**Assessing the heterogeneity of 27 Chinese scales for screening depression among children, adolescents, and young adults**

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# 1. Introduction

[儿童青少年抑郁障碍的严重性（患病率、社会成本等）]

Major depression, a highly prevalent mental disorder, imposes substantial personal, social, and economic burdens both in China (Fu and Zhang 2023) and globally (Herrman et al. 2022; McGrath et al. 2023). Adolescence is a critical period for the onset of depression: depression can occur as early as the age of 10 (Dattani, 2022), with a peak onset at 19.5 years (Solmi et al. 2022). Moreover, depression during the adolescence also accompanied with self-harm and suicide (Zeynep Başgöze et al. 2021), resulting in over 800,000 deaths annually among individuals aged 15-29 (Amaltinga and Mbinta 2020). The prevention and alleviation of depression are urgent issues in China (Ma et al. 2023) and globally (UNICEF China 2021).

While the effectiveness of interventions has garnered significant attention (Cuijpers, Stringaris, and Wolpert 2020), a more fundamental issue is often overlooked: how to *measure* the depression disorder (Fried, Flake, and Robinaugh 2022). The reported prevalence rates of depression differed signficantly when the measurements they used varied (Chen et al. 2022; Huang et al. 2022; Yu et al. 2022; Zhang et al. 2022). For example, employing a strict, clinical interview-based standard, Deng et al. (2023) found that the prevalence of major depression among Chinese children aged 6-16 years is approximately 2% to 3% (Deng et al., 2023; Li et al., 2022). In contrast, studies that used self-reported scales reported much higher prevalence rates: 14.6% among elementary school students, 23.6% to 24.2% among middle school students, and 28.0% among high school students (Chen, Zhang, and Yu., 2022; Huang, Zhang, and Yu 2022; Yu, Zhang, and Yu 2022; Zhang, Jin, and Yu 2022).

These findings underscore the importance of how depression is conceptualized, operationalized, and measured. The lack of clarity in measuring depression hinders the diagnosis and treatment of this mental disorder (Fried et al. 2022). Indeed, Fried (2017) analyzed the content of seven widely used depression scales, revealed a low overlap between scale in the symptoms, suggesting that different measurements of depression are measuring different things. In a separate study, Fried et al. (2015) investigated the number of unique symptom profiles reported by 3703 depressed outpatients and found that nearly half of the symptom were endorsed by only one individual, further highlighting the variability in diagnostic criteria in clinicals settings. Similarly, Veal et al. (2024) found that among 450 randomized controlled trials (RCTs) of unipolar and bipolar depression and identified 3888 different measures of outcomes. All these findings suggest it’s urgent to address the issue of measuring depression.

However, all previous studies focused on measuring depression among adults, few attentions have been paid to the measurement of depression among children and adolescent. Previous studies have shown that depression in children and adolescents are different from that of adults (Kułak-Bejda, Bejda, and Waszkiewicz 2022). To understand how depression is measured among children and adolescent, we conducted a comprehensive content analysis of 27 Chinese depression scales to assess their heterogeneity. Our findings revealed a low overlapping among these scales and call for attention to the measurement of depression of children and adolescent. Our results also provided a comprehensive list of symptoms used for screening depression among children and adolescent, laid a solid ground for further development of measurements. These results offered insights into the potential psychopathology and social pathways of depression in Chinese society (and, by extension, East Asian societies) and will inspire future development of scales for measuring depression in clinical settings and public health policies.

# 2. Methods

We took three steps to extract symptoms from all scales that measure depressions among the Chinese student’s population (see Fig 1 for the flowchart). Firstly, we identified all scales that has been used for screening depression. Secondly, we identified unique symptoms of each scale. Thirdly, we compared the symptoms across all scales. The latter two steps followed Fried (2017) with minor modifications (see details below).

## 2.1 Identify and screen scales

We identified scales that measure depression from four recent meta-analyses which synthesized the prevalence of different mental health problems among four Chinese students populations: elementary school, middle school, high school, and college (Chen et al. 2022; Huang et al. 2022; Yu et al. 2022; Zhang et al. 2022). We extracted all papers included in these meta-analyses and selected scales that were used for screening depression. In total, we identified 34 scales from 438 articles from all articles included in these four meta-analyses.

