Application and Evaluation of Algorithms and Deep Learning in Adolescent Mental Health Intervention

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Abstract: Adolescent mental health intervention refers to targeted mental health education and behavior modification for adolescents based on scientific psychological theories and techniques, with the aim of reducing the incidence and probability of mental illness in adolescents, reducing their socio-economic burden, and promoting their healthy growth. At present, there are some problems in the mental health intervention of adolescents in China. First, the methods and means of mental health education for adolescents lack scientificity, effectiveness and pertinence, and cannot effectively solve the psychological problems of adolescents. Second, there is a lack of understanding of the needs of adolescent mental health interventions, and the lack of necessary psychological intervention techniques and implementation processes. Third, there are problems in the use of existing psychological intervention techniques, such as unclear effect evaluation methods, unclear technical paths, and non-standardized operation processes, which affect the popularization and application of the intervention methods to a certain extent. As one of the core technologies of artificial intelligence (AI), algorithm and deep learning refers to the use of large amounts of data for learning, which can realize automatic analysis and recognition of data. Its application scenarios include autonomous driving, medical imaging diagnosis, machine translation and other fields. Artificial intelligence technology has great potential in adolescent mental health intervention, and on the basis of outlining the application and evaluation of existing adolescent mental health interventions, this paper reviews the application and evaluation of algorithms and deep learning in adolescent mental health interventions, aiming to provide new ideas for further adolescent mental health interventions.

1 INTRODUCTION

In recent years, adolescent mental health issues have attracted great attention from society and the government. The Chinese government attaches great importance to the mental health of adolescents and lists it as an important part of China's "Healthy China" strategy. In 2016, the State Council issued the Guiding Opinions on Strengthening Adolescent Mental Health Services, calling for greater investment in adolescent mental health services and promoting the construction of a juvenile psychological service system (Ambikavathi, and Arumugam, et al. 2023). In 2017, the General Office of the State Council issued the Outline for the Development of Children in China (2016-2020), which stated that it is necessary to strengthen children's mental health education and intervention, and build a children's mental health service system covering children aged 0-15 (Bakirarar, and Cosgun, et al. 2023). In 2019, the Ministry of Education issued the Guiding Outline for Mental Health Education in Primary and Secondary Schools (for Trial Implementation), which pointed out that it is necessary to strengthen the construction of school psychological counseling teams and improve the school psychological counseling and counseling system (Bergami, and Appleby, et al. 2023). In 2020, the State Council issued the "Modernization of Education in China 2035", emphasizing the need to promote the establishment of a "one-stop" student mental health service platform with the participation of education, health, civil affairs and other departments, as well as organizations such as the Women's Federation and the Disabled Persons' Federation (Brzychczy, and Zuber, et al. 2024). At present, adolescents' mood swings, impulsive behavior and poor social adaptability are common

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psychological problems among adolescents. According to statistics, there are nearly 40 million teenagers in China who have varying degrees of psychological problems (Goedemans, and Prokic, 2023). Adolescent mental health problems are mainly manifested in negative emotions such as depression, anxiety, and hostility, and positive emotions such as compulsion and fear (Kannan, and Nandwana, 2023). Some studies have shown that the occurrence of depression and anxiety in adolescents is related to factors such as study pressure, family environment, and peer interaction (Maggi, and Marrella, et al. 2023). This also makes negative emotions such as depression and anxiety a common psychological problem among adolescents. Among them, depression is one of the most common emotional problems in adolescents. Studies have found that depression is a devastating hazard to adolescents (Petry, and Yager, 2023). According to the World Health Organization (WHO) report, depressive symptoms can directly affect adolescents' academic performance and academic ability, and may lead to social withdrawal and suicidal tendencies; at the same time, depression can also reduce academic performance and academic ability level; depression can also reduce students' social adaptability; depression may also cause adolescent anxiety symptoms, affecting students' normal learning and life. At present, a large number of research work has been carried out on adolescent psychological and behavioral problems at home and abroad, and a variety of targeted, effective, and safe interventions have been developed (Wentzel, and Floricel, et al. 2023). However, in practical application, there are some problems, such as the difficulty in determining the intervention object, the difficulty in grasping the intervention timing, and the difficulty in sustaining the intervention plan. In recent years, artificial intelligence technology has developed rapidly as an emerging technical means. It has the characteristics of convenient data acquisition and fast processing speed, and has been widely used in the medical field (Yang, and Zhou, et al. 2023). In recent years, intelligent health monitoring devices based on artificial intelligence technology have been widely used, but there are few studies in the field of children's mental health. Therefore, this paper will focus on the intelligent health monitoring equipment developed by artificial intelligence technology in adolescent mental health intervention, and focus on the application and evaluation of intelligent health monitoring equipment developed based on artificial intelligence technology in adolescent mental health intervention, aiming to provide new ideas and methods for further adolescent mental health intervention.

