



Development and Application of a Real-time Reporting System for Adolescent Drug-Use Information: A Digital Protection Framework with Real-time Monitoring, Risk Early Warning, and Multi-dimensional Support

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Published Online:

08 December 2025

Article DOI:

<https://doi.org/10.55677/CRB/I12-02-CRB2025>

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ABSTRACT:

Objective: To construct and evaluate a digital monitoring and direct reporting system for youth drug abuse risk, so as to improve the efficiency of risk identification, optimize the intervention mechanism and promote the cross-departmental collaborative management.

Method: Based on principles of systems engineering and information security, we developed the Youth Poisoning Network Information Direct Reporting System V1.0. The system integrates six modules: dynamic monitoring, network filtering, psychological support, emergency assistance, early warning reporting, and parent-child communication. It utilizes big data and AI algorithms to conduct real-time screening and early warning of potential poisoning risks among adolescents.

Results: The system has implemented multi-dimensional data collection, behavioral trajectory analysis, and intelligent early warning functions. It automatically identifies and reports dangerous keywords, suspicious websites, psychological state changes, and emergency distress behaviors, significantly enhancing the visibility of poisoning risks and response speed. Additionally, modules for parent-child communication, psychological counseling, and cybersecurity education further strengthen collaborative intervention capabilities at both family and school levels.

Conclusion: This system provides a digital, process and intelligent solution for adolescent drug abuse risk monitoring, and has significant application value in risk screening, emergency response and psychological support. It has the potential to be an important technical support for adolescent self-harm prevention system.

KEY WORDS: Adolescents, Digital, Intervention, Prevention, Self-harm.

1. INTRODUCTION

Mental health issues among adolescents have garnered increasing societal attention, with substance abuse as a particularly urgent form of self-harm requiring immediate prevention and intervention. Traditional monitoring methods, constrained by time, space,

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and human resources, struggle to comprehensively track adolescents' daily activities, especially their online behaviors. To address this, our study leverages digital technologies by collecting and analyzing online behavioral data to identify potential drug abuse risks, enabling early detection and intervention to effectively disrupt self-harm pathways (Hollis et al., 2017). System V1.0 integrates advanced technologies like big data analytics and natural language processing, ensuring accurate and timely risk identification while establishing a robust digital defense for adolescent mental health (Kessler et al., 2017). The system not only monitors direct online expressions but also examines indirect behavioral patterns, such as search history, social interaction frequency, and content to detect subtle indicators of drug abuse tendencies. Through sophisticated algorithmic models, it identifies high-risk behavioral patterns, allowing precise identification of vulnerable individuals. With real-time updates and self-learning capabilities, the system continuously optimizes its risk assessment models as new data emerges, enhancing early warning sensitivity and specificity. This innovative solution offers new hope for adolescent mental health, potentially reducing tragedies caused by self-harm behaviors like substance abuse and promoting overall well-being among young people.

2. METHODS

2.1 System Architecture Design

This system is built on a modular architecture comprising three core components: the frontend presentation layer, backend database layer, and AI-powered risk analysis engine. The frontend handles user interaction and information display, while the backend database stores youth profiles, monitoring data, and system logs. The risk analysis engine performs critical functions including data computation, risk identification, and early warning generation. Within this framework, business modules such as the Software Control Center, Youth Profile Management, Dynamic Monitoring, Cybersecurity Education, Incident Reporting, and Emergency Assistance with Early Warning Push operate as independent units, interconnected through unified data interfaces. This three-tier architecture ensures operational stability and scalability, enabling efficient collaboration between data collection, real-time analysis, and visual presentation.

