Validation Study of the Official Korean Version of the Movement Disorder Society-Unified Parkinson’s Disease Rating Scale

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Background and Purpose The Movement Disorder Society-Sponsored Revision of the Unified Parkinson’s Disease Rating Scale (MDS-UPDRS) is widely used for estimating the symptoms of Parkinson’s disease. Translation and validation of the MDS-UPDRS is necessary for non-English speaking countries and regions. The aim of this study was to validate the Korean version of the MDS-UPDRS.

Methods Altogether, 362 patients in 19 centers were recruited for this study. We translated the MDS-UPDRS to Korean using the translation-back translation method and cognitive pre-testing. We performed both confirmatory and exploratory factor analyses to validate the scale. We calculated the comparative fit index (CFI) for confirmatory factor analysis, and used un-weighted least squares for exploratory factor analysis.

Results The CFI was higher than 0.90 for all parts of the scale. Exploratory factor analysis also showed that the Korean MDS-UPDRS has the same number of factors in each part as the English version.

Conclusions The Korean MDS-UPDRS has the same overall structure as the English MDS-UPDRS. Our translated scale can be designated as the official Korean MDS-UPDRS.

Key Words Parkinson’s disease, Movement Disorder Society Sponsored Revision of the Unified Parkinson’s Disease Rating Scale, validation, rating scale.
INTRODUCTION

Parkinson's disease (PD) is characterized by various motor and nonmotor symptoms and is the second most common neurodegenerative disease. Estimating the severity of PD is challenging due to the heterogenic nature of its clinical presentation, which includes motor and nonmotor symptoms as well as motor complications. PD severity could only be assessed in interviews and using a clinical scale to evaluate the abilities to perform simple tasks. The Unified Parkinson's Disease Rating Scale (UPDRS) was introduced in the 1980s and has become the most commonly used clinical scale for estimating the motor and nonmotor symptoms of PD patients. In 2001, a taskforce sponsored by the Movement Disorder Society (MDS) highlighted some limitations and strengths of the UPDRS. A new version of the UPDRS was proposed, with the revised scale called the Movement Disorder Society Sponsored Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS). The MDS-UPDRS includes the strengths of the UPDRS and improves its many drawbacks, and shows acceptable validity and reliability. The MDS-UPDRS is currently the official clinical scale used to analyze symptoms of PD, and it has been widely used in research and clinical settings.

The MDS-UPDRS comprises four parts. Part I (nonmotor aspects of experiences of daily living) and part II (motor aspects of experiences of daily living) comprise questionnaires that should be completed by patients or caregivers, and so it is crucial that simple and common expressions are used in parts I and II to obtain accurate information. The use of easily understood expressions in part III (motor examination) and part IV (motor complications) of the MDS-UPDRS is also important for translation and validation purposes. These parts are used by general clinicians and movement experts for clinical and research purposes.

The MDS-UPDRS has been translated and validated in many countries after considering language and culture differences, including into language version for Italian, Chinese, Dutch, German, French, Hebrew, Japanese, and Korean. The Italian, Hebrew, and Japanese versions of the MDS-UPDRS have demonstrated validity and reliability.

The prevalence of PD among the older population above 60 years is 1.4% in Korea, and this is increasing more rapidly than the crude prevalence rate. Public awareness of the roles of age and education level in the prevalence of PD in Korea is also increasing, and the demand for using the MDS-UPDRS is expected to increase. The present study aimed to validate the Korean version of the MDS-UPDRS using factor analyses.

METHODS

Study design
This validation style had an observational, cross-sectional design. Translation of the MDS-UPDRS into Korean was performed in three stages: 1) translation and back-translation, 2) cognitive pretesting, and 3) large-scale validation testing. Stages 1 and 2 were performed by a task force comprising the Korean Movement Disorder Society in collaboration with the MDS. For stage 3, we enrolled 362 native-Korean-speaking PD patients selected from 17 centers in Korea to perform both confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) for the validation. We also evaluated the internal consistency to determine the reliability of the scale using Cronbach's alpha coefficient. This study was approved by the Institutional Review Board at each center, and all participants provided written informed consent (IRB no.: HY 2014-02-002-008).

Stage 1: translation protocol
We translated the original MDS-UPDRS into Korean using the translation–back-translation method. The two teams that independently performed translation and back-translation consisted of members of the Korean Movement Disorder Society. All members of the teams were experts in movement disorders, and at least one investigator on each team was fluent in English. The translation team first translated the original MDS-UPDRS into Korean, and then the back-translation team retranslated the Korean MDS-UPDRS into English. These translation and retranslation processes were performed blindly. After finishing the translation–retranslation processes, the teams compared the Korean MDS-UPDRS with the original English version and corrected mismatches.

Stage 2: cognitive pretesting
Cognitive pretesting is a qualitative approach to assessing instrument usability (or ease of completion) in terms of task difficulty for both the examiner and respondent. This pretesting method also assesses the interest, attention span, discomfort, and comprehension of the respondents. Ten PD patients and three raters were interviewed, and a scale from 1 point to 6 points was used to rate the difficulty during cognitive pretesting. When differences were observed between the back-translated Korean version and the original English version of the MDS-UPDRS, items and questions that were identified as potentially difficult in the cognitive-testing section of the English version were selected for cognitive pretesting. Topics included in the cognitive pretesting were cognitive impairment, anxiety, features of dopamine dysregulation syndrome, handwriting, freezing, hand movements, rising from a chair, postural
stability, time spent with dyskinesia, and functional impact of dyskinesia.

