**Original Article**
https://doi.org/10.9758/cpn.2017.15.4.352
*Clinical Psychopharmacology and Neuroscience 2017;15(4):352-360*
*pISSN 1738-1088 / eISSN 2093-4327*


# Psychometric Properties of the Hypomania Checklist-32 in Korean Patients with Mood Disorders

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**Objective:** The aim of this study was to examine the validity of the Korean version of the Hypomania Checklist-32, second revision (HCL-32-R2) in mood disorder patients.
**Methods:** A total of 454 patients who diagnosed as mood disorder according to Structured Clinical Interview for DSM-IV Axis I Disorders, clinician version (SCID-CV) (bipolar disorder [BD] I, n=190; BD-II, n=72; and major depressive disorder [MDD], n=192) completed the Korean module of the HCL-32-R2 (KHCL-32-R2).
**Results:** The KHCL-32-R2 showed a three-factorial structure (eigenvalue >2) that accounted for 43.26% of the total variance. Factor 1 was labeled "active/elated" and included 16 items; factor 2, "irritable/distractible" and included 9 items; and factor 3 was labeled "risk-taking/indulging" and included 9 items. A score of 16 or more on the KHCL-32-R2 total scale score distinguished between BD and MDD, which yielded a sensitivity of 70% and a specificity of 70%. MDD and BD-II also could be differentiated at a cut-off of 15 with maximized sensitivity (0.67) and specificity (0.66). Cronbach's alpha of KHCL-32-R2 and its subsets (factors 1, 2, and 3) were 0.91, 0.89, 0.81 and 0.79, respectively. Correlations between KHCL-32-R2 and Montgomery-Asberg Depression Rating Scale, Young Mania Rating Scale and Korean version of Mood Disorder Questionnaire were −0.66 ($p$=0.41), −0.14 ($p$=0.9), and 0.61 ($p$<0.001), respectively.
**Conclusion:** The KHCL-32-R2 may be a useful tool in distinguishing between bipolar and depressive patients in clinical settings.

KEY WORDS: HCL-32-R2; Validation; Sensitivity; Specificity; Bipolar disorder; Major depression.

## INTRODUCTION

Bipolar disorder (BD) is a major psychiatric disorder with a highly recurrent and chronic nature.[1)] It is often under- or misdiagnosed, thus delaying the administration of effective treatment, with one- to two-thirds of patients with BD not receiving appropriate treatment due to misdiagnosis.[2)] BD, particularly BD-II, is frequently misdiagnosed as major depressive disorder (MDD) in clinical practice.[3)] Hypomania as an element of BD-II is often not experienced or not recognized by the patient and their families as pathological; therefore, it is usually not reported to doctors and remains under-diagnosed in 25 to 50% of MDD patients.[4)] Furthermore, clinicians tend not to investigate hypomania if patients present with a depressive episode.[4)] All of these factors contribute to failure to accurately diagnose BD in clinical practice. Recommendations for improving the diagnostic accuracy of BD include establishing a comprehensive history of hypomania/mania, and supplementing it with the administration of screening tools.[5,6)] Diagnostic error has also often stemmed from the misinterpretation of hypomania as the result of antidepressant treatment ("drug induced switch to hypomania"); it is now agreed that patients who switch are true cases of BD-II, now also recognized in Diagnostic

**Received:** January 10, 2017 / **Revised:** February 7, 2017
**Accepted:** February 16, 2017
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and Statistical Manual of Mental Disorders 5th edition (DSM-5).[7] Of course, such over-diagnosis of MDD decreases the specificity of screening instruments for hypomania.

Standardized structured diagnostic interviews such as the Mini International Neuropsychiatric Interview (MINI)[8] and the Structural Clinical Interview for DSM-IV (SCID)[9] are often used in research and even clinical practice, but applying these tools is time-consuming and requires well-trained raters. Recently, several self-report screening tools have been developed to overcome these difficulties and to aid in the detection of BD. Based on DSM-IV diagnostic criteria, the 32-item Hypomania Checklist (HCL-32),[4] Mood Disorder Questionnaire (MDQ),[10] and Bipolar Spectrum Diagnostic Scale[11] are instruments intended for widespread screening of bipolarity in patient with mood disorders.

Initially developed as a 32-question instrument (HCL-32-R1), in its recently modified version, the HCL-32 includes an additional 2 questions (HCL-32-R2).[12] Transcultural analysis of the BRIDGE Study (Bipolar Disorders: Improving Diagnosis, Guidance and Education), which administered the HCL-32-R2, showed that it had good stability across five geographical regions (Iberia, Central Europe, Eastern Europe, North Africa/the Near East, and the Far East including Korea).[13]

Although the Korean version of the HCL-32-R1 has been validated,[14,15] the study of the psychometric properties of the HCL-32-R2 has not yet been tested in Korea. Therefore, the aim of this study was to exam the validity of the Korean adaptation of the HCL-32-R2 (KHCL-32-R2).

