

Development of a Risk Warning Indicator System for Depression in Children and Adolescents

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ABSTRACT:

The objective of the study was to create a risk warning indicator system specifically aimed at detecting depression in children and adolescents, facilitating early and precise identification. To establish a preliminary framework for these indicators, the researchers conducted a comprehensive literature review and engaged in expert meetings. The Delphi method was utilized over two rounds of consultations, which helped screen and enhance the proposed indicators. The research team engaged in multiple discussions to refine the outcomes of these consultations, eventually identifying crucial warning indicators. The study evaluated the developed indicators on a cohort of 386 outpatient children and adolescents diagnosed with depression to assess their reliability. Expert response rates in both Delphi rounds were recorded at 100%, with authority coefficients measuring 0.808 and 0.868, respectively. Furthermore, Kendall's coefficient of concordance for the two rounds indicated values of 0.131 and 0.142, both statistically significant ($P < 0.001$). The finalized risk warning indicator system included five primary indicators and 38 secondary indicators, meeting stringent criteria for effectiveness: a mean importance rating exceeding 3.5, a coefficient of variation below 0.25, and a full-score ratio above 20%. Notably, the content validity index (CVI) for individual items ranged from 0.881 to 1.000, yielding an average CVI of 0.995, while the universal agreement CVI stood at 0.832. The overall reliability of the indicators was substantiated by a KR-20 coefficient of 0.811 and a split-half reliability coefficient of 0.745. In conclusion, the risk warning indicator system developed in this research exhibits robust scientific validity, practicality, and innovative potential, making it a valuable tool for clinical application and broader dissemination in the field of

pediatric mental health.

Keywords: Children; Adolescents; Depression; Risk Warning; Indicator Development.

1. Introduction

The prevalence of psychological crises among children and teenagers has attracted a lot of attention in society in recent years. The 2023 China National Mental Health Development Report (2021–2022) [1] states that children and adolescents had the lowest mental health literacy rate of any group assessed, at only 6.4%. One of the most prevalent and detrimental psychiatric diseases in childhood and adolescence, depression is becoming more widespread as people mature. [2] Preventing depression requires accurate risk factor identification. [3–4] Therefore, it is essential to create a practical and scientific risk warning signal system for depression in children and adolescents in order to reduce the risk of suicide and self-harm as well as to diagnose and treat depression early. This is consistent with China's mental health policies [5], which place a strong emphasis on the early detection of depression-risk groups and the use of efficient preventative and therapeutic measures. While considerable research has been done elsewhere on risk warning indications for depression in children and adolescents, [6–8] cultural context and social beliefs restrict the relevance of these results in China. At the moment, domestic research on this subject is still in its infancy [4, 9], with the majority of studies concentrating on specific risk variables and lacking a holistic viewpoint. The linguistic, emotional, and behavioural patterns of children and adolescents with depression are methodically integrated in this research, and the assessment framework takes into account stressful situations, individual medical histories, and genetic backgrounds that are strongly associated with the aetiology of depression. The research offers useful tools for clinical healthcare providers, parents, and educators by converting abstract and complicated psychological symptoms and signals into distinct, visible, and evaluable danger warning indicators. Additionally, it provides patients with self-assessment techniques that allow for more accurate detection of depression risks.

2. Methodology

1.1 Formulating Risk Warning Indicators for Depression in Children and Adolescents

1.1.1 Establishing the Research Team

This study was approved by the ethics committee of this hospital (Ethics Approval Number: 2023-206). The research team consisted of 8 members with expertise in psychology, health management, education, and statistics, including 1 Ph.D., 1 Master's degree holder, and 6 Bachelor's degree holders. The academic ranks included 4 senior professionals, 3 associate senior professionals, and 1 mid-level professional. The team was divided into a design group and an execution group. The design group was responsible for designing the research protocol, selecting consulting experts, and reviewing research tools. The execution group was responsible for literature review, tool development, data collection, and data analysis.