2.2 Data Collection Methods

The system's data collection operates on a multi-source integration principle, achieving comprehensive risk signal detection through real-time monitoring of adolescents' online and offline behaviors. Online behavioral data includes suspicious website access records, keyword searches, and browsing activities related to illegal content. Offline behaviors encompass location information, activity ranges, and trajectory changes, reflecting adolescents' daily movement patterns. Additionally, the system integrates personal profiles and interaction records from psychological counseling or parent-child communication modules to depict adolescents' risk status across multiple dimensions. For automated emergency scenarios, the system instantly records actions like SOS button activation and emergency contact activation. All data is transmitted via encrypted channels and strictly complies with regulations such as the "Protection of Minors Law" and "Cybersecurity Law" to ensure privacy and security.

2.3 Intelligent Analysis Method

This system employs multiple intelligent algorithms during risk identification to enhance accuracy and real-time performance. First, it constructs a dictionary of risk-related keywords based on internationally recognized text recognition methods in mental health research, conducting semantic screening of adolescents' online search content to identify expressions associated with risks like substance abuse and suicidal ideation. Second, unsupervised anomaly detection algorithms identify abrupt behavioral changes such as prolonged late-night internet use and abnormal trajectory shifts, which may indicate potential crises. The risk scoring model synthesizes key indicators including online behavior patterns, trajectory changes, and historical records to generate dynamic risk scores for each adolescent. Additionally, geographic trajectory deviation analysis detects abnormal movements, such as traveling to high-risk areas. The overall risk identification framework follows international suicide risk prediction research designs, ensuring the system's high clinical and public health applicability.

2.4 User and Permission Management

This system serves diverse user groups including education and health sector regulators, mental health service providers, parents/guardians, and school counselors. To ensure sensitive information security, the system employs a strict hierarchical access

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control mechanism, with different roles possessing access permissions aligned with their responsibilities. For example, regulatory authorities can view regional statistics and overall early warning information; mental health professionals can access individual profiles, real-time monitoring results, and risk assessments; parents can only view information related to their own teenagers, while school counselors have limited access to student psychological management data. Through this refined permission control system, the system not only facilitates cross-departmental collaboration but also ensures that adolescents' privacy is neither over-accessed nor misused.

3. RESULTS

3.1 Overall system operation

During the system trial phase, all modules demonstrated stable operation and sustained capability to receive and process data from multiple sources. The system maintained low latency even under high concurrency, with front-end interfaces responding swiftly and back-end servers delivering efficient processing. This indicates the architecture is well-suited for deployment in real-world educational and healthcare environments. The data flow process remains transparent, with the average time from data collection to analysis and dissemination of risk events staying within acceptable parameters.

3.2 Risk data collection performance

The system has successfully collected multidimensional network and behavioral data, including website visit records, search frequency of sensitive keywords, and activity trajectory offsets. In the test samples, over 90% of user data upload success rates demonstrate the collection mechanism's strong compatibility, capable of adapting to complex conditions across different devices and usage scenarios. Meanwhile, the SOS signal triggering and recording function performed reliably, providing critical data sources for identifying acute risks.

3.3 Smart Analysis Module Effect

The AI risk analysis module demonstrates high recognition accuracy. Keyword matching proves particularly effective in identifying emotional distress, self-harm tendencies, or risky behaviors. The anomaly detection model successfully captures behavioral patterns that deviate significantly from normal usage. Trajectory deviation analysis effectively identifies abnormal movement events during specific time periods. The risk scoring model generates stable risk levels based on multi-source data while maintaining strong risk differentiation capabilities, indicating well-calibrated parameters in the machine learning model.

3.4 Risk Warning and User Feedback

In terms of early warning notifications, the system automatically provides intervention recommendations based on risk levels, including immediate contact with guardians, initiating psychological counseling, and alerting to sleep abnormalities. Feedback from test users indicates that the warning messages demonstrate high accuracy and practicality. Most psychological counselors believe the system's behavioral pattern analysis helps identify students at potential high-risk states, while parents report that the system reminders have enhanced their awareness and understanding of teenagers' online behavior.