Based on the results of the initial cognitive pretesting, additional rounds of translation, back-translation, and cognitive pretesting were required for the selected items. The final translation was considered to have been achieved when cognitive pretesting was completed and no problems were noted. After pretesting, the all translators collaborated to correct it and adapt it to Korean culture.

**Stage 3: factor analyses and large-scale validation testing**

This study applied both CFA and EFA, with the analyses performed using M-plus software (version 7). The unweighted least-squares (ULS) approach was used to estimate the minimum sum of the squared differences between the observed and estimated correlation matrices. We interpreted these factors used orthogonal Crawford-Ferguson (CF) varimax rotation, which restricts the uncorrelated factors. The sample size for the translation study was determined based on five subjects per item of the questionnaire being needed to perform the statistical analyses. Because the MDS-UPDRS contains 65 items, a sample of at least 325 participants was required. This study had a nationwide multicenter design, and so based on an estimated maximum dropout rate of 20%, 390 was set as the target sample size.

Any participant with missing values for any part of the MDS-UPDRS was excluded from the analysis of only that part, which meant that the sample size could vary between different parts of the scale. The investigators obtained approval from all participants to collect their data. Anonymized data that did not include patient names or medical record numbers were transferred to the analysis team via a secure website.

**Primary analysis**

The primary analysis of the Korean MDS-UPDRS data was performed using a CFA to determine if the factor structure for the English MDS-UPDRS could be confirmed based on the data collected using the Korean translation. This was the primary interest. The CFA was conducted separately for parts I and IV of the MDS-UPDRS, with the Korean data limited to factors defined by the English-language data. We evaluated the CFA results using the comparative fit index (CFI). According to the protocol, to establish a successful translated version and to designate that as the official translated version of the MDS-UPDRS, the CFI values for parts I to IV of the translated MDS-UPDRS were required to be at least 0.90 when compared with the English version. We also investigated the root-mean-square error approximation (RMSEA) for the CFA. The mean and variance-adjusted weighted least-squares (WLSMV) estimator was used to confirm the model fit.

**Secondary analysis**

We conducted an EFA of the Korean version of the MDS-UPDRS (parts I–IV) to explore the underlying factor structure without the limitation of a prespecified factor structure. We produced a scree plot of the English version and used information from it to choose the number of factors to retain for each part of the MDS-UPDRS. The subjective scree test uses a scatter plot of eigenvalues versus their ranks with regard to magnitude to extract as many factors as there are eigenvalues that decrease before the last large decrease like elbow shape occurs in the plot. An item was retained for a chosen factor if the factor loading for that item was at least 0.40. The interpretation of the factors was assisted by using an orthogonal CF varimax rotation, which sets the factors to be uncorrelated.

The ULS estimator is the default used for factor analysis in M-plus. When the ULS estimator converges, it yields more accurate parameter estimates and standard errors than when using the WLSMV estimator. However, the convergence rate is generally better for the WLSMV than the ULS estimator. If convergence does not occur, it is suggested that the maximum likelihood (ML) should be used because this method may converge when the ULS estimator does not. The ULS algorithm did converge in the present study, but this was to an incorrect value (i.e., it explained more than 100% of the variance), and so the ML was used.

**RESULTS**

**Cognitive pretesting**

Ten PD patients and three raters were interviewed using the structured interview format that is typical used for cognitive pretesting. Cognitive pretesting produced acceptable results for most of the scale items. The overall cognitive pretesting score for all items was 5.5±1.3 (mean±standard deviation). However, two items had relatively low scores: dopamine dysregulation (4.7±1.1) and postural stability (5.1±0.3). The feedback from the responders indicated that the dopamine regulation item had problems with privacy infringement, while the postural stability item had problems caused by long sentences. After these two items were modified to make them easier to understand, no items were identified as problematic during the second round of testing.

The modified version of the scale was approved by the MDS as the Official Working Draft of the Korean MDS-UPDRS that was administered to a larger group of PD patients for further testing. After cognitive pretesting, this translated Korean MDS-UPDRS was posted on the official MDS homepage and shared before large-scale validation was performed.
The Korean data set contained information obtained from 390 native Korean-speaking PD patients who were examined using the MDS-UPDRS. The data from 28 of these 390 participants were excluded due to incorrect or missing information, and so finally 362 PD patients were enrolled.

The demographic information of the participants (all of whom were Korean) is presented in Table 1. Table 2 presents the distributions of item responses provided by the Korean-speaking and English-speaking groups.

### Table 1. Demographic data of the study participants

|                        | Korean (n=362) | English (n=876) | p     |
|------------------------|---------------|-----------------|-------|
| Sex, male/female       | 150/212       | 554/322         | <0.01*|
| Age, years             | 68.3±9.5      | 67.5±10.9       | 8.15  |
| Disease duration, years| 6.1±4.0       | 8.3±6.7         | 5.10  |
| Education level, years | 8.1±4.82      |                 |       |
| Hoehn and Yahr stage   | 2.2±0.99      |                 |       |
| MDS-UPDRS part III score | 25.6±15.35    |                 |       |

Data are n or mean±standard-deviation values.
*Chi-squared test.
MDS-UPDRS: Movement Disorder Society Sponsored Revision of the Unified Parkinson’s Disease Rating Scale.