1.1.2 Literature Review

Literature searches were conducted using databases such as CNKI, Wanfang, VIP, PubMed, Science Direct, and Springer Link, covering publications from 2016 to 2024. The search terms in Chinese included “Depression,” “Depressive disorders,” “Children,” “Adolescents,” “Early warning indicators,” and “Risk factors,” while the English search terms included “depression,” “depressive disorders,” “children,” “adolescents,” “early warning indicators,” and “risk factors.”

Inclusion criteria:

① Chinese literature included in core journals from 2016 to 2024, such as those indexed in the Chinese Science Citation Database (CSCD), Chinese Social Sciences Citation Index (CSSCI), Chinese Scientific and Technical Papers and Citations Database (CSTPCD), and the Peking University Core Journals Catalog.

② English literature included in core journals from 2016 to 2024, such as those indexed in the Science Citation Index (SCI) and Social Sciences Citation Index (SSCI).

Exclusion criteria:

- ① Full text unavailable.
- ② Studies with low-quality evaluation ratings.
- ③ Duplicate publications or direct translations.

After screening, 17 studies [2-18] were ultimately included as the theoretical foundation for this research. Based on the patterns of risk factors for depression in children and adolescents presented in the literature, a preliminary pool of risk warning indicators was formulated.

1.1.3 Recent studies

It summarises the literature available on the epidemiology, etiology, and symptomatology of depression in pediatric populations, and a critical evaluation of currently available diagnostic models and early detection techniques [19], [20]. The increase in the rates of depression among the youth, especially females, will be given special attention to indicate the urgency of the need to improve the prevention and early intervention options [21]. This worldwide trend in child depression highlights the urgent necessity of systematic early identification strategies, particularly in the light of the fact that the existing screening tools are characterized by a certain degree of imprecision in the context of different population groups and are often limited in terms of the comprehensive, culturally-appropriate frameworks of specific demographic groups, such as the Chinese pediatric populations [22]. In particular, adolescent depression, which refers to a low mood persistently accompanied by a loss of interest in people aged 13-19, has become a major health issue across the globe, and has affected younger age groups more [23]. The insidious, frequently untenable nature of this condition in adolescents can be highly influential in terms of outcome in academic achievement, socialization, and long-term well-being, requiring sophisticated risk stratification instruments [24], [25]. Although

the importance of early identification has been acknowledged, much of the available literature has been retrospective studies on the risk factors involved, instead of the development of predictive statistical models to proactively identify high risk individuals with depression [26]. This gap underscores the need to have a sound system of risk warning indicators that incorporates a variety of data points to improve the accuracy and timeliness of depression risk assessment in children and adolescents [27]. This type of a system would best utilize multimodal data streams, such as physiological, psychological, and environmental factors to detect pre-symptomatic signs and enable timely interventions [28].

1.1.4 Theoretical Frameworks of Depression in Youth

In order to provide adequate attention to this need, the ecological systems theory offers a comprehensive theoretical perspective through which to analyse the multifaceted interplay of macro-level sociocultural contexts, proximal environmental factors, and individual-level intrinsic characteristics that lead to the manifestation and development of adolescent depression [29]. This framework is especially relevant due to the fact that the prevalence of adolescent depression has increased significantly across the globe with the prevalence rate ranging between 10 and 20, which only exacerbates the situation [30]. In China, in particular, prevalence rates are between 15 percent and 25 percent across the different regions with very high rates of detection among primary school students than in several western countries [31], [32]. This data reflect the interdependence between family, individual, and school contexts and the mental health of adolescents within an ecological system framework [33]. Such an approach requires a multidimensional analysis, including individual characteristics, family dynamics, school climate, socio-cultural pressures, and media influence, to have a comprehensive understanding of factors causing depressive symptoms among junior high school students [34].

1.1.5 Risk Factors for Depression in Children and Adolescents

A powerful risk warning indicator system must hence be able to combine these various factors, going beyond the classic single factor analyses to adopt a more holistic, multifactorial approach similar to those that have been successfully used in the field of cardiovascular medicine in terms of composite risk scoring [35], [36]. Education level, sex, type of family, length of outdoor play, and sleep habits are some of the key influential factors that contribute to depressive symptoms in adolescents [37]. Furthermore, childhood adversity, family discord, bullying, and academic demands are noteworthy psychosocial stress factors that increase susceptibility to depression [38]. On the other hand, these risks can be reduced by protective factors that include positive parent-child relationships, a strong psychological resilience, strong school connectedness, quality friendships, and community support [39].

