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Original Article

A rapid screening test for depression in junior high school children

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Abstract

Background: Depression generates a remarkable disease burden. Early onset of depression in young people is associated with a poor prognosis. This has precipitated developing a screening instrument for early detection of depression in Taiwan adolescents.
Methods: We recruited 662 junior high school students who completed the Screening Test for Depression (STD) designed using diagnostic and statistical manual-IV diagnostic criteria of major depressive disorder for assessing depressive symptoms. The students were then interviewed by psychiatrists who used the Mini International Neuropsychiatric Interview-Kid to verify the validity of the soon-to-be-developed Rapid STD (RSTD). Multiple logistic regression analysis of the STD results was used to extract items for the RSTD.
Results: We extracted four items for the RSTD: "insomnia or hypersomnia", "recurrent thoughts of death or recurrent suicidal ideation", "feelings of worthlessness or excessive or inappropriate guilt", and "psychomotor agitation or retardation". Any two of the first three yielded the best-balanced algorithm for major depressive disorder, which had a sensitivity of 75.0%, specificity of 92.9%, positive predictive value of 28.6%, and negative predictive value of 99.0%. Any two of the four yielded the best-balanced algorithm for depressive disorders, which had a sensitivity of 71.4%, specificity of 92.0%, the positive predictive value of 33.3%, and the negative predictive value of 98.3%.
Conclusion: The RSTD, a 4-item tool for junior high school children, can be easily used to assess fluctuating risks of major depressive disorder and depressive disorders at any time.

Keywords: Depression; School-based; Screening tool; Validity

1. Introduction

Depression, which affects about 121 million people worldwide, is a common mental disorder with symptoms of depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy, and poor concentration. These problems may become chronic or recurrent, leading to substantial impairments in an individual's everyday activities. At its worst, depression can result in suicide, with the loss of about 850,000 lives every year. Depression is the leading cause of disability and the fourth leading contributor to the global burden of disease in 2000. It is estimated to be the second most common cause of disability in all ages worldwide by 2020.[1] This evidence means that depression generates a remarkable disease burden. In addition

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to its effects on individual health, depression also increases overall health-service costs.[2] Furthermore, its worldwide prevalence of 3%, depression has a 15–20% lifetime prevalence in adolescents, which makes it a common problem.[3,4] Adolescent depression is a recurrent and serious illness with substantial mortality and psychiatric comorbidity.[5] In Taiwan, a study of 7th graders found that 55.5% of adolescents had mild depressive symptoms: 27.9% reported having 11–20 depressive symptoms and 9.9% reported more than 20 depressive symptoms.[6] In 1999, the results of the National Survey of Physical and Mental Health of Youth in Taiwan revealed that when the adolescents encountered obstacles or stressful life events, 30.5% of them experienced depressive symptoms.[7] Furthermore, the early onset of depression in young people is associated with a poor prognosis. They manifest deteriorated academic performance, social dysfunction, substance abuse, suicide attempts, and a variety of other predictable negative behaviors that create individual and societal burdens.[8–11] This has precipitated developing a screening instrument for preventing the onset of depression in Taiwan adolescents.

Strategies for depression prevention in adolescents include: (1) a decrease in their being exposed to risk factors for depression; (2) the early diagnosis of depression; and (3) appropriate prevention-intervention programs.[12] Early diagnosis and rapid screening seem the most practical because they are the most cost effective.

