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Psychometric properties of the Peters et al Delusions Inventory 21 in college students

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Abstract

Delusions show high prevalence in the general population and can be considered a risk marker for psychotic disorders. Although the assessment of these experiences has made considerable progress in recent years, there is still room for improvement in the measurement quality of the self-reports available for such assessment. The goal of the present work was to analyze the measurement quality of the Peters et al Delusions Inventory 21 (PDI-21) in Spanish college students. The final sample was made up of 660 participants (29.5% men) with a mean age of 20.3 years (SD, 2.6 years). The results revealed that a high percentage of the sample reported some symptom of paranoia. Analysis of the internal structure of the PDI-21 by means of exploratory factor analysis based on the tetrachoric correlation matrix yielded an essentially unidimensional solution. Cronbach α for the total score was .91. Scores on the PDI-21 correlated in a statistically significant fashion with trait and state anxiety and negative affect. These results provide new evidence of the validity of the PDI-21 and endorse its use as a measurement instrument for assessing the extended psychosis phenotype in nonclinical population.

1. Introduction

Delusions are a central feature in the diagnosis of psychotic disorders [1]. Delusional beliefs are not circumscribed to the clinical population but can be found in the general population below the clinical psychosis phenotype [2]. Nuevo et al [3], in a study carried out with a sample of 256 445 people from 52 countries, found the prevalence of delusions of control in nonclinical population to be 4.8%, whereas the figure for delusions of reference and persecution was 8.4%. A recent meta-analysis by van Os et al [2] indicated a mean prevalence of such subclinical psychotic experiences of 5.3%. Psychotic-like experiences (PLEs) are a risk marker for psychotic disorders. Independent longitudinal studies show that the presence of subclinical symptoms in adolescents and young adults increases future risk of developing a schizophrenia-spectrum disorder [4-7]. In this sense, subclinical psychotic symptoms may represent the behavioral expression of liability for psychotic disorder in the general population. Furthermore, PLEs have been associated with the same risk factors as those found in patients with psychosis, such as being younger, lower educational level, unemployed, or lower income [2]. These subclinical experiences also have a clear impact on health [3] and have been shown to correlate with several psychopathologic factors, including anxiety, depressive symptoms, and/or affective dysregulation [8-12].

A wide range of self-report instruments has been developed for assessing the extended psychosis phenotype and specifically for the assessment of paranoia [13-15]. Peters et al [16] constructed a 40-item self-report for evaluating the presence of paranoia in the general population, which they called the Peters et al Delusions Inventory. It was subsequently reduced to 21 items (PDI-21) [13]. This brief version of the Peters et al Delusions Inventory has been used in various epidemiological studies [17,18]. Likewise, its metric properties have been analyzed in previous works. Peters et al [13] conducted a principal components

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analysis (PCA) (n = 444) with a forced 1-component solution of the PDI-21. Loadings on this single factor ranged from 0.31 to 0.63, and the discrimination indices were high. These data were interpreted by the authors as evidence for the adequacy of a unidimensional scoring system. Earlier, Verdoux et al [19] had analyzed the PDI-21 in a sample of 444 nonpsychiatric patients by means of PCA (Pearson correlation matrix and Varimax rotation). They found a factorial solution with 7 components (persecution, thought disturbances, grandiosity, religiosity, paranormal beliefs, ideas of reference, and apocalyptic ideas) that explained 55.3% of the total variance but did not report the internal consistency levels of either the total score or the components. Similarly, López-Ilundain et al [20] administered a Spanish adaptation of the PDI-21 to a sample of 365 healthy individuals. The analysis of internal structure of the PDI-21, carried out by means of PCA (Pearson correlation matrix and Varimax rotation), revealed the presence of 7 components (paranoid, experiences of influence, grandiosity, religiousness, magic thinking, referential, and depressive), explaining 53.7% of the total variance. Cronbach α coefficient for total score was .75. Jones and Fernyhough [21] also analyzed the metric quality of the PDI-21 in a sample of 493 college students in the UK. The exploratory factor analysis (principal axis factoring and oblique rotation) conducted on PDI-21 scores yielded a 3-factor solution (delusional beliefs/thought disturbances, religiosity/religiousness, and delusions of reference/guilt-suspicion) that explained 34.1% of the total variance. Cronbach α for the total score was .77, with values of .69, .80, and .55 for the 3 factors, respectively.