1.1.6 Protective Factors and Resilience

Moreover, a healthy family functioning, which is defined by flexibility and good relationships, has been repeatedly associated with a lower incidence of depressive symptoms among adolescents [40]. Interventions aimed at improving family functioning can thus be important preventative measures to the onset or continued occurrence of adolescent depression [41]. Moreover, regular observation of how adolescents perceive the family and school settings are also essential in early detection of depression as interventions that would help strengthen resilience in these environments can go a long way in helping to identify high-risk individuals [42]. In fact, being a support to the family is one of the significant protective factors against depressive symptoms in adolescence, as well as peer support [43]. This is also reinforced by the evidence that parental involvement and availability of close friendships are protective factors that help to buffer mental health issues in adolescents [44]. On the other hand, family history of depression, negative events like illness or the death of a family member, and physical or sexual abuse are the common risk factors that are identified [45]. The complex interaction of these

risk and protective factors highlights the need to have a subtle understanding of the additive and interactive role of these factors on the development of depression in youth [46]. This kind of thorough understanding is critical in terms of developing a predictive model that can effectively identify those who are at risk so as to be able to target interventions and resource allocation [47].

1.1.7 Existing Screening and Diagnostic Tools for Youth Depression

Although the existing screening and diagnostic tools are indeed important in identifying the presence of existing depression, there is still an urgent need of the development of more advanced predictive models that are capable of predicting the risk of depression even before the development of symptoms. This urgent necessity requires the creation of advanced predictive analytics that incorporate a wide range of longitudinal data, such as biomarkers, psychological testing, and environmental exposures, to detect subtle, early signs of vulnerability. A system like that would not only enhance early detection, but would also facilitate personalized prevention strategies, especially with at-risk children with genetic predispositions or negative childhood experiences [48]. The predictive, preventive, and personalized medicine is a paradigm that has better capabilities to predict and prevent the onset of depression during the adolescence phase, which outdoes the effectiveness of universal prevention programs [49]. Such advanced predictive models thus constitute a huge step forward in relation to the old-fashioned symptom-based screening in that, through the application of these advanced predictive models, the timing and effectiveness of interventions are maximized [50].

1.1.8 Overview of Early Warning Systems and Predictive Modeling in Healthcare

This method uses machine learning algorithms to detect complex patterns in large data sets, which allows one to accurately predict future health outcomes or illness onset [51]. Within the framework of adolescent depression, machine learning models have proven to be of significant utility in predicting depressive outcomes, having shown to be even more efficient than traditional

statistical models in identifying high-risk individuals [52], sometimes even surpassing traditional statistical tools in this regard [53]. As an example, it has been demonstrated that machine learning models can effectively predict the risk of depression among adolescents, by combining a variety of factors, including sleep disturbances, parental mental health burden, and family financial adversity [54]. In addition, predictive models based on smartphone data, which captures a digital phenotype of an individual, have shown promising results in predicting depressive symptoms with high accuracy [55]. This methodology, commonly referred to as digital phenotyping, uses passive sensing of mobile devices to collect data about behavior, which can be crucial to early intervention in mental health care of children [56], [57].

1.1.9 Technological Approaches in Mental Health Monitoring

The digital phenotyping, specifically, uses active and passive data collected on smartphones to predict the risks of mental health disorders in adolescents, and involves the use of advanced machine learning methods to enable the early detection and scalable intervention strategies in the community context [40], [59]. Such platforms may also include artificial intelligence to analyze usage patterns, sleep metrics, and physical activity, and thus provide real-time responses and precision prevention of mental health problems [60]. In addition, machine learning algorithms may be implemented to the passively collected data by mobile and wearable sensors to predict the level of depression and variation in depressive symptoms in adolescents, overcoming the disadvantages of traditional self-report items [61]. This facilitates the establishment of non-linear relationships among more than two variables, or features, to give a more subtle picture of the mental health trajectories [62]. These AI-based methods make it possible to combine different multimodal data streams, such as clinical data, behavioral patterns, social media usage, and physiological measurements, to develop robust predictive models of various psychiatric disorders [63].