We then screened versions of scales and identified the most valid version for later analysis (See supplementary material for details). If a scale has multiple versions, we choose one of these version based on the following criteria: (1) If the reference(s) of the scale cited in articles was in English, we search for the Chinese versions because all participants in the above mentioned articles are Chinese students; (2) If the reference(s) of the scale included both English and Chinese versions of the scale, we included only the Chinese version; (3) If there were multiple Chinese versions and if the one(s) published later in time mythologically improved the previous ones, we choose the later version; (4) If there were multiple Chinese versions and no obvious methodological advances were reported, we choose the one explicitly stated symptom names; (5) If all other condition were equal, we selected the most frequently cited one. For instance, CES-D was first translated by Wang et al. (1999), which was used by 39 of all 438 papers included in the four menta-analyses. However, Zhang et al. (2010) improved the translation of the 20th item, thus, we chose the revised version by (Zhang et al. 2010).

## 2.2 Identify symptoms within scales

In this phase, four trained coders focused on identifying items that assessed identical or similar symptoms within each scale. The procedure was as follows: First, the four coders independently identified and consolidated items within each scale. Then, they formed two pairs, with each pair reviewing their results and resolving any discrepancies within the pair. Subsequently, the results from two pairs of coders were cross-checked and any remaining inconsistencies were discussed and resolve with the corresponding author when necessary. The final consolidated version of the results underwent independent verification by a clinically certified psychiatrist (Y. L).

## 2.3 Compare symptoms across different scales

In this step, the same four coders compared symptoms across all scales. The procedure was the same as the identification of symptoms within scales: independent individual coding, discussion by pairs, cross-checking between pairs, discussion with the corresponding author, and verification by a clinically certificated doctor.

The coding processes were as follow. We first pooled symptoms from all scales together and identified unique symptoms. In this step, we retained both compound symptoms and specific symptoms, as in Fried (2017). Compound symptoms are symptoms that include a range of related symptoms, whereas specific symptoms are more concrete and describe specific patterns. For example, “appetite changes” is a compound symptom, it includes two specific symptoms: “appetite increased” and “appetite decreased”, and all three of them were treated as unique symptoms. We employed an approach that maximize the number of different symptoms. More specifically, if the items describe similar symptom using different words and that the words have significantly different meanings under the Chinese context, we treat them as belonging to the same compound symptom but are different specific symptoms. For instance, there are many different words for describe depressed mood in different scales, we used 'depressed moods' as the compound symptom but distinguish different specific symptoms such as: 'blue', 'low mood', 'sad', and 'anhedonia'. This approach is slightly different from Fried (2017), where he coded all these item as a specific symptom 'Sad moods'.

Then, we assigned score of all scales on all unique symptoms. More specifically, a scale was scored as “0” on a symptom if it does not have items that measures this symptom. For instance, the Children's Depression Inventory (CDI) has no item for 'Depressed mood', we assigned “0” for CDI on this symptom. If a scale has an item that directly measures a symptom, compound or specific, it was coded as 2 on that symptom. Note if a scale has an item measures a compound symptom, then, this scale not only had a score of 2 on that compound symptom but also has a score of 1 on all specific symptoms of this compound symptom. For example, CDI has an item directly measures the compound symptom “appetite change” and scored 2 on this compound symptom. Importantly, even CDI does not have items for 'appetite increased' and 'appetite decreased', it scored 1 on these two specific symptoms (see Fig 2 and Supplementary Materials for details). However, if the item measures a specific symptom under a compound symptom, this scale was coded “2” on that specific symptom but still “0” on the corresponding compound symptom.

[Insert Fig 2 later]

**Figure 2***. Number of articles that used each scale for screening depression.* Total number of articles were based on those included in four meta-analyses (XXX). Scales with \* were excluded from our analyses.

## 2.4 Data analyses

We reported the descriptive summary of scales as well as the symptoms within scale. We highlighted symptoms that are used in DSM-5 for diagnosis of depression. More specifically, there are 28 symptoms are overlapped with the DSM-5 symptoms for depression, where were derived from the nine symptoms in DSM-5 and all their specific symptoms, see Fried et al. (2015) for details.

We used Jaccard index to quantify the degree of overlap between different scales (Fried, 2017). The formal of Jaccard index is s/(u1 + u2 + s), where "s" represents the number of items shared by two scales, and "u1" and "u2" denote the number of items that are exclusively present in each of the two scales. Jaccard index ranges from 0 (no overlap among scales) to 1 (complete overlap). We interpreted Jaccard index as in Fried (2017): very weak 0.00–0.19, weak 0.20–0.39, moderate 0.40–0.59, strong 0.60–0.79, and very strong 0.80–1.0. Moreover, we explored the relationship between the mean Jaccard coefficient, adjusted scale length and the number of captured symptoms (i.e., how many symptoms the scale captured) by employing Spearman correlation (see Supplementary Material 5 for more details).

