

Predicting Psychological Distress Among Adolescents Using a Multilayer Perceptron Neural Network Based on Academic, Family, and Social Factors

Ji-Eun. Han¹, Hsin-Yi. Chang², Ayesha. Siddiqui³

¹ Department of Counseling Psychology, Yonsei University, Seoul, South Korea

² Department of Cognitive Psychology, National Cheng Kung University, Tainan, Taiwan

³ Department of Applied Psychology, Quaid-i-Azam University, Islamabad, Pakistan

* Corresponding author email address: hsinyi.chang@ncku.edu.tw

Article Info

Article type:

Original Research

How to cite this article:

Han, J.-E., Chang, H.-Y., & Siddiqui, A. (2026). Predicting Psychological Distress Among Adolescents Using a Multilayer Perceptron Neural Network Based on Academic, Family, and Social Factors. *Journal of Adolescent and Youth Psychological Studies*, 7(9), 1-17.
<http://dx.doi.org/10.61838/kman.jayps.6288>



© 2026 the authors. Published by KMAN Publication Inc. (KMANPUB), Ontario, Canada. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

ABSTRACT

Objective: This study aimed to develop and evaluate a multilayer perceptron neural network for predicting psychological distress among Taiwanese adolescents based on academic, family, social, and selected demographic factors.

Methods and Materials: This cross-sectional predictive study was conducted among 612 adolescents aged 13–18 years enrolled in junior and senior high schools in Taiwan. Psychological distress was assessed using the Kessler Psychological Distress Scale (K10), academic stress using the Educational Stress Scale for Adolescents, family functioning using the Family APGAR Scale, and perceived social support using the Multidimensional Scale of Perceived Social Support. Academic performance, daily study time, and selected demographic variables were also assessed. The dataset was divided into training, validation, and testing subsets using a 70:15:15 ratio. A multilayer perceptron model with two hidden layers was trained using the Adam optimization algorithm, with early stopping and regularization applied to reduce overfitting. Model performance was evaluated using mean absolute error, root mean squared error, and the coefficient of determination. Predictor importance was examined using permutation-based analysis.

Findings: Psychological distress was positively associated with educational stress ($r = .68, p < .001$), despondency ($r = .64, p < .001$), worry about grades ($r = .58, p < .001$), and pressure from study ($r = .55, p < .001$), while it was negatively associated with family functioning ($r = -.53, p < .001$), perceived social support ($r = -.49, p < .001$), and academic performance ($r = -.27, p < .001$). The multilayer perceptron model explained 76% of variance in the training dataset, 69% in the validation dataset, and 66% in the independent testing dataset. In the testing set, MAE was 3.67 and RMSE was 4.76. Educational stress, despondency, family functioning, worry about grades, and perceived social support were the most influential predictors.

Conclusion: Psychological distress among adolescents can be predicted with acceptable accuracy using a multilayer perceptron model incorporating academic, family, and social factors, with educational stress and family functioning emerging as especially important predictors.

Keywords: Psychological distress; Adolescents; Multilayer perceptron; Neural network; Academic stress; Family functioning; Social support.

1. Introduction

Adolescence is a developmental period characterized by substantial biological, cognitive, emotional, interpersonal, and social transitions, during which individuals are required to negotiate expanding academic expectations, changing family relationships, increasing peer influence, emerging autonomy, identity formation, and heightened sensitivity to social evaluation. These simultaneous developmental demands can create considerable psychological strain, particularly when adolescents encounter persistent stressors without adequate internal or environmental resources. Psychological distress in adolescence commonly encompasses symptoms such as depressed mood, anxiety, emotional exhaustion, irritability, hopelessness, and impaired functioning, and may emerge before a formal psychiatric disorder becomes identifiable. Recent evidence has therefore emphasized the importance of examining adolescent mental health from a broad ecological perspective rather than focusing exclusively on isolated symptoms or diagnostic categories. Risk factors for adolescent mental health problems have been identified across individual, family, school, peer, community, and broader social domains, indicating that distress is typically produced by the interaction of multiple developmental systems rather than by a single cause (Lin & Guo, 2024). Systematic and narrative reviews have similarly shown that adolescents' emotional adjustment is shaped by combinations of personal vulnerability, environmental stress, relationship quality, educational conditions, and access to supportive resources (Goh et al., 2023; Thiha et al., 2025).

The importance of adolescent psychological distress became especially visible during and after the COVID-19 pandemic, which disrupted schooling, social relationships, family routines, recreational activities, and developmental opportunities across many countries. Reviews of the pandemic period documented increased exposure to loneliness, uncertainty, academic disruption, reduced peer contact, family tension, and restricted access to ordinary support systems among children and adolescents (Rider et al., 2021; Windarwati et al., 2022). The psychosocial consequences of school closures and social isolation were particularly concerning because school environments provide not only formal education but also daily structure, peer interaction, teacher support, opportunities for achievement, and access to mental health resources (Vaillancourt et al., 2021). Research on adolescents during

periods of remote instruction further demonstrated that school connectedness and mode of instruction were closely associated with mental health outcomes, suggesting that educational environments can function simultaneously as sources of stress and protection (Hertz et al., 2022). The pandemic also interrupted major developmental milestones, contributing to difficulties in autonomy, social competence, academic engagement, and emotional resilience (Garagiola et al., 2022). An integrative review of the educational, social, and mental health consequences of the pandemic likewise concluded that many young people experienced cumulative disruption extending beyond temporary distress and affecting broader developmental functioning (Mucci et al., 2024).

Although the pandemic created an unusually intense context for examining adolescent distress, the underlying mechanisms highlighted by this period remain relevant beyond the pandemic itself. Academic pressure, strained family relationships, social disconnection, peer difficulties, and uncertainty about the future continue to represent central influences on adolescent mental health. Qualitative evidence has shown that adolescents frequently describe anxiety in terms of interacting academic, interpersonal, family, and environmental stressors rather than as an isolated internal experience (Kara et al., 2025). Similarly, cross-cultural research indicates that adolescents and those around them conceptualize depression in contextually grounded ways that include interpersonal conflict, academic pressure, family expectations, social difficulties, and cumulative adversity (Raval et al., 2025). This contextual perspective is particularly important when studying psychological distress in adolescents from East Asian societies, where educational achievement, family expectations, social harmony, and relational obligations may be especially salient dimensions of daily life. Accordingly, models of adolescent distress should account for the simultaneous contribution of academic, family, and social variables rather than treating each domain independently.

Academic stress represents one of the most persistent and developmentally relevant sources of strain during adolescence. Educational systems often require students to manage heavy workloads, frequent examinations, competition, performance expectations, and concern about future educational opportunities. These pressures may be intensified when academic achievement is closely linked to perceived personal worth or family expectations. During periods of educational disruption, students have reported difficulty concentrating, maintaining motivation, adapting to

new modes of learning, and sustaining social connection, all of which may increase emotional strain (Espinoza et al., 2024). School-related difficulties can also contribute to avoidance and disengagement, and severe cases may manifest as school refusal, which itself reflects complex interactions among anxiety, family processes, educational demands, and social functioning (Høiseth et al., 2021). Academic distress may therefore operate through multiple pathways, including worry about grades, excessive self-expectation, perceived workload, fear of failure, and despondency. Such mechanisms are relevant not only to academic outcomes but also to broader emotional functioning because chronic educational stress can erode coping capacity and increase vulnerability to anxiety and depressive symptoms.

Schools also represent important settings for prevention and intervention. Evidence from school-based mental health programs suggests that sustained interventions can produce meaningful benefits for students' psychological wellbeing, coping, and school functioning (Berger et al., 2022). Clinical case evidence likewise indicates that school-based cognitive-behavioral approaches can support adolescents with complex combinations of depression, anxiety, and attention-related difficulties within educational settings (Goff et al., 2022). These findings highlight the dual role of schools as environments in which distress may be generated through pressure and competition, but also as environments capable of providing early identification, social support, and preventive care. School resilience frameworks developed during periods of crisis have further emphasized the need to support both students and educators, strengthen relational systems, and develop institutional practices that reduce avoidable stress while improving psychological safety (Luthar et al., 2021). From a predictive perspective, academic indicators may therefore provide important signals of psychological distress, but their influence should be interpreted alongside the family and social conditions in which adolescents are embedded.