### Table 2. Distributions of responses to the MDS-UPDRS according to language

|               | English | Korean | English | Korean | English | Korean | English | Korean | English | Korean | English | Korean | English | Korean |
|---------------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|
| **Part I**    |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
| Cognitive impairment | 0 428 48.86 | 159 43.9 | 0 212 24.20 | 177 48.9 | 1 256 29.22 | 129 35.6 | 1 216 24.66 | 96 26.5 | 2 121 13.81 | 48 13.3 | 2 364 41.55 | 70 19.3 | 3 53 6.05 | 23 6.4 |
|                | 3 53 6.05 | 23 6.4 | 3 59 6.74 | 15 4.1  | 4 17 1.94 | 2 0.6  | 4 16 1.83 | 4 1.1  | 999 1 0.11 | 1 0.3  | 999 9 1.03 | 0 0.0  | 999 1 0.11 | 1 0.3  |
| Daytime sleepiness |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
| **Hallucinations and psychosis** |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 0 687 78.42 | 291 80.4 | 0 303 34.59 | 170 47.0 | 1 89 10.16 | 42 11.6 | 1 289 32.99 | 109 30.1 | 2 51 5.82 | 19 5.3  | 2 130 14.84 | 59 16.3 | 3 35 4.00 | 8 2.2  |
| Pain and other sensations |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 4 13 1.48 | 2 0.6  | 4 39 4.45 | 0 0.0  | 999 1 0.11 | 0 0.0  | 999 9 1.03 | 0 0.0  | Total | 876 100.00 | 362 100.0 | Total | 876 100.00 | 362 100.0 |
| **Depressed mood** |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 0 471 53.77 | 182 50.3 | 0 325 37.10 | 150 41.4 | 1 265 30.25 | 123 34.0 | 1 281 32.08 | 114 31.5 | 2 81 9.25 | 38 10.5 | 2 137 15.64 | 75 20.7 | 3 45 5.14 | 18 5.0  |
| Urinary problems   |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 4 12 1.37 | 0 0.0  | 4 38 4.34 | 3 0.8  | 999 2 0.23 | 1 0.3  | 999 7 0.80 | 1 0.3  | Total | 876 100.00 | 362 100.0 | Total | 876 100.00 | 362 100.0 |
| **Anxious mood** |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 0 413 47.15 | 183 50.6 | 0 362 43.84 | 128 35.4 | 1 307 35.05 | 123 34.0 | 1 287 32.76 | 111 30.7 | 2 96 10.96 | 43 11.9 | 2 119 13.58 | 75 20.7 | 3 41 4.68 | 12 3.3  |
| Constipation problems |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 4 17 1.94 | 1 0.3  | 4 9 1.03 | 2 0.6  | 999 2 0.23 | 0 0.0  | 999 7 0.80 | 0 0.0  | Total | 876 100.00 | 362 100.0 | Total | 876 100.00 | 362 100.0 |
| **Apathy** |         |        |         |        |         |        |         |        |         |        |         |        |         |        |
|                | 0 584 66.67 | 240 66.3 | 0 490 55.94 | 198 54.7 | 1 141 16.10 | 67 18.5 | 1 216 24.66 | 107 29.6 | 2 88 10.05 | 36 9.9  | 2 103 11.76 | 48 13.3 |
Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

| Features of dopamine dysregulation syndrome | English | Korean | English | Korean |
|--------------------------------------------|--------|--------|--------|--------|
| 0                                          | 747    | 317    | 217    | 125    |
| 1                                          | 57     | 19     | 335    | 121    |
| 2                                          | 44     | 14     | 184    | 75     |
| 3                                          | 19     | 11     | 81     | 35     |
| 4                                          | 6      | 0      | 50     | 5      |
| 999                                        | 3      | 1      | 9      | 1      |
| Total                                      | 876    | 362    | 876    | 362    |

| Sleep problems                             |        |        |        |        |
|--------------------------------------------|--------|--------|--------|--------|
| 0                                          | 280    | 141    | 227    | 141    |
| 1                                          | 202    | 93     | 289    | 99     |
| 2                                          | 207    | 88     | 185    | 59     |
| 3                                          | 140    | 38     | 81     | 43     |
| 4                                          | 40     | 1      | 84     | 20     |
| 999                                        | 7      | 1      | 10     | 0      |
| Total                                      | 876    | 362    | 876    | 362    |

| Part II                                     |        |        |        |        |
|--------------------------------------------|--------|--------|--------|--------|
| Speech                                     |        |        |        |        |
| 0                                          | 252    | 151    | 227    | 141    |
| 1                                          | 236    | 126    | 289    | 99     |
| 2                                          | 233    | 55     | 185    | 59     |
| 3                                          | 126    | 30     | 81     | 43     |
| 4                                          | 22     | 1      | 84     | 20     |
| 999                                        | 7      | 0      | 10     | 0      |
| Total                                      | 876    | 362    | 876    | 362    |

| Saliva and drooling                         |        |        |        |        |
|--------------------------------------------|--------|--------|--------|--------|
| 0                                          | 341    | 177    | 277    | 181    |
| 1                                          | 115    | 94     | 378    | 116    |
| 2                                          | 203    | 62     | 111    | 40     |
| 3                                          | 157    | 25     | 55     | 20     |
| 4                                          | 53     | 4      | 50     | 5      |
| 999                                        | 7      | 0      | 5      | 0      |
| Total                                      | 876    | 362    | 876    | 362    |