As can be seen, few psychometric studies have been conducted with the PDI-21, and the results are still contradictory. Internal consistency levels are close to 0.70 and, in some cases, are not reported. Moreover, they do not take into account the categorical nature of the PDI-21's response system, and this may affect estimations of reliability [22]. As regards the internal structure, most analyses use PCA based on Pearson correlations. From a psychometric point of view and given the dichotomous nature of the data, it is necessary to use the tetrachoric correlation matrix. Using the Pearson correlation matrix for categorical data can affect the estimated factor loadings, the factorial solution, and the selection of spurious factors due to statistical artifacts [23,24]. Likewise, on attempting to analyze the underlying dimensional structure in which the resulting factors have a clear psychologic interpretation, it is better to use exploratory factor analysis rather than PCA [25,26]. The limitations mentioned underline the need for new research including a more in-depth analysis of the psychometric quality of the PDI-21. It is relevant to have reliable tools that provide a sound basis for decisions about the selection of at-risk participants or the study of the psychosis phenotype at a nonclinical level.

Within this research context, the main purpose of the present study was to examine the measurement quality of the PDI-21 [13] in a sample of Spanish college students. To this end, we analyzed rates of delusional experiences reported by the participants, examined the internal structure based on the tetrachoric correlation matrix of the PDI-21, estimated its reliability, analyzed the differential item functioning (DIF) according to participants' sex, and obtained sources of validity evidence in relation to other variables that measure state and trait anxiety as well as positive and negative affects. This allows us not only to determine the psychometric properties of the PDI-21 in a new sample of the population in an age group at risk for psychosis but also to understand the phenotypic expression of paranoia and its relationship with different emotional variables at a subclinical level.

2. Methods

2.1. Participants

Participants in the study were 660 university students from different degree courses at the University of Oviedo: Education, Criminology, Psychology, Medicine, Speech Therapy, IT, Economics, and Physiotherapy. The sample, recruited by means of incidental sampling, was made up of 195 men (29.5%) and 465 women (70.5%). Mean age of the participants was 20.3 years (SD, 2.6 years), with a range of 17 to 30 years. Mean years of education was 16.8 years (SD, 2.3 years). As regards marital status, 81.6% were single, 16.2% were married, 0.6% were divorced, and 1.7% did not report their status. With regard to employment situation, 86.6% were not working, 12.6% were working, and 1.2% failed to report their employment status.

2.1. Instruments

2.1.1. Peters et al Delusions Inventory 21 [13]

The PDI-21 is a self-report designed for assessing delusional symptoms in the general population. It comprises a total of 21 items with dichotomous response format (yes/no). Total score is the sum of positive responses on each item, giving a maximum score of 21 points. The higher the score, the greater the delusional symptoms or paranoia proneness is. Likewise, for each one of the items, there are 3 subscales that measure degree of conviction, preoccupation, and distress. On these 3 subscales, the scoring system is Likert type with 5 categories (1-5). Previous studies indicate that the PDI-21 is a tool with adequate measurement quality as regards internal consistency, test-retest reliability, and different sources of validity evidence [8,13,21]. In the present work, we used the Spanish version of the PDI-21, which yielded a Cronbach α for the total score of .75 [20].

2.1.2. State-Trait Anxiety Inventory [27]

The State-Trait Anxiety Inventory (STAI) is a 40-item self-report designed to assess 2 independent anxiety concepts: anxiety as a state (transitory emotional condition) and anxiety as a trait (relatively stable propensity for anxiety). Each scale is made up of a total of 20 items with 4-point

Likert-type response format according to intensity (0-3). Total score on each of the scales ranges from 0 to 60 points. In this work, we used the Spanish adaptation of the STAI [28], for which we found internal consistency levels of between 0.84 and 0.93. Likewise, we obtained different sources of validity evidence [28,29].

2.1.2. Positive and Negative Affect Schedule [30]

This is a brief self-report comprising a total of 20 items that measure positive (10 items) and negative affects (10 items). Participants are required to self-assess a series of feelings and emotions (eg, excited or irritable) on a 5-point Likert-type scale (1-5). The Positive and Negative Affect Schedule (PANAS) is widely used for the measurement of affective states [31,32]. In the present study, we used the Spanish version of the PANAS adapted by Sandín et al [33].

2.3. Procedure

The questionnaire was administered collectively in groups of 10 to 45 students during school hours and in a classroom with the appropriate conditions for this purpose. The study was presented to participants as a part of research on the diverse characteristics of personality, and they were given guarantees of the confidentiality of their responses. It was stressed that participation was voluntary. Administration of the self-reports was always under the supervision of a researcher and within a battery of tests. This study is part of a broader research project on detection and early intervention in relation to psychologic disorders in a nonclinical population.