Family functioning is another major determinant of adolescent psychological adjustment. The family remains a central developmental context during adolescence even as young people seek greater independence. Parental responsiveness, communication, emotional availability, conflict management, and family cohesion can either buffer or intensify the impact of external stressors. A systematic review of family relationships during the COVID-19 pandemic showed that positive family functioning was associated with better adolescent adjustment, whereas

family conflict, parental distress, and relational disruption were linked to poorer psychological outcomes (Campione-Barr et al., 2024). Research on youth suicide has also identified family processes as important risk, protective, and treatment-related factors, emphasizing the roles of parental support, attachment, communication, conflict, and family involvement (Diamond et al., 2022). These findings are consistent with broader models in which adolescents' emotional responses are shaped not only by the stressors they experience but also by the extent to which their families provide security, validation, guidance, and practical assistance.

Family influences may become especially important when adolescents face chronic health conditions or other forms of sustained adversity. Adolescents living with long-term medical conditions may experience additional emotional burdens related to uncertainty, treatment demands, altered identity, peer comparison, and concerns about independence (Russo, 2022). Qualitative work with adolescents experiencing pediatric-onset multiple sclerosis similarly illustrates how chronic illness can affect identity, social development, and psychological adaptation during a developmental period already marked by significant change (Novak, 2025). Such findings support a broader understanding of family functioning as a protective resource that can help adolescents manage diverse forms of strain. When family functioning is poor, however, the absence of reliable support may amplify the psychological consequences of academic pressure, health concerns, interpersonal conflict, and social adversity.

The social environment also plays a crucial role in adolescent psychological wellbeing. Peer relationships become increasingly salient during adolescence, and experiences of belonging, acceptance, friendship, and connectedness can substantially influence emotional regulation and self-evaluation. During periods of social restriction, loneliness has been strongly associated with stress and depressive symptoms, whereas supportive friendships have shown a protective effect (Espinoza & Hernandez, 2022). Social support can therefore operate as a buffer by providing emotional reassurance, opportunities for disclosure, practical assistance, and a sense of inclusion. Even in contexts involving interpersonal victimization, access to relational and collective resources may reduce psychological impairment and strengthen coping (Sabina et al., 2021). Similarly, peer support has been identified as an important factor in recovery from mental health difficulties following cyberbullying experiences (Shabbir & Farzand,

2022). These findings suggest that social support should not be regarded as a peripheral variable but as a central component of adolescent mental health models.

At the same time, the contemporary social environment presents new sources of risk. Adolescents increasingly interact within digital spaces where social comparison, cyberbullying, exposure to harmful content, and intensive social media use may influence psychological wellbeing. Concerns regarding the potential harms of social media for youth have led to calls for comprehensive preventive strategies that address both individual vulnerabilities and platform-level influences (Wilksch, 2025). Broader social adversity can also shape psychological wellbeing through pathways that extend beyond the immediate family or school. Youth from marginalized populations may face structural inequalities, discrimination, and barriers to healthcare or social resources that influence both physical and mental health outcomes (Boutrín & Williams, 2021). Likewise, adolescents exposed to war and armed conflict may experience abrupt disruption in safety, schooling, social relationships, and future expectations, producing complex psychological responses that cannot be explained by individual-level variables alone (Lopatovska et al., 2022). These findings reinforce the need for multidimensional approaches capable of incorporating interacting academic, family, social, and contextual influences.

The consequences of unresolved psychological distress can be substantial. Severe emotional distress in adolescence may be associated with impaired academic performance, withdrawal from social relationships, substance use, self-harm, suicidal ideation, and other adverse outcomes. Reviews conducted during the pandemic identified increased concern regarding suicidality among young people, particularly in association with social isolation, disrupted routines, family stress, and reduced access to support services (Field, 2021). Research on adolescent suicide has also emphasized the importance of emotional pain, family problems, social difficulties, and perceived lack of support as recurring themes surrounding suicidal behavior (Charesma Grace et al., 2022). Substance use may similarly function as a maladaptive coping strategy in response to stress and emotional dysregulation, with adolescent substance-use patterns during the pandemic reflecting broader mental health and environmental pressures (Lundahl & Cannoy, 2021). These outcomes demonstrate why early identification of psychological distress is important even when adolescents do not yet meet criteria for a specific psychiatric disorder.

Protective factors are therefore central to understanding variability in adolescent responses to stress. Physical activity, supportive relationships, family cohesion, social connectedness, and access to meaningful routines have all been associated with better mental health during periods of adversity (Laurier et al., 2021). Daily diary research has also shown that adolescents may experience both negative and positive emotional changes during stressful periods, with individual differences in social connection and day-to-day experiences influencing emotional health (Silk et al., 2021). Research involving children and adolescents from diverse communities likewise suggests that psychological outcomes during crisis are shaped by access to social resources, environmental stability, and supportive relationships (Silan, 2023). Multicenter evidence has further shown that adolescent mental health outcomes can be predicted by interconnected behavioral, environmental, and social-cognitive factors, highlighting the value of models that simultaneously account for both risks and protections (Sarfika et al., 2025). This perspective supports the inclusion of family functioning and social support alongside academic stress because protective relational factors may alter the extent to which academic and personal demands translate into psychological distress.

Despite extensive research on individual risk and protective factors, conventional statistical approaches often assume linear, additive, and relatively simple associations among variables. Adolescent psychological distress, however, is likely to arise from nonlinear combinations of stressors and resources. For example, high academic pressure may not produce the same level of distress among adolescents with strong family functioning and supportive friendships as among adolescents with weak relational resources. Likewise, the effects of social support may differ depending on academic demands, family cohesion, health status, and other contextual factors. Machine-learning methods are well suited to such complexity because they can model nonlinear patterns, interactions, and higher-order relationships without requiring all associations to be specified in advance. Among these methods, the multilayer perceptron neural network is particularly useful for continuous prediction because interconnected hidden layers can learn complex mappings between multiple predictors and an outcome. This approach may therefore complement traditional correlational analyses by identifying predictive patterns that are difficult to capture through standard linear models.

The use of predictive models in adolescent mental health also has practical implications. Accurate prediction of psychological distress could support earlier screening, more efficient allocation of school mental health resources, and identification of combinations of risk factors that warrant closer attention. Interpersonal and relational approaches to youth depression emphasize that emotional symptoms often emerge within broader patterns of conflict, loss, role transition, and social difficulty, reinforcing the importance of incorporating interpersonal variables in mental health assessment (Mufson et al., 2026). At the same time, prediction should not be reduced to symptom detection alone. A meaningful model should identify how academic stress, family functioning, social support, and demographic characteristics jointly contribute to vulnerability. Such an approach may offer greater ecological validity than models based on a single domain and may be particularly relevant in educational contexts where early screening must rely on information that can be feasibly collected from adolescents.

The need for multidimensional prediction is further supported by evidence showing that adolescent mental health is shaped by heterogeneous combinations of stressors, resources, and developmental conditions. Differences in school context, family functioning, social relationships, chronic health status, peer support, and exposure to broader adversity can all contribute to markedly different psychological outcomes even among adolescents of similar age (Dupuis et al., 2021). This heterogeneity helps explain why single-variable explanations are insufficient and why predictive methods that can detect complex interactions may provide added value. At the same time, predictive modeling should remain grounded in developmental theory and empirically supported variables rather than relying solely on algorithmic optimization. By integrating theoretically relevant academic, family, and social predictors within a multilayer perceptron framework, it becomes possible to combine developmental understanding with nonlinear prediction.

