Original Article

Longitudinal Factor Structure of the Brief Psychiatric Rating Scale among Incident Cases of Schizophrenia Attending a Nigerian Hospital

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Abstract

Background: Schizophrenia, from its early conceptualization, has been described in distinct clinical subtypes. However, these categories were found not to be stable phenotypes over time, hence the dimensional option, whereas at cross-sectional level, the dimensions of psychopathology have been replicated across studies; there is dearth of data on the longitudinal stability of the factor structure of the symptoms of schizophrenia in African populations. **Aim:** This study examined the longitudinal stability of the factor structure of the 18-item Brief Psychiatric Rating Scale (BPRS) across intervals of 16-week naturalistic treatment follow-up. **Patients and Methods:** Consecutive incident cases that fulfilled the criteria for schizophrenia were recruited into the study. After a baseline assessment, 160 incident cases of schizophrenia were followed up 4 weekly for indicators of symptomatic outcome for 16 weeks. The Brief Psychiatric Rating Scale (BPRS) assessments were conducted in clinical interviews and with the Scale for Assessment of Negative Symptoms (SANS). Five BPRS assessments were made across the monthly intervals of follow-up. Exploratory factor analyses (EFA) using maximum likelihood extraction and varimax rotation with Kaiser normalization was used to extract the factors. **Results:** A four-factor structure was found at baseline, namely negative, positive, depressive/anxiety, and manic symptom dimensions. From week 4, the manic and anxiety/depression dimensions remained invariant over time, while negative and positive symptoms merged into a psychosis dimension that was invariant. **Conclusion:** The persistence of the mood dimensions supports the DSM-5 recommendation to include these dimensions in the assessment of schizophrenia psychopathology. The longitudinal emergence and invariance of the psychosis factor echo the idea of unitary psychosis and, along with the prominence of mood dimensions over time, reflect recent molecular genetic findings about the sharing of genes by schizophrenia and mood disorders.

Keywords: *BPRS, factor, longitudinal, Nigeria, structure, schizophrenia*

Introduction

Schizophrenia, from its early conceptualization, has been described in distinct clinical subtypes.[1] However, these subtypes have been jettisoned in the current diagnostic manuals because the categorical diagnosis of subtypes has been found not to be stable phenotypes across time, and molecular genetic studies have not supported the categorical subtypes.[2,3] With these shortcomings, came the rise of the views that schizophrenia psychopathology should be best conceptualized by psychopathological dimensions.[4,5] The issues with the dimensional model are the lack of universally acceptable dimensions of schizophrenia[6,7] and the question of whether these factors are state- or trait-dependent. Due to the chronic relapsing nature of

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schizophrenia, there has been a burgeoning interest in the long-term study of its symptoms. An important consideration in studying changes at the level of dimensions is to establish that factor structure is invariant over time.[8,9] An instrument that has been widely used in the longitudinal study of symptoms is the Brief Psychiatric Rating Scale (BPRS).[10] The BPRS was developed to provide a highly efficient and rapid evaluation of treatment changes in psychiatric patients, while at the same time providing a comprehensive description of the major symptom dimensions.[10] However, at the cross-sectional level, its factors have been replicated, and the stability of these factors over time has been less studied.[8] Measurement invariance (factorial invariance or factor invariance) has been defined as a statistical property of measurement that indicates that the same underlying construct is measured across groups or across time.[11,12] This is evident when the relationship between manifest indicator variables (BPRS scale items) and the underlying construct is the same across groups (multi-group invariance) or across time (longitudinal invariance).[13] Researchers need invariant factor structures to unambiguously interpret changes at the symptom level. When invariance does not hold, observed changes may be cofounded by variations in measurement operations or instability of the constructs themselves.[14] Although confirmatory factor analysis (CFA) is seen as the gold standard for estimating factorial invariance, Zumbo *et al*.[13] suggested that a single exploratory factor analysis (EFA) at each time interval, separately, may be considered a test of factorial invariance.

