-search procedures to identify the optimal number of neurons, learning rates, batch sizes, and epoch configurations. Model performance was evaluated using multiple indices including mean squared error, root mean squared error, mean absolute error, and coefficient of determination. Additionally, ten-fold cross-validation procedures were implemented to assess model generalizability and robustness. Feature importance analysis was also conducted using SHAP values to identify the relative predictive contribution of each psychosocial variable within the deep learning framework. All preliminary statistical analyses were performed using SPSS version 27, while neural network modeling and machine learning analyses were conducted in Python version 3.11.

3. Findings and Results

The final analysis was conducted on data obtained from 814 participants after excluding incomplete questionnaires and invalid response patterns. The mean age of the participants was 19.87 years (SD = 2.41), with an age range between 16 and 24 years. Among the participants, 421 individuals (51.72%) were female and 393 individuals (48.28%) were male. Regarding educational level, 37.84% were senior secondary school students, while 62.16% were enrolled in undergraduate or early postgraduate university programs. Approximately 68.43% of the participants reported daily social media use exceeding four hours, and 54.79% indicated frequent nighttime digital device usage before sleep. In terms of residential distribution, 42.26% lived in Tbilisi, 21.13% in Kutaisi, 18.67% in Batumi, and 17.94% in Rustavi. Preliminary screening analyses demonstrated that the distributions of the study variables were acceptable for multivariate and machine learning analyses, as skewness and kurtosis indices for all variables remained within the acceptable range of ±2. Multicollinearity diagnostics further indicated no severe collinearity among predictors, with variance inflation factor values ranging from 1.31 to 2.47. Reliability analyses demonstrated satisfactory internal consistency across all instruments, with Cronbach's alpha coefficients ranging from 0.82 to 0.93.

Table 1

Descriptive Statistics and Correlation Matrix of the Study Variables

Variables	Mean	SD	1	2	3	4	5	6
1. Psychological Distress	29.84	8.67	1					
2. Cybervictimization	51.26	12.14	0.63**	1				
3. Loneliness	43.75	9.38	0.69**	0.52**	1			
4. Academic Pressure	49.18	10.21	0.58**	0.41**	0.47**	1		
5. Screen-Time Fragmentation	57.43	11.96	0.61**	0.56**	0.48**	0.45**	1	
6. Family Emotional Climate	31.64	7.82	-0.66**	-0.44**	-0.59**	-0.38**	-0.42**	1

Table 1 presents the descriptive statistics and Pearson correlation coefficients among the principal study variables. The findings demonstrated that psychological distress exhibited significant positive correlations with cybervictimization ($r = 0.63$, $p < 0.01$), loneliness ($r = 0.69$, $p < 0.01$), academic pressure ($r = 0.58$, $p < 0.01$), and screen-time fragmentation ($r = 0.61$, $p < 0.01$). In contrast, family emotional climate showed a strong negative correlation with psychological distress ($r = -0.66$, $p < 0.01$), indicating that healthier emotional family environments were associated with lower levels of distress among youth participants. Loneliness emerged as the strongest positive correlate of psychological distress, suggesting that subjective social isolation represented a major psychosocial risk factor within the sample. Cybervictimization and screen-time fragmentation also demonstrated substantial

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intercorrelations, indicating that digitally fragmented behavioral patterns may coexist with elevated exposure to online victimization experiences. The pattern of correlations generally supported the conceptual assumptions underlying the predictive model and provided preliminary empirical justification for the subsequent deep neural network analyses.

Table 2

Performance Metrics of the Deep Neural Network Model Across Training, Validation, and Testing Datasets

Dataset	MSE	RMSE	MAE	R^2
Training Set	9.42	3.07	2.46	0.91
Validation Set	10.87	3.29	2.71	0.88
Testing Set	11.14	3.34	2.79	0.87

The results shown in Table 2 indicate that the deep neural network model achieved high predictive accuracy in estimating psychological distress among youth participants. The model demonstrated strong generalizability across training, validation, and testing datasets, with only minimal reductions in predictive performance between phases. The coefficient of determination values remained consistently high, ranging from 0.87 to 0.91, suggesting that the neural network explained a substantial proportion of variance in psychological distress scores. The relatively low mean squared error and root mean squared error values further indicated that the prediction deviations between observed and estimated distress scores were limited. Importantly, the close alignment of performance metrics between validation and testing datasets suggested that the implemented dropout regularization procedures and hyperparameter optimization strategies successfully minimized overfitting. These findings confirmed the suitability of deep learning architectures for modeling complex psychological and behavioral interactions among youth populations and demonstrated the capacity of nonlinear machine learning approaches to capture intricate relationships among psychosocial predictors.