Accordingly, the aim of the present study was to develop and evaluate a multilayer perceptron neural network for predicting psychological distress among Taiwanese adolescents based on academic, family, social, and selected demographic factors.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a cross-sectional predictive design to develop and evaluate a multilayer perceptron (MLP) neural network for predicting psychological distress among adolescents on the basis of academic, family, and social factors. The study population consisted of adolescents enrolled in junior and senior high schools in Taiwan during the 2025–2026 academic year. A total of 612 adolescents were included in the final analysis. Participants were recruited from public and private schools located in northern, central, and southern Taiwan using multistage cluster sampling to provide adequate representation of students from different educational and socioeconomic contexts. At the first stage, schools were selected from participating regions; at the second stage, classes were randomly selected within each school; and all eligible students in the selected classes were invited to participate. Eligible participants were students aged 13–18 years who were currently enrolled in grades 7–12, were able to read and understand Traditional Chinese, and provided assent to participate together with parental or legal guardian consent when required. Students were excluded if they had a documented severe cognitive or developmental impairment that prevented independent completion of the questionnaires or if more than 10% of their questionnaire data were missing. Data were collected anonymously during regular school hours under the supervision of trained research assistants. Students were informed that participation was voluntary, that they could discontinue participation at any time without academic consequences, and that their responses would remain confidential. The questionnaires required approximately 25–30 minutes to complete. After screening the returned questionnaires for completeness and eligibility, data from 612 adolescents were retained for statistical and machine-learning analyses. The sample size was considered adequate for neural-network modeling because it provided a sufficient number of observations relative to the number of predictor variables and allowed the dataset to be divided into independent training, validation, and testing subsets while retaining adequate cases in each subset. Ethical principles concerning voluntary participation, confidentiality, anonymity, informed consent, and protection of minors were observed throughout the study.

2.2. Measures

Kessler Psychological Distress Scale (K10). Psychological distress, which constituted the outcome variable of the prediction model, was assessed using the Kessler Psychological Distress Scale developed by Kessler and colleagues. The K10 is a widely used 10-item self-report instrument designed to assess nonspecific psychological distress, particularly symptoms associated with anxiety and depression, during the preceding four weeks. Each item is rated on a five-point response scale ranging from 1 (none of the time) to 5 (all of the time), resulting in a total score ranging from 10 to 50. Higher scores indicate greater psychological distress. The scale has been extensively used in adolescent and population-based research and has demonstrated satisfactory internal consistency, construct validity, convergent validity, and screening accuracy across different cultural contexts. In the present study, the total K10 score was used as the continuous target variable for neural-network prediction, thereby allowing the MLP model to estimate individual differences in psychological distress rather than merely assigning participants to predefined diagnostic categories.

Educational Stress Scale for Adolescents (ESSA). Academic stress was assessed using the Educational Stress Scale for Adolescents developed by Sun and colleagues in 2011. The instrument contains 16 items assessing major sources of school-related stress among adolescents and includes five dimensions: pressure from study, workload, worry about grades, self-expectation, and despondency. Items are scored on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores representing greater perceived educational stress. The ESSA was specifically developed for adolescent populations and has been applied extensively in studies examining academic pressure and psychological adjustment. Previous research has demonstrated satisfactory internal consistency, factorial validity, convergent validity, and construct validity for the total scale and its component dimensions. In the present study, the total academic stress score and scores for the five dimensions were considered academic predictors of psychological distress because they captured both external educational demands and adolescents' internal responses to perceived academic expectations.

Family APGAR Scale. Family functioning was measured using the Family APGAR Scale developed by Smilkstein in 1978. The instrument consists of five items addressing five fundamental domains of perceived family functioning:

Adaptability, Partnership, Growth, Affection, and Resolve. Each item is typically rated from 0 to 2, producing a total score ranging from 0 to 10, with higher scores reflecting more satisfactory perceived family functioning and stronger family support. The scale provides a brief assessment of adolescents' perceptions of the availability, responsiveness, emotional involvement, and problem-solving capacity of their family environment. The Family APGAR has been widely used internationally in adolescent, family, community, and clinical research and has demonstrated acceptable internal consistency, test-retest reliability, criterion-related validity, and construct validity. The total Family APGAR score was entered into the neural-network model as a family-level predictor, with higher scores representing more adaptive and supportive family functioning.

Multidimensional Scale of Perceived Social Support (MSPSS). Perceived social support was assessed using the Multidimensional Scale of Perceived Social Support developed by Zimet and colleagues in 1988. The MSPSS contains 12 items organized into three four-item subscales assessing perceived support from family, friends, and a significant other. Items are rated on a seven-point Likert scale ranging from 1 (very strongly disagree) to 7 (very strongly agree). Subscale scores and an overall perceived social support score can be calculated, with higher values indicating greater perceived availability and adequacy of interpersonal support. The MSPSS has demonstrated strong psychometric properties across adolescent and young populations, including high internal consistency, stable factorial structure, convergent validity, and satisfactory test-retest reliability. In the present study, the friends and significant-other support dimensions were primarily treated as indicators of adolescents' broader social support environment, whereas family support provided an additional interpersonal measure complementary to the family-functioning assessment. The relevant subscale and total scores were entered as social predictors in the MLP model.

A demographic and educational information form was additionally used to record participants' age, sex, grade level, type of school, parental educational level, perceived family socioeconomic status, average academic performance, and average daily time devoted to schoolwork. Academic performance was reported using the student's most recent overall school average and was standardized before model development to accommodate differences in scoring practices across participating schools. These variables were incorporated as supplementary predictors where

theoretically relevant because adolescent psychological distress may reflect the combined influence of educational demands, family resources, social relationships, and individual demographic characteristics.

2.3. Data Analysis

Data analysis was conducted using IBM SPSS Statistics and Python-based machine-learning procedures. Initial data screening included assessment of missing values, implausible responses, univariate distributions, and potential outliers. Cases with excessive missing information were excluded according to the predefined eligibility criteria, whereas occasional missing values in otherwise complete records were handled using appropriate imputation procedures based exclusively on information within the training dataset to prevent information leakage. Continuous predictor variables were standardized using z-score transformation because multilayer perceptron networks are sensitive to differences in the scale of input variables. Means and standard deviations were calculated for continuous variables, whereas frequencies and percentages were calculated for categorical characteristics. Pearson correlation coefficients were initially examined to describe bivariate relationships between psychological distress and continuous academic, family, and social variables; however, predictor selection for the neural-network model was primarily based on theoretical relevance rather than statistical significance in bivariate analyses.

A multilayer perceptron feedforward artificial neural network was developed to predict participants' continuous K10 psychological distress scores. The complete dataset of 612 adolescents was randomly partitioned into training, validation, and testing subsets using a 70:15:15 ratio, corresponding to approximately 428 participants for model training, 92 for validation, and 92 for final testing. Partitioning was conducted before model fitting so that the testing subset remained completely independent during model development. The input layer consisted of standardized academic, family, social, and selected demographic predictor variables. The network architecture included two hidden layers, with 16 neurons in the first hidden layer and 8 neurons in the second hidden layer. The rectified linear unit activation function was applied to hidden-layer neurons because of its computational efficiency and capacity to model complex nonlinear relationships, whereas a linear activation function was used for the single output neuron because psychological distress

was modeled as a continuous outcome. Network weights were optimized using the Adam optimization algorithm, and mean squared error served as the loss function. The initial learning rate was set at 0.001, with a maximum of 500 training epochs and a batch size of 32 observations. To reduce overfitting, early stopping was implemented according to validation loss, with training terminated when validation performance failed to improve for 20 consecutive epochs. Dropout regularization and L2 weight regularization were additionally incorporated during model development to increase generalizability.