A number of screening tools have been developed to assess the risk of depression in adolescents. The most commonly used self-report depression screening tests include the Children's Depression Scale,[13] the Birleson Depression Self-Rating Scale,[14] the Children's Depression Inventory,[15] the Center for Epidemiological Studies-Depression Child (CES-DC),[16] the Beck Depression Inventory-Adolescent (BDI-A),[17] the Multidimensional Child and Adolescent Depression Scale,[18] the short form of the Reynolds Adolescent Depression Scale,[19] and the Kutcher Adolescent Depression Scale (KADS).[20] However, there are some drawbacks in these screening tools. The Children's Depression Scale and the Birleson Depression Self-Rating Scale are used with inpatient children and in clinical settings, respectively.[13,14] They are not suitable for community screening. The Children's Depression Inventory has been criticized for errors in cutoff scores, construct validity, discriminant validity, and a high false-negative rate for screening.[21,22] Furthermore, the CES-DC has poor reliability and validity in pre-adolescent children, although it has good psychometric properties for adolescents.[23] It also lacks diagnostic specificity, and children with a range of the present diagnostic and statistical manual (DSM)-III diagnoses had elevated scores on the measure.[24] Of the studies that investigated BDI-A screening efficiency, one concluded that the BDI and the CES-D generated too many false-positives and should not be used alone for case ascertainment.[25] The Multidimensional Child and Adolescent Depression Scale cannot be easily used in the community because it has too many items: 40 brief statements answered on a 3-point intensity scale.[18] The short form of Reynolds Adolescent Depression Scale has not been validated by a diagnostic standard.[19] There is still no conclusion on whether the 6-, 11-, or 16-item KADS instrument is the best version.[20,26] Overall, only the CES-D and the KADS have been tested against an algorithm of high risk-based on a reliable diagnostic interview.[27]

Because of the limitations of existing measures, a simpler and well-validated screening tool for detecting depression is needed for school-based screening. One short screening scale, the Disaster-Related Psychological Screening Test (DRPST), for detecting posttraumatic stress disorder and major depressive episodes (MDE), is based on the diagnostic criteria used for earthquake survivors.[28] This method seems efficient and effective for developing a new screening scale. The purpose of the present study was to develop a brief self-report screening tool, based on the DSM-IV diagnostic criteria for major depressive disorder, and specific for adolescent depression.

2. Methods

2.1. Participants

HuNei Township is located in the northwest of Kaohsiung County, next to Tainan metro area in Taiwan. Most adult residents of HuNei Township are engaged in fish farming. There are five elementary schools and one junior high school in HuNei Township. With six or seven classes in each grade in HuNei junior high school, the total number of students was about 570. We recruited a convenience sample of 7th- and 9th-grade students from this sole junior high school in HuNei Township in four semesters. Because of the administrative limit of the school, we did not enroll the 8th graders. There were 665 students of 7th graders and 9th graders invited to join the study, but only 662 students, who signed informed consent, participated in the study.

2.2. Instruments

2.2.1. Screening Test for Depression

Five psychiatrists and two public health professionals designed the Screening Test for Depression (STD) using the DSM-IV diagnostic criteria for major depressive disorder. Moreover, the questionnaire was designed to account for local language and grammar. The STD is a 9-item self-report instrument for the screening of depression. Students were told to answer the test items based on their emotional state during the previous month.

2.2.2. Mini International Neuropsychiatric Interview-Kid

The Mini International Neuropsychiatric Interview-Kid (MINI-Kid) is a structured interview for psychiatric evaluation and outcome-tracking in clinical psychopharmacology trials and epidemiological studies. It takes approximately 15 minutes to complete. Its sensitivity was substantial and specificity was excellent. Inter-rater and test-retest kappas of MINI-Kid were substantial to almost perfect for all the individual MINI-Kid disorders.[29] The MINI-Kid has been

widely used to diagnose depression in community-based adolescents.[20,30,31] Furthermore, the Chinese version of MINI-Kid was also used in community before.[32] In this study, we used the Chinese version of MINI-Kid, and inter-rater reliability was 0.66 (Fleiss' kappa $\kappa = 0.66$, substantial agreement).