[Insert Fig later]

**Figure 1**

*Research flowchart*

# 3 Result

# 3.1 A summary of scales

Among all papers included in these four meta-analyses (citations), 438 reported depressions. We identified 34 unique scales in these articles. Among all these scales, the items of four scales, the Mini International Neuropsychiatric Interview for children and adolescents (Mini-KID), WHO-CIDI 3.0, Psychological Health Inventory (PHI), and the Symptom Checklist 45, were not findable. The items of the other two scales, the Beck Depression Inventory (Zhang Yuxin Revised Edition) and Short Depression Scale, were not available either because of unidentifiable citations. These six scales were excluded from further analyses. The items used in 'Gu & Chen (2020) 'and 'Ji (2007)' were identical but in different languages, thus we regarded these two studies used the same scale referred them as 'Ji (2007)'. Also, the boys’ and girls’ version of the Child Behavior Checklist (CBCL) were treated as one scale. In total, 27 scales were included in the current study. See Fig 2 for the frequency of citations of these scales among all 438 empirical papers in the meta-analyses (Chen et al. 2022; Huang et al. 2022; Yu et al. 2022; Zhang et al. 2022). The seven most frequently used scales in this study are SDS, SCL-90, CES-D, CDI, DSRSC, BDI-I, and MSSMHS, among which, the CES-D and SDS are consistent with the scales selected by Fried (2017).

# 3.2 Items and symptoms within scales

For the 27 scales included, there are 425 items in total. Among them, 73 items were merged into 31 symptoms. Also, there were two cases where one item measured two symptoms. The item from Ji (2007), "During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing your usual activities?" measures both 'sad' and 'Sense of hopelessness'. And the 8th item from PHQ-9, "Actions or speech slowed down to a noticeable extent, or conversely—feeling restless or agitated, being unable to sit still, more than usual", measures both 'Agitation' and 'Retardation'. Thus, a total of 385 symptoms were identified across all 27 scales (See supplementary materials for number of items and symptoms of each included scale).

The comparison of 385 symptoms across 27 scales resulted in unique 84 symptoms (see Figure 3). Among these, eight are compound symptoms, including *Depressive mood, Irritability*, *Self-abasement*, *Interest/pleasure loss*, *Somatization*, *Appetite changes*, *Somnipathy*, and *Reduced socialization*. Among all 27 scales, 19 of them did not include any idiosyncratic symptoms. For the other eight scales the rate of idiosyncratic symptom varied from 3.9% to 22.2%. Interestingly, all scales include symptoms that were not covered in DSM-5. The DSI has the highest proportion of DSM-5 symptoms for depression, 71.42% of the total nine DSM-5 depression symptoms. Please see the supplementary matierals for detailed information.

[Insert Fig later]

**Figure 3***. Content Overlap Across* *Twenty-seven Depression Scales.* Each row represents a symptom, each column represents a scale.If a scale measures a symptom, then there is a dot or a circle on that row. The former represent compound symptoms and the latter represent specific symptoms. Symptoms in bold font are from DSM-5. ADI: Adolescent Depression Inventory, CDI: Children's Depression Inventory, HAMD: Hamilton Depression Rating Scale for Depression, DSI: Depression Status Inventory, SDS: Self- Rating Depression Scale, MFQ-C: Mood and Feelings Questionnaire, CBCL: Child Behavior Checklist, BDI-II：Beck Depression Inventory-II, DSRSC: Depression Self-rating Scale for Children, BDI-I: Beck Depression Inventory, KADS-11: Kutcher Adolescent Depression Scale, CES-D: The Center for Epidemiological Studies Depression Scale, PHQ-9: Patient Health Questionnaire-9 items, CSSDS: China Middle school students' depression scale, CES-D-C: Center for Epidemiologic Studies Depression Scale for Children, UPI: University Personality Inventory, SMFQ: Short Mood and Feelings Questionnaire, SCL-90: Symptom Checklist 90, CES-D-13: Short version of Center for Epidemiologic Studies Depression Scale, CCSMHS: Chinese College Student Mental Health Scale, DASS-21: The Depression Anxiety Stress Scale, BSRS-5: Brief Symptom Rating Scale, Sakuma\_2010: Sakuma et al.(2010) self-designed questionnaire, MSSMHS: Middle-school students Mental Health Scale, CEPS: China Education Panel Survey, HADS: Hospital Anxiety and Depression Scale, Ji\_2007: Comprehensive Survey Report on Health-Related/Risk Behaviors among Chinese Adolescents.The right side of the figure is *Number of symptoms that appear across combinations of scales.* There are 18 symptoms that appear only in one scale; these symptoms are referred to as idiosyncratic symptoms.