1.1.10 Expert Meetings

Four senior psychologists (associate senior rank or above) from the hospital's department that specializes in child and adolescent depression were invited to collaborate with the research team on "Risk Warning Indicators for Depression in Children and Adolescents" in order to guarantee the study's professional quality. The research team produced a first draft of the danger warning signs by condensing and improving the conversation material. Language, behavior, emotions, physiology, stress events, medical and genetic history, interpersonal interactions, and social functioning were the seven core indicators in this draft, along with thirty minor indications.

1.2 Screening Risk Warning Indicators for Depression in Children and Adolescents

1.2.1 Drafting the Expert Consultation Questionnaire

The questionnaire consisted of four sections:

① Consultation Explanation: Purpose of the study, research methods, and instructions for completion.

② Expert Background Information: Includes expert's gender, age, education, title, position, research area, years of experience, department, email, and contact information.

③ Expert Self-Assessment Form: Experts rated their familiarity with the content and performed self-assessments based on four dimensions influencing their judgment: work experience, theoretical analysis, literature references, and intuitive judgment. Each dimension was weighted according to its influence: work experience (0.5, 0.4, 0.3), theoretical analysis (0.3, 0.2, 0.1), literature references (0.1, 0.1, 0.5), and intuitive judgment (0.1, 0.1, 0.05). Familiarity was rated on a 5-point scale: very familiar (1), familiar (0.8), somewhat familiar (0.6), less familiar (0.4), and unfamiliar (0.2).

④ Indicator Evaluation Table: Experts were asked to evaluate the scientific validity and appropriateness of each indicator, assess whether it belonged to its assigned category, and rate the importance of each indicator using a 5-point Likert scale (5 = very important, 4 = important, 3 =

moderately important, 2 = slightly important, 1 = not important). Each indicator included a comments section for expert input.

1.2.2 Selection of Experts for Consultation

Experts were selected based on their authority in the field and regional representation.

Inclusion criteria:

- ① Employed in a tertiary psychiatric hospital.
- ② Over 10 years of experience in the fields of child and adolescent psychiatry or psychology.
- ③ Bachelor's degree or higher.
- ④ Senior professional title.
- ⑤ Voluntary participation in the study.

Exclusion criteria:

- ① Experts who rated their familiarity as "less familiar" or "unfamiliar" in the self-assessment form.
- ② Experts who withdrew during the consultation process.

1.2.3 Implementation of Expert Consultation

Experts were given consultation questionnaires by the study team via email and WeChat, with a one-week deadline for completion. In this research, two rounds of expert consultation were carried out. The study team conducted two offline group talks based on input from the first round. The parameters of an average significance score >3.5 , a coefficient of variation <0.25 , and a full score ratio $>20\%$ were used to filter the indicators. [19] The indicators were updated and combined with the findings of the group discussion to create the second-round consultation questionnaire, which was then sent to the experts for further assessment.

1.2.4 Validation of Indicator Reliability and Validity

A form for evaluating content authenticity was created and used. To rate the items' relevance, seven experts who took part in the consultation were chosen at random. A score of 1 to 4 was assigned, signifying "very irrelevant" to "very relevant." These scores were used to determine

content validity. 386 patients between the ages of 11 and 18 who had been diagnosed with depression and were visiting the hospital's outpatient clinic between April and June 2024 were conveniently sampled for a more direct evaluation of the indicators' practical implementation. Patients who were unable to communicate verbally were assessed. To determine the indicators' dependability, a score of "yes" was given a value of 1, and a score of "no" was given a value of 0.

1.3 Evaluation Standards [65]

1.3.1 Expert Enthusiasm

Expert enthusiasm was measured by the expert enthusiasm coefficient, which reflects the level of interest in the study. This coefficient was represented by the questionnaire recovery rate. A recovery rate $>70\%$ was considered indicative of good enthusiasm. The expert enthusiasm coefficient was calculated as:

$$\text{Expert Enthusiasm Coefficient} = \frac{\text{Number of Recovered Questionnaires}}{\text{Number of Distributed Questionnaires}} \times 100\%$$

1.3.2 Expert Authority

The basis of the experts' judgments on indicators was represented by C_a , and their familiarity with the questions was represented by C_s . The authority coefficient C_r was calculated as:

$$C_r = \frac{C_a + C_s}{2}$$

Generally, $C_r \geq 0.7$ was considered indicative of good reliability.

