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Measuring psychosis proneness in a nonclinical Korean population: is the Peters et al Delusions Inventory useful for assessing high-risk individuals?

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Abstract

Objectives: We examined the psychometric properties of the Korean version of the Peters et al Delusions Inventory (PDI) 40 and investigated the distribution of delusional ideation in a nonclinical population. We also used the item response theory to evaluate the usefulness of the PDI in measuring the risk for psychosis.
Methods: A total of 310 nonclinical individuals completed the Korean PDI-40, the Magical Ideation Scale (MIS), and the Schizotypal Personality Scale (STA). In addition, 60 psychotic inpatients with delusions completed the PDI-40. Among 310 individuals, 124 participated in a follow-up study 6 months after completing their original questionnaire.
Results: The PDI-40 revealed a slightly skewed distribution, but the score range was similar to that of the British population. Scores were negatively correlated with age, but no sex differences were found. The Korean PDI-40 exhibited good internal consistency and test-retest reliability. The PDI was significantly correlated with the MIS and the STA. Ten components were extracted through a principal component analysis with varimax rotation. The test results using item response theory revealed 39 items as the items which individuals with very high level of psychosis proneness will answer as "yes." Moreover, all items yielded "above moderate" discrimination in terms of psychosis proneness.
Conclusions: We confirmed the reliability and validity of the Korean PDI-40. The usefulness of the PDI-40 in a nonclinical population was replicated in the Korean sample. The PDI-40 can be used as an informative device when investigating "psychosis proneness" in a group at high risk for psychosis.

1. Introduction

Evidence supporting the theory of a psychosis continuum has been accumulating over the last few years [1]. Within this approach of continuity, psychotic symptoms can be conceptualized as a severe form of the schizotypal traits found in the general population. Thus, the expression "psychosis proneness" can be defined as a dimensional trait that ranges from normal to a clinical level of psychosis. Psychosis proneness is related to increased risk for more severe psychosis-like experiences and later development of

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psychosis [2,3]. Recently, the clinical significance of these studies has increased with growing interest in the early intervention of psychosis. Elucidation of the constructs modulating the distribution and expression of psychosis will contribute to identifying the risk factors for developing psychosis [4].

Several assessment scales for measuring psychosis proneness are based on a "quasidimensional" model that takes an abnormal state as a reference point [5] and focuses on exploring attenuated or full-blown psychotic symptoms in nonclinical populations. These scales are frequently used in studies of the distribution and characteristics associated with psychotic symptoms in nonclinical populations. The Peters et al Delusions Inventory (PDI) 40 was based on this kind of quasidimensional model; it was derived from the Present State Examination [6] and was developed to measure delusional ideation in the general population [7]. Peters et al [7] reported that the PDI-40 had good psychometric properties among the general population. An abbreviated version with 21 items was also standardized, and its psychometric properties were confirmed by Peters et al [8]. The PDI has been widely used as an instrument for measuring delusion proneness in a number of large-scale studies involving both general populations [9-14] and specific populations such as twins [15], members of a specific religion [16], cannabis users [17], and the relatives of individuals with schizophrenia and bipolar disorder [18]. Recent studies have reported the validity and psychometric properties of the Japanese, Spanish, and Italian versions of the PDI [10,19,20].

Results have indicated that the expression of delusional ideation tends to be differentially influenced by ethnicity, religion, or living environment [11,16,21]. Most of the studies using the PDI were conducted in western countries. Therefore, it is necessary to examine the suitability of the PDI-40 as a measure of schizotypal traits, one criterion for an "at-risk mental state" among Korean nonclinical population. Compared to western countries, Koreans are ethnically homogenous and have a cultural background influenced by the Confucianism and Buddhism. The high level of homogeneity in ethnicity and culture may be advantageous in interpreting the results of studies on psychosis proneness in general population.

In this study, we examined the reliability and validity of the Korean version of the PDI-40. In addition, we tried to evaluate the usefulness of the PDI in measuring the risk for psychosis and in screening a nonclinical population at high risk for developing psychosis.

2. Methods

2.1. Participants and procedure

This study was carried out in accordance with the latest version of the Declaration of Helsinki, and the study design was reviewed and approved by an Institutional Review Board of Boramae Hospital (06-2006-23). Written informed consents of the participants were obtained after the details of study aim and protocol had been fully explained using lay terms.

2.1.1. Healthy general population

We recruited participants in collaboration with coinvestigators who worked in rural (Yeoncheon-gun) and urban (Seoul and Gwangju) areas of Korea. Participants included community residents and local hospital staff. Individuals with a psychiatric history or a professional background in mental health were excluded. Psychiatric history was defined as any kind of "psychiatric illness or treatment." A total of 310 individuals completed the Korean version of the PDI-40, the Magical Ideation Scale (MIS), and the Schizotypal Personality Scale (STA). After 6 months, all participants who had agreed to take part in a follow-up investigation were contacted by mail and asked to complete another PDI. A total of 124 individuals completed and returned the questionnaire.