# 3.3 Symptoms across scales

Among the 84 symptoms, 18 (21.43%) were idiosyncratic symptoms and only appeared in one scale. None of the 84 symptoms were present in all scales. The most frequently presented symptom, appeared in 22 out of 27 scales, was *Sense of hopelessness*. The second most measured symptom, 18 out of 27, was *Interest loss*. Note that *markedly diminished interest or pleasure*, a key symptom of diagnosis of major depression in DSM-5, is splitted into two specific symptoms: *interest loss* and *pleasure loss* in this study*.* We found *Pleasure loss* was observed less frequently than *Interest loss*, being measured in 9 out of 27 scales. Another frequently measured symptom is the compound symptom *Depressed mood*, which was directly measured in 5 scales. However, this compound symptom includes several specific symptoms: *blue* appeared in 10 scales, *low mood* in 15 scales, *sad* in 13 scales, and *anhedonia* in 16 scales*.* Combined as a cluster, depressed mood and related specific symptom presented in 25 out of 27 scale and are the most frequently measured symptom.

The degree of overlap between scales was calculated using the Jaccard coefficient. The mean overlap across all scales was 0.19, range from 0.09 to 0.25, indicating a very low level of similarity between these scales (see Figure 5). CES-D has the highest mean degree of overlap with other scale. The highest overlap, 0.75, appeared between two versions of CES-D: CES-D for adults and CES-D-C for children. The second highest overlap, 0.72, was between DSI and SDS. Many scales that have no overlap with each other. For example, there was no overlap between China Education Panel Survey with Middle-school students Mental Health Scale, PHQ-9, CSSDS, SMFQ, CSSMHS. Note that because Ji\_2005 has only one item that measures two symptoms, it has no overlap with PHQ-9, KADS-11.

We found a correlation between the mean Jaccard coefficient of each scale and the scale length, *r* = 0.54, 95% CI [0.14, 0.78]. Similarly, the correlation between mean overlap of scales and the number of captured symptoms is *r* = 0.70, 95% CI [0.39, 0.87]. These findings suggests that longer scales exhibit increased overlap with other scales, thus demonstrating enhanced representativeness.

[Insert Fig later]

**Figure 5.** *Overlap of item content of 27 depression scales.* ADI: Adolescent Depression Inventory, CDI: Children's Depression Inventory, HAMD: Hamilton Depression Rating Scale for Depression, DSI: Depression Status Inventory, SDS: Self- Rating Depression Scale, MFQ-C: Mood and Feelings Questionnaire, CBCL: Child Behavior Checklist, BDI-II：Beck Depression Inventory-II, DSRSC: Depression Self-rating Scale for Children, BDI-I: Beck Depression Inventory, KADS-11: Kutcher Adolescent Depression Scale, CES-D: The Center for Epidemiological Studies Depression Scale, PHQ-9: Patient Health Questionnaire-9 items, CSSDS: China Middle school students' depression scale, CES-D-C: Center for Epidemiologic Studies Depression Scale for Children, UPI: University Personality Inventory, SMFQ: Short Mood and Feelings Questionnaire, SCL-90: Symptom Checklist 90, CES-D-13: Short version of Center for Epidemiologic Studies Depression Scale, CCSMHS: Chinese College Student Mental Health Scale, DASS-21: The Depression Anxiety Stress Scale, BSRS-5: Brief Symptom Rating Scale, Sakuma\_2010: Sakuma et al.(2010) self-designed questionnaire, MSSMHS: Middle-school students Mental Health Scale, CEPS: China Education Panel Survey, HADS: Hospital Anxiety and Depression Scale, Ji\_2007: Comprehensive Survey Report on Health-Related/Risk Behaviors among Chinese Adolescents. Mean overlap is detailed in the supplementary materials.

# 4 讨论

[第一段: 总结结果，并强调本研究的特色]

This study aimed at assessing the heterogeneity of Chinese scales that used for screening depression among children and adolescents. We identified 84 unique symptoms from 27 scales used in for screening depression from recent four meta-analyses (citations). We found a low overlap among scales: there was no single symptom appreared in all the scales and more than one fifth of the symptoms appreared in only one scale. Our results revealed greater heterogeneity than previous findings on the depression scales for adults (Fried, 2017), suggesting that depression among children and adolescents may have a varied pathological pathways and different depression scales are not interchangeable.