## METHODS

### Subjects

This study was carried out from September 1, 2013 to March 31, 2015 via 10 universities or psychiatric hospitals in Korea.

Mood disorders patients who were diagnosed with BDs (BD-I, BD-II, or BD-not otherwise specified [NOS]) or unipolar disorders (MDD, depressive disorder NOS [DEP-NOS], or dysthymic disorder [DD]) via the SCID were recruited. Their ages ranged between 18 and 60 years and all had a minimum of six years of education. One main eligibility criteria for participation in this study was the ability to provide independent written informed consent, regardless of their symptom severity. Exclusion criteria included mood disorders secondary to general medical or neurological conditions, patients diagnosed with unstable or severe clinical status, those who could not cooperate with the study procedures, patients who received eletroconvulsive therapy or modified eletroconvulsive therapy during the previous four weeks, and individuals who were illiterate or suffered from mental retardation, dementia or intellectual impairment. The study was approved by the relevant ethics committees or institutional review boards.

A total of 454 patients were enrolled; the total number of enrolled BD-I, BD-II and MDD patients was 190 (41.9%), 72 (15.9%) and 192 (42.3%), respectively. Two hundred seventy-six patients (60.8%) were female and 324 (71.4%) were outpatients.

### Instruments and Assessment Procedure

Patients with mood disorders were referred to the research team at each recruitment site to be screened for eligibility. All inpatients and patients who visited outpatient clinic and fulfilled the study criteria were invited to participate in the study.

The Montgomery-Asberg Depression Rating Scale (MADRS)[16,17] was used to measure the severity of depressive symptoms within the past week. The Young Mania Rating Scale (YMRS) was also applied to all patients.[18,19] The MDQ, a self-report questionnaire used to screen mania/hypomania, was administered.[10] It consisted of 13 yes/no questions, reflecting DSM-IV inclusion criteria, followed by a single yes/no question about whether the symptoms clustered simultaneously and another question about the causality of the symptoms. The Korean version of MDQ was used in this study.[20]

The HCL-32-R2 is a slightly extended version of the original 32-item HCL-32 scale (R1).[4,21] Compared to the HCL-32-R1,[4] the HCL-32-R2 includes two additional items ("I gamble more" and "I eat more"), yielding a total of 34 items. The HCL-32-R2 used in this study was adopted from the Korean HCL-32-R2 module included in BRIDGE study[12] with the author's permission. The Korean version of the HCL-32-R1 has been validated,[14,15] but the extended version has not yet been validated.

The diagnostic assessment of BD and MDD was conducted at the time of inclusion with the SCID clinical version (SCID-CV) to establish DSM-IV diagnoses by clinicians who were blind to the diagnosis and the HCL-32-R2 scores of each subject.[9]

After providing written informed consent, patients were invited to complete the HCL-32-R2, MDQ, and the additional clinical assessments including MADRS and YMRS. Sociodemographic information was collected

from medical records and patients' families.

### Statistical Analysis

Data distribution was ascertained using the Kolmogorov-Smirnov test. Parametric and non-parametric tests included (1) the chi-square or Mann-Whitney *U* test to compare frequency distributions and (2) the one-way ANOVA (using least significant difference *post-hoc* method) or Kruskal-Wallis tests to compare continuous outcomes, respectively.

Optimal cut-off scores maximizing the sensitivity (proportion of patients with a SCID diagnosis of BD who screened positive on the HCL-32-R2) and specificity (proportion of patients not meeting SCID criteria for BD who screened negative on the HCL-32-R2) were calculated for the KHCL-32-R2. These optimal cut-off scores were determined in order to discriminate between MDD and BD, between MDD and BD-I, and between MDD and BD-II. The area under the receiver operating characteristic (ROC) curve (AUC) was calculated at various cut-off points. The sensitivity and specificity at various cut-offs were presented in figures and tables. If the Cronbach's alpha was greater than 0.7, it could be concluded that the internal consistency of the KHCL-32-R2 was acceptable.[22)]

The dimensionality of the KHCL-32-R2 was measured by exploratory factor analysis. Principal component analysis was carried out to extract the factors; varimax rotation was used to obtain the most meaningful original factor structure of the KHCL-32-R2. Items were assigned to a specific factor when loadings were at least 0.4. Determination of the number of factors to retain was based on several criteria: Kaiser's criterion (factors with eigenvalue $>1.0$), the scree plot, and Horn's parallel test, but principally this decision was based on the coherence and interpretability of factors.