2.1.2. Psychotic patients with delusions

We selected a deluded patient group using the criteria originally set out by Peters et al [7]. The patients were selected if the patient was observed to have active delusion by the attending psychiatrist during the hospitalization. Sixty psychotic inpatients with delusions (18 men, 42 women) participated. Their mean score for delusion as measured by the Manchester Scale [22] was 3.10 ± 0.63 (a "marked" level). All patients were recruited from the psychiatric ward of the Gil Medical Center in the City of Incheon. Incheon is the third biggest city in South Korea, with a population of approximately 2.5 million. All patients also completed the PDI-40.

2.2. Assessment instruments

2.2.1. The Korean version of the PDI-40

It is a self-reported measure which assesses 3 dimensions of delusional ideation, that is, distress, preoccupation, and conviction. It is rated using a 5-point Likert scale. Items in the PDI-40 can be grouped into the 8 categories of delusions identified in the Present State Examination. Because this study aimed to gather as many delusional themes as possible to measure delusional ideas comprehensively within the general population, the 40-item PDI was chosen instead of abbreviated 21-item PDI. The PDI-40 yields 4 separate scores: total, distress, preoccupation, and conviction. The total score of PDI was obtained by giving a 1 to each "Yes" and a 0 to each "No." The total score is obtained by summing the number of positive answers (maximum score = 40). If the item had been responded as "Yes," a rating between 1 and 5 was obtained on each of the 3 dimensions. The total score for each dimension is obtained by summing the ratings for that dimension among all 40 items (range, 0-200) [7]. Two Korean psychiatrists, HYJ and JSY, made the Korean translation

of the PDI-40, which was then translated back into English by a native speaker (SH). Korean and English language specialists then rechecked the translation.

2.2.2. The Korean version of the STA

The STA assesses various characteristics of schizotypy and is designed to evaluate general schizotypal traits [23]. It is a self-rating measure and is composed of 37 items with dichotomous scale of Yes/No.

2.2.3. The Korean version of the MIS

The MIS is one of the 7 Chapman scales of psychosis proneness [24]. It was developed to measure psychotic and psychotic-like delusional beliefs on a continuum of deviancy from normal to grossly psychotic. It is a self-reported measure and is composed of 24 items with a true/false measure. The standardized Korean version of the MIS was already validated, and Cronbach α for Korean-version MIS was reported at .81 (test-retest reliability, .83) [25].

2.2.4. The Korean version of the Manchester Scale

The first version of the Manchester scale consist of 8 symptoms (depressed, anxious, coherently expressed delusions, hallucinations, incoherence and irrelevance of speech, poverty of speech-mute, flattened incongruous affect, psychomotor retardation) [22]. It is an observer-rated scale using 5 levels of severity (from 0 to 4). The Korean version was used in this study.

2.3. Statistics

According to the results of normality tests, 2 sample *t* tests and nonparametric Mann-Whitney *U* tests were used for between-group comparisons. Pearson and Spearman tests were performed to examine correlations between 2 continuous variables. Categorical variables were compared using χ^2 tests. Reliability of PDI-40 was examined by the Cronbach α for measuring internal consistency. A principal component analysis with varimax rotation was used to reveal underlying factor structure of the PDI-40 in this sample population.

Because the PDI-40 was originally designed to measure delusion proneness in nonclinical population [7], it was assumed that each of delusional themes on PDI-40 reflects a dominant construct of delusion proneness. Although classic test models are useful in measuring reliability and validity of rating scales, test models based on item response theory can provide more flexible and sophisticated framework for evaluating or comparing diverse psychometric instruments in terms of item-level usefulness and measurement precision [26]. Given the potential construct of delusion proneness, the authors decided to use 2-parameter logistic item response model (2PLM), in which the precision of measurement depends on 3 factors including the number of items, the discriminating quality of items, and the match between the item difficulties and the trait level. The 2PLM consists of 2 essential determinants of an examinee's response—the latent trait (eg, delusion proneness) and the item discrimination. Thus, the probability of "endorsement on a specific item" can be presented as a function of an individual's level on the "trait" assessed by the item [27]. To summarize the usefulness of the PDI-40, the "test information function" was used. By summing the item information at a specific level of delusion proneness, the test information function can provide the graphical information about how well the test is doing in estimating delusion proneness over the whole range of delusion proneness [28].

3. Results

3.1. Sample characteristics

A total of 310 healthy general population comprised 125 men and 185 women, with a mean age of 32.07 ± 9.58 years, ranging from 18 to 65 years. The mean duration of formal education was 14.14 ± 2.23 years. Participants were grouped into one of the following occupational groups: administrative and managerial worker (24.5%), student (21.9%), professional (19.0%), housewife (18.7%), services and retail sales worker (7.7%), unemployed (5.2%), skilled worker (1.6%), factory or manual worker (0.6%), and unskilled worker (0.6%).

Of the participants, 43.9% were single, 53.2% were married, 1.3% were widowed, and 1.6% were divorced. Participants identified themselves as belonging to one of the following religious categories: no religion (43.9%), Protestantism (35.5%), Catholicism (9.7%), Confucianism (0.3%), Catholicism (9.7%), and others (0.3%). No significant differences in mean age, sex distribution, religion, occupation, or marital status were observed between respondents (n = 124) and nonrespondents (n = 186) at follow-up. Deluded patients had a mean age of 36.15 ± 10.67 years, ranging from 20 to 64 years, and a mean education of 11.93 ± 3.28 years.