Model performance was evaluated on the independent testing subset using the mean absolute error (MAE), root mean squared error (RMSE), and coefficient of determination (R^2). Lower MAE and RMSE values represented smaller discrepancies between observed and predicted psychological distress scores, whereas higher R^2 values indicated that the model accounted for a greater proportion of variability in adolescents' psychological distress. Predicted scores were also compared with observed K10 scores to evaluate calibration and the overall correspondence between estimated and actual levels of distress. To obtain a more robust estimate of model stability and reduce dependence on a single random partition of the data, repeated model evaluation and cross-validation procedures were used during model development, while final performance estimates were reported exclusively from data not used for fitting model parameters. Predictor importance was subsequently examined using permutation-based importance analysis, in which each predictor was independently disrupted in the testing data and the resulting reduction in predictive performance was quantified. Greater deterioration in model accuracy following permutation indicated greater contribution of that variable to psychological-distress prediction. This procedure permitted comparison of the relative predictive contributions of academic stress, academic performance, family functioning, perceived social support, and demographic characteristics without assuming linear or additive associations. All preprocessing parameters, including scaling and imputation procedures, were estimated from the training data and subsequently applied unchanged to the validation and testing datasets to prevent data leakage and provide a methodologically rigorous estimate of out-of-sample predictive performance.

3. Findings and Results

The final analytical sample consisted of 612 adolescents enrolled in junior and senior high schools in Taiwan. Participants ranged in age from 13 to 18 years, with a mean age of 15.54 years ($SD = 1.63$). Of the total sample, 306 participants (50.0%) were male, 298 (48.7%) were female, and 8 (1.3%) selected another gender category or preferred not to report their gender. Regarding educational level, 104 adolescents (17.0%) were in Grade 7, 99 (16.2%) in Grade 8, 101 (16.5%) in Grade 9, 103 (16.8%) in Grade 10, 100 (16.3%) in Grade 11, and 105 (17.2%) in Grade 12. A total of 467 participants (76.3%) attended public schools and 145 (23.7%) attended private schools. Based on self-reported family socioeconomic status, 93 adolescents (15.2%)

described their family socioeconomic position as below average, 408 (66.7%) as average, and 111 (18.1%) as above average. The mean standardized academic performance score corresponded to an original school average of 78.64 ($SD = 9.71$) on a 0–100 scale. Participants reported spending an average of 2.84 hours ($SD = 1.26$) per day on schoolwork outside regular class hours. Initial inspection of the data indicated that no variable showed severe univariate non-normality, and the proportion of missing data was low. Cases retained for the final analysis met all predefined completeness criteria, and no influential outliers were identified that warranted exclusion. The distribution of psychological distress scores covered a broad range, indicating sufficient variability in the target outcome for predictive modeling.

Table 1

Descriptive Statistics for Psychological Distress and Predictor Variables (N = 612)

Variable	Possible Range	Observed Range	Mean	SD
Psychological distress (K10)	10–50	11–48	26.73	8.21
Educational stress total	16–80	21–76	49.18	10.64
Pressure from study	4–20	4–20	13.27	3.49
Workload	3–15	3–15	9.68	2.71
Worry about grades	3–15	3–15	10.11	2.62
Self-expectation	3–15	3–15	9.74	2.58
Despondency	3–15	3–15	6.38	2.41
Family functioning (Family APGAR)	0–10	1–10	6.91	2.13
Perceived social support total	12–84	24–84	60.82	12.07
Family support	4–28	7–28	20.56	4.76
Friends support	4–28	6–28	20.81	4.51
Significant-other support	4–28	5–28	19.45	4.83
Academic performance	0–100	51–98	78.64	9.71
Daily study time, hours	—	0.50–6.50	2.84	1.26

As presented in Table 1, the mean K10 psychological distress score was 26.73 ($SD = 8.21$), suggesting substantial variation in psychological distress across the adolescent sample. Educational stress was also relatively elevated, with a mean total score of 49.18 ($SD = 10.64$). Among the educational stress dimensions, pressure from study had the highest mean score relative to its possible range ($M = 13.27$, $SD = 3.49$), followed by worry about grades ($M = 10.11$, $SD = 2.62$), self-expectation ($M = 9.74$, $SD = 2.58$), and workload ($M = 9.68$, $SD = 2.71$). The mean despondency score was 6.38 ($SD = 2.41$), but this dimension showed substantial variability and was subsequently found to have considerable predictive relevance. The mean Family

APGAR score was 6.91 ($SD = 2.13$), indicating that perceived family functioning varied from markedly impaired to highly supportive across participants. The average total perceived social support score was 60.82 ($SD = 12.07$), with similar mean levels of family support ($M = 20.56$, $SD = 4.76$), friend support ($M = 20.81$, $SD = 4.51$), and significant-other support ($M = 19.45$, $SD = 4.83$). Academic performance averaged 78.64 ($SD = 9.71$), whereas mean daily study time was 2.84 hours ($SD = 1.26$). The observed ranges further indicated that the dataset contained sufficient dispersion in both the outcome and predictor variables to examine nonlinear and potentially interactive relationships through neural-network modeling.

Table 2

Correlations Between Psychological Distress and Academic, Family, and Social Variables

Variable	Psychological Distress, r	p
Educational stress total	.68	< .001
Pressure from study	.55	< .001
Workload	.47	< .001
Worry about grades	.58	< .001
Self-expectation	.41	< .001
Despondency	.64	< .001
Family functioning	-.53	< .001
Perceived social support total	-.49	< .001
Family support	-.51	< .001
Friends support	-.38	< .001
Significant-other support	-.34	< .001
Academic performance	-.27	< .001
Daily study time	.22	< .001

Table 2 shows that psychological distress was significantly related to all major academic, family, and social variables examined prior to construction of the neural-network model. The strongest positive association was observed between total educational stress and psychological distress ($r = .68$, $p < .001$), indicating that adolescents experiencing greater school-related pressure tended to report substantially higher psychological distress. Among the dimensions of educational stress, despondency showed the strongest relationship with psychological distress ($r = .64$, $p < .001$), followed by worry about grades ($r = .58$, $p < .001$) and pressure from study ($r = .55$, $p < .001$). Workload ($r = .47$, $p < .001$) and self-expectation ($r = .41$, $p < .001$) also showed moderate positive associations with psychological distress. In contrast, family functioning was inversely correlated with psychological distress ($r = -.53$, $p < .001$), indicating that adolescents who perceived their families as

more adaptive, responsive, and supportive tended to report lower distress. Total perceived social support also demonstrated a significant inverse association with psychological distress ($r = -.49$, $p < .001$). At the subscale level, family support displayed the strongest inverse association ($r = -.51$, $p < .001$), followed by support from friends ($r = -.38$, $p < .001$) and significant others ($r = -.34$, $p < .001$). Academic performance was negatively related to psychological distress ($r = -.27$, $p < .001$), whereas daily study time showed a weaker but significant positive relationship ($r = .22$, $p < .001$). These findings indicated that psychological distress was associated with a combination of academic burden, diminished family functioning, lower perceived interpersonal support, and less favorable academic outcomes, thereby supporting the inclusion of variables from multiple ecological domains in the predictive neural-network model.

Table 3

Performance of the Multilayer Perceptron Model Across Training, Validation, and Testing Data

Dataset	n	MAE	RMSE	R ²
Training	428	3.14	4.08	.76
Validation	92	3.53	4.57	.69
Testing	92	3.67	4.76	.66

The predictive performance of the multilayer perceptron neural network is presented in Table 3. The model demonstrated strong fit within the training dataset, yielding a mean absolute error of 3.14, a root mean squared error of 4.08, and an R² of .76. Thus, the final network accounted for approximately 76% of the variability in psychological distress scores among participants used for model

estimation. Importantly, predictive performance remained comparatively stable in the validation dataset, where the MAE was 3.53, the RMSE was 4.57, and R² was .69. This moderate reduction in performance relative to the training data was expected when the model was applied to observations not directly used for weight optimization and suggested that overfitting had been adequately controlled

through early stopping and regularization procedures. The most important evaluation was based on the independent testing dataset, which was excluded from all stages of parameter estimation and hyperparameter adjustment. In this subset, the model produced an MAE of 3.67 and an RMSE of 4.76, indicating that the predicted K10 score differed from the observed score by approximately 3.7 points on average. The testing R^2 of .66 demonstrated that the model explained 66% of the variance in psychological distress among previously unseen adolescents. The relatively small differences between training, validation, and testing indices indicated acceptable model generalizability rather than

substantial memorization of the training observations. Examination of residuals further showed no marked systematic tendency toward overprediction or underprediction across the middle portion of the K10 score distribution, although prediction errors were somewhat larger among participants at the most extreme levels of psychological distress. Overall, the results indicated that an MLP model based on academic, family, social, and demographic information was capable of predicting individual differences in adolescent psychological distress with substantial out-of-sample accuracy.