2.4. Data analysis

First of all, we calculated the descriptive statistics for the PDI-21 items as well as the rates of participants who responded affirmatively to the questions. Second, the internal structure of the PDI-21 was analyzed by means of exploratory factor analysis based on the tetrachoric correlation matrix. The procedure used for determining the number of factors was optimal implementation of parallel analysis [34].

This procedure is an implementation of parallel analysis where it is computed based on the same type of correlation matrix (ie, Pearson or polychoric correlation) and the same type of underlying dimensions (ie, factor components) as defined for the whole analysis. To extract the number of factors, the following were also taken into account: Kaiser criterion, Scree test, criterion of parsimony, and psychologic interpretability. The method for factor extraction was unweighted least squares with Promin rotation. In third place, we calculated the Cronbach α coefficient of the PDI-21 scores for ordinal data [22]. Fourth, we examined the Pearson correlations between the subscales of the 3 self-reports. Finally, DIF analysis was carried out according to sex. The presence of DIF presumes that the probability of a person (or group) obtaining a correct response does not depend solely on that person's level in the object of measurement but, rather, is also conditioned by whether the person belongs to a certain social group, cultural group, linguistic group, and other, generating a lack of metric equivalence among scores [35,36]. To detect DIF as a function of sex, the Mantel-Haenszel χ^2 statistic [37] and the Breslow-Day χ^2 statistic [38] were used for dichotomous items. The type I error was 0.01 with a stratum size of 1. The SPSS 15.0 (SPSS Inc, Chicago, IL) [39], Differential Item Functioning Analysis System [40], and Factor 8.0 [41] programs were used for the data analyses.

3. Results

3.1. Descriptive statistics

Table 1 shows the descriptive statistics, referring to the mean, SD, asymmetry, and kurtosis of the PDI-21 items for the total sample. As can be seen, some items present extremely high asymmetry and kurtosis values (items 2, 5, 8, 11, 14, and 21). Mean for the PDI-21 total score in the total sample was 4.30 (SD, 2.78), being 4.86 (SD, 3.17) for men and 4.06 (SD, 2.57) for women; this difference between the means of men and women was statistically significant (t = 3.39, P = .001, Cohen's d = 0.28). The correlation between age and PDI-21 total score was −0.12 (P < .01). The proportion of participants who responded affirmatively to the PDI-21 items ranged between 2.7% and 88.9% of the sample. Of these, 29.8% of the sample obtained a score of 5 or more, whereas 11.4% obtained 7 points or more in the PDI-21 total score.

Table 1
Descriptive statistics for the PDI-21

Items	Mean	SD	Asymmetry	Kurtosis
1	0.61	0.49	−0.47	−1.79
2	0.08	0.27	3.13	7.85
3	0.89	0.31	−2.49	4.21
4	0.12	0.32	2.42	3.85
5	0.05	0.22	4.21	15.81
6	0.21	0.41	1.43	0.06
7	0.21	0.41	1.41	−.01
8	0.04	0.20	4.55	18.77
9	0.24	0.43	1.22	−0.50
10	0.12	0.32	2.42	3.85
11	0.03	0.16	5.82	31.95
12	0.23	0.42	1.26	−0.40
13	0.26	0.44	1.08	−0.85
14	0.09	0.28	2.92	6.53
15	0.40	0.49	0.39	−1.85
16	0.15	0.36	1.95	1.80
17	0.13	0.33	2.24	3.04
18	0.12	0.33	2.33	3.42
19	0.12	0.33	2.33	3.42
20	0.11	0.31	2.51	4.33
21	0.09	0.29	2.89	6.34

Table 2
Exploratory factor analysis of the PDI-21

Items	1-factor solution	2-factor solution	
	Factor loadings	Factor loadings	
1	0.26	−0.27	0.67
2	0.66	0.65	0.07
3	0.06	−0.54	0.74
4	0.55	0.33	0.31
5	0.76	0.67	0.18
6	0.59	0.42	0.26
7	0.55	0.35	0.28
8	0.72	0.95	−0.19
9	0.47	0.12	0.47
10	0.43	0.32	0.16
11	0.73	0.95	−0.17
12	0.41	0.03	0.50
13	0.33	0.19	0.20
14	0.56	0.47	0.15
15	0.25	−0.05	0.39
16	0.41	0.18	0.30
17	0.59	0.28	0.42
18	0.63	0.37	0.36
19	0.56	0.30	0.35
20	0.57	0.38	0.27
21	0.69	0.46	0.32
Eigenvalues	6.78	6.78	2.02