Based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria, 46 patients had been diagnosed with schizophrenia, 2 with schizophreniform disorder, 3 with schizoaffective disorder, 3 with bipolar disorder, 1 with delusional disorder, 4 with brief psychotic disorder, and 1 with psychotic disorder not otherwise specified. The mean ± SD of total score on the Korean version of the Positive and Negative Syndrome Scale was 81.95 ± 16.78 [29].

3.2. The Korean version of the PDI-40 in the general population

In the descriptive statistical data for the 4 PDI scale scores for the healthy sample (Table 1), age was negatively correlated with the total PDI scores for distress, preoccupation, and conviction ($P < .05$). Significant inverse correlations also appeared between age and MIS and STA scores ($P < .05$). However, with regard to the correlation coefficient squared (r^2), only small amount of variability in the PDI, MIS, and STA scores was explained by age. No sex differences appeared in any scale except the STA, in which an analysis of covariance

Table 1
Descriptive data for the Korean general population (N = 310)

Scale	Total (mean [SD])	Men (mean [SD])	Women (mean [SD])	Range	Median	Mode	Kurtosis	Skewness	Gender difference (Z)[a]	Age (r)[b]
PDI	7.82 (7.7)	7.21 (7.29)	8.24 (7.96)	0-40	6.00	0	2.91	1.49	−1.09	−0.138 *
D	16.50 (19.68)	14.26 (16.23)	18.06 (21.61)	0-103	9.00	0	3.26	1.78	−1.110	−0.168 **
P	18.00 (19.33)	15.86 (16.45)	19.45 (20.95)	0-98	12.00	0	1.55	1.36	−1.07	−0.147 **
C	19.81 (20.75)	18.34 (18.57)	20.79 (22.10)	0-100	13.00	0	1.54	1.34	−0.62	−0.139 *
STA	7.28 (6.01)	5.77 (5.34)	8.30 (6.24)	0-28	6.00	3	0.66	1.05	−3.78 ***	−0.151 **
MIS	4.38 (3.37)	3.98 (3.11)	4.64 (3.52)	0-15	4.00	3	0.50	0.97	−1.42	−0.139 *

D, distress rating scale; P, preoccupation rating scale; C, conviction rating scale.
[a] Mann-Whitney *U* test (2-tailed).
[b] Spearman correlation (2-tailed).
* $P < .05$.
** $P < .01$.
*** $P = .001$.

controlling for age revealed that women scored significantly higher than men ($P < .01$). Normal distributions were identified in both STA and MIS scores (about ± 1), but the distribution of PDI scores for distress, preoccupation, and conviction were more positively skewed. Positive value of skewness (>1) indicates a pileup on the left of the PDI score distribution. The ranges of PDI total scores overlapped considerably between the populations classified as "normal" and "deluded"; 17.7% of the general population scored higher than the mean of the psychotic patients. However, the average of the deluded subjects on the whole is twice that of normal subjects.

3.3. Reliability

Cronbach α coefficient was .92, confirming that the Korean version of the PDI-40 had good internal consistency. Item-total correlations ranged from 0.26 to 0.59 ($P < .01$). The test-retest reliability was assessed by following up with 124 individuals after 6 months. No significant differences appeared in PDI, distress, preoccupation, and conviction scores between respondents (n = 124) and nonrespondents (n = 186), nor did any statistical differences appear between the demographic characteristics and STA and MIS scores of the 2 groups. The correlations of the PDI scores at the 2 time points were highly statistically significant ($r = 0.673$, $P < .001$).

3.4. Validity

3.4.1. Concurrent validity

Relationships between the PDI and the STA and MIS were examined to assess the PDI's concurrent validity. The results of the PDI and STA were significantly correlated ($r = 0.670$, $P < .001$), as were those of the PDI and MIS ($r = 0.599$, $P < .001$). These results indicate that the Korean PDI has good concurrent validity.

3.4.2. Criterion validity

We investigated the criterion validity by comparing results for the healthy sample with results for psychotic patients with delusions (Table 2). Scores for all scales and ratings were significantly higher in the patient group ($P < .001$). No sex differences appeared among any scales or ratings in the patient group. Age was significantly negatively correlated with the PDI ($r = −0.278$, $P < .05$) and with distress ratings ($r = −0.295$, $P < .05$) in the patient group using Spearman correlation analysis.

Of the 40 items, the patient group endorsed 25 items more frequently ($P < .05$). The ranges for PDI scores within the general population and the patient group largely overlapped with those observed in Peters et al [7] (Fig. 1). The 2 groups were also compared in 3 dimensions. Psychotic patients rated 31 items significantly higher on the distress ratings, 29 on the preoccupation ratings, and 27 on the conviction ratings. The mean PDI scores for distress, preoccupation, and conviction were significantly higher for psychotic patients than for the general population ($P < .001$). None of the subject reported "Yes" in the items 26, 27, 29, 30, 31, 32, 34, 35, 36, 37, and 38; therefore, these items were omitted from Fig. 1.

