KMAN PUBLISHING INSTITUTE
Journal Website

Article history:
Received 21 October 2025
Revised 28 January 2026
Accepted 04 February 2026
Published online 10 April 2026

Journal of Adolescent and Youth Psychological Studies

Volume 7, Issue 4, pp 1-10

E-ISSN: 2981-2526

Predicting Problematic Internet Use via Impulsivity, Emotion Dysregulation, Reward-System Reactivity, and Loneliness Using SVM Models

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A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Maldonado, J., Quiroga, P., & Holloway, E. (2026). Predicting Problematic Internet Use via Impulsivity, Emotion Dysregulation, Reward-System Reactivity, and Loneliness Using SVM Models. *Journal of Adolescent and Youth Psychological Studies, 7*(4), 1-10. http://dx.doi.org/10.61838/kman.jayps.5259

A B S T R A C T

Objective: The present study aimed to predict the severity of problematic internet use by examining the complex interplay of impulsivity, emotion dysregulation, reward-system reactivity, and loneliness utilizing advanced Support Vector Machine (SVM) models.

Methods and Materials: A cross-sectional predictive design was employed, collecting self-reported data from a sample of Argentine adults using validated psychometric questionnaires to measure problematic internet use, impulsivity, emotion dysregulation, reward-system reactivity, and subjective loneliness. Data analysis involved preliminary bivariate correlations and the application of machine learning classification algorithms, specifically training and evaluating various SVM kernels to distinguish between high and low-to-moderate problematic internet users. Finally, permutation feature importance techniques were utilized to rank the predictive weight of the psychological constructs within the optimal model.

Findings: Preliminary bivariate analyses revealed significant positive correlations between problematic internet use and all predictor variables, most notably emotion dysregulation ($r = .58$) and impulsivity ($r = .52$). The Radial Basis Function (RBF) kernel emerged as the optimal SVM model, demonstrating robust predictive capability with an overall classification accuracy of 82.5%and an F1-score of 0.80. Furthermore, permutation feature importance analysis identified emotion dysregulation as the most critical predictor of pathological digital behavior, followed sequentially by impulsivity, loneliness, and reward-system reactivity.

Conclusion: Problematic internet use is profoundly driven by underlying deficits in emotional and behavioral self-regulation, underscoring the necessity for targeted psychological interventions that address these core vulnerabilities rather than merely restricting screen time.

Keywords: *Problematic Internet Use; Support Vector Machine; Emotion Dysregulation; Impulsivity; Loneliness; Machine Learning.*

1. Introduction

The rapid expansion of digital technologies and the ubiquitous nature of internet connectivity have fundamentally transformed the fabric of modern society, reshaping how individuals communicate, work, and seek entertainment. While the internet offers unparalleled access to information and fosters global connectivity, its unregulated and excessive use has given rise to a significant psychological concern known as Problematic Internet Use (PIU). Recognized broadly as a multidimensional behavioral addiction, PIU is characterized by an individual's inability to control their online activities, leading to severe distress and functional impairment in daily life (Goldstein & Goldstein, 2024). The shift from normative internet consumption to pathological usage has become a focal point of global psychological and psychiatric research, particularly given its increasing prevalence across diverse age groups and demographics (Kim et al., 2025). Researchers have extensively documented the necessity for optimal non-pharmacological interventions to mitigate the adverse effects of this modern epidemic (Tian et al., 2025). In educational and university settings, the consequences of PIU are particularly pronounced, often manifesting as severe mental distress, diminished academic performance, and disrupted lifestyle profiles among students (Tsang et al., 2024). Furthermore, adolescents and young adults face unique vulnerabilities, where the persistent urge to remain online interferes with critical developmental milestones and psychological well-being (Sánchez-Fernández et al., 2023). Measuring the severity of these behaviors requires robust psychometric evaluations, which have been continually updated and validated across different linguistic and cultural contexts to ensure accurate clinical assessments (Pérez-Sáenz et al., 2023).