1.3.3 Expert Opinion Coordination

Coordination of expert opinions was represented by the coefficient of variation (C_v) and the coordination coefficient (W). A C_v closer to 0 indicated less variation and higher coordination among expert opinions, with $C_v < 0.25$ being the threshold. W ($P < 0.05$) indicated consistent and credible expert opinions.

1.3.4 Content Validity and Reliability

Reliability: Higher reliability is indicated by numbers closer to 1 on the KR-20 scale, which

runs from 0 to 1. It needed a KR-20 ≥ 0.70 . A split-half dependability coefficient of at least 0.60 was necessary. Validity of Content: Each item's index has to be at least 0.78 according to the item-level content validity index (I-CVI). The average (S-CVI/Ave) of the scale-level content validity index, which represents the average I-CVI for all items, had to be at least 0.90. At least 80% of the items have to achieve the I-CVI criterion for the scale-level content validity index, universal agreement (S-CVI/UA).

1.4 Statistical Methods

The expert excitement coefficient, authority level, and coordination coefficient of the indicators were computed by data analysis using SPSS 26.0 software. Yaahp 0.3 software was used to calculate indicator weights and apply the analytic hierarchy process (AHP). The product approach was used to determine combined weights.

3. Results

2.1 General Information on Consulted Experts

Twenty experts from six provinces and municipalities (Jiangsu, Shandong, Shanghai, Hunan, Guangdong, and Beijing) were chosen as consultation participants using a convenience selection technique. These professionals have a great deal of expertise in child and adolescent psychiatry or psychology and were connected to eight elite mental institutions (Class III Grade A). With an average age of 48.47 ± 5.60 years and an average working experience of 27.71 ± 7.24 years, the panel included 12 clinical medical experts, 6 nursing management experts, and 2 clinical nursing experts. Two rounds of consultations were undertaken for this project. Ten experts seven medical experts and three nursing experts participated in the first round; six had senior professional titles, four had associate senior titles, and three had bachelor's degrees, six master's degrees, and one PhD. Ten more experts five in the medical field and five in nursing participated in the second round. Four of them had senior professional titles, six had associate senior titles, four had bachelor's degrees, and six had master's degrees.

2.2 Expert Enthusiasm, Authority, and Coordination of Opinions

Ten surveys were sent out in each of the two rounds, and all of them were returned within seven days, yielding a 100% effective response rate. Twelve experts in all (60%) offered recommendations. The first round's authority coefficient (Cr), judgment basis (Ca), and familiarity with questions (Cs) were Cr = 0.808, Ca = 0.868, and Cs = 0.7955; the second round's Cr = 0.868, Ca = 0.899, and Cs = 0.837. In every instance, the indicators' coefficient of variation (CV) was less than 0.25. For the two rounds, the coordination coefficients (W) were 0.142 ($\chi^2 = 363.077$, $P < 0.001$) and 0.131 ($\chi^2 = 371.893$, $P < 0.001$).

2.3 Reliability and Validity Testing

Data from 386 children and teenagers with depression diagnoses who used outpatient treatments between June and September 2024 were used for reliability testing. The split-half reliability value was 0.745 and the total KR-20 reliability coefficient was 0.811. According to content validity tests, the scale-level content validity index average (S-CVI/Ave) was 0.995, the scale-level content validity index universal agreement (S-CVI/UA) was 0.832, and the item-level content validity index (I-CVI) varied from 0.881 to 1.000.