3.5. Factor analysis

The classification of Comrey and Lee [30] indicated that 310 participants was a sufficient sample size for factor analysis (>300). The Kaiser-Meyer-Olkin measure of sampling adequacy represents the ratio of the squared correlation between variables to the squared partial correlation between variables [31]. The Kaiser-Meyer-Olkin statistic was 0.89, thereby indicating a reliable factor solution can be possible in the study sample [32]. Because the Bartlett test of sphericity

Table 2
Comparison of results of the PDI, STA, and MIS for the Korean general population and psychotic patients

Scale	Total, mean (SD)		Range	
	Healthy	Deluded	Healthy	Deluded
PDI	7.82 (7.70)	14.37* (8.19)[a]	0-40	0-36
D	16.53 (19.68)	42.73* (30.33)	0-103	0-151
P	18.00 (19.33)	40.45 * (28.19)	0-98	0-145
C	19.81 (20.75)	44.13* (30.07)	0-100	0-116
STA	7.28 (6.01)	13.70* (8.23)	0-28	0-32
MIS	4.38 (3.37)	7.08* (4.14)	0-15	0-17

[a] Mann-Whitney *U* test between deluded and healthy samples (2-tailed).
* $P < .001$.

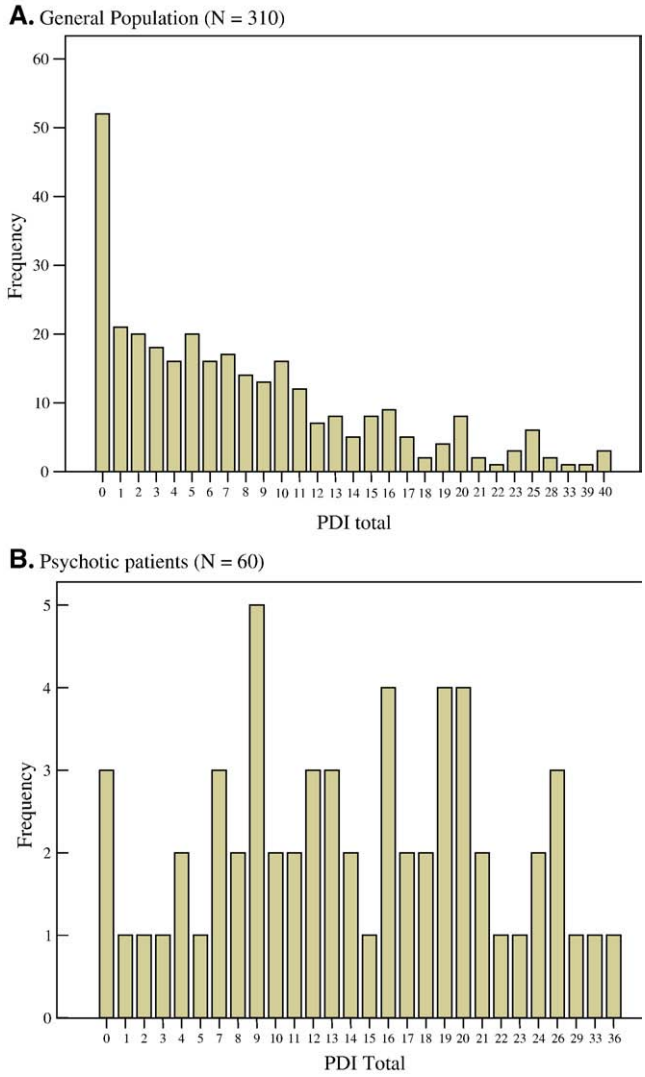

Fig. 1. Distribution of PDI scores in the Korean general population and psychotic patients.

was highly significant (4133.2, $P < .001$), the null hypothesis that the original correlation matrix for 40 items is identical matrix could be rejected, and factor analytic approach was justified. The PDI scores for 40 items were subjected to a principal component analysis with varimax rotation (Table 3). When the Kaiser criterion of eigenvalues below 1 was applied, 10 components were extracted and explained 57.1% of the total variance. Before rotation, the first factor explained considerably more variance than the remaining 9 (26.1% compared with 2.6%-5.2%), but it accounted for only 7.8% of total variance after varimax rotation. The first component had heavy loadings in items addressing somatic concern; the second, in grandiose ideas; the third, in religious or superstitious ideas; the fourth, in passivity experiences; the fifth, in persecutory ideas; the sixth, in thought disturbances; the seventh, in jealousy and suspiciousness; the eighth, in paranormal beliefs; the ninth, in olfactory hallucination; and the 10th, in idea of guilt (factor loading >0.4).

3.6. Item response theory analyses

The presence of a dominant factor often indicates unidimensionality. Factor extraction using a screen plot revealed the presence of one dominant factor in the sample population, justifying the use of an item response model with 40 PDI items in total (Fig. 2). There are 3 parameters in unidimensional dichotomous response models: item difficulty, item discrimination, and item guessing. The 2PLM specifies both difficulty and discrimination of each item. Item guessing is often redundant in modeling health-related scales [33].