The association between the current mood state measured with the KHCL-32-R2 current mood state item, score on the MADRS, YMRS, MDQ and KHCL-32-R2 were computed by Spearman's and Pearson's correlations. Data were analyzed with the IBM SPSS statistics, version 22.0 (IBM Co., Armonk, NY, USA). The level of significance was $p<0.05$ (two tailed) using 95% confidence intervals (CIs) across analyses.

## RESULTS

### Demographic Characteristics of Subjects

The population-based equivalent subject number was provided by all participating centers. All 514 patients were screened and invited to participate in the study; 60 patients (11.7%) did not participate due to the following reasons: declined to participate, failure to complete interview, or violation of study procedure and study protocol. A final total of 454 patients were included in analysis: 192 diagnosed with MDD (42.3%), 190 diagnosed with BD-I (41.9%), and 72 diagnosed with BD-II (15.9%). Essential demographic and clinical data of subjects have been outlined in Table 1. Patients with BD-I were younger, more educated, less likely to be married, more frequently admitted to the hospital, and had an earlier age at onset of illness than those with MDD. Patients with BD-I also had significantly higher YMRS scores, lower MADRS scores and higher MDQ total scores. Among the three groups, depressive episodes were more frequent in BD-II patients. MDQ and KHCL-32-R2 scores were higher in BD patients than in MDD patients.

**Table 1.** Demographic and clinical characteristics of patients

| | Total (n=454) | MDD (n=192) | BD-I (n=190) | BD-II (n=72) | *p* value |
|---|---|---|---|---|---|
| Sex, male | 178 (39.2) | 66 (34.4) | 86 (45.3) | 26 (36.1) | NS |
| Age (yr) | 40.61±13.13 | 42.95±14.04 | 38.60±12.08 | 39.69±12.47 | <0.001 (BD-I<MDD) |
| Education (yr) | 12.82±2.89 | 12.40±2.78 | 13.29±2.84 | 12.69±3.13 | <0.05 (BD-I>MDD) |
| Married | 200 (44.1) | 104 (54.2) | 64 (33.7) | 32 (44.4) | <0.001 |
| Outpatient | 324 (71.7) | 160 (84.2) | 104 (54.7) | 60 (83.3) | <0.001 |
| Age at onset (yr) | 31.10±12.63 | 37.03±13.15 | 26.65±10.37 | 27.06±10.08 | <0.001 (MDD>BD-I=BD-II) |
| Number of depressive episodes | 2.90±3.61 | 2.39±1.98 | 2.29±2.32 | 5.72±6.84 | <0.001 (BD-II>BD-I, MDD) |
| Number of admission | 2.03±3.61 | 0.21±0.46 | 5.47±5.43 | 0.10±0.30 | <0.001 (BD-I>BD-II, MDD) |
| YMRS, total | 7.40±10.28 | 3.80±3.56 | 11.84±13.99 | 5.25±5.15 | <0.001 (BD-I>BD-II, MDD) |
| MADRS, total | 15.62±11.21 | 19.51±10.08 | 10.14±9.26 | 19.83±12.68 | <0.001 (BD-I<BD-II, MDD) |
| MDQ, total | 7.35±3.93 | 5.25±3.77 | 8.77±3.40 | 9.19±2.93 | <0.001 (BD-I, BD-II>MDD) |
| KHCL-32-R2, total | 16.25±8.01 | 12.73±8.21 | 18.89±6.86 | 18.64±6.71 | <0.001 (BD-I, BD-II>MDD) |

Values are presented as number (%) or mean±standard deviation.
MDD, major depression; BD-I, bipolar I disorder; BD-II, bipolar II disorder; YMRS, Young Mania Rating Scale; MADRS, Montgomery-Asberg Depression Rating Scale; MDQ, Mood Disorders Questionnaire; KHCL-32-R2, the Korean adaptation of Hypomania Checklist-32, second version; NS, not significant.

### Frequency of Positive Responses in the KHCL-32-R2 according to MDD and BD Diagnosis

Figure 1 shows the frequency of positive responses (a score of 1 or more for each item) for patients diagnosed with MDD and BD on items in the KHCL-32-R2. Differences in positive responses between patients with BD and patients with MDD were found to be significant; patients with BD reported more positive responses than patients with MDD ($p < 0.001$), with the exception of items 7, 13, 31, 32, 33 and 34.