2.4 Results of Round 1 Expert Consultation

Ten specialists in all offered their opinions. Among them, three experts suggested stressing controllable features in children's main surroundings (home and school) and concentrating on practical and relevant variables. Although genetic and historical history was recommended to be eliminated as uncontrolled elements, their significance to early warning indications justified their preservation. Following group discussion, demographic and socioeconomic variables were eliminated since they did not satisfy selection criterion [37] and were considered superfluous. Given that children with depression often vocally communicate physical suffering, two specialists suggested combining the major physiological signs with linguistic indicators. Following a debate in the group, this change was approved. Experts recommended the following

changes to indicator splitting, merging, and supplementation: splitting "devaluation of self-worth and self-blame or guilt" into two secondary indicators due to different emphases; combining "frequent complaints of physical discomfort" and "no organic physical disease found through medical examination but frequent complaints of discomfort"; adding the topic "what is the least painful way to die" under language indicators; supplementing "sleep disturbances and eating disorders" under behavioral indicators; and adding "body image anxiety" under stress indicators.

2.5 Results of Round 2 Expert Consultation

Four specialists in all offered their opinions. The following changes were implemented in conjunction with group discussions: The language indicator "frequently expressing inner distress and conveying suicidal tendencies uncontrollably" was divided into two distinct secondary indicators: "perceptual disturbances" and "inconsistencies between behavior and inner feelings" were added under behavioral indicators; "physical symptoms often accompanying low mood" was added under emotional indicators; and "environmental adaptation issues" was added under stress indicators. A comprehensive collection of early warning risk indicators for depression in children and adolescents, consisting of five major indicators and thirty-eight subsidiary indicators was produced after two rounds of Delphi expert consultations and several discussions by the following study team.

Comprehensive Screening Framework for Adolescent Depression Risk

This framework categorizes clinical indicators based on their weighted importance and observational frequency as identified in the source data [64].

I. Linguistic and Cognitive Indicators

These indicators reflect the internal cognitive state and verbalized distress of the adolescent.

- **Persistent Fatigue and Cognitive Decline:** Frequent complaints of general fatigue, decreased energy, and "slow

thinking" (e.g., "my mind feels blank") [64].

- **Expressions of Hopelessness:** Verbalizing a lack of life goals, motivation, or a sense of meaninglessness [64].
- **Diminished Self-Worth:** Continuous questioning or belittling of personal value and self-blaming behaviors (e.g., "I'm useless" or "I'm just trouble to others") [64].
- **Suicidal Ideation and Escapism:** Involuntary expressions regarding death-related topics, viewing life as "torture," or seeking methods of painless death [64].
- **Social-Verbal Withdrawal:** Responding with minimal "one-word" answers or remaining silent during social interactions [64].

II. Emotional and Affective Indicators

These observe the volatility and timing of emotional states.

- **Emotional Volatility:** Rapid transitions between extreme emotional states, such as moving from sadness to sudden anger or calm to intense anxiety [64].
- **Circadian Mood Variation:** A specific pattern of "morning depression" (waking up with low mood) followed by "evening relief" as the day progresses [64].
- **Affective Dysregulation:** Unprovoked or disproportionate crying or laughing, and high irritability over trivial matters [64].

III. Behavioral and Physiological Indicators

These are observable changes in daily functioning and physical health.

- **Nonsuicidal Self-Injury:** Behaviors occurring at least once a week, including cutting, biting, scratching, or overdosing [64].
- **Pattern Disruption:** Sudden loss of interest in activities previously enjoyed or significant performance decline in areas where the student previously excelled [64].

- **Psychomotor and Self-Care Changes:** Slowed movement and a visible decrease in the ability to perform basic daily tasks (washing, dressing, eating) [64].
- **Somatic Complaints:** Reports of physical pain (headaches, stomach pain, muscle tension) despite medical confirmation of no organic disease [64].
- **Abnormal Preparatory Behaviors:** Sudden organizing of personal belongings and the "gifting" of cherished items to friends or classmates (often a warning sign for suicidal intent) [64].
- **Physiological Distress:** Appearance of obsessive-compulsive symptoms, panic-related symptoms (shortness of breath, sweating, trembling), or perceptual disturbances like hallucinations [64].
- **IV. Social and Relational Stressors**

External factors that frequently trigger or exacerbate depressive symptoms

- **Social Avoidance:** Instinctive avoidance behaviors and a preference for solitude or staying in bed [64].
- **Interpersonal Trauma:** Experiences of bullying at school (physical, verbal, or relational) or significant romantic betrayal [64].