Baker has made practical suggestions about verbal descriptions of difficulty and discrimination levels [34]. In the difficulty and discrimination level of each PDI item (Table 4), the mean ± SD of item difficulty (b) was 1.36 ± 0.49, ranging from 0.45 to 2.39. Five levels were suggested to describe the degree of item difficulty; "very easy" (<−2.0), "easy" (−2.0 to −0.5), "medium" (−0.5 to +0.5), "hard" (+0.5 to +2.0), and "very hard" (>+2.0). In addition, 7 levels were also proposed to classify the degree of item discrimination in logistic model; "none" (0), "very low" (0.01 to 0.34), "low" (0.35 to 0.64), "moderate" (0.65 to 1.34), "high" (1.35 to 1.69), "very high" (>1.70), and "perfect" (+ infinity). According to these descriptions, 35 items on the PDI-40 were classified as "hard" (0.5-2.0), meaning that only individuals with "high level of delusion proneness" can endorse these items. In contrast, item 23 ("Do you ever feel as if electrical devices such as computers can influence the way you think?") was associated with relatively familiar and frequent experiences in healthy adults (−0.5 to 0.5), yielding the lowest level of difficulty. Four very hard items were also identified (items 14, 27, 30, and 34; >2.0), and these items are probably appropriate for clinical population.

The mean ± SD of item discrimination (a) was 1.64 ± 0.33, ranging from 1.02 to 2.38. According to Baker's classification, this result indicated that 6 items had "moderate" discrimination (0.65-1.34), 16 items had "high" discrimination (1.35-1.69), and 18 items had "very high" discrimination (>1.70) in terms of delusion proneness. For the characteristic curves of 3 representative items (Fig. 3), item 14 ("Do you ever feel as if some organization or institution has it in for you?") yielded the highest levels of discrimination and difficulty among the 40 items. Item 26 ("Do you believe in the power of witchcraft, voodoo, or the occult?") yielded the lowest levels of discrimination, and item 23 ("Do you ever feel as if electrical devices such as computers can influence the way you think?") yielded the lowest level of difficulty.

The test information function of 2PLM indicates the precision or reliability of PDI-40 for evaluating individuals at different levels of the target construct, with higher information representing more precision [34]. In this sample, the test information function of 2PLM indicates the range over delusion proneness (the target construct) for which PDI-40 is in practical use for screening delusion proneness

Table 3
Principal component analysis of the PDI-40 items in nonclinical population

PDI-40 items[a]	1	2	3	4	5	6	7	8	9	10
Variance explained[b]	7.8%	7.0%	6.8%	6.5%	6.3%	6.2%	5.6%	4.4%	3.2%	3.2%
Rotting inside	.687	.121	.270	.010	.169	.036	.030	.097	−.041	.094
Body changed in a peculiar way	.640	.073	.075	.080	.191	.183	.110	.133	.214	.064
Being experimented on	.560	.216	−.026	.210	.206	.250	.096	.008	−.059	−.045
People looking oddly at me	.485	.083	.0001	.245	−.006	.144	.400	.085	.059	.103
End of the world	.480	.125	.272	−.009	.023	.144	.069	.364	.181	−.071
Strangers want to have sex with me	.447	.433	.041	.222	.228	−.202	.145	−.072	−.224	.178
Like a robot or a zombie	.401	−.038	.016	.291	.194	.180	.153	.047	.100	−.073
Being a special or unusual person	.191	.728	.155	.170	.160	.118	−.019	−.024	.049	−.067
Being someone very important	.094	.709	.292	.110	.074	.108	.019	.081	−.118	−.067
Someone or something is watching me	.059	.517	−.090	.050	.293	.086	.355	.123	.024	.284
Having special abilities or powers	.071	.500	.408	.153	.048	.111	.082	.136	.082	.085
Being especially close to God	.182	.100	**.776**	.177	−.011	−.022	.041	−.083	.028	.125
Being chosen by God in some way	−.019	.091	.744	.098	.230	.107	.125	.015	.057	.177
Mysterious power working for the good of the world	.119	.170	.586	.104	.154	−.037	.148	.142	−.115	−.308
Special purpose or mission	.140	.294	.430	.091	.029	.221	.018	.212	−.036	.078
Being possessed	.172	.196	.068	.676	.049	.112	.197	.242	−.094	.066
Being under the control of some force or power other than myself	.145	.103	.302	.662	.039	.016	−.121	.186	.026	−.033
Feelings or actions not under my control	.014	.060	.193	.490	.131	.370	.285	.033	.102	.120
Hints/double meanings	.053	.306	.060	.476	.228	.124	.333	−.065	.166	.038
Forces affecting me in strange ways	.237	.145	.187	.470	.351	.155	−.080	−.004	.009	.143
Someone trying to harm me	.131	.031	.091	.092	.750	.183	.050	.117	.075	−.037
Organization or institution having it in for me	.178	.210	.125	.053	.634	−.059	.182	.063	−.073	−.072
Conspiracy	.273	.167	−.004	.070	.535	−.018	.172	.344	.049	.082
Being persecuted	.081	.205	.277	.166	.418	.200	.280	−.191	.136	−.099
Having no thought in the head	.187	.116	−.008	.020	−.019	.616	.132	.134	.119	.067
Alien thoughts	.124	.106	.160	.232	.372	.565	−.020	.048	−.196	.191
Someone or something playing games with my mind	.142	.024	.082	.160	.439	.452	.037	.021	.099	.102
Thought echoing back	.181	.181	.099	.199	.051	.449	.229	.179	−.345	−.028
People are not what they seem to be	.080	.126	.114	.383	.092	.430	.121	.171	.120	−.211
Thought broadcasting	.394	.097	.057	.117	.055	.429	.188	−.062	−.056	−.422
Worrying about one's partner's unfaithfulness	.204	.115	.112	.010	.188	.017	.732	.078	.002	−.011
Other people can read my mind	.134	−.072	.164	.115	.104	.297	.555	.228	.016	−.007
Everyone is gossiping about me	.125	.402	−.026	.369	.032	.074	.407	.054	.292	−.018
Believing in the power of witchcraft, voodoo or the occult	.104	.018	−.074	.280	.112	.048	.128	.690	.014	.165
Telepathic communication	.075	.078	.229	.085	.119	.201	.095	.664	−.024	−.204
Smelling very unusual to other people	.398	.021	.045	.194	.148	.084	.114	.066	.652	.084
Sinned more than the average person	.204	.097	.279	.134	−.005	.181	.122	.005	.048	.702