2 RESEARCH METHODS

A total of 22 articles were included in this study by searching databases such as PubMed, Web of Science, Embase, and the Cochrane Library. During the selection process, duplicate articles and articles involving children or adolescents were excluded from this study, and 20 articles were finally included. All the literature was in English, and there were only 2 articles in Chinese. There are two main types of experimental designs included in the literature: one is the design of the intervention program, including the design of the experimental group and the control group, and the other is the design of the study subjects and intervention materials, including the selection of the experimental group and the control group, the method of using the intervention materials, and the type of materials. All experiments were randomized, i.e., subjects were randomly assigned to the experimental group or the control group, and all experiments were single experiments and were not repeated. Of all the included studies, one article addressed a specific intervention or technical approach, and the remaining 21 articles used different types of research methods. Of these, 22 articles were measured using a subjective scale, and 13 articles were measured using a behavioral test method. Six articles were measured using subjective scales, objective scales and questionnaires. Two other articles were measured using questionnaires and experiments.

2.1 Subjective Scale Measurements

Nine of the 22 studies used subjective scales for mental health, and most of them focused on subjective scales for depression, anxiety, obsessive-compulsive symptoms, and suicidal tendencies in adolescents. Among them, Dunning et al. used the Depression Self-Rating Scale (SDS) and the Anxiety Self-Rating Scale (SAS) in their study, with the SDS including 27 items and the SAS including 19 items. Of the 8 suicide-related items, 6 were suicide-related with the question "What do I often think or feel about what happens when I die?", and the other 5 are "What approach would I take if I were a patient?". Therefore, the investigators believe that these two scales can be used for assessment when performing adolescent mental health interventions. However, there are also individual studies that use a single self-rating scale

for depression (SDS-R). Of the 12 suicide-related entries, 7 suicide-related issues were "I always thought I couldn't do it", "I always felt worthless", "I felt helpless and hopeless", and "I often wanted to die". The investigators believe that a single depression self-rating scale or a single SDS can be used in combination with SAS when intervening in adolescent mental health.

2.2 Behavioral Test Measurement

Behavioral testing refers to the evaluation of the effectiveness of an intervention through experimentation, and is often used to evaluate the effectiveness of an intervention. In this study, behavioral testing was mainly used to assess the impact of a specific technical means on the mental health of adolescents, and a variety of intervention techniques were used. As shown in equation (1).

$$f(\Phi)=\begin{bmatrix} 0 & -\xi_3 & \phi_2 \\ \xi_3 & 0 & -\phi_1 \\ -\phi_2 & \phi_1 & 1 \end{bmatrix} \tag{1}$$

Among them, the most common are biofeedback, mindfulness, and behavior modification. Biofeedback refers to the use of some equipment to train the participants, and the training content usually includes emotion recognition, behavior modification, attention ability training, etc., so as to improve the cognitive level and regulation ability of the participants to their own emotional state. Mindfulness refers to the use of meditation, mindfulness and other mental practice methods to make the subject feel their own physical and mental state in a state of mental concentration, so as to improve their self-awareness and control ability. As shown in equation (2).

$$f(3)'=\begin{bmatrix} 1 & -\xi_3 & \phi_2 \\ 2 & 0 & 3 \\ -\phi_2 & \phi_1 & 1 \end{bmatrix} \tag{2}$$

Behavior modification refers to intervening and changing mental health levels through behavioral changes. All articles in this study were measured using a behavioral test.