Table 4

Permutation-Based Importance of Predictors in the Final Multilayer Perceptron Model

Rank	Predictor	Increase in Testing RMSE After Permutation	Relative Importance (%)
1	Educational stress total	2.31	100.0
2	Despondency	2.04	88.3
3	Family functioning	1.78	77.1
4	Worry about grades	1.56	67.5
5	Perceived social support total	1.43	61.9
6	Family support	1.29	55.8
7	Pressure from study	1.17	50.6
8	Academic performance	0.84	36.4
9	Friends support	0.71	30.7
10	Workload	0.63	27.3
11	Self-expectation	0.51	22.1
12	Significant-other support	0.44	19.0
13	Daily study time	0.36	15.6
14	Family socioeconomic status	0.29	12.6
15	Age	0.21	9.1
16	Sex	0.17	7.4

The permutation importance analysis presented in Table 4 demonstrated that predictive information was distributed across academic, family, and social domains, although academic stress variables contributed most strongly to model performance. Total educational stress emerged as the most influential predictor, with permutation of this variable increasing the testing RMSE by 2.31 points and therefore receiving a relative importance value of 100%. Despondency was the second most important variable, producing a 2.04-point increase in RMSE and reaching 88.3% of the relative importance of total educational stress. Family functioning ranked third, with an RMSE increase of 1.78 and a relative importance of 77.1%, demonstrating that family relational processes contributed substantial predictive information even after accounting for academic stress. Worry about grades was the next strongest academic predictor, followed by overall perceived social support, family support, and

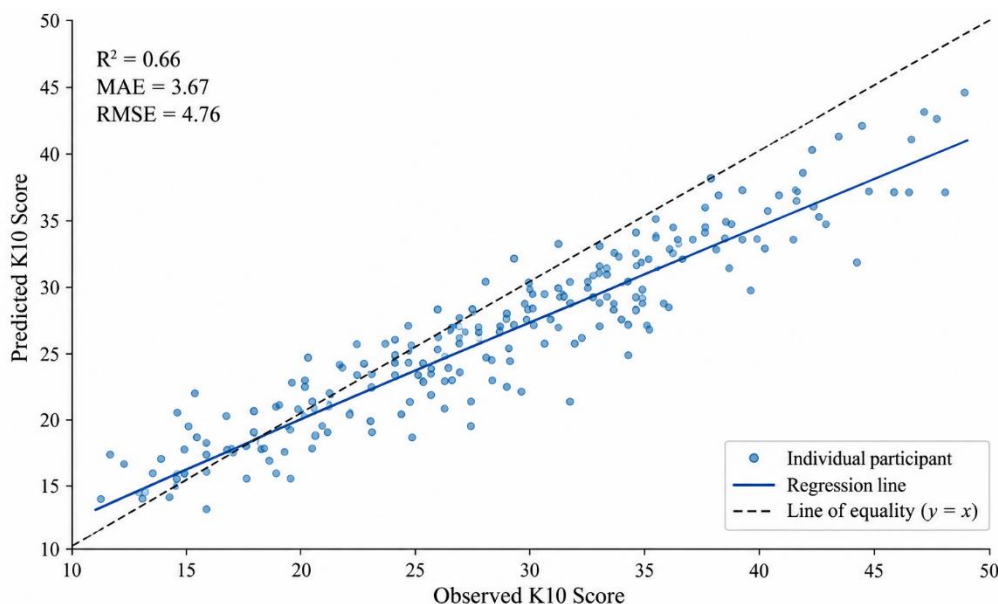
pressure from study. Specifically, permutation of perceived social support increased RMSE by 1.43, corresponding to a relative importance of 61.9%, whereas permutation of family support increased RMSE by 1.29, corresponding to a relative importance of 55.8%. Academic performance displayed moderate predictive relevance, whereas support from friends, workload, self-expectation, significant-other support, and daily study time made smaller but still discernible contributions. Demographic variables contributed comparatively less to prediction: family socioeconomic status, age, and sex ranked among the least influential predictors. These findings suggest that the MLP primarily derived its predictive accuracy from adolescents' subjective experiences of educational pressure, emotional responses to academic demands, and quality of family and social relationships rather than from demographic characteristics alone. The coexistence of highly ranked

predictors from multiple domains also supported the use of a multivariable nonlinear approach because psychological distress appeared to reflect overlapping contributions from

educational and interpersonal environments rather than a single dominant factor.

Figure 1

Observed and Predicted Psychological Distress Scores in the Independent Testing Dataset



Visual examination of the relationship between observed and predicted psychological distress scores indicated close correspondence across most of the testing sample. Predicted scores were concentrated around the line representing equality between observed and predicted values, consistent with the testing R^2 of .66 and the relatively low prediction errors reported in Table 3. Predictions were particularly accurate for adolescents with low-to-moderately elevated and moderately high levels of psychological distress. Some regression toward the mean was evident at the extremes, such that the model tended to slightly overestimate distress among a small number of participants with very low observed K10 scores and modestly underestimate distress among those with the highest observed scores. Nevertheless, there was no pronounced systematic divergence between predicted and observed scores, and the pattern of prediction errors suggested generally stable calibration across the central range of psychological distress. Taken together with the independent testing indices, the graphical results provided additional evidence that the final multilayer perceptron network captured meaningful nonlinear relationships between academic, family, and social predictors and adolescents' psychological distress while retaining acceptable predictive accuracy when applied to previously unseen cases.

4. Discussion

The present study examined whether psychological distress among Taiwanese adolescents could be predicted using a multilayer perceptron neural network based on academic, family, social, and selected demographic factors. The findings showed that the model achieved satisfactory predictive performance, with an R^2 of .76 in the training sample, .69 in the validation sample, and .66 in the independent testing sample. The relatively small decline in performance across the three datasets indicated that the model retained acceptable generalizability and that the predictive relationships identified during training were not limited to the training observations. The testing MAE of 3.67 and RMSE of 4.76 further suggested that the model was capable of estimating K10 psychological distress scores with a clinically meaningful degree of accuracy. Importantly, predictor importance analysis demonstrated that psychological distress was not determined by a single domain. Educational stress, despondency, family functioning, worry about grades, perceived social support, family support, and pressure from study emerged as the most influential predictors, while demographic characteristics such as age and sex contributed comparatively little. These findings support a multidimensional understanding of

adolescent psychological distress in which academic pressures interact with family and social resources to shape emotional adjustment.

The strong predictive contribution of educational stress was one of the most important findings of the study. Total educational stress was the highest-ranked predictor in the neural network, and it also showed the strongest bivariate association with psychological distress. This finding is consistent with contemporary models of adolescent mental health that identify academic pressure, school demands, performance concerns, and educational uncertainty as central sources of psychological strain (Lin & Guo, 2024). School environments occupy a substantial portion of adolescents' daily lives, and academic expectations may influence mood, sleep, self-worth, family relationships, and peer experiences simultaneously. Recent evidence has shown that educational disruption and difficulties adapting to school-related demands can contribute to deteriorations in emotional health, particularly when students experience reduced motivation, concentration problems, or uncertainty about academic progression (Espinoza et al., 2024). Reviews of adolescent mental health during periods of educational disruption have similarly shown that school-related pressures frequently co-occur with anxiety, depressive symptoms, and social difficulties (Thiha et al., 2025; Windarwati et al., 2022). The present findings extend this literature by showing that academic stress was not merely associated with distress but also carried substantial predictive information within a nonlinear multivariable model.