2.3. Procedures

We conducted the research during four consecutive semesters. In each semester, we only approached one grade of students. All the 7th- and 9th-grade students were invited to join the study, and after they agreed to participate and had given written informed consent, the participants filled out the STD. Afterwards, each of the participants was scheduled for interview by one of four licensed psychiatrists with the MINI-Kid to assess depression status. The interval between the STD screening day and the MINI-Kid interview ranged from 0 days to 60 days. The scores of the MINI-Kid would be used to verify the validity of the soon-to-be-developed Rapid STD (RSTD), which we planned to develop by extracting predicted items from the STD. The Institutional Review Board of Jianan Mental Hospital approved the study protocols.

2.4. Statistical analysis

There were three steps in the statistical analysis. First, a multiple logistic regression with forward conditionals was used to find predictive items in the STD for the MINI-Kid-diagnosed depressive disorders. Best-subset regression analysis and the receiver operating characteristics (ROC) curve were used to select a subset of items and cutoff points from the RSTD. Statistical significance was set at $p < 0.05$. Second, we summarized the predictive items and developed the RSTD for school children. Third, the optimal threshold was estimated using the ROC analysis. The sensitivity, the specificity, and the positive predictive value (PPV) and negative predictive value (NPV) were calculated against the validity of the RSTD score assessed using interviews.

3. Results

3.1. Demographics of the study participants

We invited 7th graders ($n = 184$) and 9th graders ($n = 481$) to join the study. One of the 7th graders and two of the 9th graders refused to participate. Finally, we recruited a convenience sample of 662 students in this study. There were 319 (48.2%) boys and 343 (51.8%) girls in the sample [mean age: 14.45 ± 0.90 years ; Grade 7: 183 (27.6%); and Grade 9: 479 (72.4%)].

3.2. Comorbid psychiatric diagnosis of the study participants

The diagnoses of major depressive disorder and dysthymia accorded to the definition of DSM-IV diagnostic criteria.[33] Depressive disorder was defined as meeting either major depressive disorder or dysthymia. The combination of major depressive disorder and dysthymia has been called double depression. Of the 662 participants, 24 were diagnosed with major depressive disorder, whereas 22 were with dysthymia. There were 11 participants who had double depression.

Among the participants with major depressive disorder ($n = 24$), three had panic disorder (12.5%), seven had agoraphobia (29.2%), five had separation anxiety (20.8%), two had social phobia (8.3%), and four had general anxiety disorder (16.7%).

Among the participants with dysthymia ($n = 22$), three had panic disorder (13.6%), three had agoraphobia (13.6%), six had separation anxiety (27.3%), one had social phobia (4.5%), and one had general anxiety disorder (4.5%).

3.3. Item prevalence on the STD

The item prevalence of the nine items on the STD ranged from 5.4% ("psychomotor agitation or retardation") to 21.1% ("depressed mood or irritable mood") (Table 1).

3.4. Predictive items on the MINI-Kid

Participants were identified as positive if they had any positive responses on the MINI-Kid interview. There were 24 (3.6%) students diagnosed with major depressive disorder, 22 (3.3%) diagnosed with dysthymia, and 35 (5.3%) diagnosed with the depressive disorders. The predictors for major depressive disorder based on the MINI-Kid were "insomnia or hypersomnia" [odds ratio (OR) = 10.24, 95% confidence interval (CI) = 3.81−27.54], "recurrent thoughts of death, recurrent suicidal ideation" (OR = 5.38, 95% CI = 1.90−15.19), and "feelings of worthlessness or excessive or inappropriate guilt" (OR = 4.56, 95% CI = 1.60−13.00). On the other hand, the MINI-Kid-based depressive disorder predictors were "insomnia or hypersomnia" (OR = 8.56, 95% CI = 3.69−19.88), "recurrent thoughts of death, recurrent suicidal ideation" (OR = 5.74, 95% CI = 2.38−13.87), "psychomotor agitation or retardation" (OR = 3.39, 95% CI = 1.20−9.55), and "feelings of worthlessness or excessive or inappropriate guilt" (OR = 2.85, 95% CI = 1.16−7.01) (Table 2).