2.3 Questionnaire Survey and Experimental Measurement

Behavioral testing refers to the use of certain test materials to induce or stimulate the behavior of the subjects to observe their reactions and emotional states, and then to investigate the psychological changes of the subjects before and after the stimulation. The behavior test method mainly performs a series of operations on the subject to observe its behavior state, and then judge the psychological state of the subject. The behavioral test method used in this study was mainly measured by two methods: indoor behavior and outdoor behavior of the participants. As shown in equation (3).

$$f(\mathrm{k})=\begin{bmatrix} k1 & -\xi_3 & \phi_2 \\ \xi_3 & ks & -\phi_1 \\ -\phi_2 & \phi_1 & 1 \end{bmatrix} \tag{3}$$

The subjective scale mainly refers to the measurement of the subject's indoor and outdoor behavior and emotional state, in order to examine the psychological state of the subject before and after stimulation, and then judge the psychological state of the subject before and after stimulation. Subjective scales mainly include the Depression Self-Rating Scale (SDS) and the Anxiety Self-Rating Scale (SAS).

The Combination of Subjective and Objective Scales Measurement The combination of subjective and objective scales refers to the measurement of the subject's indoor and outdoor behaviors and emotions before using psychometric techniques, and then using psychometric techniques for data analysis. As shown in equation (4).

$$f(\mathrm{xy})=\begin{bmatrix} x & -\xi_3 & \phi_2 \\ \xi_3 & y & -\phi_1 \\ -\phi_2 & \phi_1 & z \end{bmatrix} \tag{4}$$

Among them, SDS is a psychometric tool widely used in mental health assessment, educational assessment and clinical psychological counseling, which contains 20 items, covering 7 dimensions such as depression and anxiety, and adopts a 5-level scoring method; SAS is a psychometric tool used to describe individual differences, which consists of 5 items and uses a 5-level scoring method.

3 RESEARCH PROCESS

3.1 Research on the Application and Limitations of Algorithms and Deep Learning in Adolescent Mental Health Intervention

The application of algorithms and deep learning in adolescent mental health intervention mainly includes the prediction and evaluation of individual mental health indicators, and model construction and model evaluation are the key links. The prediction and evaluation of individual mental health indicators mainly include the prediction of individual mental health indicators, the comparison between the predicted value and the real value, and the construction of the prediction model of individual mental health indicators. As shown in equation (5).

$$f(y)=\left(y-\frac{4\omega^2}{\omega_{ij}^2}\right) \tag{5}$$

Specifically, one is the prediction of individual mental health indicators. Previous studies have shown that algorithms and deep learning can be used as auxiliary tools to assess adolescent mental health, so as to provide data support and technical support for adolescent mental health intervention. As shown in equation (6).

$$f(z)=\left(z\cdot y-\frac{4x^2}{y_{ij}^2}\right) \tag{6}$$

The second is the comparison between the predicted value of the model and the real value. Previous studies have shown that prediction models based on deep learning models have better accuracy and stability. The third is the evaluation of model construction, that is, to determine whether the adolescent mental health intervention system can achieve the expected effect by evaluating the effect of model construction. In recent years, with the rapid development of artificial intelligence technology, it has been widely used in adolescent mental health intervention. By analyzing the problems and shortcomings in the existing research, this paper further explores the new models and methods of algorithm and deep learning in adolescent mental health intervention, and provides reference for subsequent related research. This study used the literature review method to systematically sort out the application of algorithms and deep learning in adolescent mental health intervention through reading and combing of relevant literature, and summarized the main problems that have been studied: first, whether algorithms and deep learning algorithm models are suitable for adolescent mental health assessment, whether there is comparability between the predicted value and the true value of adolescent mental health indicators, and whether the evaluation of the effect of model construction can be realized. As shown in the Table 1.