Among the individual academic dimensions, despondency emerged as the second most important predictor and showed a strong positive correlation with psychological distress. This finding suggests that the affective component of educational stress may be especially important. Despondency captures feelings of discouragement, helplessness, and emotional depletion in relation to academic demands, which may overlap conceptually with broader depressive experiences. Studies of adolescent mental health have repeatedly shown that emotional responses to stress may be more consequential than objective exposure alone, particularly when adolescents perceive demands as uncontrollable or persistent (Kara et al., 2025). Cross-cultural work has also indicated that adolescents often conceptualize depression in relation to a combination of academic pressure, interpersonal difficulties, and a sense of being overwhelmed by expectations (Ravalet et al., 2025). The present results therefore suggest that

screening for academic stress should not focus exclusively on workload or examination frequency, but should also assess whether students feel defeated, hopeless, or emotionally exhausted by educational demands.

Worry about grades and pressure from study also contributed substantially to model performance. These findings are consistent with the developmental reality that academic evaluation becomes increasingly consequential during adolescence because grades may influence educational opportunities, parental approval, peer comparison, and perceived future success. Although school can function as an important source of structure and connectedness, it may simultaneously expose adolescents to high performance pressure. Research on school connectedness has shown that supportive educational contexts can protect mental health, whereas disconnection from school and disruptive learning environments are associated with poorer psychological outcomes (Hertz et al., 2022). The coexistence of these functions suggests that schools may either amplify or buffer psychological distress depending on how academic expectations are experienced. The current findings are also compatible with evidence emphasizing the importance of resilient and supportive school systems in protecting student wellbeing during periods of heightened stress (Luthar et al., 2021). Therefore, the predictive contribution of academic variables in the present model may reflect not only the quantity of academic demands but also the broader emotional meaning adolescents assign to achievement and school performance.

Family functioning was the third most influential predictor in the neural network and showed a substantial negative association with psychological distress. Adolescents reporting more adaptive family functioning tended to report lower distress, and permutation of family functioning meaningfully worsened model performance. This finding aligns with evidence showing that supportive family relationships are among the most consistent protective factors for adolescent adjustment. A systematic review of family relationships during the COVID-19 period found that family cohesion, supportive communication, and positive parental involvement were associated with better adolescent psychological outcomes, whereas family conflict and parental stress were associated with poorer adjustment (Campione-Barr et al., 2024). Family processes have also been identified as central risk and protective factors in youth suicide, especially through mechanisms involving attachment, communication, emotional availability, and conflict management (Diamond et al., 2022). The current

findings are therefore consistent with the view that family functioning provides a psychological buffer through which adolescents can regulate stress, seek reassurance, and interpret challenges within a stable relational context.

The importance of family functioning may be particularly pronounced in environments where academic achievement and family expectations are closely linked. In such contexts, the family can either intensify pressure through criticism and unrealistic expectations or reduce its effects by offering emotional support and flexible coping. This interpretation is also consistent with studies showing that adolescents facing chronic health conditions or other sustained stressors benefit from stable relational support and family involvement (Novak, 2025; Russo, 2022). Although these studies examined different populations, they support the broader principle that family relationships influence how adolescents cope with persistent demands. The present findings therefore suggest that the family context should not be treated as secondary to academic influences; rather, it is a core component of the psychological system through which stress is either intensified or buffered.

Perceived social support also emerged as an important protective predictor, with total social support and family support ranking among the strongest contributors to the model. This finding is in line with evidence that supportive relationships reduce vulnerability to stress and depressive symptoms during adolescence. Research conducted during periods of social disruption showed that friendship quality could buffer the association between loneliness, stress, and depressive symptoms (Espinoza & Hernandez, 2022). Social support has also been shown to aid recovery from cyberbullying-related mental health difficulties, highlighting the protective role of peers and relational resources (Shabbir & Farzand, 2022). Likewise, relational and collective support has been associated with better psychological functioning among adolescents exposed to interpersonal violence (Sabina et al., 2021). The current findings therefore support the interpretation that psychological distress is partly shaped by whether adolescents perceive that meaningful interpersonal resources are available when they experience academic or emotional difficulties.

Family support was more influential than support from friends or significant others in the current model. One possible explanation is that family support may operate across several domains simultaneously, including emotional reassurance, instrumental assistance, supervision, academic guidance, and regulation of stressful situations. Peer support, although highly important during adolescence, may be more

context-dependent and may not provide the same degree of stability. Previous research has shown that adolescents' social connectedness can substantially influence emotional health, particularly during periods of school disruption and isolation (Vaillancourt et al., 2021). Daily emotional experiences during periods of restricted social interaction have also demonstrated the importance of interpersonal contact and social connection for adolescent wellbeing (Silk et al., 2021). Thus, the present finding does not diminish the value of peer relationships; rather, it suggests that family-based support may have broader predictive relevance when multiple forms of distress are considered simultaneously.

The inverse association between academic performance and psychological distress was comparatively weaker but still meaningful. Adolescents with lower academic performance tended to experience higher distress, and academic achievement retained modest predictive importance within the neural network. This association may be bidirectional. Psychological distress can impair concentration, motivation, sleep quality, and cognitive performance, while academic difficulties may increase worry, shame, perceived failure, and family conflict. Such reciprocal processes are consistent with broader evidence showing that emotional and educational functioning are deeply interconnected in adolescence (Mucci et al., 2024). School-based mental health interventions may therefore improve not only psychological wellbeing but also engagement and educational functioning (Berger et al., 2022). Clinical evidence from school-based psychological treatment also indicates that improvements in emotional symptoms may facilitate broader functioning among adolescents with complex psychological conditions (Goff et al., 2022).

Daily study time showed only modest predictive importance despite its positive correlation with distress. This distinction is informative because it suggests that the quantity of time spent studying may be less important than the quality and emotional meaning of academic demands. Spending many hours on schoolwork does not necessarily indicate maladaptive stress if adolescents feel competent, supported, and in control. Conversely, relatively fewer hours may still be distressing when accompanied by intense worry, self-criticism, or perceived failure. This interpretation is consistent with contemporary models that emphasize appraisal, coping, and contextual resources rather than objective exposure alone (Sarfika et al., 2025). It also helps explain why educational stress dimensions such as

despondency and worry about grades were much more important than daily study time in the neural network.

The relatively low predictive importance of demographic variables, including age and sex, is another noteworthy finding. Although demographic characteristics can be associated with differences in adolescent mental health, they may have limited utility when more proximal psychological and contextual factors are entered into a multivariable predictive model. The present results suggest that the immediate academic, family, and social environments in which adolescents function may provide more actionable information than broad demographic categories. This interpretation is consistent with evidence showing that mental health outcomes vary substantially within demographic groups according to contextual conditions, social resources, and environmental stressors (Dupuis et al., 2021). Research on adolescent mental health across different social contexts has similarly emphasized that structural and interpersonal factors can shape psychological outcomes beyond simple demographic classifications (Boutrín & Williams, 2021). Thus, demographic variables may remain relevant for identifying population-level inequalities, but they appear less informative for individualized prediction when more direct measures of lived experience are available.

The predictive performance of the multilayer perceptron model also supports the use of nonlinear analytic methods in adolescent mental health research. Psychological distress is unlikely to result from simple additive effects. An adolescent with high academic pressure but strong family support may have a different psychological outcome from another adolescent with similar academic pressure but poor family functioning and low peer support. Likewise, the influence of social support may depend on the intensity of academic demands or the adolescent's emotional response to those demands. Conventional linear models can represent some of these interactions when they are explicitly specified, but neural networks can identify more complex nonlinear patterns without requiring all relationships to be predetermined. The current model's ability to explain 66% of the variance in psychological distress in an independent testing sample suggests that such complexity contained substantial predictive information.