| Eating tasks                                |        |        |        |        |
|--------------------------------------------|--------|--------|--------|--------|
| 0                                          | 363    | 184    | 180    | 142    |
| 1                                          | 265    | 122    | 317    | 120    |
### Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

| Part | English | Korean | English | Korean |
|------|---------|--------|---------|--------|
|      | n %     | n %    | n %     | n %    |
| **Dressing** | | | | |
| 0    | 220     | 25.11  | 151     | 41.7   | 0     | 184  | 21.00 | 123  | 34.0 |
| 1    | 322     | 36.76  | 149     | 41.2   | 1     | 336  | 38.36 | 147  | 40.6 |
| 2    | 211     | 24.09  | 40      | 11.1   | 2     | 105  | 11.99 | 58   | 16.0 |
| 3    | 76      | 8.68   | 21      | 5.8    | 3     | 172  | 19.63 | 24   | 6.6  |
| 4    | 42      | 4.79   | 0       | 0.0    | 4     | 74   | 8.45  | 10   | 2.8  |
| 999  | 5       | 0.57   | 1       | 0.3    | 999  | 6    | 0.68  | 1    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
| **Hygiene** | | | | |
| 0    | 342     | 39.04  | 184     | 50.8   | 0     | 453  | 51.71 | 236  | 65.2 |
| 1    | 367     | 41.89  | 117     | 32.3   | 1     | 182  | 20.78 | 72   | 19.9 |
| 2    | 88      | 10.05  | 46      | 12.7   | 2     | 89   | 10.16 | 37   | 10.2 |
| 3    | 33      | 3.77   | 14      | 3.9    | 3     | 90   | 10.27 | 10   | 2.8  |
| 4    | 38      | 4.34   | 1       | 0.3    | 4     | 56   | 6.39  | 7    | 1.9  |
| 999  | 8       | 0.91   | 0       | 0.0    | 999  | 6    | 0.68  | 0    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
| **Handwriting** | | | | |
| 0    | 161     | 18.38  | 101     | 27.9   | 0     | 453  | 51.71 | 236  | 65.2 |
| 1    | 251     | 28.65  | 172     | 47.5   | 1     | 182  | 20.78 | 72   | 19.9 |
| 2    | 222     | 25.34  | 66      | 18.2   | 2     | 89   | 10.16 | 37   | 10.2 |
| 3    | 146     | 16.67  | 18      | 5.0    | 3     | 90   | 10.27 | 10   | 2.8  |
| 4    | 87      | 9.93   | 5       | 1.4    | 4     | 56   | 6.39  | 7    | 1.9  |
| 999  | 9       | 1.03   | 0       | 0.0    | 999  | 6    | 0.68  | 0    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
| **Speech** | | | | |
| 0    | 189     | 21.58  | 111     | 30.7   | 0     | 422  | 48.17 | 220  | 60.8 |
| 1    | 379     | 43.26  | 180     | 49.7   | 1     | 245  | 27.97 | 94   | 26.0 |
| 2    | 213     | 24.32  | 67      | 18.5   | 2     | 78   | 8.90  | 28   | 7.7  |
| 3    | 69      | 7.88   | 4       | 1.1    | 3     | 71   | 8.11  | 10   | 2.8  |
| 4    | 22      | 2.51   | 0       | 0.0    | 4     | 55   | 6.28  | 10   | 2.8  |
| 999  | 4       | 0.46   | 0       | 0.0    | 999  | 5    | 0.57  | 0    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
| **Facial expression** | | | | |
| 0    | 96      | 10.96  | 60      | 16.6   | 0     | 202  | 23.06 | 94   | 26.0 |
| 1    | 300     | 34.25  | 192     | 53.0   | 1     | 351  | 40.07 | 178  | 49.2 |
| 2    | 361     | 41.21  | 90      | 24.9   | 2     | 167  | 19.06 | 59   | 16.3 |
| 3    | 89      | 10.16  | 19      | 5.3    | 3     | 97   | 11.07 | 21   | 5.8  |
| 4    | 26      | 2.97   | 1       | 0.3    | 4     | 55   | 6.28  | 10   | 2.8  |
| 999  | 4       | 0.46   | 0       | 0.0    | 999  | 5    | 0.57  | 0    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
| **Rigidity: neck** | | | | |
| 0    | 260     | 29.68  | 144     | 39.8   | 0     | 655  | 74.77 | 255  | 70.4 |
| 1    | 300     | 34.25  | 192     | 53.0   | 1     | 351  | 40.07 | 178  | 49.2 |
| 2    | 361     | 41.21  | 90      | 24.9   | 2     | 167  | 19.06 | 59   | 16.3 |
| 3    | 89      | 10.16  | 19      | 5.3    | 3     | 97   | 11.07 | 21   | 5.8  |
| 4    | 26      | 2.97   | 1       | 0.3    | 4     | 55   | 6.28  | 10   | 2.8  |
| 999  | 4       | 0.46   | 0       | 0.0    | 999  | 5    | 0.57  | 0    | 0.0  |
| Total| 876     | 100.00 | 362     | 100.0  | 876  | 100.0| 362   | 100.0|
|                  | English | Korean |                  | English | Korean |
|------------------|---------|--------|------------------|---------|--------|
|                  | n      | %     |                  | n      | %     |
| 1                | 247    | 28.20 |                  | 95     | 10.84 |
|                  | 274    | 31.28 |                  | 60     | 6.85  |
|                  | 73     | 8.33  |                  | 26     | 2.97  |
| 4                | 16     | 1.83  |                  | 38     | 4.34  |
|                  | 6      | 0.68  | 999              | 2      | 0.23  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Rigidity: RUE    |         |        | Postural stability |       |        |
| 0                | 176    | 20.09 |                  | 422    | 48.17 |
|                  | 282    | 32.19 |                  | 157    | 17.92 |
|                  | 342    | 39.04 |                  | 96     | 10.68 |
|                  | 69     | 7.88  | 4                 | 149    | 17.01 |
|                  | 6      | 0.68  | 999              | 2      | 0.23  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Rigidity: LUE    |         |        | Posture |         |        |
| 0                | 205    | 23.40 |                  | 173    | 19.75 |
|                  | 268    | 30.59 |                  | 337    | 38.47 |
|                  | 317    | 36.19 |                  | 279    | 31.85 |
|                  | 77     | 8.79  | 3                 | 132    | 14.97 |
|                  | 4      | 0.46  | 999              | 0      | 0.00  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Rigidity: RLE    |         |        | Global spontaneity of movement |       |        |
| 0                | 272    | 31.05 |                  | 108    | 12.33 |
|                  | 248    | 28.31 |                  | 278    | 31.74 |
|                  | 275    | 31.39 |                  | 279    | 31.85 |
|                  | 67     | 7.65  | 3                 | 184    | 21.00 |
|                  | 4      | 0.46  | 999              | 0      | 0.00  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Rigidity: LLE    |         |        | Postural tremor: right hand |       |        |
| 0                | 286    | 32.65 |                  | 544    | 62.10 |
|                  | 227    | 25.91 |                  | 262    | 29.91 |
|                  | 275    | 31.39 |                  | 43     | 4.91  |
|                  | 75     | 8.56  | 3                 | 23     | 2.63  |
|                  | 11     | 1.26  | 4                 | 1      | 0.11  |
|                  | 2      | 0.23  | 999              | 3      | 0.34  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Finger tapping: right hand |        |        | Postural tremor: left hand |       |        |
| 0                | 122    | 13.93 |                  | 518    | 59.13 |
|                  | 342    | 39.04 |                  | 276    | 31.51 |
|                  | 252    | 28.77 |                  | 49     | 5.59  |
|                  | 144    | 16.44 | 4                 | 29     | 3.31  |
|                  | 15     | 1.71  | 999              | 3      | 0.34  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
| Finger tapping: left hand |        |        | Kinetic tremor: right hand |       |        |
| 0                | 108    | 12.33 |                  | 546    | 62.33 |
|                  | 1      | 0.11  | 999              | 3      | 0.34  |
| Total            | 876    | 100.00| 362              | 100.00 |        |
Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