Quantitative Rating Summary

Based on the importance ratings provided in the source, the following indicators were weighted with high priority (Mean ≥ 4.80) [64]:

1. **Extreme Mood Swings** (4.94)
2. **Linguistic Expressions of Pain** (4.95)
3. **Suicidal Thoughts** (4.85)
4. **Persistent Fatigue** (4.89)

Note: This framework serves as an early warning system. Indicators appearing across multiple categories, particularly linguistic and behavioral markers of self-harm or hopelessness, require immediate professional intervention.

4. Discussion

3.1 The process of constructing risk warning indicators for depression in children and adolescents is scientific and reliable

Using two rounds of the Delphi method, this study first created an indicator system item pool based on a thorough review of the literature and expert meeting techniques. Twenty experts from eight tertiary specialized psychiatric hospitals spread across six Chinese provinces and cities were consulted. The professionalism and applicability of the indicator system were guaranteed by this procedure. Additionally, the study team continuously reviewed and updated the outcomes of the two consultation rounds, which increased the indicators' practical and scientific usefulness. The fact that all of the experts finished the questionnaires on time and that 70% of them offered specific recommendations shows how highly they consider this research. Furthermore, with Cr, Ca, and Cs values all at high levels, the experts' authority levels throughout the two consultation rounds were comparatively high. In terms of opinion coordination, the CV values for both rounds were ≤ 0.25 , showing that the experts' views were consistent. This was further supported by the significance test of the W value ($P < 0.001$). Additionally, this confirmed that the experts' opinions on each signal were reliable and consistent. Regarding content validity, the S-CVI/Ave value was 0.995, indicating high overall content validity of the indicators; the S-CVI/UA value was 0.832, indicating strong applicability of the indicators across various contexts; and the I-CVI values for each indicator ranged from 0.881 to 1.000, indicating high correlation among the items. This research used outpatient data from 386 instances of depression in children and adolescents to perform an empirical analysis on dependability. According to the findings, the indicators' aggregate KR-20 value was 0.811, suggesting a good degree of consistency in evaluating the patients' situations. Further supporting the stability and dependability of the indicators for kids and teenagers with depression was the split-half reliability value of 0.745.

3.2 Content and weight analysis of the indicator system

3.2.1 Language indicators

The indicators ranked first out of all the major indicators, with a weight of 0.347. Children with depression often have unique emotional tones and recognizable patterns in their verbal expressions, which are a crucial means of expressing emotions. [66] These language characteristics provide crucial hints for the illness's early identification. "Uncontrollably revealing suicidal ideation" ranked first in the language indicators and was a crucial component among the secondary indicators under this dimension, with a total weight of 0.084. Suicidal ideation is a crucial signal in the risk warning for depression and has been identified as a significant assessment indication prior to an individual's suicide [67]. As a result, parents and educators should be aware of whether children's linguistic expressions include assertions or indications of suicide intentions. This is the first line of defense in detecting and stopping suicide, in addition to being a duty. Furthermore, the secondary indicators "lack of life goals and motivation" and "frequent complaints of general fatigue" both had high combined weights (0.062). These complaints plainly portray depressed symptoms in children's bodily and psychological states, reflecting their condition of mental emptiness and physical tiredness. [66] This implies that in order to prevent postponing the children's condition, parents and educators should listen to the children's explanations of their physical and mental states throughout everyday contact, refrain from making subjective assessments based on personal experience, and react positively.

3.2.2 Emotional indicators

The indicators ranked second among main indicators with a weight of 0.251. Negative emotions are thought to be one of the early stress elements of depression onset, and emotions modulate the link between stress variables and suicide thoughts. [67] "Morning low, evening high" ranked highest among all secondary indicators under this dimension, with a total weight of 0.105. Patients with depression often experience this phenomena, which is marked by the lowest mood

when they wake up in the morning, a gradual improvement with daytime activities, and a noticeable sense of relaxation by evening [66]. Without a doubt, this distinctive pattern of emotional volatility is a defining characteristic of depression diagnosis. When parents see similar patterns of frequent emotional swings in their kids, they should take them seriously and get help right once. "Persistent emotional downturn" ranked second in this category with a total weight of 0.068. It is also one of the main signs of depression, which in extreme circumstances might result in suicide. [66] As a result, parents and educators should quickly implement tailored intervention strategies to assist children in building a strong emotional support network when they see different indicators of emotional decline.