### Current Mood State, Symptom Measures and KHCL-32-R2 Scores

Table 2 shows that there was a significant difference in mean total KHCL-32-R2 scores between the seven levels of current mood states in patients with MDD ($p < 0.05$); however, patients with BD did not show significant differences at different levels of current mood states. There were no significant correlations between current mood state and KHCL-32-R2 scores in patients with MDD (rho=0.06, $p$=0.84) or BD (rho=−0.2, $p$=0.65).

In order to examine the relationship between symptom measures and KHCL-32-R2 scores, total scores of MADRS, YMRS, and MDQ scores were compared using Pearson's and Spearman's correlation. Total scores of MADRS (rho=−0.07, $p$=0.36) and YMRS (rho=−0.10, $p$=0.20) were not significantly correlated with KHCL-32-R2 score; MDQ scores were significantly correlated with KHCL-32-R2 score (r=0.73, $p < 0.001$).

### Factor Analysis of HCL-32-R2

Principal component analysis with varimax rotation revealed that the eigenvalue for eight factors was greater than 1, accounting for 60.03% of the total variance. The screeplot showed that would justify retaining 3 components, of which eigenvalues were above 2 (Fig. 2). The ei-

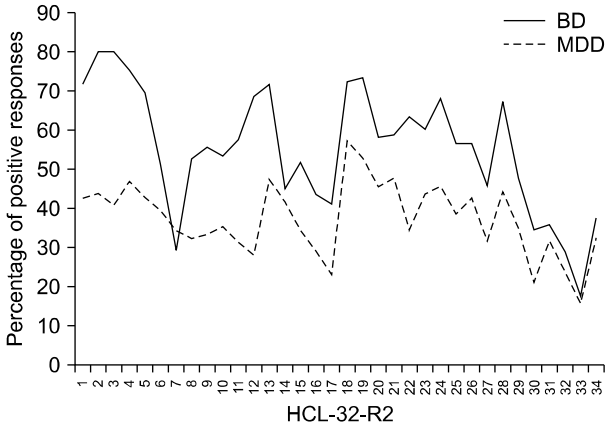



**Fig. 1.** Frequency of positive responses of Hypomania Check List-32 (HCL-32) items between bipolar disorder (BD) and major depressive disorder (MDD) patients (total=494, BD=262, MDD=192). HCL-32-R2, HCL-32 second revision. There were significant differences between the two groups in all items ($p < 0.001$) except items 7, 14, 31, 32, 33 and 34.

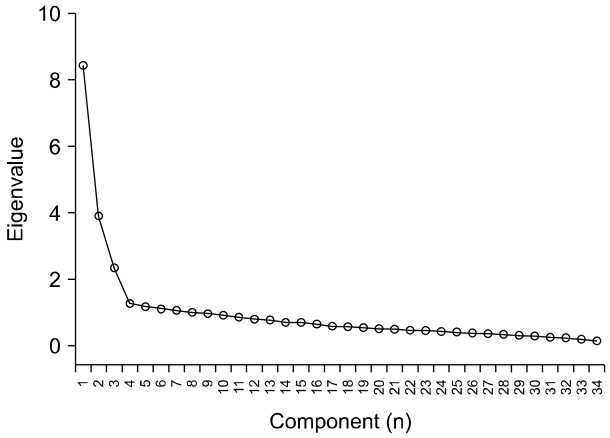



**Fig. 2.** Scree plot of Hypomania Check List-32 second revision at exploratory factor analysis. The three factors were retained (eigenvalue >2).

**Table 2.** KHCL-32-R2 scores at different level of current mood state

| Current mood state | MDD (n=192) | | BD (n=262) | |
|---|---|---|---|---|
| | Patient (n) | Score (mean±SD) | Patient (n) | Score (mean±SD) |
| 1. Much worse than usual | 16 | 12.00±6.87 | 22 | 19.64±5.10 |
| 2. Worse than usual | 22 | 13.27±9.43 | 20 | 20.70±4.47 |
| 3. A little worse than usual | 40 | 15.60±9.45 | 38 | 19.26±7.11 |
| 4. Neither better nor worse than usual | 96 | 10.60±6.48 | 130 | 17.75±7.32 |
| 5. A little better than usual | 10 | 17.00±10.89 | 22 | 18.27±7.95 |
| 6. Better than usual | 8 | 18.50±8.77 | 24 | 21.75±4.85 |
| 7. Much better than usual | 0 | | 6 | 20.33±3.39 |
| $p$ value* | | **0.021** | | **0.235** |

KHCL-32-R2, the Korean adaptation of Hypomania Checklist-32, second version; MDD, major depressive disorder; BD, bipolar disorders; SD, standard deviation.
*By Kruskal-Wallis test.