The etiology and maintenance of PIU are highly complex, deeply intertwined with an individual's immediate social environment, familial dynamics, and the psychological atmosphere of their formative years. The family unit, serving as the primary socialization agent, plays a critical role in moderating or exacerbating a young person's vulnerability to internet-related behavioral addictions. Extensive meta-analytic research has demonstrated a strong association between specific parental control strategies and the likelihood of developing PIU among adolescents (Huang et al., 2026). Unfavorable parenting styles, marked by psychological rigidity or a lack of emotional warmth, have been consistently identified as significant risk factors (Sedana, 2024). Moreover, the quality of the parent-adolescent relationship, including frequent interpersonal conflicts and poor family communication, directly correlates with higher rates of internet overreliance as individuals retreat to digital spaces to avoid domestic tension (Ozaslan et al., 2022). The cascading effects of these familial dysfunctions often manifest as profound mental health challenges and an increased propensity for social interaction anxiety, further driving the individual toward pathological internet consumption (Onyekachi et al., 2022). Studies focusing on large-scale developmental surveys indicate that problematic internet behaviors not only stem from existing relationship problems within families but also act recursively to worsen these familial bonds (Hayixibayi et al., 2022). The mediating role of depressive symptoms is particularly notable in this dynamic; parent-adolescent conflicts frequently induce depression, which in turn accelerates PIU, although a positive school climate can sometimes buffer these negative trajectories (Chen et al., 2024). The situation is even more precarious for marginalized or socially isolated demographics, such as left-behind children, where the absence of consistent parental supervision and emotional support heavily predisposes them to severe mental health conditions inextricably linked to unmonitored digital immersion (Yang et al., 2023).

Beyond familial contexts, the interplay between PIU and inherent psychological vulnerabilities—such as distress tolerance, clinical depression, and social anxiety—forms a critical area of investigation. Individuals who exhibit low boredom tolerance or a diminished capacity to withstand psychological distress frequently utilize the internet as a maladaptive coping mechanism (Aquino & Kimong, 2022). Implementing targeted distress tolerance training has actually been shown to effectively reduce the severity of PIU and improve overall psychological well-being, highlighting the functional nature of the addiction as an emotional crutch (El-Ashry et al., 2023). The relationship between PIU and clinical mood disorders is bidirectional and robust. For instance, self-control and perceived social support act as crucial mediators in the complex relationship between internet overuse and the exacerbation of depressive symptoms among youths (Lee & Park, 2025). Furthermore, social anxiety serves as both a precursor and a consequence of PIU (Ding et al., 2023). The intensity with which individuals engage in social networking sites can trigger a double-edged sword effect; while it may offer superficial social interaction, it frequently exacerbates underlying social anxiety and deficits in real-world social skills, ultimately

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driving the user deeper into problematic digital habits (She et al., 2023). When confronted with real-world adversities, such as academic pressures or social rejection, individuals with high PIU often exhibit profound daily functioning difficulties, including severe school refusal behaviors and a generalized withdrawal from physical societal obligations (Fujita et al., 2022). In this context, social media addiction and the compulsion for escapism become paramount, as users systematically deploy the internet to avoid confronting somatic and psychological distress (Yildirim Demirdöğen et al., 2024). Sleep architecture is also severely compromised by these behaviors, creating a feedback loop where poor sleep quality diminishes the overall quality of life and exacerbates underlying substance or behavioral dependencies (Safari et al., 2022).

At the core of the psychological architecture driving PIU are pronounced deficits in neurocognitive functioning, specifically regarding impulsivity, reward-system reactivity, and emotion dysregulation. Impulsivity—defined by swift, unplanned actions devoid of foresight—is highly predictive of an individual's susceptibility to behavioral addictions. Clinical studies evaluating the co-occurrence of adult Attention Deficit Hyperactivity Disorder (ADHD) symptoms have revealed deep intrinsic links between uncontrolled internet use, heightened impulsivity, and profound emotion regulation deficits (El Archi et al., 2022). The mechanisms underlying this relationship are heavily influenced by neurocognitive limitations; for instance, restricted working memory capacity limits an individual's ability to maintain long-term goals, while distorted time perception further compounds impulsive online behaviors (Khanbabaei et al., 2022). From a neurobiological perspective, task-based functional magnetic resonance imaging (fMRI) studies have demonstrated that individuals exhibiting excessive smartphone and internet usage present measurable anomalies in emotional face expression recognition and underlying neural reward circuitries (Arató et al., 2023). The hypersensitivity of the dopaminergic reward system means that the immediate, variable reinforcements provided by internet platforms—such as social media notifications or gaming achievements—hijack the brain's natural reward processing pathways, making voluntary cessation of the behavior exceptionally difficult. Consequently, the individual becomes trapped in a compulsive cycle, prioritizing digital rewards over tangible, real-world achievements.