|                      | English | Korean |                      | English | Korean |
|----------------------|---------|--------|----------------------|---------|--------|
|                      | n %     | n %    |                      | n %     | n %    |
| Hand movements: right hand |         |        | Kinetic tremor: left hand |         |        |
| 0                    | 187     | 21.35  | 122                  | 33.7    | 0      | 586    | 66.89  | 262    | 72.4  |
| 1                    | 346     | 39.50  | 169                  | 46.7    | 1      | 112    | 12.79  | 71     | 19.6  |
| 2                    | 250     | 28.54  | 76                   | 21.0    | 2      | 121    | 13.81  | 25     | 6.9   |
| 3                    | 125     | 14.27  | 16                   | 4.4     | 3      | 53     | 6.05   | 4      | 1.1   |
| 4                    | 25      | 2.85   | 5                    | 1.4     | 4      | 3      | 0.34   | 0      | 0.0   |
| 999                  | 1       | 0.11   | 0                    | 0.0     | 999    | 1      | 0.11   | 0      | 0.0   |
| Total                | 876     | 100.00 | 362                  | 100.0   | Total  | 876    | 100.00 | 362    | 100.0 |
| Hand movements: left hand |         |        | Rest tremor amplitude: RUE |         |        |
| 0                    | 164     | 18.72  | 122                  | 33.7    | 0      | 586    | 66.89  | 262    | 72.4  |
| 1                    | 311     | 35.50  | 143                  | 39.5    | 1      | 112    | 12.79  | 71     | 19.6  |
| 2                    | 250     | 28.54  | 76                   | 21.0    | 2      | 121    | 13.81  | 25     | 6.9   |
| 3                    | 125     | 14.27  | 16                   | 4.4     | 3      | 53     | 6.05   | 4      | 1.1   |
| 4                    | 25      | 2.85   | 5                    | 1.4     | 4      | 3      | 0.34   | 0      | 0.0   |
| 999                  | 1       | 0.11   | 0                    | 0.0     | 999    | 1      | 0.11   | 0      | 0.0   |
| Total                | 876     | 100.00 | 362                  | 100.0   | Total  | 876    | 100.00 | 362    | 100.0 |
| Pronation–supination movements: right hand |         |        | Rest tremor amplitude: LUE |         |        |
| 0                    | 199     | 22.72  | 111                  | 30.7    | 0      | 603    | 68.84  | 242    | 66.9  |
| 1                    | 335     | 38.24  | 185                  | 51.1    | 1      | 120    | 13.70  | 69     | 19.1  |
| 2                    | 216     | 24.66  | 57                   | 15.8    | 2      | 99     | 11.30  | 44     | 12.2  |
| 3                    | 107     | 12.21  | 9                    | 2.5     | 3      | 45     | 5.14   | 7      | 1.9   |
| 4                    | 17      | 1.94   | 0                    | 0.0     | 4      | 5      | 0.57   | 0      | 0.0   |
| 999                  | 2       | 0.23   | 0                    | 0.0     | 999    | 4      | 0.46   | 0      | 0.0   |
| Total                | 876     | 100.00 | 362                  | 100.0   | Total  | 876    | 100.00 | 362    | 100.0 |
| Pronation–supination movements: left hand |         |        | Rest tremor amplitude: RLE |         |        |
| 0                    | 162     | 18.49  | 115                  | 31.8    | 0      | 777    | 88.70  | 313    | 86.5  |
| 1                    | 297     | 33.90  | 145                  | 40.1    | 1      | 52     | 5.94   | 37     | 10.2  |
| 2                    | 235     | 26.83  | 72                   | 19.9    | 2      | 35     | 4.00   | 12     | 3.3   |
| 3                    | 150     | 17.12  | 30                   | 8.3     | 3      | 9      | 1.03   | 0      | 0.0   |
| 4                    | 29      | 3.31   | 0                    | 0.0     | 4      | 0      | 0.00   | 0      | 0.0   |
| 999                  | 3       | 0.34   | 0                    | 0.0     | 999    | 3      | 0.34   | 0      | 0.0   |
| Total                | 876     | 100.00 | 362                  | 100.0   | Total  | 876    | 100.00 | 362    | 100.0 |
| Toe tapping: right foot |         |        | Rest tremor amplitude: LLE |         |        |
| 0                    | 168     | 19.18  | 145                  | 40.1    | 0      | 795    | 90.75  | 309    | 85.4  |
| 1                    | 323     | 36.87  | 147                  | 40.6    | 1      | 46     | 5.25   | 33     | 9.1   |
| 2                    | 228     | 26.03  | 64                   | 17.7    | 2      | 20     | 2.28   | 17     | 4.7   |
| 3                    | 129     | 14.73  | 6                    | 1.7     | 3      | 12     | 1.37   | 3      | 0.9   |
| 4                    | 27      | 3.08   | 0                    | 0.0     | 4      | 0      | 0.00   | 0      | 0.0   |
| 999                  | 1       | 0.11   | 0                    | 0.0     | 999    | 3      | 0.34   | 0      | 0.0   |
| Total                | 876     | 100.00 | 362                  | 100.0   | Total  | 876    | 100.00 | 362    | 100.0 |
| Toe tapping: left foot |         |        | Rest tremor amplitude: lip/jaw |         |        |
| 0                    | 154     | 17.58  | 138                  | 38.1    | 0      | 780    | 89.04  | 318    | 87.9  |
| Language | English | % | Korean | % | English | % | Korean | % |
|----------|---------|---|--------|---|---------|---|--------|---|
| 1        | 251     | 28.65 | 117    | 32.3 | 1       | 7.19 | 38     | 10.5 |
| 2        | 268     | 30.59 | 85     | 23.5 | 2       | 20.5 | 6      | 1.7  |
| 3        | 154     | 17.58 | 20     | 5.5  | 3       | 1.48 | 0      | 0.0  |
| 4        | 46      | 5.25  | 2      | 0.6  | 4       | 1.11 | 0      | 0.0  |
| 999      | 3       | 0.34  | 0      | 0.0  | 999     | 1.11 | 0      | 0.0  |
| Total    | 876     | 100.00 | 362    | 100.0 | Total   | 876 | 100.00 | 362 | 100.0 |