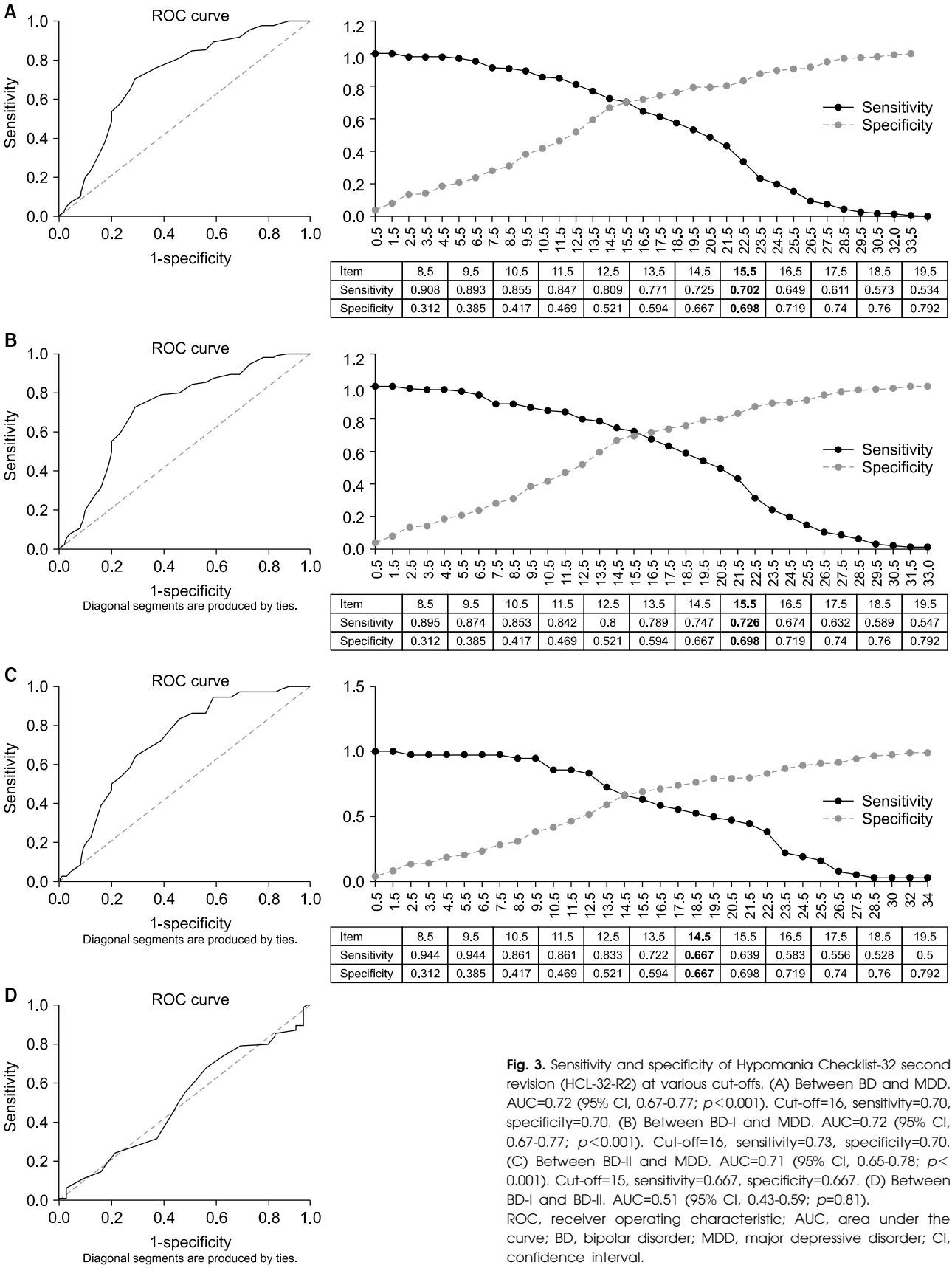
genvalue for factor 1, 2, and 3 were 8.44, 3.92, and 2.35, respectively, while other factors had eigenvalues less than 2. The first three factors accounted for 45.46% of the total variance (Table 3). If all items suppressed absolute factor loadings less than 0.4 and deleted when cross-loaded on more than two factors, 5 items would be excluded from HCL-32-R2. However, clinical decision of coherence made all items included to the analysis. Factor analysis showed that the first three factors accounted for 43.26% of the variance. When forced two-factor solution was conducted according to previous reports,[23] four items were excluded and found to account for 36.36% of the variance. Although many previous reports have adapted a two-factor solution, we chose to use a three-factor solution retaining the whole 34 items in the present study because statistical tests (Kaiser's criterion, scree test, and Horn's parallel test) showed that three-factor solution had fewer unassigned items and clearer interpretation than two-factor solution (Table 3).