Table 1
Prevalence of depressive symptoms in the Screening Test for Depression based on DSM-IV diagnostic criteria

	Symptoms	*n*
1.	Depressed mood or irritable mood	140 (21.1)
2.	Diminished interest or pleasure	100 (15.1)
3.	Weight loss, or decrease or increase in appetite	50 (7.6)
4.	Insomnia or hypersomnia	87 (13.1)
5.	Psychomotor agitation or retardation	36 (5.4)
6.	Fatigue or loss of energy	116 (17.5)
7.	Feelings of worthlessness or excessive or inappropriate guilt	85 (12.8)
8.	Diminished ability to think or concentrate, or indecisiveness	137 (20.7)
9.	Recurrent thoughts of death, recurrent suicidal ideation	90 (13.6)

Data are presented as *n* (%).

Table 2
Logistic regression analysis of predictors for the major depressive disorder and the depressive disorders based on a MINI-Kid-diagnosis

	Major depressive disorder		Depressive disorders	
	OR	95% CI	OR	95% CI
5. Psychomotor agitation or retardation			3.39	1.20–9.55
7. Feelings of worthlessness or excessive or inappropriate guilt	4.56	1.60–13.00	2.85	1.16–7.01
9. Recurrent thoughts of death, recurrent suicidal ideation	5.38	1.90–15.19	5.74	2.38–13.87
4. Insomnia or hypersomnia	10.24	3.81–27.54	8.56	3.69–19.88

CI = confidence interval; OR = odds ratio.

3.5. Forming the RSTD

After summarizing the above results, we extracted three predictive items for the major depressive disorder and four predictive items for the depressive disorders. We used binominal symptom-scoring when composing the RSTD (see Table 3 for the items). When filling out the RSTD, participants selected "yes" or "no" based on their physical and emotional condition during the previous month. The total score on the RSTD was calculated from these three or four items: "yes" equaled 1 and "no" equaled 0.

3.6. Validity of the RSTD

We estimated the optimal threshold for major depressive disorder, with its cutoff point of two positive RSTD items, by analyzing the area under the ROC curve (0.89). With the threshold of any two of these three RSTD symptoms of major depressive disorder, sensitivity was 75.0%, specificity was 92.9%, PPV was 28.6%, and NPV was 99.0% (Table 4).

We also estimated the optimal threshold for the depressive disorders, with its cutoff point of two, by using the ROC curve (0.89) analysis. With the threshold of any two of these four RSTD symptoms of depressive disorder, sensitivity was 71.4% (acceptable), specificity was 92.0%, PPV was 33.3%, and NPV was 98.3% (Table 4).

4. Discussion

We used the item prevalence, the item prediction, and the ROC curve analysis to develop and validate a new screening test, the RSTD, from the DSM-IV diagnosis criteria of major depressive disorder. Compared with traditional methods, these methods are simpler, and the results are equally persuasive.

Table 3
The Rapid Screening Test for depression items

	Item	Major depressive disorder		Depressive disorders	
1.	Insomnia or hypersomnia	☐1	☐0	☐1	☐0
2.	Recurrent thoughts of death, recurrent suicidal ideation	☐1	☐0	☐1	☐0
3.	Feelings of worthlessness or excessive or inappropriate guilt	☐1	☐0	☐1	☐0
4.	Psychomotor agitation or retardation			☐1	☐0

1 = yes; 0 = no.

Compared with other adolescent depression screening tests, the RSTD has high accessibility at the expense of reduced sensitivity (75.0% and 71.4% for the major depressive disorder and the depressive disorders, respectively), and the specificity of the RSTD is satisfactory (92.9% and 92.0% for the major depressive disorder and the depressive disorders, respectively). Most other depression screening tests assess the emotional condition of the children based on how they felt during the previous week, but the criteria of the MINI-Kid and the RSTD both evaluate children's emotional states for the previous month. This difference may be another reason for reduced sensitivity. However, the sensitivity values are still acceptable.