**Leg agility: right leg**

| Language | English | % | Korean | % | English | % | Korean | % |
|----------|---------|---|--------|---|---------|---|--------|---|
| 0        | 250     | 28.54 | 187    | 51.7 | 0       | 46.69 | 174    | 48.1 |
| 1        | 329     | 37.56 | 121    | 33.4 | 1       | 24.43 | 115    | 31.8 |
| 2        | 190     | 21.69 | 48     | 13.3 | 2       | 10.39 | 50     | 13.8 |
| 3        | 86      | 9.82  | 4      | 1.1  | 3       | 9.70  | 14     | 3.9  |
| 4        | 18      | 2.05  | 2      | 0.6  | 4       | 7.65  | 9      | 2.5  |
| 999      | 3       | 0.34  | 0      | 0.0  | 999     | 1.14  | 0      | 0.0  |
| Total    | 876     | 100.00 | 362    | 100.0 | Total   | 876 | 100.00 | 362 | 100.0 |

**Leg agility: left leg**

| Language | English | % | Korean | % | English | % | Korean | % |
|----------|---------|---|--------|---|---------|---|--------|---|
| 0        | 216     | 24.66 | 173    | 47.8 | 0       | 18.84 | 35     | 9.7  |
| 1        | 298     | 34.02 | 121    | 33.4 | 1       | 9.25  | 35     | 9.7  |
| 2        | 213     | 24.32 | 54     | 14.9 | 2       | 10.39 | 50     | 13.8 |
| 3        | 106     | 12.10 | 11     | 3.0  | 3       | 9.70  | 14     | 3.9  |
| 4        | 38      | 4.34  | 3      | 0.8  | 4       | 7.65  | 9      | 2.5  |
| 999      | 5       | 0.57  | 0      | 0.0  | 999     | 1.14  | 0      | 0.0  |
| Total    | 876     | 100.00 | 362    | 100.0 | Total   | 876 | 100.00 | 362 | 100.0 |