Factor 1 comprised 16 items (items 2-6, 9-15, 18, 20, 22 and 28) and could be described as "active/elated". Factor 2 comprised 9 items (items 2, 8, 19, 21, and 23-27) and was labeled as "irritable/distractible'. Factor 3 included 9 items (items 7, 16, 17, and 29-34) and was named "risk-taking/indulging". Factors 2 and 3 could be characterized as the "dark side" of mania, as Angst *et al*.[4] originally described it (Table 3).

**Table 3.** Item loadings for the three factors of the KHCL-32-R2 from the exploratory factor analysis

| Item description | Factor loading | | |
|---|---|---|---|
| | Factor 1 | Factor 2 | Factor 3 |
| 1. I need less sleep | | 0.57 | |
| 2. I feel more energetic and more active | 0.71 | | |
| 3. I am more self-confident | 0.71 | | |
| 4. I enjoy my work more | 0.74 | | |
| 5. I am more sociable (make more phone calls, go out more) | 0.61 | | |
| 6. I want to travel and do travel more | 0.41 | | |
| 7. I tend to drive faster or take more risks when driving | | | 0.42 |
| 8. I spend more/too much money | | 0.46 | |
| 9. I take more risks in my daily life (in my work and/or other activities) | 0.43 | | |
| 10. I am physically more active (sport, etc.) | 0.60 | | |
| 11. I plan more activities or projects | 0.62 | | |
| 12. I have more ideas, I am more creative | 0.67 | | |
| 13. I am less shy or inhibited | 0.59 | | |
| 14. I wear more colorful and more extravagant clothes/make-up | **0.39** | | |
| 15. I want to meet or actually do meet more people | 0.53 | | |
| 16. I am more interested in sex, and/or have increased sexual desire | | | 0.67 |
| 17. I am more flirtatious and/or am sexually more active | | | 0.65 |
| 18. I talk more | 0.52 | | |
| 19. I think faster | | 0.51 | |
| 20. I make more jokes or puns when I am talking | 0.50 | | |
| 21. I am more easily distracted | | 0.67 | |
| 22. I engage in lots of new things | 0.52 | | |
| 23. My thoughts jump from topic to topic | | 0.61 | |
| 24. I do think more quickly and/or more easily | | 0.46 | |
| 25. I am more impatient and/or get irritable more easily | | 0.72 | |
| 26. I can be exhausting or irritating for others | | 0.70 | |
| 27. I get into more quarrels | | 0.55 | |
| 28. My mood is higher, more optimistic | 0.69 | | |
| 29. I drink more coffee | | | 0.45 |
| 30. I smoke more cigarettes | | | 0.67 |
| 31. I drink more alcohol | | | 0.58 |
| 32. I take more drugs (sedatives, anxiolytics, stimulants) | | | 0.60 |
| 33. I gamble more | | | 0.78 |
| 34. I eat more | | | **0.36** |
| Eigenvalue | 8.44 | 3.92 | 2.34 |
| % of variance (total, 43.26%) | 24.83 | 11.53 | 6.91 |

KHCL-32-R2, the Korean adaptation of Hypomania Checklist-32, second version.
Two items (item 14 and item 34) were included although factor loadings <0.4. Factor 1, 'active/elated'; factor 2, 'irritable/distractible'; factor 3, 'risk-taking/indulging'.




| Item | 8.5 | 9.5 | 10.5 | 11.5 | 12.5 | 13.5 | 14.5 | **15.5** | 16.5 | 17.5 | 18.5 | 19.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sensitivity | 0.908 | 0.893 | 0.855 | 0.847 | 0.809 | 0.771 | 0.725 | **0.702** | 0.649 | 0.611 | 0.573 | 0.534 |
| Specificity | 0.312 | 0.385 | 0.417 | 0.469 | 0.521 | 0.594 | 0.667 | **0.698** | 0.719 | 0.74 | 0.76 | 0.792 |

| Item | 8.5 | 9.5 | 10.5 | 11.5 | 12.5 | 13.5 | 14.5 | **15.5** | 16.5 | 17.5 | 18.5 | 19.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sensitivity | 0.895 | 0.874 | 0.853 | 0.842 | 0.8 | 0.789 | 0.747 | **0.726** | 0.674 | 0.632 | 0.589 | 0.547 |
| Specificity | 0.312 | 0.385 | 0.417 | 0.469 | 0.521 | 0.594 | 0.667 | **0.698** | 0.719 | 0.74 | 0.76 | 0.792 |

| Item | 8.5 | 9.5 | 10.5 | 11.5 | 12.5 | 13.5 | **14.5** | 15.5 | 16.5 | 17.5 | 18.5 | 19.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sensitivity | 0.944 | 0.944 | 0.861 | 0.861 | 0.833 | 0.722 | **0.667** | 0.639 | 0.583 | 0.556 | 0.528 | 0.5 |
| Specificity | 0.312 | 0.385 | 0.417 | 0.469 | 0.521 | 0.594 | **0.667** | 0.698 | 0.719 | 0.74 | 0.76 | 0.792 |