[a] Three items loaded less than 0.4 in the 10 factors ("special messages on TV or magazines", "electrical device influencing way of thinking", and "thought blocking").
[b] Rotation tends to equalize the relative importance of factors.

(Fig. 4). The PDI-40 produced maximum information at +1.5 (item difficulty) of the level of delusion proneness, and individuals with this level of delusion proneness are highly delusion-prone, according to Baker's criteria.

4. Discussion

Our results indicate that the Korean version of the PDI-40 is a reliable and valid instrument for measuring delusional ideation within the general Korean population. The 40-item PDI had a near-normal distribution in a healthy British sample [7], but its distribution in the Korean population was more skewed. A much larger proportion (16.8%) of our sample (Fig. 1) had a total score of 0 than did the sample in Peters et al [7] (3.7%). Previously, Peters et al [8] have speculated that the slightly older mean age of the participants in 2 European studies [12,15] might have contributed to their lower mean PDI when compared to the British sample. However, despite that the Korean sample had a lower mean age (32.07 ± 9.58) than the British sample (36.5 ± 10.2), the mean PDI scores and ratings for distress, preoccupation, and conviction were slightly lower in the Korean sample, when compared with the British sample. In particular, the mean conviction rating was lower in the Korean than the British sample (20.1 vs 29.8, respectively). Lundberg et al [11] reported higher scores for a 21-item PDI and its 3 subscales in their Ugandan sample than in samples from various European countries. These results may indicate differential expression of delusional ideation caused by different cultural backgrounds [16,21].

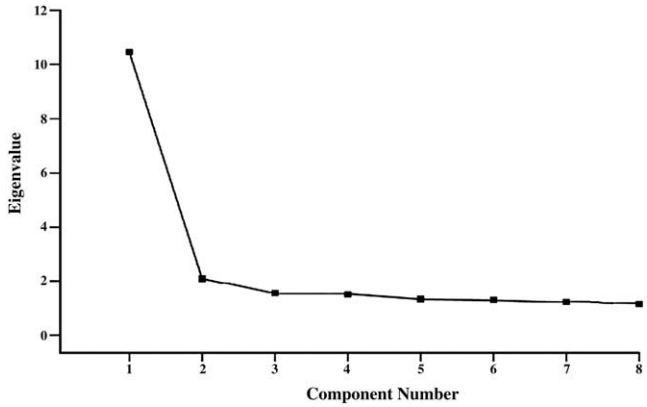

Fig. 2. Screen plot for PDI-40 scores of healthy adults (N = 310). The point of inflection warranted an assumption of only one underlying factor.

Although the means on the PDI of our sample were slightly lower and the distribution was more skewed, the results were remarkably similar to those of British and European samples with respect to score ranges and the percentage of the general population scoring higher than the mean of the psychotic sample.

No sex differences appeared, but significant inverse relationships were detected between age and 4 kinds of PDI-40 scores (PDI-40 total score, distress subscale score, preoccupation subscale score, and conviction subscale score). These results are in line with the results of previous studies that applied the PDI to nonclinical samples [4,7,35] or primary care patients with no psychiatric disorder [13]. Some authors have reported that women score higher for "positive" schizotypy, whereas men score higher for "negative schizotypy [36,37]. Further examination is required to clarify the relationships between sex and various dimensions of schizotypal characteristics.

The sample composed of psychotic patients scored significantly higher than the general population, but the total score ranges overlapped, with some subjects from general population scoring higher than the deluded subjects. However, when the scores were compared item by item, there was very little overlap. The 2 groups were differentiated by their ratings for distress, preoccupation, and conviction raised by the delusional experience; these results are also consistent with results from previous studies [7,20]. Although all patients were clearly psychotic, some scored very low, and 3 even scored zero. Therefore, whether or not delusions reach levels of clinical psychosis may depend on multidimensional determinants, including the degrees of distress, preoccupation, and conviction, rather than delusional contents. This theory has been supported by previous studies of religious and psychotic populations [7,16]. Recent studies have also concluded that the distress associated with subpsychotic experiences may play an important role in the formation of clinical caseness or psychotic symptoms requiring care [38,39].