**Part IV**

| Time spent with dyskinesia | Functional impact of fluctuations | English | % | Korean | % | English | % | Korean | % |
|----------------------------|-----------------------------------|---------|---|--------|---|---------|---|--------|---|
| 0                          | 563                               | 64.27   | 248 | 68.5   | 0 | 433     | 49.43 | 264    | 72.9 |
| 1                          | 173                               | 19.75   | 53  | 14.6   | 1 | 165     | 18.84 | 35     | 9.7  |
| 2                          | 87                                | 9.93    | 36  | 9.9    | 2 | 81      | 9.25  | 35     | 9.7  |
| 3                          | 27                                | 3.08    | 18  | 5.0    | 3 | 119     | 13.58 | 22     | 6.1  |
| 4                          | 17                                | 1.94    | 7   | 1.9    | 4 | 63      | 7.19  | 6      | 1.7  |
| 999                        | 9                                 | 1.03    | 0   | 0.0    | 999 | 1.14    | 0      | 0      | 0.0  |
| Total                      | 876                               | 100.00  | 362 | 100.0  | Total | 876 | 100.00 | 362 | 100.0 |

| Functional impact of dyskinesia | Complexity of motor fluctuations | English | % | Korean | % | English | % | Korean | % |
|----------------------------------|----------------------------------|---------|---|--------|---|---------|---|--------|---|
| 0                                | 695                               | 79.34   | 274 | 75.7   | 0 | 404     | 46.12 | 238    | 65.8 |
| 1                                | 90                                | 10.27   | 35  | 9.7    | 1 | 291     | 33.22 | 85     | 23.5 |
| 2                                | 29                                | 3.31    | 26  | 7.2    | 2 | 69      | 7.88  | 34     | 9.4  |
| 3                                | 46                                | 5.25    | 19  | 5.3    | 3 | 50      | 5.71  | 5      | 1.4  |
| 4                                | 5                                 | 0.57    | 8   | 2.2    | 4 | 46      | 5.25  | 0      | 0.0  |
| 999                              | 11                                | 1.26    | 0   | 0.0    | 999 | 1.83    | 0      | 0      | 0.0  |
| Total                            | 876                               | 100.00  | 362 | 100.0  | Total | 876 | 100.00 | 362 | 100.0 |

| Time spent in the off state | Painful off-state dystonia | English | % | Korean | % | English | % | Korean | % |
|------------------------------|----------------------------|---------|---|--------|---|---------|---|--------|---|
| 0                            | 383                         | 43.72   | 235 | 64.9   | 0 | 680     | 77.63 | 309    | 85.4 |
| 1                            | 341                         | 38.93   | 77  | 21.3   | 1 | 114     | 13.01 | 29     | 8.0  |
| 2                            | 106                         | 12.10   | 38  | 10.5   | 2 | 45      | 5.14  | 16     | 4.4  |
| 3                            | 22                          | 2.51    | 8   | 2.2    | 3 | 13      | 1.48  | 8      | 2.2  |
| 4                            | 14                          | 1.60    | 4   | 1.1    | 4 | 15      | 1.71  | 0      | 0.0  |
| 999                          | 10                          | 1.14    | 0   | 0.0    | 999 | 1.03    | 0      | 0      | 0.0  |
| Total                        | 876                         | 100.00  | 362 | 100.0  | Total | 876 | 100.00 | 362 | 100.0 |

LLE: left lower extremity, LUE: left upper extremity, MDS-UPDRS: Movement Disorder Society Sponsored Revision of the Unified Parkinson's Disease Rating Scale, RLE: right lower extremity, RUE: right upper extremity.
DISCUSSION

This study found that the translated Korean MDS-UPDRS shows acceptable validity in factor analyses. The CFA showed that all parts of the Korean MDS-UPDRS are consistent with all parts of the English MDS-UPDRS, while the EFA extracted the same number of factors from the Korean and English versions of the MDS-UPDRS. The MDS proposed a unified statistical method for translating the MDS-UPDRS into another language. Compared with previous reports of the MDS-UPDRS for other languages, the CFI values for all parts of the Korean MDS-UPDRS exceeded 0.90, indicating significant consistency. The Korean MDS-UPDRS therefore shares a common structure with the English MDS-UPDRS.

This study was conducted at ten centers across Korea. Most of the participants were female, which is similar to previous studies involving Asian populations.12,13 This female predominance could be due to several confounding factors, including genetic susceptibility, environmental factors, and preventative factors.13

A few mismatches were detected during cognitive pretesting of the Korean translation of the MDS-UPDRS. Dopamine dysregulation syndrome is an unfamiliar term in Korean, with "dysregulation" in particularly not being commonly used in Korea. We therefore changed that term to a more natural expression during cognitive pretesting. Moreover, there is only a former term for postural stability in Korean, and so we rephrased it into a colloquial expression.