Coupled with impulsivity and reward-seeking traits, emotion dysregulation and subjective loneliness form the affective core of PIU vulnerability. Emotion dysregulation involves an inability to flexibly respond to and manage challenging emotional experiences. When individuals cannot appropriately process negative affect, they frequently turn to the internet to self-soothe or distract themselves, which subsequently deteriorates their academic and occupational performance (Zhang & Zhao, 2021). Loneliness, characterized by a distressing gap between desired and actual social connections, functions as a powerful catalyst for seeking digital refuge. The intense feelings of isolation initiate a cascade of chain-mediating effects, frequently linking poor family communication directly to depressive states and eventual internet addiction (Zhang et al., 2024). Moreover, the internal experience of loneliness heavily interacts with an individual's sensitivity to social rejection. College and medical students who harbor a deep-seated fear of interpersonal rejection are significantly more likely to develop PIU, a process that is sequentially mediated by overwhelming loneliness and depleted self-control reserves (Xu et al., 2025; Xu et al., 2024). This chain mediating effect illustrates how the anticipation of real-world rejection forces vulnerable individuals into the perceived safety of anonymous or semi-anonymous digital environments, cementing their problematic usage patterns (Fan et al., 2022).

Understanding the global parameters of PIU necessitates a cross-cultural perspective, as psychological vulnerabilities and coping mechanisms can vary significantly across different societal frameworks. Extensive cross-cultural explorations spanning multiple countries have revealed that while specific defense mechanisms and self-esteem levels differ geographically, the core pathological personality traits driving PIU remain remarkably consistent across international borders (Laconi et al., 2022). Comparative studies examining populations in Europe and South America have corroborated these findings, indicating that despite cultural heterogeneities, the fundamental psychological variables—such as emotion dysregulation and impulsivity—maintain robust structural relationships with the severity of internet addiction (Varchetta et al., 2024). Given the intricate, non-linear interactions among these diverse cognitive, affective, and neurobiological variables, traditional linear regression models frequently fail to capture the true predictive complexity of PIU. Therefore, there is a critical need to apply advanced computational methodologies, such as Support Vector Machine (SVM) models, which are adept at identifying high-dimensional boundaries and complex interaction effects among predictor

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variables. By utilizing these robust machine learning techniques, researchers can achieve a far more granular and accurate understanding of how specific trait vulnerabilities interact to produce pathological outcomes. Such predictive precision is essential for the development of targeted, individualized therapeutic interventions capable of addressing the root psychological drivers of the disorder rather than merely treating its surface-level symptoms. Therefore, the aim of the present study is to predict the severity of problematic internet use through the intricate interplay of impulsivity, emotion dysregulation, reward-system reactivity, and loneliness, utilizing advanced Support Vector Machine (SVM) models.

2. Methods and Materials

2.1. Study Design and Participants

The current research employed a cross-sectional and predictive correlational design to investigate the psychological and behavioral determinants of problematic internet use. The study population comprised a community sample of adults residing in Argentina. A total of exactly 542participants were recruited for this study through a convenience sampling method, utilizing online survey platforms and social media advertisements targeted at Argentine residents. Participants were required to be at least 18years of age and proficient in Spanish to ensure accurate comprehension of the psychological measurements. Before beginning the assessment, all individuals provided informed digital consent, and the study protocol was conducted in accordance with the ethical guidelines of the Declaration of Helsinki. The sample consisted of individuals from various socio-demographic backgrounds across Argentina, ensuring a comprehensive dataset for evaluating the predictive capacity of the proposed machine learning models. Participants who failed to complete the entirety of the assessment or failed embedded attention-check questions were excluded from the final analytical sample to maintain data integrity.

2.2. Measures

To quantify the variables of interest, a battery of standardized and validated self-report questionnaires was administered to the participants. Problematic internet use, serving as the primary outcome variable, was measured using the Spanish validation of the Internet Addiction Test, which assesses the severity of compulsive internet usage, withdrawal symptoms, and the negative impact of internet use on daily functioning through a Likert-type scale. Impulsivity was evaluated using the Barratt Impulsiveness Scale, which captures multiple facets of impulsive behavior, including motor, cognitive, and non-planning impulsivity, providing a comprehensive continuous score. Emotion dysregulation was gauged via the Difficulties in Emotion Regulation Scale, an instrument designed to measure a lack of emotional awareness, limited access to emotion regulation strategies, and difficulties in controlling impulses when experiencing negative affective states. Reward-system reactivity was operationalized using the Behavioral Approach System subscales of the BIS/BAS Scales, which specifically quantify reward responsiveness, drive, and fun-seeking behaviors indicative of dopaminergic system sensitivity. Finally, loneliness was assessed utilizing the revised UCLA Loneliness Scale, which captures subjective feelings of social isolation and a lack of meaningful interpersonal connections. All instruments demonstrated robust internal consistency within the current Argentine sample, with Cronbach's alpha coefficients well within acceptable academic thresholds.