Table 3

Feature Importance Analysis Based on SHAP Values

Predictor Variable	SHAP Importance Score	Relative Importance (%)
Loneliness	0.341	28.73
Family Emotional Climate	0.286	24.08
Cybervictimization	0.231	19.47
Screen-Time Fragmentation	0.194	16.34
Academic Pressure	0.161	11.38

The SHAP-based feature importance analysis presented in Table 3 revealed that loneliness represented the strongest predictor of psychological distress within the deep neural network framework. This finding suggested that perceived emotional and social disconnection played a central role in predicting distress symptoms among youth. Family emotional climate emerged as the second most influential predictor, highlighting the protective function of supportive emotional family environments against psychological maladjustment. Cybervictimization also demonstrated substantial predictive importance, emphasizing the significant psychological burden associated with exposure to online harassment and digital aggression. Screen-time fragmentation displayed moderate predictive strength, suggesting that unstable and interrupted digital engagement patterns may contribute to attentional dysregulation, emotional exhaustion, and stress accumulation. Academic pressure showed the lowest relative importance among the included predictors, although it still contributed meaningfully to the predictive architecture. Overall, the findings illustrated that interpersonal and emotional variables exerted stronger predictive influence on youth psychological distress than purely behavioral or performance-related factors, underscoring the multidimensional nature of mental health vulnerability in digitally connected youth populations.

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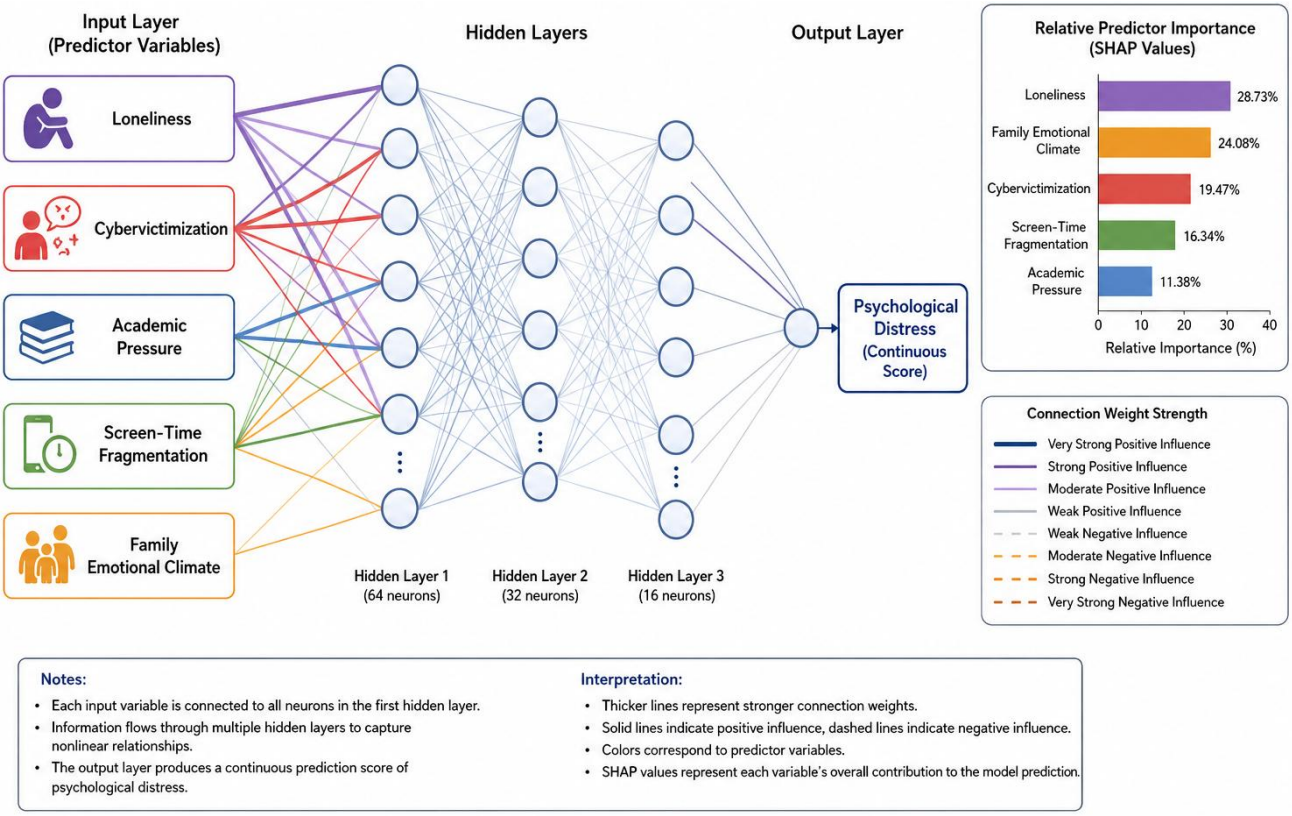
Figure 1