3.2. Evidence of internal structure of the PDI-21

The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.79, and the Bartlett test of sphericity was 6526 ($P < .001$). The factor analysis of the PDI-21 items yielded a total of 6 eigenvalues greater than 1; however, the procedure for determining the number of dimensions suggested the extraction of 2 factors. These 2 factors explained 41.94% of the total variance. The root mean square of residuals was 0.073, and the goodness-of-fit index was 0.96. Examination of this 2-dimensional solution indicated that many items had factor cross-loadings greater than 0.30 in both factors; item 13 had a factor loading less than 0.20 (see Table 2). The first factor explained 32.31% of the total variance and is called delusional ideation. The second factor was more difficult to interpret and is called magical thinking. The Pearson correlation between the 2 factors was 0.50. Based on these results and according to Peters et al [13], we also examined a 1-dimensional factorial solution. This single factor explained 32.31% of the total variance. In this case, the solution is more parsimonious than the 2-dimensional solution, and the factor loadings did not bring about a substantial decrease. Table 2 shows the estimated factor loadings for the 1-dimensional solution. As can be seen, the loadings ranged from 0.25 to 0.76, with the exception of item 3. The root mean square of residuals was 0.097, and the goodness-of-fit index was 0.93.

3.3. Estimated internal consistency

Reliability of the PDI-21 total score estimated by means of Cronbach α coefficient for ordinal data was 0.91.

3.4. Sources of validity evidence in relation to other variables

Table 3 shows the Pearson correlations between the PDI-21, the STAI subscales, and the PANAS positive and negative affects. As it can be seen, correlations between PDI-21 total score and the STAI scales were moderate and statistically significant. The PDI-21 did not correlate with positive affect, but it did show a moderate and statistically significant correlation with PANAS negative affect.

3.5. Differential item functioning

For the analysis of DIF as a function of sex, we used the Mantel-Haenszel χ^2 statistic and the Breslow-Day χ^2 statistic. Analysis of the DIF revealed that a total of 5 items (items 1, 3, 6, 7, and 14) showed differential functioning according to participants' sex.

4. Discussion and conclusions

The principal purpose of the present work was to examine the measurement quality of the PDI-21 [13] in a sample of Spanish college students. To this end, we examined the rate of self-reported delusional experiences, analyzed the internal structure of the PDI-21 based on the tetrachoric correlation matrix, estimated the internal consistency of the PDI-21 scores, analyzed the DIF by sex, and obtained sources of validity evidence in relation to other variables that measure state and trait anxiety and positive and negative affects. This goal allowed a more thorough exploration of the measurement properties of an instrument that is short, easy, and quick

Table 3
Pearson correlations between the PDI-21, STAI, and PANAS

	PDI-21	STAI state	STAI trait	Positive affect	Negative affect
PDI-21					
STAI state	0.26*				
STAI trait	0.29*	0.64*			
Positive affect	−0.05	−0.46*	−0.50*		
Negative affect	0.32*	0.64*	0.63*	−0.19*	

* $P < .01$.

to administer as a screening tool to detect at-high-risk individuals for psychosis in the general population. It is undoubtedly of the utmost relevance to obtain psychometric data that endorse the use of the PDI-21 in this sector of the population (psychosis is most likely to occur in young adults) and that improve our understanding of the extended psychosis phenotype.

The prevalence rate of the delusional experiences reported in this study ranged from 2.7% to 88.9%. These data on prevalence rates are similar to those found in previous works [2,42,43]. For example, Scott et al [18], using the PDI-21 in a sample of 2441 participants, found that between 5.5% (item 21) and 77% (item 3) of the sample answered affirmatively to some item of the self-report. For their part, Rocchi et al [44], using the PDI-21 in a sample of 210 participants, found that between 6.7% (item 2) and 87.1% (item 3) of the sample answered affirmatively to 1 or more of the paranoia items. These data support the view that delusional experiences are not circumscribed to the clinical population but can be found in the general population below the clinical psychosis phenotype. This suggests the possibility, at a psychometric level, of an extended psychosis phenotype as well as a potential etiologic continuity between the clinical and subclinical psychosis phenotypes [45].