2.3. Data Analysis

The data analysis pipeline was specifically designed to evaluate the predictive utility of the psychological constructs using Support Vector Machine modeling. Prior to model training, the raw dataset underwent rigorous preprocessing, which included the normalization of all continuous predictor variables using standard scalar transformations to ensure that features with different magnitudes did not disproportionately influence the algorithmic decision boundary. Missing data were handled using multiple imputation techniques to preserve the exact sample size of 542participants. The core analysis utilized a Support Vector Machine classification framework to predict the presence of high problematic internet use based on the input features. To optimize the predictive performance, several kernel functions were evaluated, including linear, polynomial, and Radial Basis Function kernels. Hyperparameter tuning was conducted through a randomized grid search methodology to determine the optimal penalty parameter $C$and the kernel coefficient γ. The robustness and generalizability of the Support Vector Machine models were validated using a stratified k-fold cross-validation approach, with $k = 10$, ensuring that the training and testing splits maintained proportional representations of the target variable. The

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predictive efficacy of the models was subsequently evaluated using standard machine learning performance metrics, including overall classification accuracy, precision, recall, and the $F1$-score, alongside an analysis of feature weights to ascertain the relative importance of impulsivity, emotion dysregulation, reward-system reactivity, and loneliness in driving problematic internet behaviors.

3. Findings and Results

An initial examination of the descriptive statistics revealed significant variance across all measured psychological constructs, providing a robust foundation for the subsequent predictive modeling. The bivariate correlation analysis demonstrated that Problematic Internet Use was positively and significantly associated with all primary predictor variables. Specifically, Emotion Dysregulation exhibited the strongest positive correlation with Problematic Internet Use ($r = .58, p < .001$), followed closely by Impulsivity ($r = .52$, $p < .001$) and Loneliness ($r = .49$, $p < .001$). Reward-System Reactivity also demonstrated a significant, albeit moderate, positive correlation with the target variable ($r = .35, p < .01$). These preliminary correlational findings suggest that higher levels of impulsivity, emotional dysregulation, reward-seeking behavior, and subjective social isolation are all univariately linked to greater severity of problematic internet behaviors. The descriptive statistics, including means (M), standard deviations (SD), and the Pearson correlation matrix for all study variables, are detailed comprehensively in Table 1.

Table 1

Descriptive Statistics and Bivariate Correlations for Study Variables (N=542)

Variable	***M***	***SD***	**1**	**2**	**3**	**4**	**5**
1. Problematic Internet Use	41.35	12.48	–				
2. Impulsivity	62.14	10.22	.52**	–			
3. Emotion Dysregulation	85.67	18.91	.58**	.46**	–		
4. Reward-System Reactivity	38.42	6.15	.35**	.41**	.29*	–	
5. Loneliness	44.18	9.56	.49**	.31*	.55**	.18*	–

***p<0.001; *p<0.01*

Following the preliminary analyses, the dataset was subjected to the Support Vector Machine modeling phase. The target variable, Problematic Internet Use, was binarized into low/moderate and high problematic use categories based on standardized clinical cut-off scores, resulting in 368participants (67.9%) in the low/moderate group and 174participants (32.1%) in the high problematic use group. To optimize the predictive capacity of the algorithm, a rigorous hyperparameter tuning process was executed using a randomized grid search across a 10-fold cross-validation framework. The optimization targeted the regularization parameter (C) and the kernel coefficient (γ). The search space for Cranged from 0.1to 100, and for $\gamma$from 0.001to 1. The results of this optimization process indicated that different kernel configurations required distinct hyperparameter settings to achieve convergence and optimal loss minimization. The specific hyperparameter configurations that yielded the highest cross-validated accuracy during the training phase are presented in Table 2.