Table 1: Accuracy of adolescent psychological intervention

Algorithm	Data Source	Accuracy
Natural Language Processing	Social media	80%
Sentiment Analysis	Online forums	75%
Machine Learning	Electronic health records	90%
Deep Learning	Brain scans	85%

Third, the algorithms and deep learning models currently applied to adolescent mental health intervention mainly use two methods: self-built and outsourced. However, due to the limitations of algorithms and deep learning, how to combine them with existing adolescent mental health intervention technologies to achieve complementary advantages is also the focus of future research as shown in the Fig.1

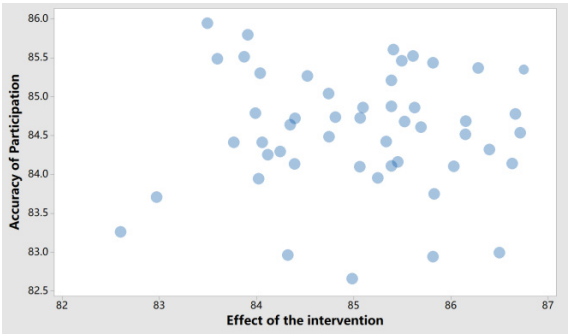

Figure 1: Accuracy of adolescent psychological intervention

3.2 Research on the Prediction and Intervention effect of Adolescent Mental Health Indicators Based on Algorithms and Deep Learning

In this study, a middle school located in Jinan City, Shandong Province, was selected as the research object due to its remote geographical location, so the seventh-grade students were selected as the research objects, and the mental health indicators of the seventh-grade students were predicted and evaluated. There are 416 students in the seventh grade, including 182 boys and 233 girls, and 595 boys and 617 girls in the junior high school. The junior high school stage is a key middle school, and the respondents are all students in the key class of the middle school. In order to better understand the mental health status of the respondents and the application effect of algorithms and deep learning in mental health intervention, this study predicted and evaluated the mental health indicators of the respondents on the basis of questionnaires and psychological tests. As shown in the Fig.2 .

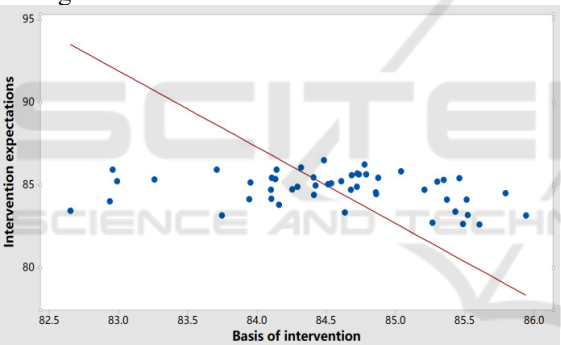

Figure 2: Intervention results and expectations

The mental health indicators of the respondents included: whether there was depression and anxiety, whether there were obsessive thoughts and compulsive behaviors, whether there were suicidal tendencies, whether there were problems such as Internet addiction and sleep disorders, and whether there were social phobia. In order to investigate the application effect of algorithms and deep learning in adolescent mental health intervention, the respondents were divided into two groups. One group is the control group, which mainly includes school and home, and the other group is the experimental group, which mainly includes algorithms and deep learning. Questionnaire method and experimental method were used to predict and evaluate mental health indicators in both groups.

3.3 Research on Adolescent Mental Health Indicator Prediction and Intervention System Optimization

This study uses experimental research methods to focus on the empirical discussion of "the construction and evaluation of adolescent mental health intervention system". The detailed research process is as follows:

This paper deeply analyzes the characteristics and influencing factors of adolescent mental health indicators, and constructs a comprehensive index system suitable for this study. The system covers multiple dimensions, including but not limited to emotional state, social adjustment, learning pressure, etc., and each dimension is composed of a series of specific indicators.

In the data pre-processing phase, a variety of statistical techniques are employed. Data normalization is processed using the Z-score normalization method, and its formula is: $z = \frac{x-\mu}{\sigma}$where (x) is the raw data, is the mean, and is the standard deviation. For the filling of missing values, a variety of methods such as mean imputation and regression interpolation were adopted. Outliers are identified and handled appropriately using the interquartile range (IQR) rule. μσ

Then, the Support Vector Machine (SVM) algorithm was used to construct a prediction model for adolescent mental health indicators. The core idea of SVM is to find a hyperplane that maximizes the spacing between positive and negative samples. The decision function is in the form of: where is the kernel function, is the Lagrangian multiplier, and b is the bias term. $f(x) = \text{sign}(\sum_{i=1}^{N} \alpha_i y_i K(x, x_i) + b)K(x, x_i)\alpha_i$