In our study, the PPVs for the RSTD were 28.6% and 33.3%. The most probable reason for the low PPV is the low prevalence of depression in our study population, and such condition was also presented in a previous study.[34] The prevalence of the adolescent depression ranges from 1.9% to 6.6% in different ethnic groups,[35] and the prevalences of the major depressive disorder and the depressive disorders in our study were 3.6% and 5.3%, respectively. The NPV, which ranged from 99.0% to 98.3%, was acceptable. Because of the low PPV, a two-stage procedure was indicated for confirmatory diagnosis.

Estimating the validity of STD, the optimal cutoff point was three for the major depressive disorder, with a sensitivity of 83.3%, specificity of 82.0%, PPV of 14.8%, and NPV of 99.2%; and the optimal cutoff point was also three for the depressive disorders, with a sensitivity of 85.7%, specificity of 83.3%, PPV of 22.2%, and NPV of 99.1%. Comparing the RSTD with the STD for the major depressive disorder and the depressive disorders, we found that the sensitivity of RSTD decreased and the specificity and PPV increased. The validity of RSTD was close to the validity of STD when taking four as cutoff point for major depressive disorder, with a sensitivity of 70.8%, specificity of 90.0%, PPV of 20.1%, and NPV of 98.8%; and for depressive disorder, with a sensitivity of 74.3%, specificity of 91.2%, PPV of 32.1%, and NPV of 98.5%. However, considering the number of their items, the RSTD apparently has better accessibility for the school-based screening.

The Taiwanese Depression Questionnaire (TDQ) was a culturally relevant depression screening questionnaire and it has been commonly used in depression epidemiological surveys. The TDQ has a sensitivity of 89% and a specificity of 92% at cutoff score of 19 in adult.[36] With our sample, we validated the TDQ for major depressive disorder; with its cutoff point of 21, the sensitivity was 80.0%, specificity 90.4%, PPV 16.0%, and NPV 99.5%. We also validated the TDQ for the depressive disorders; with its cutoff point of 14, the sensitivity was 89.7%, specificity 78.8%, PPV 16.0%, and NPV 99.4%. The results were acceptable. We then conducted best-subset regression analysis and the ROC curve from the TDQ and then extracted six predictive items, TDQ-short form, for both major depressive disorder and depressive disorder. We

Table 4
Optimal thresholds for the Rapid Screening Test for depression symptoms

	Major depressive disorder				Depressive disorders			
	Sen (%)	Spe (%)	PPV (%)	NPV (%)	Sen (%)	Spe (%)	PPV (%)	NPV (%)
Any one symptom	87.5	74.9	11.6	99.4	88.6	74.6	16.3	99.2
Any two symptoms	75.0	92.9	28.6	99.0	71.4	92.0	33.3	98.3
Any three symptoms	41.7	98.7	55.6	97.8	40.0	98.2	56.0	96.7
Four symptoms					20.0	99.8	87.5	95.7

NPV = Negative predictive value; PPV = Positive predictive value; Sen = Sensitivity; Spe = Specificity.

estimated the optimal threshold for the major depressive disorder, with its cutoff point of four positive TDQ-short form items, by analyzing the area under the ROC curve (0.920). With the threshold of any four of six TDQ-short form symptoms of the major depressive disorder, sensitivity was 93.3%, specificity 66.4%, PPV 6.0%, and NPV 99.8%. We also estimated the optimal threshold for depressive disorder, with its cutoff point of four, by using the ROC curve (0.919) analysis. With the threshold of any four of six TDQ-short form symptoms of the depressive disorder, sensitivity was 93.1%, specificity 67.6%, PPV 11.5%, and NPV 99.5%. Compared with the TDQ-short form, the RSTD, with sensitivity of 75.0% and specificity of 92.9% in detecting the major depressive disorder, was better than TDQ-short form. With the threshold of any two of these four RSTD symptoms of depressive disorder, its sensitivity was 71.4%, specificity 92.0%, PPV 33.3%, and NPV 98.3%, which was also better than the TDQ-short form's. Beside, the TDQ was originally developed for adults; whether it was suitable in adolescent or not should be treated circumspectly.