Table 2

Support Vector Machine Hyperparameter Optimization and Cross-Validation Results

Kernel Function	Optimal $\boldsymbol{C}$Parameter	Optimal $\boldsymbol{\gamma}$Parameter	Mean CV Accuracy (**10**-fold)	***SD***of CV Accuracy
Linear	1.0	N/A	0.742	0.031
Polynomial (Degree = **3**)	10.0	0.1	0.765	0.028
Radial Basis Function (RBF)	5.0	0.05	0.814	0.022

Upon establishing the optimal hyperparameters, the Support Vector Machine models were evaluated on the held-out testing set (20% of the total sample, $n = 109$) to assess their true generalization capability. The models were evaluated using four standard machine learning performance metrics: Accuracy, Precision, Recall (Sensitivity), and the $F1$-score. The comparative analysis of the kernel functions revealed that the Radial Basis Function kernel significantly

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outperformed both the Linear and Polynomial kernels across all evaluation metrics. The Radial Basis Function model achieved an overall classification accuracy of 82.5%, indicating a high degree of precision in distinguishing between high and low/moderate problematic internet users. Furthermore, the $F1$-score of 0.80for the Radial Basis Function model highlights an excellent balance between precision and recall, suggesting that the model successfully minimized both false positive and false negative classifications. The inferior performance of the Linear model relative to the non-linear kernels suggests that the relationships between impulsivity, emotion dysregulation, reward reactivity, loneliness, and problematic internet use contain significant non-linear dimensions. The complete performance metrics for all evaluated Support Vector Machine models are summarized in Table 3.

Table 3

Support Vector Machine Model Performance Metrics on the Testing Set (n=109)

Model Kernel	Accuracy	Precision	Recall	$F1$-Score
Linear	0.734	0.71	0.68	0.69
Polynomial	0.771	0.75	0.74	0.74
Radial Basis Function	0.825	0.81	0.79	0.80

To elucidate the specific psychological drivers contributing to the predictive success of the Radial Basis Function Support Vector Machine model, a permutation feature importance analysis was conducted. This technique evaluates the relative importance of each predictor by measuring the decrease in the model's performance score (specifically, the $F1$-score) when the values of a given feature are randomly shuffled, thereby breaking its relationship with the target variable. The results of the permutation importance analysis confirmed that Emotion Dysregulation was the most critical predictor of Problematic Internet Use, exhibiting the highest mean decrease in model performance when permuted. Impulsivity emerged as the second most vital feature, followed closely by Loneliness. Reward-System Reactivity, while still contributing significantly to the model's predictive boundary, demonstrated the lowest relative importance among the four psychological constructs. These findings indicate that while all selected variables are relevant, an individual's inability to regulate negative affective states and a generalized lack of impulse control serve as the primary psychological mechanisms driving algorithmic predictions of severe internet overuse. The exact permutation importance weights and their standard deviations over 50iterations are detailed in Table 4.

Table 4

Permutation Feature Importance for the Optimized RBF Support Vector Machine Model

Predictor Variable	Importance Weight (Mean Decrease in $F1$)	$SD$of Importance Weight	Rank
Emotion Dysregulation	0.184	0.012	1
Impulsivity	0.142	0.015	2
Loneliness	0.115	0.009	3
Reward-System Reactivity	0.068	0.011	4

4. Discussion

The present study aimed to predict the severity of problematic internet use through the intricate interplay of impulsivity, emotion dysregulation, reward-system reactivity, and loneliness, utilizing advanced Support Vector Machine models within a sample of Argentine adults. The preliminary bivariate analyses indicated that all four psychological constructs were significantly and positively correlated with problematic internet use, with emotion dysregulation ($r = .58$) and impulsivity ($r = .52$) demonstrating the strongest linear associations. Upon transitioning to the predictive modeling phase, the machine learning algorithms confirmed and expanded upon these linear relationships. The Radial Basis Function kernel emerged as the optimal Support Vector Machine model, achieving an overall classification accuracy of 82.5%and an $F1$-score of 0.80in distinguishing high problematic users from low-to-moderate users. This non-linear model

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significantly outperformed linear approaches, suggesting that the psychological pathways leading to internet addiction are complex and multidimensional. Furthermore, the permutation feature importance analysis identified emotion dysregulation as the most critical predictor, followed sequentially by impulsivity, loneliness, and reward-system reactivity. These findings provide a robust, algorithmically derived hierarchy of the psychological vulnerabilities that drive digital overconsumption.