The BPRS, as an instrument used to measure the symptom changes over time among patients with schizophrenia, needs to be evaluated for the stability of its factor structure among African population. Long *et al*.[8] reported that the BPRS demonstrated configural invariance among patients with schizophrenia. The literature is sparse on the longitudinal factor structure of BPRS among schizophrenia patients in Africa. To pursue the trait/state dependency of these factors, there is need to demonstrate their invariance across time, as a rationale for determining the genetic correlates of the dimensions of psychopathology in schizophrenia, and also to provide the basis for the broad dimensional assessments required by the DSM-5. This study appears to be the first study from Africa to examine the factorial stability of the dimensions of schizophrenia psychopathology, using the BPRS. The objectives of the study were

1. To determine the factor structure of the 18-item BPRS among incident cases of schizophrenia in an African population.
2. To examine the longitudinal factor stability across four intervals of naturalistic treatment follow-up for 16 weeks.

Materials and Methods

Study design and population

This was a naturalistic longitudinal follow-up outcome study which took place at the Federal Neuropsychiatric Hospital (FNH), Enugu, Nigeria. Consecutive incident cases of schizophrenia, who presented at the hospital, aged 18–49 years, and with traceable home address around Enugu metropolis, and mobile telephone number, were included in the study. Patients with schizophrenia of suspected organic etiology, including substance use disorders, medical or psychiatric co-morbidities, or both, were excluded. Patients were interviewed when they were in a stable clinical condition (i.e., fully conscious and could optimally participate during the interview). Ethical approval for the study was obtained from the Research and Ethics Committee of the Federal Neuropsychiatric Hospital, Enugu.

Procedure and measurements

Diagnostic interview

Most of the new cases of schizophrenia were offered hospitalization, and their initial assessments were completed in the wards after obtaining a written informed consent. Consenting subjects, who were not admitted, were seen monthly at the out-patient clinic and a relative ensured that they were compliant with their medications. Participants were incident cases of schizophrenia diagnosed by the consultant psychiatrist. Diagnosis was based on the International Classification of Mental and Behavioral Disorders (ICD-10), Diagnostic Criteria for Research version.[1] Brief Psychiatric Rating Scale (BPRS) assessments were conducted in a clinical interview. The Scale for Assessment of Negative Symptoms (SANS) was also applied. The BPRS ratings were made by JUO[1] and two resident doctors in psychiatry with at least two years in training. All the rating clinicians received training, involving three weeks of joint rating sessions with a senior psychiatrist with experience in the use of the instruments, before the assessment of the study participants. Five BPRS assessments were made across the monthly intervals of follow-up. Participants and their relatives were contacted via telephone calls or text messages a week prior to the follow-up date and then further reminded a day to the date of follow-up. Participants who missed their appointment were traced using contact phone numbers, family contact, and next of kin's address or phone number. A record of

participants lost to follow-up was made. No death was recorded during the period of study.

Psychopathology and psychosocial assessment tools

The Brief Psychiatry Rating Scale (BPRS) English version

The BPRS is a widely used instrument for assessing the severity of positive, negative, general, and affective symptoms of individuals who have severe mental disorders, especially schizophrenia.[10] The BPRS consists of 18-symptom constructs and takes 20–30 minutes for the interview and scoring. It is rated on a Likert scale of 1 (not present) to 7 (extremely severe) or 0–6 in the new version. We used the 1–7 scale rating.

Scale for the Assessment of Negative Symptoms (SANS)

The Scale for the Assessment of Negative Symptoms (SANS) was developed by Nancy Andreasen and was first published in 1984.[15] SANS is a rating scale to measure negative symptoms in schizophrenia. It is split into five domains and within each domain; separate symptoms are rated from 0 (absent) to 5 (severe).

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (IBM-SPSS), version 20. First, the stability of the 18-item BPRS data for factor analysis was examined using the Bartlett's test of sphericity and the Kaiser–Mayer–Olkin measure of sampling adequacy. Factor analysis at baseline and across the intervals of the treatment follow-up was done using the maximum likelihood extraction and varimax rotation. A factor loading of >/=0.40 was used to determine the items in each factor. The scree plot determined the number of factors selected for rotation.