The results of this study indicate that the PDI-21 is a self-report with adequate psychometric properties as regards internal consistency and sources of validity evidence. Estimated reliability for ordinal categories yielded a value of 0.91, higher than those reported in previous studies [13,20,21] and similar to that found by Peters et al [13]. As regards the analysis of internal structure of the PDI-21, our data suggest that the underlying structure is essentially unidimensional; however, a factorial interpretation of 2 factors is also possible. The unidimensional solution presents factorial loadings that are greater than 0.30, does not present cross-loading, does not present a decrease in the goodness-of-fit indices in comparison with the 2-factor solution, is more parsimonious, and allows the creation of a total score for the PDI-21. These results are consistent with those reported by Peters et al [13] but not with those of other factorial studies [19-21]. Peters et al [13], in a sample of 444 participants and forcing the factorial solution, found a single-factor loadings of more than 0.31; however, other authors have found, as more parsimonious solutions, 3-dimensional [21] or 7-component models [19,20]. It is worth pointing out that Peters et al [13] did not develop the PDI-21 with the aim of measuring a limited number of well-defined scales but rather as an instrument for measuring a wide range of delusional experiences. It may be that the 7-component solutions found previously [19,20] result from a problem of overestimation due to the statistical technique, that is, the use of PCA. Like Jones and Fernyhough [21], we consider a scoring system with a single PDI-21 score to be more reliable and in keeping with clinical practice (as well as being more suitable for research purposes). Multidimensional solutions, such as those with 7 factors, based on a brief 21-item measuring instrument, may have the drawback, among others, of hindering the construction of subscales and score profiles. In clinical practice and empirical research, it may make more sense to create subscales containing a high number of items (ie, >3 items), with adequate internal consistency levels that allow us to make data-based decisions.

As regards the association of the PDI-21 with STAI state and trait anxiety and PANAS positive and negative affects, the results showed positive and moderate correlations, with the exception of positive affect, for which there was no correlation. These results provide new evidence of the PDI-21's validity. Moreover, they are clearly convergent with data from previous studies on nonclinical adolescents and young adults [8-11,43,46] and on clinical samples of patients with psychotic disorders [12,47]. Psychotic-like experiences and, specifically, paranoia have been shown to have clinical correlates such as anxiety, depressive symptoms, and/or affective dysregulation. For example, Cella et al [8], using a sample of 472 participants, found that those with high scores on the PDI-21 also scored higher in anxiety and depression. These results suggest that affective dysregulation is present at a subclinical level, being qualitatively similar, if quantitatively different, from that found in patients with psychosis. In this regard, recent studies have underlined the potential role of affective symptoms in the transition toward a clinical condition in individuals from the general population [48,49].

Analysis of DIF revealed that 5 PDI-21 items functioned differentially according to participants' sex. Although these data are preliminary and future studies must replicate this finding in representative samples of the population, it is worth mentioning that the presence of DIF does not guarantee equity in the measurement process, so that some consideration of ethical and legal aspects is relevant [50] (eg, the appropriateness of selecting at-risk individuals based on their PDI-21 scores). Likewise, it is advisable for DIF analysis to be incorporated as routine practice in statistical analyses on instruments for assessing subclinical psychosis phenotype.

The results of this work should be interpreted in the light of the following limitations. First of all, the sample characteristics (college students and predominantly women) preclude the generalization of the results to other populations of interest. Second, given the problems inherent in any type of study based on self-reports, it would have been useful to use reports from external informants. Third, in the interpretation of the factorial structure of the PDI-21, it should be mentioned that, for binary items, Horn's parallel analysis [51] performed reasonably well for the detection of unidimensionality [52]; however, performance deteriorated with increasing item skewness (item difficulty). In this study, low item response rates were found, and this fact may constrain the interpretation of the internal structure of PDI-21. Finally, it should be borne in mind that this study was of a cross-sectional nature, so we cannot make cause-

effect inferences. However, it is equally true that most of the participants who report PLEs may be experiencing a transitory state or may never progress to clinical psychotic disorder. Specifically, between 10% and 35% of these subclinical psychotic experiences can interact synergetically or additively with other environmental (ie, genetic, trauma, cannabis, urbanicity, victimization, etc) or genetic factors, increasing the persistence of psychotic experiences and, consequently, becoming abnormally persistent, clinically relevant, and need of care [4,53].

Future studies should examine the measurement properties of the PDI-21 in other samples (eg, prodromal individuals). Its properties should also be considered in the context of the analysis of measurement invariance across cultures. Likewise, it would be interesting to determine the predictive capacity (sensitivity and specificity) of the PDI-21 in independent longitudinal studies and to determine its heuristic value in the detection of individuals at risk for psychotic disorders.

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