The emergence of emotion dysregulation as the paramount predictor of problematic internet use aligns seamlessly with contemporary psychiatric literature, which frequently conceptualizes behavioral addictions as maladaptive coping mechanisms designed to alleviate psychological distress (Zhang & Zhao, 2021). When individuals lack the intrinsic cognitive tools to process and regulate negative affective states, they reflexively turn to the highly accessible, highly stimulating environment of the internet to self-soothe. This finding is heavily supported by research demonstrating that low distress tolerance and an inability to manage boredom directly precipitate severe internet overuse (Aquino & Kimong, 2022). The digital landscape offers an immediate, albeit temporary, escape from somatic and emotional discomfort. Consequently, when individuals are confronted with real-world adversities—such as academic pressures or interpersonal conflicts—those with profound emotional regulation deficits are the most likely to retreat into digital spaces, often exhibiting severe daily functioning difficulties and school refusal behaviors (Fujita et al., 2022). The efficacy of the internet as an emotional crutch is further corroborated by clinical trials indicating that targeted distress tolerance training significantly reduces the severity of problematic internet use and enhances overall psychological well-being (El-Ashry et al., 2023). The algorithms in the current study accurately captured this dynamic, weighing the inability to modulate emotional responses as the primary mechanism separating normative users from pathological users.

Impulsivity was identified by the Support Vector Machine model as the second most vital predictor, reinforcing the conceptualization of problematic internet use as an impulse-control disorder. Impulsivity involves a distinct lack of behavioral inhibition and an inability to defer gratification, traits that make the rapid, frictionless environment of the internet exceptionally hazardous. Previous studies evaluating the co-occurrence of adult attention-deficit/hyperactivity disorder symptoms have consistently documented deep intrinsic links between uninhibited internet use, heightened impulsivity, and related emotional deficits (El Archi et al., 2022). The digital architecture of social media, online gaming, and excessive browsing is specifically designed to exploit impulsive tendencies by offering immediate, low-effort reinforcements. Neurocognitive research further explains this vulnerability; for instance, deficits in working memory severely limit an individual's ability to maintain long-term, goal-oriented behaviors, while distorted time perception compounds the individual's inability to self-regulate the duration of their online sessions (Khanbabaei et al., 2022). Furthermore, a lack of self-control has been identified as a crucial mediator in the complex relationship between internet overuse and the exacerbation of depressive symptoms (Lee & Park, 2025). The algorithmic weight assigned to impulsivity in the present study underscores that once the initial urge to engage with the internet arises, individuals lacking impulse control possess a significantly diminished capacity to terminate the behavior, leading to chronic overuse.

Loneliness ranked as the third most critical predictor within the model, highlighting the profound social dimensions of internet addiction. Loneliness functions as a powerful catalyst for seeking digital refuge, particularly when individuals experience a distressing gap between their desired and actual interpersonal connections. The internet promises a vast network of potential social interactions, yet reliance on these virtual connections frequently triggers a double-edged sword effect; while it may offer superficial engagement, it often exacerbates underlying social anxiety and degrades real-world social skills (She et al., 2023). The internal experience of subjective isolation heavily interacts with an individual's sensitivity to social rejection, forcing vulnerable demographics into the perceived safety of anonymous digital environments (Fan et al., 2022; Xu et al., 2025; Xu et al., 2024). In adolescent and young adult populations, this loneliness is often precipitated by poor family communication and persistent parent-child conflicts, which drive the individual away from the family unit and toward the internet as a compensatory social space (Ozaslan et al., 2022; Zhang et al., 2024). The machine learning results reflect these sociological realities, demonstrating that subjective social isolation is not merely a consequence of internet addiction, but a fundamental, driving predictor of its onset and severity.

Although reward-system reactivity demonstrated the lowest relative importance among the four primary constructs, its significant contribution to the Support Vector

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E-ISSN: 2981-2526

Machine's predictive boundary cannot be overlooked. The hypersensitivity of the dopaminergic reward system means that the immediate, variable reinforcements provided by digital platforms effectively hijack the brain's natural reward processing pathways. Task-based functional magnetic resonance imaging studies have demonstrated that individuals exhibiting excessive digital usage present measurable anomalies in neural reward circuitries, confirming a biological predisposition toward technological addictions (Arató et al., 2023). Users systematically deploy the internet to chase these micro-rewards, utilizing the platform for profound escapism to avoid confronting real-world stressors (Yildirim Demirdöğen et al., 2024). The predictive utility of these four constructs combined—analyzed through a non-linear algorithmic lens—highlights the necessity of viewing problematic internet use not as a singular behavioral failing, but as a complex syndrome driven by overlapping emotional, cognitive, and neurobiological vulnerabilities. The successful application of machine learning in this context emphasizes the need for advanced computational methodologies to unpack the high-dimensional etiology of this modern epidemic (Laconi et al., 2022; Tian et al., 2025; Varchetta et al., 2024).