Results

Table 1 shows the socio-demographic characteristics of the study participants across the intervals of the treatment follow-up. The participants were mostly young, not living with a partner (74.4%), and unemployed (63.8%). Table 2 show the summary statistics (i.e., the mean and standard deviation) of the items of the BPRS across the intervals of treatment follow-up. The table shows that conceptual disorganization, emotional withdrawal, hallucinations, affective blunting, unusual thought content and psychomotor retardation had the highest mean scores at baseline. A 4-factor (negative, depressive/anxiety, manic and positive syndrome) model of psychopathology was demonstrated at the baseline [Table 3]. Factor 1 was comprised of 6 items that explained 23.2% of the variance, with factor loadings from 0.5 to 0.8. The overall variance explained by all the 4 factors was 55.5%. Table 4 shows the stability of the BPRS factors at the intervals of treatment follow-up. All the factors emerged in about the same sequence as at baseline, and they were stable, having at least 3 items loading >0.4, in meaningful constructs. At the cross-sectional level, four dimensions were delineated. However, at week 4, the psychosis factor (i.e., combination of positive and negative symptoms) emerged and remained invariant across the intervals of treatment follow-up. Similarly, the manic symptoms dimension was invariant across the intervals of treatment follow-up. For Factor 2, the depressive/anxiety dimension was split at week 4 into clear anxiety and depression components; but

Table 1: Characteristics of the study participants across intervals of measurement

Variables	Weeks				
	0	4	8	12	16
Sample size (*n*)	160	135	126	116	113
Mean age (SD)	31.2 (7.8)	30.8 (7.5)	31.2 (7.5)	31.5 (7.3)	31.5 (7.5)
Gender					
Male	78 (48.8%)	69 (51.1%)	63 (50.0%)	59 (50.9%)	57 (50.4%)
Female	82 (51.2%)	66 (48.9%)	63 (50.0%)	57 (49.1%)	56 (49.6%)
Marital status					
Not living with a partner	119 (74.4%)	101 (74.8%)	92 (73.0%)	87 (75.0%)	84 (74.3%)
Living with a partner	41 (25.6%)	34 (25.2%)	34 (27.0%)	29 (25.0%)	29 (25.7%)
Educational status					
≤6 years of education	41 (25.6%)	34 (25.2%)	33 (26.2%)	30 (25.9%)	30 (26.5%)
Above 6 years of education	119 (74.4%)	101 (74.8%)	93 (73.8%)	86 (74.1%)	83 (73.5%)
Employment status					
Unemployed	102 (63.8%)	90 (66.7%)	82 (65.1%)	74 (63.8%)	73 (64.6%)
Employed	58 (36.3%)	45 (33.3%)	44 (34.9%)	42 (36.2%)	40 (35.4%)

Table 2: Scores on the BPRS items at intervals of follow-up

Items	Weeks									
	0		4		8		12		16	
	M	SD	M	SD	M	SD	M	SD	M	SD
Somatic concern	1.7	1.3	1.5	0.9	1.6	0.9	1.3	0.9	1.2	1.0
Anxiety	1.6	1.4	1.1	0.9	1.1	0.9	0.9	0.8	0.9	1.0
Emotional withdrawal	4.9	1.2	3.5	1.8	2.6	2.0	2.4	2.2	2.1	2.3
Conceptual disorganization	5.0	1.3	3.4	1.9	2.4	2.2	2.2	2.4	2.0	2.4
Guilt feelings	0.6	1.0	0.3	0.6	0.3	0.9	0.1	0.3	0.1	0.4
Tension	1.4	1.1	1.2	1.1	1.1	1.0	1.1	1.0	0.8	1.0
Mannerism and posturing	2.5	2.0	1.4	1.7	1.0	1.6	0.9	1.4	0.7	1.3
Grandiosity	0.3	0.9	0.2	0.7	0.2	0.6	0.1	0.5	0.1	0.3
Depressive mood	1.6	1.4	1.0	1.0	0.7	1.0	0.6	0.9	0.5	0.8
Hostility	1.5	1.6	0.9	1.4	0.8	1.3	0.6	1.1	0.5	1.0
Suspiciousness	3.9	1.8	2.1	1.7	1.2	1.5	1.0	1.4	0.8	1.3
Hallucination	4.2	1.5	2.5	1.9	1.7	1.9	1.4	1.9	1.2	1.7
Motor retardation	4.1	1.3	3.1	1.6	2.3	1.8	2.0	1.9	1.7	1.9
Uncooperativeness	3.3	1.8	1.9	2.0	1.4	1.9	1.4	1.9	1.1	1.6
Unusual thought content	4.1	1.5	2.4	1.8	1.6	1.9	1.5	1.9	1.3	1.7
Blunted affect	4.1	1.2	2.9	1.8	2.3	2.0	2.0	2.1	1.7	1.9
Excitement	0.3	1.2	0.3	1.8	0.2	0.7	0.2	0.6	0.1	0.7
Disorientation	0.1	0.4	0.0	0.5	0.0	0.5	0.1	0.4	0.1	0.6