At the same time, the present results should be interpreted within a developmental and contextual framework rather than as evidence that neural-network prediction alone can explain adolescent mental health. Psychological distress may be influenced by broader factors not included in the current model, such as social media exposure, cyberbullying,

discrimination, chronic illness, substance use, traumatic experiences, war-related stress, and other forms of adversity. Contemporary research has increasingly emphasized the potential mental health consequences of problematic digital environments and harmful social media exposure among youth (Wilksch, 2025). Other studies have demonstrated that adolescents exposed to armed conflict, displacement, or major societal disruption may experience forms of distress that differ from those associated with routine academic and family stressors (Lopatovska et al., 2022). Substance use may also emerge as a maladaptive response to psychological strain and environmental adversity (Lundahl & Cannoy, 2021). Therefore, the present model should be understood as a strong but necessarily incomplete representation of adolescent psychological distress.

The findings are also consistent with evidence that psychological distress exists on a continuum and may precede more severe outcomes. Persistent distress can contribute to withdrawal, academic disengagement, self-harm, or suicidality when protective resources are insufficient. Research on youth suicidality has highlighted the importance of social isolation, family stress, and psychological vulnerability (Field, 2021), while studies of adolescent suicide have identified emotional pain, relational difficulties, and lack of perceived support as recurring contextual features (Charesma Grace et al., 2022). The present findings therefore reinforce the importance of early identification before distress progresses to more severe impairment. From this perspective, predictive models may be particularly useful as screening aids in school settings, where information about educational stress, family functioning, and social support can be collected relatively easily.

5. Conclusion

Finally, the pattern of findings supports an interpersonal and ecological interpretation of adolescent distress. Contemporary therapeutic approaches to youth depression increasingly emphasize the role of interpersonal conflict, role transitions, relational difficulties, and social support in the development and treatment of depressive symptoms (Mufson et al., 2026). Broader resilience research similarly indicates that physical activity, supportive relationships, stable routines, and environmental resources contribute to more adaptive psychological functioning (Laurier et al., 2021). The present study adds to this body of evidence by showing that predictors from multiple ecological domains

jointly contributed to out-of-sample prediction. Academic stress was the dominant risk domain, but family functioning and social support provided substantial additional information, indicating that adolescent psychological distress is best understood as the product of interacting academic and interpersonal systems rather than a single source of vulnerability.

6. Limitations & Suggestions

The present study has several limitations. First, the cross-sectional design precludes causal interpretation and does not establish the temporal ordering of academic stress, family functioning, social support, and psychological distress. Second, all principal variables were assessed through self-report questionnaires, which may introduce common-method variance, recall bias, and socially desirable responding. Third, although the sample included adolescents from multiple regions and school types in Taiwan, the findings may not generalize equally to adolescents in other cultural or educational contexts. Fourth, the neural-network model was internally evaluated using training, validation, and testing subsets from the same overall sample, and external validation in an entirely independent dataset was not performed. Fifth, several potentially relevant variables, including sleep quality, social media use, bullying, physical activity, personality traits, chronic illness, and prior mental health history, were not included. Finally, although permutation importance identified the relative contribution of predictors, neural networks remain less directly interpretable than conventional regression models, and predictor importance should not be interpreted as evidence of causality.

Future research should employ longitudinal designs to examine how academic, family, and social factors predict changes in psychological distress over time and to determine whether neural-network models can identify adolescents at risk before symptoms become clinically significant. External validation should be conducted using independent samples from different regions, school systems, and cultural contexts. Future studies could also compare multilayer perceptron models with alternative machine-learning methods such as random forests, gradient boosting, support vector regression, and ensemble approaches to determine which algorithms provide the best balance between accuracy and interpretability. Incorporating additional predictors, including sleep, physical activity, social media exposure, cyberbullying, school connectedness, resilience, coping

strategies, and previous mental health history, may improve predictive performance. Explainable artificial intelligence methods such as SHAP values or partial dependence analyses could also be used to clarify nonlinear relationships and interactions among predictors. Longitudinal repeated-measures data would further allow researchers to develop dynamic prediction models capable of detecting within-person changes in risk.

In practice, the findings suggest that adolescent mental health screening should assess academic stress, family functioning, and perceived social support together rather than focusing on demographic characteristics or academic achievement alone. Schools could incorporate brief psychological distress and educational stress measures into routine wellbeing assessments and establish referral pathways for students reporting high levels of despondency, grade-related worry, or perceived family and social difficulties. School counselors and psychologists may benefit from considering whether academic pressure is accompanied by weak family support or social isolation, because combinations of these factors may indicate greater vulnerability. Family-oriented interventions could focus on communication, emotional responsiveness, realistic academic expectations, and supportive problem solving. At the school level, reducing unnecessary performance pressure, strengthening teacher support, expanding access to counseling, and creating peer-support opportunities may help mitigate distress. Predictive models should be used as supplementary decision-support tools rather than as substitutes for clinical judgment, with appropriate safeguards for privacy, transparency, and responsible interpretation.

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.