Lopez-Ilundaine et al [10] used a factor analysis of a 21-item PDI to obtain 7 easily interpretable factors and found the PDI-21 to be useful in measuring the dimensionality of delusional ideation in a general Spanish population. Our principal component analysis of 40 items on the PDI yielded 10 components. Although the number of components are similar to the results of study on the British sample (10 vs 11), the differences were observed in the overall factor structure of 40 items between the Korean and the British samples.

Table 4
Results of goodness-of-fit tests using a 2-parameter logistic model and parameter estimates for the PDI-40 in healthy adults (N = 310)

Item no.	χ^2	df[a]	a (SE)	b (SE)
1	3.2	6	1.37 (0.20)	1.27 (0.16)
2	1.5	3	1.48 (0.29)	1.96 (0.26)
3	7.8	4	2.11 (0.37)	1.05 (0.10)
4	1.6	5	1.80 (0.25)	0.73 (0.09)
5	0.5	3	1.73 (0.32)	1.68 (0.19)
6	0.4	5	1.83 (0.27)	0.77 (0.10)
7	11.7	6	1.62 (0.27)	1.21 (0.13)
8	7.8	5	1.74 (0.26)	0.82 (0.10)
9	6.0	6	1.60 (0.24)	0.71 (0.10)
10	2.4	3	2.10 (0.38)	1.58 (0.16)
11	3.5	2	1.83 (0.39)	1.94 (0.25)
12	4.2	5	1.58 (0.25)	1.00 (0.12)
13	0.6	2	2.02 (0.44)	1.92 (0.22)
14	0.5	0	2.38 (0.72)	2.39 (0.37)
15	0.3	4	1.63 (0.27)	1.62 (0.18)
16	5.3	5	1.86 (0.32)	1.30 (0.13)
17	3.6	6	1.44 (0.21)	0.51 (0.10)
18	7.4	7	1.19 (0.20)	1.24 (0.18)
19	5.1	5	1.57 (0.26)	0.96 (0.16)
20	4.4	6	1.79 (0.31)	1.09 (0.12)
21	3.8	4	1.36 (0.28)	1.72 (0.25)
22	7.8	7	1.06 (0.17)	0.97 (0.16)
23	5.3	6	1.22 (0.18)	0.45 (0.11)
24	3.2	4	2.03 (0.36)	1.39 (0.14)
25	8.8	7	1.41 (0.24)	1.08 (0.14)
26	6.1	7	1.02 (0.18)	1.48 (0.23)
27	0.2	2	1.93 (0.46)	2.02 (0.26)
28	2.9	3	1.43 (0.29)	1.97 (0.27)
29	2.2	2	2.30 (0.47)	1.84 (0.19)
30	1.9	2	1.73 (0.34)	2.10 (0.29)
31	3.7	7	1.22 (0.20)	1.42 (0.18)
32	6.7	5	1.47 (0.22)	1.04 (0.14)
33	5.5	7	1.07 (0.17)	0.56 (0.13)
34	2.9	2	2.01 (0.45)	2.02 (0.28)
35	7.1	6	1.52 (0.28)	1.39 (0.17)
36	2.1	5	1.86 (0.29)	1.33 (0.14)
37	3.4	4	1.51 (0.26)	1.73 (0.21)
38	2.7	5	1.63 (0.27)	1.51 (0.17)
39	2.0	3	1.96 (0.38)	1.74 (0.18)
40	4.3	7	1.35 (0.21)	0.97 (0.14)

χ^2 Statistics show the overall good fit of the 2-parameter logistic model to the data at a 95% significance level.

[a] For the χ^2 goodness-of-fit test. The test statistic follows a χ^2 distribution with $(k - c)$ df where k is the number of nonempty cells and c is the number of estimated parameter for the distribution + 1. k means the number of endorsement. In this 2-parameter model, $c = 3$. Because the number of endorsement is not same in 40 items, the df can vary item by item. The null hypothesis of this test is that the data follow a specified distribution predicted by 2-parameter model.