NB: M=mean; SD=standard deviation

was reunited as depression/anxiety at weeks 8, and 16. From the perspective of structural integrity of the factors, Table 5 shows that the χ2/df ratio for the model at intake was less than 2, while the values for the subsequent intervals were less than 4, which fulfills the goodness of fit requirement for acceptable fit.[16]

Discussion

The study was aimed at determining the factor structure of the BPRS at intake and the stability of these factors among incident cases of schizophrenia over a 16-week period. This was with a view to assessing whether the dimensions of schizophrenia psychopathology are stable enough over time, to (i) determine whether they are trait- or state-dependent and (ii) justify the broad dimensional assessments recommended in the DSM-5 and the molecular genetic search for the genetic basis for these dimensions. The highlights of the findings of this study are (1) a four-factor structure of psychopathology, namely negative, depression/anxiety, manic, and positive symptom dimensions, was demonstrated at the cross-sectional level at intake; (2) at week 4 of follow-up, a psychosis factor (from the merger of positive and negative symptoms) emerged and remained invariant across the treatment intervals; (3) the manic symptoms dimension remained invariant across intervals of follow-up, while the dimension of depression/anxiety was invariant at weeks 8, 12, and 16; and (4) the factors were stable and parsimonious, appearing in about the same sequence across time, while the models showed acceptable structural integrity, as they met the goodness-of-fit criterion of χ^2/df less than 4.[16]

The discussion is guided by the fact that differences in the literature with regard to factor structure are related to types of instruments used (e.g., BPRS or PANSS) and whether the subjects were from chronic or acutely ill populations. The finding of a four-factor model at the cross-sectional level in this study has been widely reported in the literature, following the seminal report of Liddle.[17] For example, from Spain, Ventura *et al*.[18] found a four-factor structure of positive, negative, agitation-mania, and depressive-anxiety among patients with schizophrenia. Although Van der Beek *et al*.[19] reported a five-factor structure, nevertheless, four-, five-, and six-factor structures have been reported in patients with schizophrenia,[20] However, it appears that the four-factor model is the most replicated.[18] The finding of similar symptom constructs among Nigerian and western patients with schizophrenia is an indication that these constructs are core to the disease and transcend cultural influence. In particular, our four dimensions at intake are similar to the dimensions recommended for assessment by the DSM-5.[5]

The emergence of the psychosis factor by week 4 is a reflection of the fact that, by that time, the group had shown significant response (i.e., over 50% reduction in BPRS scores).[21] Hence, it is reasonable to expect that this later dimension would persist across time, since the patients continued to show significant remission of

Table 3: Factor structure of BPRS among the study population at baseline

Items	Factors				Dimensions	% Variance explained by each factor
	1	2	3	4		
Motor retardation	**0.8**	-	-0.4	-	Negative symptoms	23.2
Emotional withdrawal	**0.8**	-0.2	-	-		
Blunted affect	**0.7**	-0.2	-0.2	0.1		
Uncooperativeness	**0.7**	-0.2	0.3	-		
Mannerism and posturing	**0.6**	-0.2	0.4	-0.1		
Conceptual disorganization	**0.5**	-0.4	0.3	-		
Anxiety	-0.2	**0.9**	-	0.1	Depressive/anxiety symptoms	13.4
Depressive mood	0.2	**0.7**	0-	-		
Guilt feelings	-	**0.7**	0.2	0.2		
Tension	-	**0.6**	0.4	-		
Somatic concern	-0.4	**0.6**	-	-		
Excitement	-	-	**0.7**	-	Manic symptoms	10.8
Hostility	0.2	-	**0.6**	-		
Grandiosity	-	-	**0.5**	0.2		
Disorientation	-	0.2	0.1	-		
Suspiciousness	-0.1	-	-	**0.8**	Positive symptoms	8.1
Unusual thought content	-	-	0.2	**0.7**		
Hallucinatory behavior	0.4	-	0.2	**0.5**		
					Cumulative variance	=55.5