**Fig. 3.** Sensitivity and specificity of Hypomania Checklist-32 second revision (HCL-32-R2) at various cut-offs. (A) Between BD and MDD. AUC=0.72 (95% CI, 0.67-0.77; $p<0.001$). Cut-off=16, sensitivity=0.70, specificity=0.70. (B) Between BD-I and MDD. AUC=0.72 (95% CI, 0.67-0.77; $p<0.001$). Cut-off=16, sensitivity=0.73, specificity=0.70. (C) Between BD-II and MDD. AUC=0.71 (95% CI, 0.65-0.78; $p<0.001$). Cut-off=15, sensitivity=0.667, specificity=0.667. (D) Between BD-I and BD-II. AUC=0.51 (95% CI, 0.43-0.59; $p=0.81$).
ROC, receiver operating characteristic; AUC, area under the curve; BD, bipolar disorder; MDD, major depressive disorder; CI, confidence interval.

### Internal Consistency

The value of Cronbach's alpha for the KHCL-32-R2 was 0.91 in the whole sample, 0.89 for factor 1, 0.81 for factor 2 and 0.79 for factor 3.

### Comparison between MDD and BD KHCL-32-R2 Total and Subscale Scores

The mean total KHCL-32-R2 score in the MDD group (12.73±8.21) was significantly lower than that in the BD (18.82±6.81; $p<0.001$), BD-I (18.89±6.86; $p<0.001$), and BD-II (18.64±6.71; $p<0.001$) groups; however, there was no significant difference between the BD-I and BD-II groups ($p$=0.97) (Table 1).

The mean score for factor 1 in the MDD group (6.48±4.80) was significantly lower than that of the BD-I (10.23±4.13; $p<0.001$) and BD-II groups (10.19±4.35; $p<0.001$); however, the difference between BD-I and BD-II groups ($p$=0.95) was not significant. The mean score for factor 2 in the MDD group (3.78±2.77) was significantly lower than that of the BD-I (5.51±2.61; $p<0.001$) and BD-II groups (5.28±2.73; $p<0.001$); however, there was no significant difference between the BD-I and BD-II groups ($p$=0.54). Finally, the mean score for factor 3 in the MDD group (2.47±2.51) was significantly lower than that of the BD-I (3.16±2.53; $p<0.01$) and BD-II groups (3.17±2.32; $p<0.05$); however, there was no significant difference between the BD-I and BD-II groups ($p$=0.98).

### ROC Curve Analysis

#### MDD vs. BD

ROC curve analysis demonstrated that the total KHCL-32-R2 score differed between MDD and BD patients ($p<0.001$); the AUC was 0.72 (95% CI, 0.67-0.77). A cut-off score of 16 was optimal for maximizing sensitivity (0.70) and specificity (0.70) (Fig. 3A). The sensitivity and specificity for a cut-off value of 14 were 0.77 and 0.59, respectively.

#### MDD vs. BD-I

ROC curve analysis showed that KHCL-32-R2 score differed between MDD and BD-I patients ($p<0.001$); the AUC was 0.72 (95% CI, 0.67-0.77). A cut-off score of 16 was optimal to maximize sensitivity (0.73) and specificity (0.70) (Fig. 3B). The sensitivity and specificity of a cut-off value of 14 were 0.79 and 0.59, respectively.

#### MDD vs. BD-II

ROC curve analysis revealed that the KHCL-32-R2 differentiated between MDD and BD-II patients ($p<0.001$). The AUC was 0.71 (95% CI, 0.65-0.78). A screening score of 15 was the optimal cut-off to maximize sensitivity (0.67) and specificity (0.67) (Fig. 3C). The sensitivity and specificity of a cut-off score of 14 were 0.72 and 0.59, respectively.

#### BD-I vs. BD-II

The KHCL-32-R2 did not differentiate between BD-I and BD-II in ROC curve analysis ($p$=0.81). The AUC was 0.51 (95% CI, 0.43-0.59).

### Positive Predictive Value (PPV) and Negative Predictive Value (NPV)

The PPV and the NPV were 0.76 and 0.63, respectively, between MDD and BD at a cut-off of 16 according to the KHCL-32-R2.