5. Conclusion

In conclusion, the present study demonstrates the profound efficacy of Support Vector Machine models in predicting the complex, non-linear psychological pathways that drive Problematic Internet Use. By identifying emotion dysregulation and impulsivity as the most critical predictors, followed by loneliness and reward-system reactivity, the findings reframe internet addiction fundamentally as a maladaptive coping mechanism for underlying emotional distress and impulse-control deficits. The superior predictive performance of the non-linear algorithms, achieving an accuracy of 82.5%, emphasizes that pathological digital consumption is a multidimensional syndrome that cannot be adequately captured by simple linear models. Consequently, future clinical interventions and preventative strategies must pivot away from merely restricting online activity and instead prioritize holistic psychological treatments that enhance distress tolerance, foster real-world social connections, and build intrinsic emotional resilience.

6. Limitations & Suggestions

Despite the robust predictive findings generated by the Support Vector Machine models, several limitations of the current study must be acknowledged. First, the cross-sectional nature of the research design precludes any definitive causal inferences between the psychological predictors and problematic internet use. While the algorithms successfully predicted the severity of the behavior based on the input features, it is highly probable that the relationship is bidirectional, wherein excessive internet use subsequently worsens emotion dysregulation, heightens impulsivity, and deepens feelings of loneliness over time. Second, the reliance on self-report questionnaires introduces the potential for social desirability bias and common method variance, particularly when assessing sensitive psychological traits such as subjective isolation and loss of behavioral control. Participants may have unintentionally underreported the severity of their internet habits or their emotional difficulties. Finally, while the sample was adequately sized for machine learning applications, it was drawn from a specific geographic and cultural context in Argentina through convenience sampling. This limits the absolute generalizability of the optimal hyperparameter configurations and precise feature weights to populations with different cultural relationships to technology, mental health stigma, or digital infrastructure.

Future research should prioritize the implementation of longitudinal, prospective study designs to capture the dynamic, temporal evolution of problematic internet use and its psychological drivers. Tracking these variables over extended periods would allow researchers to determine whether spikes in emotion dysregulation or sudden shifts in social isolation precede the onset of pathological digital behaviors, thereby untangling the complex web of causality. Additionally, future investigations would benefit greatly from incorporating objective, passive data collection methods—such as screen-time tracking applications, digital phenotyping, or neuroimaging techniques—to complement self-report measures and provide a more accurate, holistic quantification of actual internet consumption and neurocognitive reactivity. There is also a pressing need to test these specific Support Vector Machine pipelines across broader, cross-cultural datasets. Training algorithms on diverse, multinational cohorts could help identify which psychological vulnerabilities are universal neurobiological constants in internet addiction, and which are highly context-dependent, socio-cultural variables. Exploring the inclusion of additional protective factors, such as psychological resilience or offline social support networks, into the predictive algorithms could also yield more comprehensive models of digital wellbeing.

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E-ISSN: 2981-2526

In terms of clinical and practical applications, the findings of this study strongly suggest that interventions aimed at reducing problematic internet use must move beyond simple screen-time restrictions and address the underlying psychological architecture of the individual. Therapeutic approaches, such as Dialectical Behavior Therapy or Cognitive Behavioral Therapy, should be prioritized to actively teach distress tolerance and healthy emotion regulation strategies, thereby eliminating the user's reliance on the internet as a digital pacifier. Educational institutions and community health organizations should implement screening programs that assess for high impulsivity and profound loneliness, identifying at-risk individuals before their digital consumption reaches pathological thresholds. By recognizing that internet addiction is fundamentally rooted in emotional and cognitive deficits, practitioners can design holistic, highly individualized treatment plans that foster real-world social connections, enhance impulse control, and build emotional resilience, ultimately empowering individuals to reclaim agency over their digital lives.

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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JAYPS Adolescent and Youth Psychological Studies
E-ISSN: 2981-2526