Notes: Extraction method; maximum likelihood; rotation method; varimax with Kaiser normalization. loadings larger than 0.4 are in bold

Table 4: BPRS factor structure across intervals of treatment follow-up

	Weeks																			
	0				4				8				12				16			
	Factors				Factor				Factor				Factor				Factor			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
MR	**0.8**	-	-0.4	-	**0.9**	-	-	0.1	**0.9**	-	0.2	-	**0.7**	0.1	**0.6**	-0.01	**0.9**	0.1	0.2	-
EW	**0.8**	-0.2	-	-	**0.9**	0.1	-	-	**0.9**	-	0.1	0.2	**0.7**	-	**0.6**	-0.3	**0.9**	0.3	0.3	0.1
BA	**0.7**	-0.2	-0.2	0.1	**0.9**	0.1	-	-	**0.9**	-	-	0.2	**0.8**	-	**0.5**	-	**0.9**	0.2	0.2	0.2
UC	**0.7**	-0.2	0.3	-	**0.7**	0.4	-0.1	-	**0.8**	-	-	0.4	**0.9**	-	0.2	0.2	**0.8**	0.4	-	-
MP	**0.6**	-0.2	0.4	-0.1	**0.7**	0.2	-0.2	-	**0.8**	0.3	-0.2	0.3	**0.8**	-	0.2	0.3	**0.8**	0.4	-	-
CD	**0.5**	-0.4	0.3	-	**0.9**	0.3	-	-	**0.9**	-	-	0.2	**0.8**	-	0.4	0.3	**0.9**	0.3	0.3	0.1
Anxiety	-0.2	**0.9**	-	0.1	-0.1	-	**0.8**	-	-	0.3	**0.7**	0.2	0.2	**0.9**	0.2	**0.1**	-	0.3	**0.7**	-
DM	0.2	**0.7**	0-	-	0.2	-0.2	-	**0.9**	0.4	0.1	**0.5**	-	0.1	**0.5**	0.2	-	-	-	**0.5**	-
GF	-	**0.7**	0.2	0.2	-	-	0.2	**0.5**	0.1	0.4	**0.5**	-	-	**0.6**	-	-	-	-	**0.5**	0.1
Tension	-	**0.6**	0.4	-	0.2	0.2	**0.5**	0.2	0.4	0.3	**0.5**	-	0.4	**0.6**	0.3	0.3	0.4	0.4	**0.6**	-
SC	-0.4	**0.6**	-	-	-0.1	-0.2	**0.8**	0.1	-0.1	0.1	**0.8**	-	0.1	**0.8**	0.1	-0.1	0.2	-	**0.7**	0.1
Excitement	-	-	**0.7**	-	-	**0.6**	-	-	0.1	**0.8**	0.1	0.1	0.2	0.2	-0.1	**0.5**	-	0.2	0.1	**0.9**
Hostility	0.2	-	**0.6**	-	0.4	**0.7**	-	-	0.4	**0.6**	-	0.4	0.4	0.1	-	**0.5**	0.4	0.4	0.2	**0.6**
Grandiosity	-	-	**0.5**	0.2	0.1	**0.5**	-	0.2	-	**0.6**	0.3	0.1	0.2	-	-	**0.5**	0.1	-	0.1	**0.5**
Disorientation	-	0.2	0.1	-	-	0.4	-0.1	-	-	**0.7**	0.3	-	-	-	-0.1	-	0.1	-0.1	-	**0.8**
Suspiciousness	-0.1	-	-	**0.8**	**0.6**	0.4	0.3	0.1	**0.8**	0.3	0.3	**0.6**	**0.8**	0.3	0.2	-	**0.5**	**0.7**	0.3	-
UTC	-	-	0.2	**0.7**	**0.7**	0.4	0.3	-	**0.6**	0.2	0.3	**0.5**	**0.8**	0.2	0.1	-	**0.7**	**0.5**	0.2	-
HB	0.4	-	0.2	**0.5**	**0.8**	-	0.1	0.1	**0.5**	0.2	-	**0.5**	**0.9**	-	0.1	-	**0.7**	**0.6**	0.1	-

