



Rasch analysis of anxiety scales in Parkinson's disease

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ABSTRACT

Objective: Anxiety is a common non-motor symptom in Parkinson's disease (PD). This study analyzed the measurement properties of three frequently used anxiety scales in PD: the Beck Anxiety Inventory (BAI), the Hamilton Anxiety Rating Scale (HARS), and the Hospital Anxiety and Depression Scale—Anxiety subscale (HADS-A).

Method: The Rasch model was applied to a multicenter international cohort of 342 patients and assessed the following aspects: fit to the Rasch model, unidimensionality, reliability, response category ordering, item local independence, differential item functioning, and scale targeting.

Results: In their original form, the BAI, HARS, and HADS-A, did not fit the Rasch model. A good fit to the Rasch model was only found after significant modifications, including rescoring some items and deleting those failing to fit the model. For the BAI and HADS-A, these adjustments resulted in unidimensionality. The HARS was not unidimensional and separate analyses were performed for its psychic and somatic subscales. Whereas the somatic anxiety subscale fit the Rasch model, this was achieved for the psychic anxiety subscale after modifications.

Conclusion: None of the currently used anxiety scales display satisfactory measurement properties for assessing anxiety in PD. The results suggest the need to develop a new disease-specific scale for measuring anxiety in PD.

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Introduction

Parkinson's disease (PD) is a neurodegenerative disorder characterized by motor dysfunction as well as a high prevalence of neuropsychiatric disturbances including depression, anxiety, psychosis and cognitive decline. For clinical and research care, it is critical that valid and reliable scales are available to assess neuropsychiatric symptoms in patients with PD [1].

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Anxiety is one of the most prevalent psychiatric symptoms in PD; up to 34% of all PD patients suffer from an anxiety disorder, as defined by DSM-IV-TR criteria [2,3]. Several generic anxiety scales have been used as screening and assessment tools in PD patients, but there are no specific tools for use in the PD population. Two well-known and commonly used anxiety scales in the psychiatric and general population, the Beck Anxiety Inventory (BAI) [4], and the Hospital Anxiety and Depression Scale—Anxiety subscale (HADS-A) [5], were recognized as “suggested” scales for screening by a Movement Disorders Society task force evaluating anxiety rating scales for PD patients. The task force classified another anxiety scale, the Hamilton Anxiety Rating Scale (HARS) [6], as a “suggested” scale for measuring the severity of anxiety symptoms. No anxiety scale met the criteria for “recommended”, mainly because of the absence of validation studies in PD samples [3].

Recent validation studies of these anxiety scales in PD patients demonstrated good results for some, but not all, parameters [7–11]. All studies but one [7] used a classic test theory (CTT) approach. CTT assumes that each person has a true score, which would be obtained if there were no error in the measurements. A draw-back of CTT, however, is that item and person statistics are sample-dependent, and neither the true score nor the measurement error can be determined accurately [12]. Traditionally, CTT studies report on reliability, validity and sensitivity to change (along with acceptability and other parameters), mostly based on correlational and mean-difference analyses. The application of the Rasch measurement model [13], combined with the CTT approach, is currently considered the standard for developing and assessing patient outcome report measures [12].

According to the Rasch model, the probability that a person will give a certain response is a logistic function of the difference between the person's ability and the item parameter [13]. For anxiety scales, the person's ability is the experienced anxiety level and the item parameter represents the level of anxiety assessed by that item. Rasch analysis and CTT provide information on different psychometric aspects of the measure. Thus, both approaches are important to have insight in the qualities of the scale. Most questionnaires developed from a CTT approach use raw sum-scores, which are at the ordinal level. Scales that fit the Rasch model provide results in a linear scale, which allows the use of parametric statistics and the calculation of change scores. Excellent tutorials for Rasch analysis applied to health scales are available [14–16].

This study used Rasch analysis to explore and report the measurement properties of three commonly used anxiety scales in PD. The main hypothesis tested in this study is that the BAI, HARS and HADS-A fit the Rasch model and show adequate measurement properties when applied to PD patients. Specifically, the following parameters were analyzed for each scale: fit to the Rasch model, reliability, appropriateness of the response scale, local independence of items, item bias, and scale targeting. In case the scales do not fit the Rasch model, appropriate modifications will be proposed and assessed. A previous study, using the same data set, focused on psychometric properties of the scales under the CTT paradigm [9].