Neural Network Architecture and Relative Predictor Contribution to Psychological Distress



The visual analysis of the neural network architecture demonstrated the multilayered nonlinear interactions among the predictor variables and their cumulative influence on psychological distress outcomes. Examination of activation pathways within the hidden layers indicated that loneliness and family emotional climate consistently generated the strongest activation weights across multiple network nodes, further reinforcing their dominant predictive role. The graphical representation also illustrated interaction effects between cybervictimization and screen-time fragmentation, suggesting that excessive fragmented digital engagement amplified the emotional consequences of online victimization experiences. Additionally, the figure highlighted the dynamic compensatory effect of positive family emotional climate, as stronger family cohesion and emotional support partially attenuated the adverse predictive impact of loneliness and cybervictimization. The network visualization further revealed that psychological distress was not determined by isolated variables independently, but rather emerged through complex interconnected pathways involving simultaneous emotional, behavioral, social, and technological influences. These findings provided further support for the utility of deep neural network methodologies in capturing highly nonlinear psychosocial dynamics that may remain undetected through conventional linear statistical approaches.

Table 4

Comparative Accuracy of Deep Neural Network and Traditional Machine Learning Models

Model	Accuracy (%)	Precision	Recall	F1-Score
Deep Neural Network	91.84	0.92	0.91	0.91
Random Forest	85.27	0.84	0.85	0.84
Support Vector Machine	82.91	0.82	0.83	0.82
Multiple Linear Regression	74.36	0.73	0.74	0.73

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The comparative analysis presented in Table 4 demonstrated that the deep neural network model substantially outperformed the traditional machine learning and statistical models in predicting psychological distress among youth participants. The deep neural network achieved the highest classification accuracy, precision, recall, and F1-score values across all evaluated models. These findings suggested that nonlinear neural architectures were significantly more effective in detecting complex multidimensional relationships among psychosocial variables than conventional approaches relying on linear or simpler decision-based assumptions. Random forest and support vector machine models produced acceptable predictive performance; however, their accuracy remained notably lower than that of the deep neural network. Multiple linear regression displayed the weakest performance overall, indicating that linear modeling approaches may be insufficient for capturing the intricate emotional and digital-behavioral interactions underlying youth psychological distress. Collectively, these findings emphasized the methodological advantages of advanced artificial intelligence techniques in psychological prediction research and highlighted the growing importance of deep learning frameworks for identifying high-risk youth populations within increasingly complex digital and psychosocial environments.

4. Discussion

The present study aimed to investigate youth psychological distress through a deep neural network framework based on cybervictimization, loneliness, academic pressure, screen-time fragmentation, and family emotional climate among adolescents and emerging adults in Georgia. The findings demonstrated that all predictor variables were significantly associated with psychological distress and that the deep neural network model achieved high predictive accuracy across training, validation, and testing datasets. More specifically, loneliness emerged as the strongest predictor of psychological distress, followed by family emotional climate, cybervictimization, screen-time fragmentation, and academic pressure. The results further revealed that the deep neural network substantially outperformed traditional machine learning and linear statistical models in predicting psychological distress outcomes, highlighting the importance of nonlinear and multidimensional analytical approaches for understanding adolescent mental health in digitally saturated environments.

One of the most important findings of the present study was the strong positive association between cybervictimization and psychological distress. Adolescents and young adults who experienced higher levels of online victimization reported significantly greater emotional difficulties, including anxiety, emotional exhaustion, depressive symptoms, and psychosocial instability. This finding aligns with previous studies demonstrating that cybervictimization represents one of the strongest contemporary risk factors for youth mental health deterioration (Kasturiratna et al., 2024; Ruan Víctor dos Santos et al., 2025). The persistent and invasive nature of online aggression may intensify emotional vulnerability because digital victimization often occurs continuously, publicly, and anonymously, thereby reducing opportunities for emotional recovery and increasing feelings of helplessness (Evangelio et al., 2022; Garaigordobil, 2025). The present findings are also consistent with studies reporting significant relationships between cybervictimization and depressive symptoms, psychosomatic complaints, suicidal ideation, self-harm tendencies, and diminished self-esteem among adolescents and university students (Mohamed et al., 2023; Predescu et al., 2024; Wang et al., 2021). Moreover, the findings support evidence indicating that cybervictimization disrupts emotional security and social belonging, both of which are essential developmental needs during adolescence (Lee et al., 2025; María del Mar Molero et al., 2025). Adolescents exposed to repeated online humiliation may internalize feelings of worthlessness and social rejection, increasing emotional dysregulation and long-term psychological vulnerability.