Notes: Extraction method; maximum likelihood; rotation method; varimax with Kaiser normalization. Loadings larger than 0.4 are in bold. EW=emotional withdrawal; UC=uncooperativeness; BA=blunted affect; MR=motor retardation; CD=conceptual disorganization; DM=depressed mood; GF=guilt feelings; SC=somatic concern; UTC=unusual thought content; MP=mannerism and posturing; HB=hallucinatory behavior

symptoms. This psychosis dimension is akin to the old conception of unitary psychosis[22], and the results of recent family and genome-wide association studies (GWAS) seem to provide molecular genetic support for it.[2,3]

While the manic syndrome was the most enduring factor, the depression/anxiety dimension first separated into its component constructs (of anxiety vs. depression) at week 4, but was strongly evident by weeks 8, 12, and

Table 5: Goodness-of-fit indices for the 18-item Brief Psychiatric Rating Scale (BPRS; configural invariance)

Time	χ^2	df	χ^2/df	*P*
Baseline	164.21	87	1.88	<0.001
Week 4	297.45	87	3.42	<0.001
Week 8	309.71	87	3.56	<0.001
Week 12	283.16	87	3.25	<0.001
Week 16	311.95	87	3.59	<0.001

16. This underscores the popular idea of comorbidity in schizophrenia and the need to assess these patients for mood symptoms at intervals of follow-up. Substantial evidence shows that schizophrenia and mood disorders distributed across a multi-dimensional spectra.[23,24] In this regard, recent GWAS reports have provided support for the sharing of genes between schizophrenia and mood disorders.[2] Studies have shown the persistence of depressive symptoms across all phases (pre-, acute, and post-psychotic) of schizophrenia.[25,26] In a longitudinal follow-up study, the persistence of depressive symptoms was found in 80% of the participants.[25] Depression in schizophrenia has always been a challenge to psychiatric nosology. However, many factor analytic studies of psychosis have identified depressive-anxiety symptoms as a distinct dimension. The presence of distinct anxiety-depression dimension challenges the Kraepelian dichotomy and supports the introduction of this dimension in the DSM-5.[5]

Generally, there is support for the factorial invariance of the four-factor model in the literature. For example, Van der Does *et al*.,[7] found that a four-factor model, consisting of positive, negative, depressive, and disorganization dimensions, remained invariant over a year of follow-up. Similarly, Long *et al*.[8] demonstrated that the four-factor model was invariant over three years. Hence, the clinical studies and molecular genetic studies appear to support the idea that these dimensions are trait-dependent in schizophrenia, thereby providing an explanation for the widely noted comorbidity of the symptoms of psychopathology. As usual, there are some discordant findings in the literature as Czobor and colleague failed to find invariance of their five-factor structure of BPRS over four points of treatment follow-up.[27] Also, a previous Nigerian 3-month naturalistic follow-up study of 102 acutely ill schizophrenia patients, involving a combination of items of the BPRS, SANS, and ICD-10, found a five-factor model at baseline, which was not stable over the time period.[28,29]

Limitations

This study used exploratory factor analysis at each interval of follow-up to examine factorial invariance; though it is simple and acceptable, a confirmatory factor analysis (CFA) is the gold standard. In this regard, we used the maximum likelihood method of factor analysis, because it provides a measure of structural integrity that is at the heart of the CFA method, namely χ^2/df ratio, and the results indicated an acceptable level of "good fit." We note that a longer period of follow-up would have provided more information about factor invariance.

Contributors

Justus Uchenna Onu was the principal investigator. However, the first and second authors contributed to the study design, analysis, and interpretation of data and drafting the manuscript. All the authors approved the final draft for submission.

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Conflicts of interest

There are no conflicts of interest.

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