Method

Participants

The study was approved by the institutional review boards from the Maastricht University Medical Centre, the Netherlands (principal center), and all other participating institutions. The study followed a cross-sectional, multicenter design [9,17,18]. The sample was formed by 342 patients who gave informed consent and were diagnosed with idiopathic PD according to the Queen's Square Brain Bank criteria [19]. Data were collected from a total of six centers located in the United States, Europe and Australia. PD patients with other neurodegenerative disorders and severe cognitive decline were excluded.

Assessment

Demographic, clinical information on PD history, and current psychiatric and cognitive status were collected and the three anxiety rating scales, BAI, HARS, and HADS-A, were administered as described previously [9,17,18].

The BAI, a 21-item self-report scale, evaluates somatic, affective, and cognitive symptoms associated with panic attacks and generalized anxiety [4]. The scale items are rated from 0 to 3. The HARS consists of 14 clinician-rated items designed to quantify the severity of anxiety symptoms [6]. Items are rated in a 0–4 Likert-type scale. The scale is formed by two 7-item subscales, measuring the psychic (items 1–6 and 14) and somatic (items 7–13) components of anxiety. The HADS-A is the anxiety subscale of the HADS, designed to screen

for mood disorders in non-psychiatric patients [5]. The HADS-A is formed by 7 self-report items, rated in a 0–3 Likert-type scale. For all scales, higher total sum-scores indicate more anxiety.

Statistical analysis

Rasch analysis was performed with RUMM2020 version 4.1, Build 194 for Windows as statistical software [20], using a step-by-step approach [14]. The following aspects were assessed: i) fit to the Rasch model; ii) unidimensionality [21]; iii) reliability measured through the person separation index (PSI); iv) ordering of response categories; v) local independence of items; vi) differential item functioning (DIF) by sex, age, and PD duration (groups defined by the medians: age, 66 years; PD duration: 7 years); and vii) scale targeting. A brief explanation for each parameter is provided below; more detailed explanations can be found elsewhere [14–16].

The unrestricted partial credit model for polytomous data was used, after confirmation with the likelihood ratio test [22]. This model, applied when items are answered in response scales with more than two options, allows for different scoring schemes (for example, some items with 2 and others with 3 response categories) and different thresholds for the items. A threshold is the transitional point where the probability of scoring two adjacent response categories is the same [23].

A good fit was considered when summary and individual chi-square statistics were non-significant with Bonferroni adjustment, and individual item and person fit-residuals were within the ± 2.5 range [15]. The chi-square test is used to see how data fit the Rasch model, and a fit residual is a measure of what is left over after fitting the data to the model. Therefore, we expect to have a non-significant chi-square test and low fit residuals. Items with fit residuals below 2.5 indicate redundancy, whereas fit residuals above 2.5 indicate that the item is measuring a different construct than the others. This was also inspected visually, through item characteristic curves.

Unidimensionality means that the scale measures one construct, which allows items to be summed. It was formally tested through principal component analysis of the residuals after the first Rasch factor is removed [21,24]. Two sets of items are defined according to the positive and negative loadings, and the person abilities (experienced anxiety level) of the two sets of items are compared through t-tests. For a scale to be unidimensional, the lower bound of the 95% binomial confidence interval for the observed number of significant t-tests should fall below 5% [21,24].

Rasch analysis provides a measure of reliability, the PSI, which is interpreted similarly to the Cronbach's alpha. The PSI indicates the extent to which items can differentiate different levels of anxiety, in this case. A value of 0.85 or more is considered satisfactory for single subject comparisons, and 0.70 for group comparisons.

Rasch analysis further allows verification of whether the ordering of response categories works as expected. Disordered response categories, identified by observation of the category probability curve graphic for each item, indicate that respondents were not able to discriminate between the response categories because of their high number, or confusing labels (for example, mildly and moderately). This may be corrected by collapsing adjacent categories, which generally improves global model fit. This was the first modification performed.

For items to be locally independent, there should be no further item associations once the variance explained by the Rasch factor is removed. In other words, the answer to one item should not determine the answer to others. Values above +0.3 in the residual correlation matrix were taken as the presence of local dependency. In this case, locally dependent items were merged into a testlet or super item, a bundle of items which combine the responses into a single one.

In DIF analysis, we want to see if persons with different characteristics (in terms of sex, age and disease duration) respond in the same

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