References

- Berger, E., Reupert, A., Allen, K. A., & Campbell, T. C. H. (2022). A Systematic Review of the Long-Term Benefits of School Mental Health and Wellbeing Interventions for Students in Australia. *Frontiers in Education*, 7. <https://doi.org/10.3389/educ.2022.986391>
- Boutrín, M. C., & Williams, D. R. (2021). What Racism Has to Do With It: Understanding and Reducing Sexually Transmitted Diseases in Youth of Color. *Healthcare*, 9(6), 673. <https://doi.org/10.3390/healthcare9060673>
- Campione-Barr, N., Skinner, A. T., Moeller, K., Cui, L., Kealy, C., & Cookston, J. T. (2024). The Role of Family Relationships on Adolescents' Development and Adjustment During the <scp>COVID</Scp>-19 Pandemic: A Systematic Review. *Journal of Research on Adolescence*, 35(1). <https://doi.org/10.1111/jora.12969>
- Charesma Grace, K. L.-a., Atianzar, M. B., & Gano, E. B. (2022). Teen Suicide in One Province in Cordillera. *International Review of Social Sciences Research*, 2(4), 40-61. <https://doi.org/10.53378/352951>
- Diamond, G., Kodish, T., Ewing, E. S. K., Hunt, Q. A., & Russon, J. (2022). Family Processes: Risk, Protective and Treatment Factors for Youth at Risk for Suicide. *Aggression and Violent Behavior*, 64, 101586. <https://doi.org/10.1016/j.avb.2021.101586>
- Dupuis, J. B., Bourque, J., & Adlouni, S. E. E. (2021). Odds of Anxiety and Depression Symptoms in School-Aged Children From Official Language Minority Communities. *Frontiers in Public Health*, 9. <https://doi.org/10.3389/fpubh.2021.660041>
- Espinoza, G., & Hernandez, H. L. (2022). Adolescent Loneliness, Stress and Depressive Symptoms During the <scp>COVID</Scp>-19 Pandemic: The Protective Role of Friends. *Infant and Child Development*, 31(3). <https://doi.org/10.1002/icd.2305>
- Espinoza, G., Mariano, J. E., & Blanco, A. N. (2024). "Our Social Lives Were Kind of Ruined": Challenges and Sources of Support During COVID-19 Distance Learning Among Latinx High School Students. *Journal of Adolescent Research*, 39(6), 1447-1475. <https://doi.org/10.1177/07435584241231432>
- Field, T. (2021). Suicidality in Youth During COVID-19: A Narrative Review. *Journal of Psychiatry Research Reviews & Reports*, 3(2), 1. [https://doi.org/10.47363/jpsrr/2021\(3\)124](https://doi.org/10.47363/jpsrr/2021(3)124)
- Garagiola, E. R., Lam, Q., Wachsmuth, L. S., Tan, T. Y., Ghali, S., Asafo, S. M., & Swarna, M. (2022). Adolescent Resilience During the COVID-19 Pandemic: A Review of the Impact of the Pandemic on Developmental Milestones. *Behavioral Sciences*, 12(7), 220. <https://doi.org/10.3390/bs12070220>
- Goff, T. M., Moody, M. E., Acosta, L. L., & Joyce-Beaulieu, D. (2022). School-Based Cognitive-Behavioral Therapy in an Inclusion Model for an Adolescent With Comorbid Major Depressive Disorder, Generalized Anxiety Disorder, and Attention Deficit Hyperactivity Disorder: A Case Study. *Clinical Case Studies*, 21(5), 457-473. <https://doi.org/10.1177/15346501221078329>
- Goh, W. S., Tan, J. H. N., Luo, Y., Ng, S. H., Mohamed Sufyan Bin Mohamed, S., Wong, J. C. M., & Loh, V. W. K. (2023). Risk and Protective Factors Associated With Adolescent Depression in Singapore: A Systematic Review. *Singapore medical journal*, 66(1), 2-14. <https://doi.org/10.4103/singaporemedj.smj-2021-192>
- Hertz, M., Kilmer, G., Verlenden, J., Liddon, N., Rasberry, C. N., Barrios, L. C., & Ethier, K. A. (2022). Adolescent Mental Health, Connectedness, and Mode of School Instruction During COVID-19. *Journal of Adolescent Health*, 70(1), 57-63. <https://doi.org/10.1016/j.jadohealth.2021.10.021>
- Høiseth, M., Alsos, O. A., Holme, S., Ek, S., & Gabrielsen, C. T. (2021). Serious Game Design to Support Children Struggling With School Refusal. *International Journal of Serious Games*, 8(2), 109-128. <https://doi.org/10.17083/ijsg.v8i2.416>
- Kara, B., Scharf, N., Bhreathnach, L., Currie, C., & Symonds, J. (2025). Adolescent Anxiety During the COVID-19 Pandemic: A Qualitative Systematic Review of Risk and Protective Factors. *Journal of adolescence*, 97(8), 2048-2066. <https://doi.org/10.1002/jad.70038>
- Laurier, C., Pascuzzo, K., & Beaulieu, G. (2021). Uncovering the Personal and Environmental Factors Associated With Youth Mental Health During the COVID-19 Pandemic: The Pursuit of Sports and Physical Activity as a Protective Factor. *Traumatology an International Journal*, 27(4), 354-364. <https://doi.org/10.1037/trm0000342>
- Lin, J., & Guo, W. (2024). The Research on Risk Factors for Adolescents' Mental Health. *Behavioral Sciences*, 14(4), 263. <https://doi.org/10.3390/bs14040263>
- Lopatovska, I., Arora, K., Fernandes, F. V., Rao, A., Sivkoff-Livneh, S., & Stamm, B. (2022). Experiences of the Ukrainian Adolescents During the Russia-Ukraine 2022 War. *Information and Learning Sciences*, 123(11/12), 666-704. <https://doi.org/10.1108/ils-07-2022-0093>
- Lundahl, L. H., & Cannoy, C. N. (2021). COVID-19 and Substance Use in Adolescents. *Pediatric Clinics of North America*, 68(5), 977-990. <https://doi.org/10.1016/j.pcl.2021.05.005>
- Luthar, S. S., Pao, L. S., & Kumar, N. L. (2021). COVID-19 and Resilience in Schools: Implications for Practice and Policy. *Child Policy Nexus*, 34(3), 1-65. <https://doi.org/10.1002/sop2.16>
- Mucci, G., Collins, E., Pearce, E., Avina, M., Hao, S., Onungwa, C., Bunac, J., Hunte, Y., Coopersmith, L., & Yewell, N. (2024). The Lost Years: An Integrative Review of the Mental Health, Educational, and Social Impact of the Pandemic on Children and Adolescents From 2019 to 2022. *Journal of Pediatric Neuropsychology*, 10(1), 49-90. <https://doi.org/10.1007/s40817-024-00160-0>
- Mufson, L., Young, J. F., Dietz, L. J., & Schwartz, K. T. G. (2026). Interpersonal Psychotherapy for Depression in Youth. 473-493. <https://doi.org/10.1037/0000438-025>
- Novak, A. M. (2025). Growing Up With MS: The Adolescent Experience of Pediatric-Onset Multiple Sclerosis. *Adolescents*, 5(4), 66. <https://doi.org/10.3390/adolescents5040066>
- Raval, V. V., Raman, V., Aggarwal, P., Sreenivas, K. K., Krishnamurthy, S., Goud, B. R., Hay, M. C., & Visweswariah,

- A. M. (2025). How Do Adolescents and Others Around Them Conceptualize Depression? Toward a Contextually Grounded Understanding of Depression During Adolescence in India. *Journal of Cross-Cultural Psychology*, 56(6), 607-628. <https://doi.org/10.1177/00220221251319343>
- Rider, E. A., Ansari, E. A., Varrin, P., & Sparrow, J. (2021). Mental Health and Wellbeing of Children and Adolescents During the Covid-19 Pandemic. *bmj*, n1730. <https://doi.org/10.1136/bmj.n1730>
- Russo, K. (2022). Assessment and Treatment of Adolescents With Chronic Medical Conditions. *Journal of Health Service Psychology*, 48(2), 69-78. <https://doi.org/10.1007/s42843-022-00059-4>
- Sabina, C., Marsical, E. S., & Cuevas, C. A. (2021). Psychological Functioning Among Latino Victims of Teen Dating Violence: The Role of Relational and Collective Resources. *Journal of interpersonal violence*, 37(21-22). <https://doi.org/10.1177/08862605211044097>
- Sarfika, R., Saifudin, I. M. M. Y., Wicaksana, A. L., Malini, H., Wenny, B. P., Rahayuningsih, A., Wijaya, N. E., Putri, D. E., & Abdullah, K. L. (2025). Predictors and Protective Factors of Mental Health Outcomes Among Indonesian Adolescents: An SCT-Based Multi-Center Study. *International Journal of Social Psychiatry*, 72(3), 582-593. <https://doi.org/10.1177/00207640251372672>
- Shabbir, S., & Farzand, K. (2022). Cyberbullying Among University Students; How Do Peers Support in Recovering From Mental Health Problems. *Educational Research and Innovation*, 2(01), 51-61. <https://doi.org/10.61866/eri.v2i01.15>
- Silan, M. A. A. (2023). Are the Kids Alright? The Impact of COVID-19 Pandemic on the Mental Health and Psychosocial Wellbeing of Filipino Children in Selected Cities in Metro Manila. <https://doi.org/10.31234/osf.io/v2ygm>
- Silk, J. S., Scott, L. N., Hutchinson, E., Lu, C., Sequeira, S., McKone, K. M., Quyen, B., & Ladouceur, C. D. (2021). Storm Clouds and Silver Linings: Day-to-Day Life in COVID-19 Lockdown and Emotional Health in Adolescent Girls. *Journal of Pediatric Psychology*, 47(1), 37-48. <https://doi.org/10.1093/jpepsy/jsab107>
- Thiha, N., Soe, P. P., Win, H. H., Delorme, L., Clevenbergh, P., & Babin, F. X. (2025). Exploring the Psychological Impact on Children and Adolescents During the Initial Period of the COVID-19 Pandemic-a Systematic Review. *BMC psychology*, 13(1). <https://doi.org/10.1186/s40359-025-03165-2>
- Vaillancourt, T., McDougall, P., Comeau, J., & Finn, C. A. (2021). COVID-19 School Closures and Social Isolation in Children and Youth: Prioritizing Relationships in Education. *Facets*, 6, 1795-1813. <https://doi.org/10.1139/facets-2021-0080>
- Wilksch, S. (2025). Reducing the Harms of Social Media for Youth: An Urgent Call for Comprehensive Action. *International Journal of Eating Disorders*, 59(4), 650-665. <https://doi.org/10.1002/eat.70001>
- Windarwati, H. D., Lestari, R., Supianto, A. A., Wicaksono, S. A., Ati, N. A. L., Kusumawati, M. W., Humayya, A., & Ekawati, D. (2022). A Narrative Review Into the Impact of COVID-19 Pandemic on Senior High School Adolescent Mental Health. *Journal of Child and Adolescent Psychiatric Nursing*, 35(3), 206-217. <https://doi.org/10.1111/jcap.12370>