Compared with the KADS-6 and MDE for the items, "sleep disturbance" on the RSTD has a special meaning. Although depressed adults experience decreased sleep efficiency, the results of sleep architecture analysis in children and adolescents are contradictory.[37] In the present study, we found that sleep problems were highly correlated with depression in school children.

The "psychomotor agitation or retardation" item in the RSTD is seldom seen in other adolescent screening tests. Nonetheless, psychomotor retardation significantly correlates with anhedonia, an inability to experience pleasure.[38] The item "feeling that life is not very much fun" in the KADS-6, and "I wasn't able to feel happy" in the CES-DC are similar to anhedonia. The behaviors of psychomotor agitation on the adolescent depression scale appear in the forms of "feeling nervous, tense, keyed-up, anxious" on the KADS-6, and "bothered by things that usually don't" on the CES-DC. Thus, we may claim that the RSTD is congruent with the key issues for screening adolescent depression, and the RSTD is appropriate for screening a wider community or a school-based population.

Chou et al[28] used a similar method to develop and validate the MDE screening test, also based on DSM-IV criteria. The three-symptom MDE scale items include "depressive mood", "loss of energy", and "feelings of worthlessness".[28] The MDE and the RSTD share only one item: "feelings of worthlessness". The RSTD item prevalences of "depressive mood or irritable mood" (21.1%) and "loss of energy" (17.5%) in school children are high. Although a Chi-square test showed significant differences in the prevalences of the major depressive disorder and the depressive disorders for students with and without a "depressed mood or irritable mood" and with and without a "loss of energy" ($p < 0.01$ for both), these two symptoms were not predictive for the major depressive disorder and the depressive disorders. The most probable reason that they were significantly different is that despite their high prevalence in both disorders, they are not specific symptoms for the depressive disorders in school children. For example, school children with adjustment disorder may have depressed moods, but they do not meet the criteria for major depressive disorder or dysthymia. Although the item prevalence of "insomnia or hypersomnia" for earthquake survivors is the highest (20.8%), this item is not a specific symptom for major depressive disorder in earthquake survivors. The DSM-IV diagnostic criteria of the major depressive disorder are key symptoms of the depressive disorders; the predictive items are different in different populations based on their different characteristics. The RSTD measures the predictive items in school children, and the DRPST measures the predictive items in adult earthquake survivors. Therefore, the predictive items of the DRPST and the RSTD are different.

Our study had some limitations. The prevalence of depression in school children is low, and the limited resources, especially the psychiatrists, unacceptably vary the time lag between the screening day and the interview day. This kind of variation may prevent psychiatric workers from making a timely mood status evaluation of the students. Moreover, we could only recruit the 7th graders and 9th graders in this study because of the administrative factor. Furthermore, we used the Chinese version of MINI-Kid as gold standard for validating the RSTD. However, there is only validation data of MINI-Kid English version published by Sheehan et al.[29] This becomes a noticeable limitation in this study. Social economic status is a factor related with adolescent depression.[39–41] In our study, the school was located in a rural area and most of the students come from family with relatively lower social economic status. However, we failed to discuss this issue in this study. It is important to further investigate possible influences of social economic status on the screening tools. Furthermore, because the target population of the RSTD was school children, school dropouts and adolescents with severe mental disorders may have been missed in our sample.

The RSTD is a rapid screening instrument developed for early detection of depression in Taiwan adolescents. We used

the diagnosis of registered psychiatrists as the validation standard, instead of other depression questionnaires. The diagnostic criteria of the DSM-IV were more persuasive than the results of commonly used depression questionnaires, such as TDQ. Moreover, even nonparamedical staff can carry out the depression screening. The RSTD is a practical instrument for assessing fluctuating risks of depression in community.

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