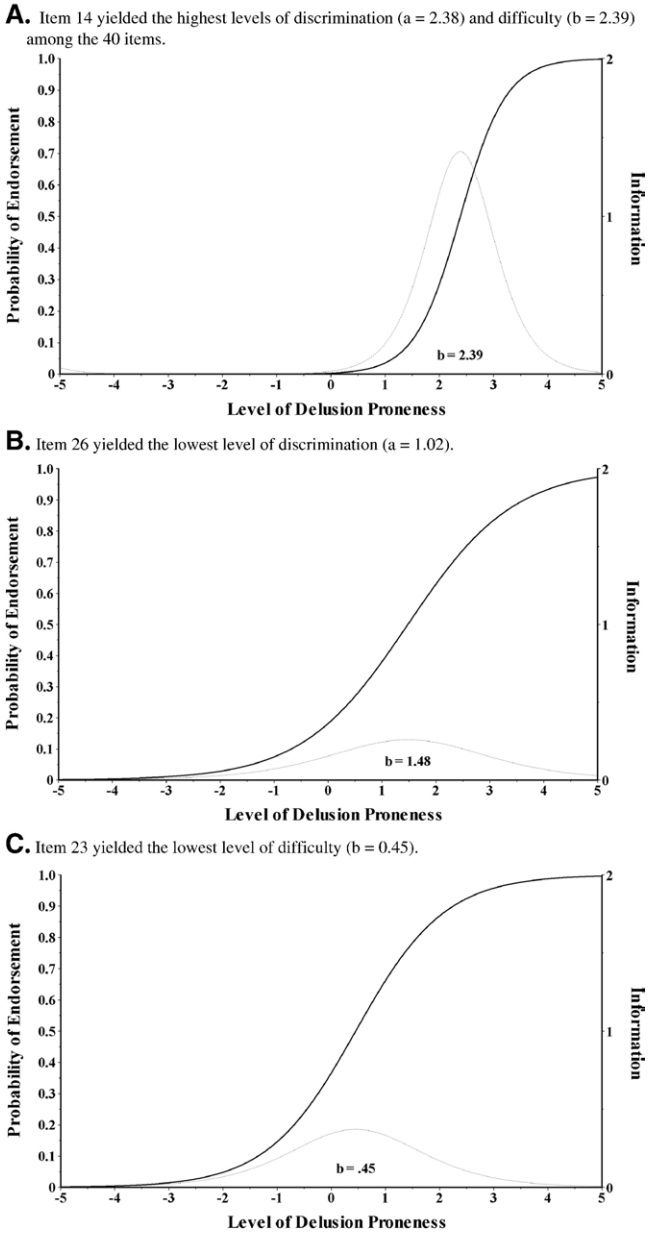

Fig. 3. Item characteristic curves of 3 PDI-40 items (14, 26, and 23) in healthy adults (N = 310). Solid line indicates functional relationship between the level of delusion proneness and the probability of endorsement for each item; broken line, precision of each item in estimating the level of delusion proneness of respondents. (A) Item 14 yielded the highest levels of discrimination (a = 2.38) and difficulty (b = 2.39) among the 40 items. (B) Item 26 yielded the lowest level of discrimination (a = 1.02). (C) Item 23 yielded the lowest level of difficulty (b = 0.45).

Item response test analysis revealed that the nonclinical population classified 39 of the total 40 items as hard or very hard. The general Korean population might have considered most PDI items to describe very unusual experiences, which could explain why Koreans responded No more frequently. Of the 40 items, 34 were highly sensitive to the degree of delusion proneness. The discrimination parameter appears to be directly related to the correlation between an item and the total scale score, indicating a relationship between an item and the latent construct measured by the rating scale [40]. Therefore, from the perspective of item response theory, the test results suggest that most PDI-40 items are appropriate for measuring the latent construct of delusion proneness, yielding more objective and comparative information than simple calculation of the endorsement rate for individual items.

The test information function indicates the range of delusion proneness for which the PDI-40 can screen, that is, the target construct (Fig. 4). The test information function refers to the precision or reliability of the PDI-40 to evaluate respondents at various levels of delusion proneness, with higher levels of information indicating more precision [34]. The test information function results indicated that the PDI-40 is useful for measuring moderate to high levels of delusion proneness, rather than average or subaverage levels. In addition, the amount of information significantly decreased at an extreme level of delusion proneness, which may indicate clinical psychosis. Therefore, the PDI-40 is a kind of criterion-referenced test that is suitable for screening nonclinical individuals who are highly prone to delusion formation. Recently, Preti et al [41] reported that the PDI has a high negative predictive value within the general population, suggesting its value as a screening tool for psychosis proneness.

We confirmed the reliability and validity of the Korean version of the PDI-40. Although we identified differences in factor structure and endorsement patterns, the usefulness of the PDI-40 in the nonclinical population was replicated in a Korean sample. Multidimensional measuring of delusion proneness will enhance the understanding of both the formation and pathologic characteristics of delusions. The PDI-40 can be used as an informative device when investigating psychosis proneness in individuals at high risk for psychosis.

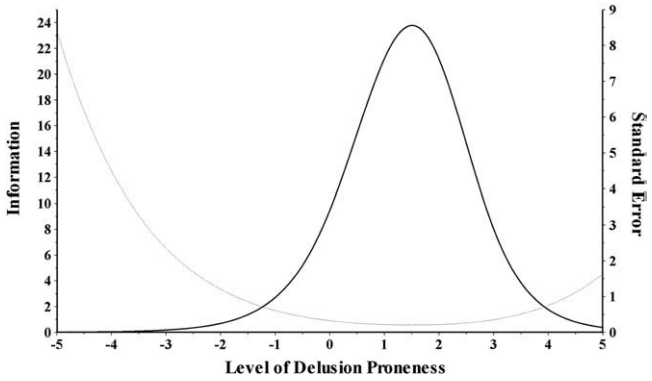

Fig. 4. Test information and measurement error for the PDI-40 in healthy adults (N = 310). Solid line indicates test information function showing the range over the level of delusion proneness for which PDI-40 is useful for selecting delusion-prone individuals; dotted line, reciprocity of the standard error with the test information function in which a decrease in the SE of the estimated delusion proneness reflects an increase in the quantity of information.

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