### Test-retest Reliability

A total of 158 subjects (MDD, n=72; BD-I, n=70; and BD-II, n=16) completed the second KHCL-32-R2 within four weeks after the first trial. Test-retest reliability coefficient was 0.84 ($p<0.001$); however, mean scores for the second KHCL-32-R2 among MDD (15.64±9.50), BD-I (17.31±7.64) and BD-II patients (18.63±7.17) were not significantly different according to the Kruskal-Wallis test ($\chi^2$=2.10, $p$=0.35).

## DISCUSSION

The principal objective of this study was to examine the psychometric properties of the Korean adaptation of HCL-32-R2 as a screening tool for BD in mood disorder patients. Compared to patients with MDD, patients with BD were younger and had a younger age at onset and more frequent episodes, which was consistent with previously reported demographic and clinical features of BD patients.[2,12] Although the patients with BD were more educated, due to the clinical features of BD, they may be at increased risk for relationship problems, which may explain why fewer BD patients in present study were married.[24,25]

The optimal cut-off value between MDD and BD was 16; similarly, the optimal cut-off value between MDD and BD-I was also 16, while the optimal cut-off value between MDD and BD-II was 15. These cut-off values were slightly higher than those reported in a large transcultural study including 18 countries (Europe, North Africa, Near East, Far East),[13] an Italian study[23,26] and in studies from

Russia[27] and China,[28] all of which used the HCL-32-R2, and furthermore in a Korean study using the HCL-32-R1.[14] At present, there is no obvious pattern (e.g., setting, sample, or cultural background) that would account for the variance in the optimal cut-off value.[29] Our findings that the HCL-32-R2 does not distinguish between BD-I and BD-II is consistent with results from previous studies testing the Italian, Arabic and Chinese versions of this instrument,[23,26,30] with some exceptions.[31,32] By changing the 4-day duration for hypomania to 2 days, the HCL-32 R2 can distinguish between BD-I and BD-II with an optimal cut-off value of 14.[31] Another explanation for differentiation may be the considerable difference in the proportion of MDD, BD-I and BD-II and the episode status (sample-specific prevalence).[29]

The value of Cronbach's alpha for the KHCL-32-R2 was 0.91, which was slightly higher than the previous studies.[23,26,29] The internal consistency of HCL-32 reported by previous studies has been excellent[29] and results from the present study are also consistent with these previous results.

The factor structure in the present study is somewhat different from previous studies that administered the HCL-32-R1 and R2.[4,23,26,30] Most studies have favored two-factor solutions, as suggested in the original study, which reflected a bright and dark side of hypomania; however, these studies also did not reject the possibility of there being three-factor or greater structures for HCL-32.[23,24] A previous Korean study outlined a three-factor structure for HCL-32-R1, determining the three factors to be "elated mood/increased energy," "risk-taking behavior/irritability" and "increased sexual activity".[15] This study also identified a three-factor structure through exploratory factor analysis, which could be labeled as "active/elated," "irritable/distractible" and "risk-taking/indulging." Of the HCL-32-R2 items, those regarding sexual activity, drinking, eating and other activities were classified as the unique dimension in this study that was outside the realm of previous studies.[4,15,29] Further studies may be required to determine whether this dimension can be considered a distinct factor.

As with results from previous studies using HCL-32,[4,24,31] there were no significant relationships between the HCL-32-R2 score and the severity of depression or manic symptoms measured with MADRS and YMRS. The HCL-32-R2 is highly correlated with MDQ scores (r=0.73) and test-retest reliability is also good (r=0.84), which suggests its psychometric properties are robust.

Some limitations of this study should be acknowledged. Although the study used a multi-center design and inclusion of in- and out-patients sample was used to avoid sample-specific prevalence of BD, nevertheless, there may be a selection bias due to non-equivalent proportions of BD-I and BD-II. Although the inclusion of BD-NOS was permitted in this study, there were no patients with that diagnosis, and hence it may limit the conclusions that can be drawn from this study. Secondly, psychiatric co-morbidity was not measured, which could have influenced the sensitivity and specificity of the HCL-32-R2.[24,29] Finally, we did not further analyze with more recent statistical methods such as confirmatory factor analysis or Item Response Theory.[24,25] Further studies will be needed to verify the strength of the KHCL-32-R2 as the screening tools for BDs from MDD in the context of recent literature.

The results of this study indicate that the psychometric properties of the Korean adaptation of the HCL-32-R2 are satisfactory when tested in mood disorder patients. We expect the Korean adaptation of the HCL-32-R2 to be useful as a screening tool for BD in clinical practice.

## ■ Acknowledgments

This study was partially funded by Pfizer Pharmaceutical. The company had no role in the study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

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