[第二段: 进一步介绍具体量表的结果，并与已有研究进行比较]

Our results revealed that CES-D has the highest mean overlap with other scales (0.25). This result differed from Fried (2017)’s finding that CES-D had the lowest mean overlap with other six scales (0.27). Also, we found that CES-D had no idiosyncratic symptoms, while in Fried (2017), CES-D displayed 33% of idiosyncratic symptoms. The primary reason for these differences lies in the fact that we included more scales. We also found that longer scales tend to have greater overlap with other scales, thus presenting more representative content (Fried 2017). For example, the single item measurement (i.e., Ji\_2005) had the lowest mean overlap (0.09) with other scales. Despite previous research suggesting that longer scales may negatively affect the quality of responses, their reliability, and response rate (Sharma 2022). However, excessively brief scales could result in a loss of substantial information.

The scales exhibit significant variations based on the categorization of symptoms according to the DSM-5. None of the scales captured all individual diagnostic criteria of the depression disorders in the DSM-5. Interestingly, the PHQ-9 was crafted based on the symptoms of DSM-5 (Kroenke, Spitzer, and Williams 2001). Yet, in our findings, it only captured 64.29% of all the DSM-5 symptoms, ranking it second highest. This is due to the Chinese version of the PHQ-9 scale containing significantly less information compared to the symptoms of DSM-5. For instance, the seventh symptom in DSM-5 is "feelings of worthlessness or inappropriate guilt," yet the corresponding scale item in the Chinese version of PHQ-9 is "feeling terrible about oneself, or feeling like a failure, or a disappointment to oneself or one's family," which does not carry the concept of guilt in the Chinese context.

[第三段: 分析异质性的原因，以及重新阐述问题的严重性]

The heterogeneity of depression scales may arise due to varied clinical perspectives on depression and the fact that scales are developed for different purposes (Fried 2017). In addition to this, it may also be influenced by certain cultural factors. In China, school education has a significant negative impact on the mental health of teenagers. In our findings, the depression scales MSSMHS, CSSDS, ADI and CCSMHS designed by Chinese researchers all include symptoms related to learning and school. The ADI and CCSMHS also include some idiosyncratic symptoms, which may reflect the unique insights of Chinese researchers into depression.

This heterogeneity in content can pose problems in certain situations, as these scales are often perceived as interchangeable (e.g., in meta-analyses). However, the reality is that different scales assess various aspects of depression, hence choosing a specific scale for a study could carry a significant risk of producing biased results. Therefore, it may not be prudent to combine research findings from different scales (for instance in meta-analyses), particularly those that have little overlap. In light of the fact that the results of large-scale surveys can even influence the formulation of policies (Ma et al. 2023), this problems becomes particularly crucial.

[第四段：如何解读结果，call for better standards]

We cannot simply assume that a low overlap equates to a poor-quality scale, or conversely, that a high overlap equates to a good quality scale. Low overlap merely implies that the results obtained from this type of scale are less likely to be extrapolated to other scales. Considering that scales may measure different intrinsic aspects of depression, it implies that users need to identify the structure they wish to examine before selecting a scale, and should not interchangeably use these measures or interpret them (Kook et al. 2022). When determining which scale to choose, consideration needs to be given to the evaluation objectives, psychometric properties, treatment settings and cultural considerations, administration and format, as well as performance characteristics such as specificity and sensitivity (Wall and Lee 2022). For Chinese researchers, even after deciding to use a specific scale, careful attention should be paid to the selection of translated versions. We recommend researching whether there is a more recent version that improves upon earlier editions. At present, there isn't any specific research evaluating which scales are suitable for depression. Given this situation, using multiple scales may enhance the robustness of the study (Fried 2017).

[第五段: 展望未来]

Limitations and Future Directions

Our study has some limitations. Despite being independently examined by different groups and ultimately validated by a psychiatrist to ensure the reliability of the results, content analysis is essentially subjective. We surmise that slight differences in results may occur if the study were to be redone by another research group. In the spirit of open science, we will make our coding public, allowing others to reanalyze this data. Another limitation of our study is that our meta-analytical dataset includes 27 scales. The inclusion of more scales would contribute to increased heterogeneity (Fried 2017). Similarly, the fact that some scales have fewer items may also increase heterogeneity. If the analysis is only limited to those scales that are used more frequently, the final average overlap might be slightly higher.

Based on our findings, we urge researchers and clinicians to be thoughtful in using and promoting the results generated from different depression scales, because what they measure might not be consistent. This study can serve as a reference for researchers who are interested in a particular symptom of depression. In future research, if we could evaluate the quality of these scales, it would provide great convenience for the practical application of Chinese researchers. Lastly, it is imperative for Chinese researchers to focus on the development of depression scales that are localized. A majority of the scales referred to in this study are translations from foreign sources with only a minimal contribution from Chinese researchers. It is only when Chinese researchers create these resources that there will be an increased likelihood of incorporating and measuring those issues that reflect specific Chinese characteristics.

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