4. DISCUSSION

The adolescent online risk monitoring and early warning system developed in this study has demonstrated significant practical value through its integration of multi-source data analysis and dynamic identification capabilities. By utilizing a keyword risk dictionary, behavioral pattern anomaly detection, trajectory deviation analysis, and a comprehensive risk scoring model, the system enables real-time monitoring of adolescents' internet usage patterns, psychological risk indicators, and behavioral deviations, providing scientific evidence for early intervention mechanisms (Marie et al., 2025). Compared to traditional risk identification methods relying on manual observation or passive reporting, this system achieves breakthroughs in coverage scope, detection sensitivity, and timely intervention effectiveness, validating the advantages of digital monitoring in adolescent mental health management as previously highlighted (Wei & Mukherjee, 2021). The research findings indicate that multi-source data fusion is the core factor in improving risk identification accuracy. Particularly, the combined analysis of online behavioral characteristics and geographic trajectory deviations effectively compensates for misjudgments caused by single-source data,

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thereby creating a more comprehensive adolescent status profile (Xu et al., 2025). This discovery aligns with international explorations of digital behavioral characterization technologies, demonstrating that identifying psychological crises through behavioral data is highly feasible (Witt et al., 2021). Additionally, the introduction of an AI-powered risk analysis engine enables the system to automatically push intervention recommendations based on risk levels. This proactive mental health support model significantly reduces crisis response time and plays a crucial role in minimizing delayed interventions (Calvo et al., 2024). While the system demonstrates strong performance in risk identification, ethical challenges in social technology applications remain critical (Patchin et al., 2023). Our research reveals persistent concerns among guardians and mental health professionals regarding data collection, privacy protection, and system access boundaries, aligning with existing literature on ethical controversies surrounding digital monitoring systems. Future system development should therefore reinforce data minimization principles, establish transparent usage protocols, and integrate informed consent processes for adolescents and parents into routine management. Additionally, monitoring may lead to digital intervention fatigue and avoidance behaviors, necessitating measures to prevent psychological backlash from excessive technological intrusion (Wang et al., 2020). The study further highlights that implementing digital monitoring systems in educational and healthcare settings requires cross-departmental collaboration. For instance, mental health providers should establish communication channels with school counseling teams to ensure actionable intervention cycles after early warnings. Government agencies must account for regional resource disparities during system deployment to avoid technological gaps that could limit coverage of vulnerable populations (Campisi et al., 2022). Ultimately, the proposed monitoring system represents not merely a technical solution, but a structural innovation in adolescent mental health governance. It provides new theoretical foundations and practical pathways for building digital support systems with proactive identification, rapid response, and precise intervention capabilities.

5. CONCLUSION

This study developed and validated a comprehensive digital security and psychological risk monitoring system for adolescents. Through data collection, intelligent analysis, and multi-department collaboration, the system provides a feasible technical pathway for early identification, intervention, and protection against psychological crises. Research findings demonstrate that the system can integrate multiple dimensions including online behavior, geographic trajectories, historical records, and interaction data. By employing risk algorithms, it achieves efficient crisis detection and early warning alerts, transforming potential risks from passive rescue to proactive discovery. Practical testing revealed the system's excellent sensitivity and stability, enabling synchronized monitoring of online and offline risks for adolescents without increasing burdens on guardians or educational institutions. Additionally, the system provides psychological service providers with more precise case profiles, making interventions more targeted and timely. Although challenges such as ethical boundaries, privacy protection, and cross-institutional data coordination remain, this study demonstrates the practical value of technology in adolescent psychological risk governance and offers a reference framework for establishing a national digital mental health protection system. Future optimizations in algorithm transparency, privacy classification systems, and user-friendliness could potentially provide more universal and sustainable digital models for adolescent mental health promotion.

FUNDING

This work was supported by the Zhejiang Provincial Department of Medicine and Health project (No.2023KY899) and Wenzhou Municipal Science and Technology Bureau (No.Y20220099)

Consent FOR publication

Not applicable.

COMPETING interests

The authors declare no competing interests.

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