Another major finding was that loneliness emerged as the strongest predictor of psychological distress within the deep neural network model. This finding suggests that subjective social isolation and emotional disconnection may play a central role in adolescent psychological maladjustment within contemporary digital contexts. The result corresponds with previous research emphasizing loneliness as a significant determinant of depression, anxiety, emotional instability, and reduced life satisfaction among youth populations (Heiman & Olenik-Shemesh, 2022; Matthews et al., 2025). Although digital communication technologies theoretically increase interpersonal connectivity, excessive online engagement may fail to provide meaningful emotional intimacy and may instead intensify feelings of social inadequacy and relational dissatisfaction (Ehrenreich et al., 2021; Marano et al., 2025). The present findings

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further support cohort-based evidence demonstrating that problematic online experiences and maladaptive social media use are associated with persistent loneliness trajectories among young people (Matthews et al., 2025). Adolescents who lack emotionally supportive peer relationships may become increasingly dependent on digital interactions for validation, yet such interactions often involve superficial communication patterns, social comparison processes, and vulnerability to online rejection. Consequently, loneliness may operate simultaneously as both a direct emotional stressor and a mechanism amplifying the psychological consequences of cybervictimization and fragmented digital engagement. The current results also align with studies demonstrating reciprocal relationships between loneliness and cybervictimization, whereby socially isolated adolescents become more susceptible to online aggression while victimization experiences further intensify emotional withdrawal and interpersonal insecurity (Iorga et al., 2022; López-Martínez et al., 2021).

The findings additionally revealed that family emotional climate was strongly and negatively associated with psychological distress. Youth participants who reported emotionally supportive, cohesive, and communicative family environments demonstrated lower levels of emotional maladjustment despite exposure to digital and educational stressors. This finding is highly consistent with previous literature emphasizing the protective role of family systems in adolescent mental health and cybervictimization resilience (Lozano-Blasco et al., 2023; Tozzo et al., 2022). Emotionally healthy family climates may enhance adolescents' coping capacities, emotional regulation abilities, and perceptions of psychological safety, thereby buffering the harmful consequences of online victimization and loneliness. The present results further align with studies indicating that supportive parenting styles and strong family cohesion reduce the likelihood of cybervictimization involvement and mitigate emotional difficulties associated with digital aggression (Iorga et al., 2022; Lozano-Blasco et al., 2023). Adolescents who perceive emotional acceptance within the family environment may develop greater self-worth, stronger interpersonal trust, and healthier coping mechanisms, all of which reduce vulnerability to psychological distress. Furthermore, emotionally responsive families may provide adolescents with guidance regarding digital behavior regulation, emotional expression, and stress management, thereby reducing maladaptive technological engagement patterns and emotional dysregulation. The protective influence of family emotional climate identified in this study also corresponds with evidence showing that gratitude, emotional flexibility, and social support weaken the negative psychological impact of cybervictimization experiences (Espino et al., 2023; Oriol et al., 2021).

The present study also demonstrated significant positive relationships between screen-time fragmentation and psychological distress. Adolescents who exhibited more fragmented digital engagement patterns, frequent application switching, interrupted screen use cycles, and unstable attentional behaviors reported greater emotional difficulties. This finding supports recent theoretical perspectives suggesting that the psychological consequences of digital technology are shaped not only by the duration of screen exposure but also by the structural quality and fragmentation of online engagement (Ehrenreich et al., 2021; Karaköse et al., 2023). Fragmented digital behavior may contribute to attentional dysregulation, cognitive overload, emotional exhaustion, sleep disturbance, and diminished emotional self-regulation capacities. The current findings also align with research linking excessive digital media engagement and problematic internet use with depression, emotional instability, and psychosocial maladjustment among adolescents (Burgess, 2025; Marano et al., 2025). Constant notifications, rapid multitasking behaviors, and algorithm-driven online environments may create persistent cognitive interruptions that impair emotional recovery and increase stress accumulation. Furthermore, adolescents experiencing loneliness or cybervictimization may engage compulsively in fragmented online behaviors as maladaptive coping mechanisms, thereby reinforcing cycles of emotional dysregulation and psychological distress.