3.2.3 Behavioral indicators

The indicators ranked third among key indicators with a weight of 0.190. Because an individual's exterior conduct closely reflects their internal emotional state, cognitive habits, and stress-reduction strategies, behavioral markers are crucial. [68] "Self-harming behavior" ranked highest among the secondary indications under this dimension, with a total weight of 0.035. Self-harming activity greatly raises the death risk from suicide and unintentional injuries and serves as a means for people to express extreme psychological suffering. [35] In order to lessen impulsive self-harm, parents who see their children engaging in self-harming activities should first settle their own emotions, enable their children to communicate their inner thoughts, and assist them in diverting their focus via talking and listening. [32] To guarantee that the children get an appropriate intervention, professional assistance should be sought in the meantime. "Sleep disturbances" ranked second among the behavioral indicators with a total weight of 0.032. An individual's physical and mental healths are closely linked to the quality of their sleep, and psychological issues like anxiety and depression are often linked to sleep disorders. [33] As a result, parents should monitor their kids' sleep patterns, spot any anomalies, and take proactive measures to address a variety of issues, including routines, the environment, nutrition, psychology, and their own parenting techniques.

3.2.4 Stress event indicators

The indicators ranked fourth among key indicators with a weight of 0.144. In this research, stress episodes were defined as occurring during the previous three months. [69] As external stressors, short-term stress episodes are more likely to have major detrimental effects on children's and teenagers' mental health and may even accurately predict the development of depression. [70] "Being criticized or punished" ranked highest among the secondary indications under this dimension, with a total weight of 0.031. Children and teenagers typically experience extreme irritation and feelings of humiliation when they get criticism and punishment, which may result in overreactions or even suicidal conduct. They also have better self-esteem but comparatively lesser psychological endurance. [36] This serves as a reminder to parents and educators to stress good counsel, avoid harsh criticism or light punishment, and concentrate on teaching strategies. Furthermore, the total weight of the secondary variable "experiencing school bullying" was 0.024. Research has verified [71, 72, 73] that school bullying raises the risk of emotional illnesses, self-harm, suicide, and criminal conduct in addition to having an impact on teenagers' academic performance. In order to prevent bullying and lessen the psychological and physical harm it does, parents and educators should educate kids and teenagers how to manage negative emotions and deal with bullying at school.

3.2.5 History and genetic history

The indicators ranked fifth among key indicators with a weight of 0.068. It is possible to identify children and adolescents who may be at risk of acquiring the illness by knowing their genetic background and history. "Direct relatives suffering from depression" ranked highest among the

secondary indicators under this dimension, with a total weight of 0.034. According to research, those with a family history of mental illnesses are more susceptible, have longer disease courses, anhedonia, and more noticeable anxiety symptoms, which persist even after taking medicine. In order to lessen their psychological strain and minimize their risk of sickness, children and adolescents who have close relatives who suffer from depression should be given extra attention. This may be achieved via a variety of strategies, including family support and psychological treatment. Furthermore, "history of suicide and self-harm, experiences of trauma and abuse" ranked second in the history and genetic history dimension with a total weight of 0.021. According to psychological studies, trauma, abuse, and a history of suicide or self-harm are significant factors in the emergence and progression of mental diseases, as well as in identifying high-risk situations [73]. More thorough intervention strategies are needed for these high-risk populations, such as offering expert psychiatric therapy, setting up efficient monitoring systems, and keeping an eye on their social and familial support networks.

5. Conclusion

This work developed a risk warning indicator system for depression in children and adolescents using scientific methods and carried out first practical validation. However, a certain amount of subjectivity was unavoidable throughout the development process, which may have resulted in the inadequate identification or exclusion of certain depression risk warning variables. Furthermore, these markers have not yet been widely used in clinical practice because of their brief development period. In order to improve the system's usefulness, future study will concentrate on further honing and improving these indications.

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Author Declaration

- Author declare that there is no conflict of interest.