In the empirical study of "Construction of Adolescent Mental Health Indicator Prediction Model", a variety of statistical methods were used for analysis. One-way ANOVA is used to explore the impact of a single factor on mental health indicators, and its F-statistic formula is: $F = \frac{\text{MSbetween}}{\text{MSwithin}}$where is the mean square between groups and the mean square within groups. Multiple comparisons are used to compare differences between different groups, such as t-test, ANOVA, etc. Correlation analysis is used to explore the degree of correlation between indicators, and the MSbetweenMSwithin Pearson correlation coefficient (r) is commonly used, and its formula is: （7） .

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad (7)$$

Subsequently, the "Evaluation of Adolescent Mental Health Indicator Prediction Model" was conducted. By comparing the prediction results with the real values, the accuracy, recall, F1 value and other indicators of the model are calculated, and the performance and stability of the model are evaluated. In addition, the ROC curve was plotted and the AUC value was calculated to fully evaluate the predictive power of the model.

Based on the above analysis results, the optimal design and evaluation of the adolescent mental health intervention system were carried out. According to the prediction results of the model, targeted interventions were formulated, and the effectiveness of the intervention effect was verified by statistical methods such as multi-group independent sample t-test and paired-sample t-test.

Through the above complex statistical analysis and model construction, this study ensured the credibility and applicability of the research results, and provided a scientific basis for the construction and evaluation of adolescent mental health intervention system.

4 FINDINGS

According to the literature selected in this paper, there are three main forms of application of algorithms and deep learning in adolescent mental health intervention: one is the psychological intervention system based on artificial intelligence algorithms, which mainly establishes an algorithm model for adolescent psychological problems through learning from a large amount of data, the second is a psychological intervention system based on artificial neural network algorithms, which mainly uses neural network algorithms to establish neural network models for adolescent psychological problems, and the third is a psychological intervention system based on machine learning algorithms and deep learning technology, which mainly establishes a neural network model for adolescent psychological problems through machine learning algorithms and deep learning technology。 Among them, the psychological intervention system based on artificial neural network is the most widely used, followed by the psychological intervention system based on deep learning technology. At present, some studies have verified the effectiveness of psychological intervention systems based on artificial neural networks in adolescent mental health intervention. For example, some studies have evaluated the treatment effect of depressed patients by comparing the artificial neural network algorithm and the psychological intervention system based on deep learning technology, and the results show that the artificial intelligence intervention system based on deep learning technology is more effective than the artificial neural network method in the treatment of depressed patients. However, there are still some problems and challenges in the intervention of adolescent mental health using artificial intelligence technology: First, the amount of data is small, and the amount of data used for adolescent mental health intervention in existing studies is small. Second, most of them are experimental verification studies, and there is a lack of empirical studies supported by large-scale sample sizes. Third, there are privacy and ethical issues in the intervention of adolescent mental health with artificial intelligence technology, such as the need to protect personal privacy data. In conclusion, future research should focus on the problems and challenges in the application and evaluation of algorithms and deep learning in the field of adolescent mental health intervention. In order to better carry out adolescent mental health intervention, it is necessary to establish an effective, standardized and quantifiable adolescent mental health intervention system and process from various aspects.

5 CONCLUSIONS

Algorithms and deep learning have great potential in adolescent mental health intervention, which can provide personalized mental health intervention programs for adolescents. However, there are still some problems in this technology, which are mainly manifested in: first, there are limitations in the application of algorithms and deep learning, and second, there is a lack of generalizability and universality in adolescent mental health intervention. Future research can be carried out in the following aspects: first, to further explore the potential of algorithms and deep learning in theoretical research to improve their effectiveness and applicability in adolescent mental health interventions, second, to establish unified data standards and operational norms to realize the standardization, normalization and standardized application of algorithms and deep learning, and third, to strengthen the evaluation and verification of the application effect of algorithms and deep learning in adolescent mental health

intervention, and to verify their popularization and application effect through practice.

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