Academic pressure was another significant predictor of psychological distress in the present study, although its predictive strength was lower than loneliness and family emotional climate. This finding nevertheless highlights the important role of educational stress in adolescent emotional functioning. Modern educational systems frequently expose students to intense performance expectations, competitive evaluation processes, and future-oriented uncertainty, all of which may contribute to chronic emotional strain and psychological vulnerability (Fredrick et al., 2025; Karaköse et al., 2023). Adolescents experiencing elevated academic pressure may struggle with sleep disturbances, concentration difficulties, emotional exhaustion, and reduced self-efficacy, thereby increasing susceptibility to distress symptoms. The present findings also support evidence suggesting that digital behaviors and academic stress interact dynamically. For

example, adolescents experiencing cybervictimization within school-related peer contexts may perceive educational environments as socially threatening and emotionally unsafe (Menabò et al., 2023). Similarly, fragmented digital engagement may impair attentional control and academic efficiency, thereby intensifying educational stress perceptions and emotional frustration.

5. Conclusion

An especially important contribution of the current study lies in the successful application of deep neural network analysis for predicting youth psychological distress. The findings demonstrated that the deep neural network substantially outperformed traditional machine learning approaches and linear statistical models in predictive accuracy. This result supports emerging perspectives emphasizing that adolescent mental health is shaped by highly nonlinear and multidimensional interactions that may not be adequately captured through conventional regression-based techniques (Chiappini et al., 2025; Giannakopoulos & Prassou, 2025). Deep learning models possess the capacity to detect hidden interaction pathways, latent relational structures, and dynamic emotional-behavioral patterns across complex datasets. The strong performance of the neural network model in the present study suggests that psychological distress emerges not through isolated variables independently but rather through interconnected psychosocial and digital processes operating simultaneously. The interaction observed between cybervictimization, loneliness, fragmented digital behavior, and family emotional climate illustrates the multidimensional nature of adolescent emotional vulnerability in modern technological environments. The current findings therefore contribute to the growing integration of artificial intelligence methodologies within psychological science and support the use of deep learning techniques for identifying high-risk youth populations more precisely and efficiently.

6. Limitations & Suggestions

One limitation of the present study is its cross-sectional design, which restricts causal interpretation of the relationships among cybervictimization, loneliness, academic pressure, screen-time fragmentation, family emotional climate, and psychological distress. Although the deep neural network model demonstrated strong predictive performance, longitudinal research is necessary to determine the temporal directionality and developmental progression of these psychosocial relationships over time. Another limitation concerns the use of self-report measures, which may be influenced by social desirability bias, memory inaccuracies, or subjective interpretation of emotional experiences. Additionally, the study sample was limited to adolescents and emerging adults in Georgia, which may reduce the generalizability of findings to other cultural or socioeconomic contexts. The screen-time fragmentation measure also relied partly on self-reported behavioral estimation rather than objective digital tracking technologies.

Future research should employ longitudinal and experimental designs to examine causal pathways linking digital behavior patterns and psychological distress across different developmental stages. Researchers are encouraged to integrate objective digital behavioral tracking systems, wearable technologies, and ecological momentary assessment methods to obtain more precise measurements of online engagement and emotional functioning. Further studies should also investigate additional protective variables such as resilience, emotional intelligence, mindfulness, gratitude, peer connectedness, and digital literacy skills within advanced machine learning frameworks. Cross-cultural comparative studies would also provide valuable insights regarding how sociocultural factors shape the psychological impact of cybervictimization and fragmented digital engagement among adolescents and young adults in different societies.

The findings of the present study have important practical implications for educators, mental health professionals, policymakers, and families. Schools and universities should implement comprehensive mental health programs that address cybervictimization prevention, emotional regulation skills, digital well-being, and healthy peer relationship development simultaneously. Family-centered interventions aimed at improving emotional communication, cohesion, and psychological support may also serve as effective protective mechanisms against youth distress. Mental health practitioners should consider the interconnected roles of loneliness, online victimization, fragmented screen engagement, and educational stress when assessing adolescent emotional difficulties. Additionally, policymakers and educational institutions should develop evidence-based digital wellness initiatives that encourage balanced technology use, healthy online interaction patterns, and awareness regarding the psychological consequences of fragmented digital behavior. The successful use of deep

neural network methodologies in the present study further suggests that artificial intelligence systems may eventually assist in early identification and targeted prevention efforts for adolescents at elevated psychological risk.

Acknowledgments

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

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors equally contributed to this article.

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