The distributions for the following items differed between the Korean and English versions of the MDS-UPDRS: daytime sleepiness, cognitive impairment, hallucination, and depressive mood in part I; turning in and getting out of bed, speech, dressing, handwriting, walking/balance, and freezing in part II; toe tapping, leg agility, and postural stability in part III; and complexity of motor fluctuations, time spent in the off state, time spent with dyskinesia, and functional impact of dyskinesia in part IV. The difference in the "turning in and getting out of bed" item may have been caused by cultural differences. Most Koreans sleep on a Korean-style mattress on the floor rather than on a bed, and so sleeping on a Korean-style mattress makes getting out of bed more difficult. The differences in other items may have been caused by language differences. The terms "tapping," "agility," "complexity," "fluctuation," "off state," "postural stability," and "dyskinesia" are more difficult to translate into Korean and are not easy to understand. Several items in part I, including cognitive impairment, hallucination, and depressive mood, are usually rated by caregivers rather than by the patients themselves. Caregivers can be easily affected by the medical environment or healthcare system in their own country. "Time spent with dyskinesia" and

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**Table 3. Confirmatory factor analysis model fit**

| Part I: nonmotor aspects of experiences of daily living (two-factor model)* |  |
|---|---|
| Korean MDS-UPDRS CFI=0.91, RMSEA=0.08 (356 patients) |  |
| English MDS-UPDRS CFI=0.96, RMSEA=0.06 (849 patients) |  |

| Part II: motor aspects of experiences of daily living (three-factor model) |  |
|---|---|
| Korean MDS-UPDRS CFI=0.96, RMSEA=0.14 (359 patients) |  |
| English MDS-UPDRS CFI=0.97, RMSEA=0.09 (851 patients) |  |

| Part III: motor examination (seven-factor model) |  |
|---|---|
| Korean MDS-UPDRS CFI=0.92, RMSEA=0.09 (360 patients) |  |
| English MDS-UPDRS CFI=0.95, RMSEA=0.07 (801 patients) |  |

| Part IV: motor complications (two-factor model) |  |
|---|---|
| Korean MDS-UPDRS CFI=0.99, RMSEA=0.11 (362 patients) |  |
| English MDS-UPDRS CFI=1.00, RMSEA=0.04 (848 patients) |  |

*Dopamine dysregulation syndrome was not included in this analysis since it did not load onto any factor.

CFI: comparative fit index, MDS-UPDRS: Movement Disorder Society Sponsored Revision of the Unified Parkinson’s Disease Rating Scale, RMSEA: root-mean-square error approximation.
Fig. 1. Scree plot of the Korean and English Movement Disorder Society Sponsored Revision of the Unified Parkinson's Disease Rating Scale, from which two factors were extracted for part I (nonmotor aspects of experiences of daily living) (A), three factors for part II (motor aspects of experiences of daily living) (B), seven factors for part III (motor examination) (C), and two factors for part IV (motor complications) (D).
DRS. be designated as the official Korean version of the MDS-UPDRS. The version validated in the present study can be used for future studies of the interrater and intrarater reliabilities. The Cronbach’s alpha coefficient indicated excellent internal consistency. How-ever, future studies of the interrater and intrarater reliabilities are necessary. The version validated in the present study can be designated as the official Korean version of the MDS-UPDRS.

**Table 4. Cronbach’s alpha coefficients for the four parts of the Korean MDS-UPDRS**

| MDS-UPDRS | Cronbach’s alpha coefficient | Number of items |
|-----------|------------------------------|----------------|
| Part I    | 0.73                         | 13             |
| Part II   | 0.90                         | 13             |
| Part III  | 0.94                         | 33             |
| Part IV   | 0.88                         | 6              |
| Total     | 0.94                         | 65             |

MDS-UPDRS: Movement Disorder Society Sponsored Revision of the Unified Parkinson’s Disease Rating Scale.

“time spent in the off state” are usually obtained from patients, which can cause an informative bias because many patients with PD have cognitive dysfunction during the motor-complications stage. It is particularly interesting that these differences were not similar to those of the Japanese validation study, which indicates that differences in culture and language between countries should always be considered when translating the MDS-UPDRS. However, the discrepancies did not affect the validation of the Korean MDS-UPDRS in the present study.

The good fitness of the model was indicated by the CFI values exceeding 0.90 for all parts of the Korean MDS-UPDRS. The RMSEA values for parts II and IV were relatively high, but we decided to use the CFI to evaluate statistical significance. Variability from sample to sample was expected during the EFA, and we identified isolated item differences in the factor structures of the Korean and English versions of the MDS-UPDRS. Several items had cross-loading for multiple factors in the Korean scale, which might have been due to inherent differences between the Korean and English languages as well as cultural differences. However, scree plots of the Korean version revealed that two, three, seven, and two factors in parts I, II, III, and IV, respectively, were similar to those for the English version (Fig. 1). Both the EFA and CFA demonstrated that the Korean and English versions of the MDS-UPDRS share a common structure. The Korean MDS-UPDRS is available at the official MDS webpage (https://www.movementdisorders.org/MDS/MDS-Rating-Scales/MDS-Unified-Parkinsons-Disease-Rating-Scale-MDS-UPDRS.htm).

The high CFI values (all >0.90) obtained in the CFA for all four parts of the Korean MDS-UPDRS indicate that the overall factor structure of the Korean version of the MDS-UPDRS is consistent with that of the English version. Moreover, the EFA also showed that the number of factors was the same in each part of the Korean and English versions. Cronbach’s alpha coefficient indicated excellent internal consistency. However, future studies of the interrater and intrarater reliabilities are necessary. The version validated in the present study can be designated as the official Korean version of the MDS-UPDRS.

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**Conflicts of Interest**

The authors have no potential conflicts of interest to disclose.

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