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 pretesting. 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 unweighted 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 diease, 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.[1] In 2001, a taskforce sponsored by the Movement Disorder Society (MDS) highlighted some limitations and strengths of the UPDRS.[2] 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).[3] The MDS-UPDRS includes the strengths of the UPDRS and improves its many drawbacks, and shows acceptable validity and reliability.[4] 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.[5-7]

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.[8] 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.[9] 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.[10] 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.[11] 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	8.12±4.82		
Hoehn and Yahr stage	2.23±8.99		
MDS-UPDRS part III score	25.67±15.35		

Data are n or mean±standard-deviation values.
*Chi-squred 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	
	n	%	n	%		n	%	n	%
Part I									
Cognitive impairment					Daytime sleepiness				
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	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
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Hallucinations and psychosis					Pain and other sensations				
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	3	106	12.10	24	6.6
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					Urinary problems				
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	3	88	10.05	19	5.3
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					Constipation problems				
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	3	70	7.99	46	12.7
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					Light headedness on standing				
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)

	English n	English %	Korean n	Korean %		English n	English %	Korean n	Korean %
3	52	5.94	18	5.0	3	51	5.82	9	2.5
4	8	0.91	0	0.0	4	9	1.03	0	0.0
999	3	0.34	1	0.3	999	7	0.80	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Features of dopamine dysregulation syndrome					Fatigue				
0	747	85.27	317	87.6	0	217	24.77	125	34.5
1	57	6.51	19	5.3	1	335	38.24	121	33.4
2	44	5.02	14	3.9	2	184	21.00	75	20.7
3	19	2.17	11	3.0	3	81	9.25	35	9.7
4	6	0.68	0	0.0	4	50	5.71	5	1.4
999	3	0.34	1	0.3	999	9	1.03	1	0.3
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Sleep problems									
0	280	31.96	141	39.0					
1	202	23.06	93	25.7					
2	207	23.63	88	24.3					
3	140	15.98	38	10.5					
4	40	4.57	1	0.3					
999	7	0.80	1	0.3					
Total	876	100.00	362	100.0					
Part II									
Speech					Doing hobbies and other activities				
0	252	28.77	151	41.7	0	227	25.91	141	39.0
1	236	26.94	126	34.8	1	289	32.99	99	27.4
2	233	26.60	55	15.2	2	185	21.12	59	16.3
3	126	14.38	30	8.3	3	81	9.25	43	11.9
4	22	2.51	0	0.0	4	84	9.59	20	5.5
999	7	0.80	0	0.0	999	10	1.14	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Saliva and drooling					Turning in bed				
0	341	38.93	177	48.9	0	277	31.62	181	50.0
1	115	13.13	94	26.0	1	378	43.15	116	32.0
2	203	23.17	62	17.1	2	111	12.67	40	11.1
3	157	17.92	25	6.9	3	55	6.28	20	5.5
4	53	6.05	4	1.1	4	50	5.71	5	1.4
999	7	0.80	0	0.0	999	5	0.57	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Chewing and swallowing					Tremor				
0	549	62.67	255	70.4	0	189	21.58	114	31.5
1	230	26.26	81	22.4	1	360	41.10	157	43.4
2	54	6.16	24	6.6	2	212	24.20	62	17.1
3	34	3.88	2	0.6	3	72	8.22	18	5.0
4	3	0.34	0	0.0	4	36	4.11	10	2.8
999	6	0.68	0	0.0	999	7	0.80	1	0.3
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Eating tasks					Getting out of bed				
0	363	41.44	184	50.8	0	180	20.55	142	39.2
1	265	30.25	122	33.7	1	317	36.19	120	33.2

Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

	English		Korean			English		Korean	
	n	%	*n*	%		*n*	%	*n*	%
2	187	21.35	44	12.2	2	199	22.72	66	18.2
3	42	4.79	12	3.3	3	104	11.87	28	7.7
4	10	1.14	0	0.0	4	70	7.99	5	1.4
999	9	1.03	0	0.0	999	6	0.68	1	0.3
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Dressing					Walking and balance				
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	5	0.57	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Hygiene					Freezing				
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	Total	876	100.00	362	100.0
Handwriting									
0	161	18.38	101	27.9					
1	251	28.65	172	47.5					
2	222	25.34	66	18.2					
3	146	16.67	18	5.0					
4	87	9.93	5	1.4					
999	9	1.03	0	0.0					
Total	876	100.00	362	100.0					
Part III									
Speech					Rising from a chair				
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	Total	876	100.00	362	100.0
Facial expression					Gait				
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	4	0.46	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Rigidity: neck					Freezing of gait				
0	260	29.68	144	39.8	0	655	74.77	255	70.4

Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

	English n	English %	Korean n	Korean %		English n	English %	Korean n	Korean %
1	247	28.20	151	41.7	1	95	10.84	65	18.0
2	274	31.28	52	14.4	2	60	6.85	23	6.4
3	73	8.33	14	3.9	3	26	2.97	12	3.3
4	16	1.83	1	0.3	4	38	4.34	7	1.9
999	6	0.68	0	0.0	999	2	0.23	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Rigidity: RUE					Postural stability				
0	176	20.09	100	27.6	0	422	48.17	201	55.5
1	282	32.19	178	49.2	1	157	17.92	74	20.4
2	342	39.04	76	21.0	2	60	6.85	40	11.1
3	69	7.88	8	2.2	3	149	17.01	40	11.1
4	6	0.68	0	0.0	4	86	9.82	7	1.9
999	1	0.11	0	0.0	999	2	0.23	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Rigidity: LUE					Posture				
0	205	23.40	103	28.5	0	173	19.75	75	20.7
1	268	30.59	182	50.3	1	337	38.47	174	48.1
2	317	36.19	66	18.2	2	206	23.52	86	23.8
3	77	8.79	9	2.5	3	125	14.27	18	5.0
4	7	0.80	2	0.6	4	33	3.77	9	2.5
999	2	0.23	0	0.0	999	2	0.23	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Rigidity: RLE					Global spontaneity of movement				
0	272	31.05	175	48.3	0	108	12.33	58	16.0
1	248	28.31	146	40.3	1	278	31.74	172	47.5
2	275	31.39	35	9.7	2	279	31.85	106	29.3
3	67	7.65	6	1.7	3	184	21.00	17	4.7
4	10	1.14	0	0.0	4	27	3.08	8	2.2
999	4	0.46	0	0.0	999	0	0.00	1	0.3
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Rigidity: LLE					Postural tremor: right hand				
0	286	32.65	167	46.1	0	544	62.10	185	51.1
1	227	25.91	146	40.3	1	262	29.91	146	40.3
2	275	31.39	38	10.5	2	43	4.91	29	8.0
3	75	8.56	9	2.5	3	23	2.63	2	0.6
4	11	1.26	2	0.6	4	1	0.11	0	0.0
999	2	0.23	0	0.0	999	3	0.34	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Finger tapping: right hand					Postural tremor: left hand				
0	122	13.93	81	22.4	0	518	59.13	174	48.1
1	342	39.04	165	45.6	1	276	31.51	150	41.4
2	252	28.77	83	22.9	2	49	5.59	30	8.3
3	144	16.44	32	8.8	3	29	3.31	8	2.2
4	15	1.71	0	0.0	4	1	0.11	0	0.0
999	1	0.11	1	0.3	999	3	0.34	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Finger tapping: left hand					Kinetic tremor: right hand				
0	108	12.33	84	23.2	0	546	62.33	213	58.8

Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

	English		Korean			English		Korean	
	n	%	*n*	%		*n*	%	*n*	%
1	298	34.02	134	37.0	1	265	30.25	127	35.1
2	265	30.25	94	26.0	2	46	5.25	19	5.3
3	181	20.66	46	12.7	3	13	1.48	2	0.6
4	22	2.51	4	1.1	4	2	0.23	1	0.3
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
Hand movements: right hand					Kinetic tremor: left hand				
0	187	21.35	122	33.7	0	493	56.28	200	55.3
1	346	39.50	169	46.7	1	293	33.45	133	36.7
2	231	26.37	54	14.9	2	72	8.22	25	6.9
3	98	11.19	16	4.4	3	14	1.60	3	0.8
4	12	1.37	0	0.0	4	0	0.00	1	0.3
999	2	0.23	1	0.3	999	4	0.46	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	0.8
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

Table 2. Distributions of responses to the MDS-UPDRS according to language (continued)

	English		Korean			English		Korean	
	n	%	*n*	%		*n*	%	*n*	%
1	251	28.65	117	32.3	1	63	7.19	38	10.5
2	268	30.59	85	23.5	2	18	2.05	6	1.7
3	154	17.58	20	5.5	3	13	1.48	0	0.0
4	46	5.25	2	0.6	4	1	0.11	0	0.0
999	3	0.34	0	0.0	999	1	0.11	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Leg agility: right leg					Constancy of rest tremor				
0	250	28.54	187	51.7	0	409	46.69	174	48.1
1	329	37.56	121	33.4	1	214	24.43	115	31.8
2	190	21.69	48	13.3	2	91	10.39	50	13.8
3	86	9.82	4	1.1	3	85	9.70	14	3.9
4	18	2.05	2	0.6	4	67	7.65	9	2.5
999	3	0.34	0	0.0	999	10	1.14	0	0.0
Total	876	100.00	362	100.0	Total	876	100.00	362	100.0
Leg agility: left leg									
0	216	24.66	173	47.8					
1	298	34.02	121	33.4					
2	213	24.32	54	14.9					
3	106	12.10	11	3.0					
4	38	4.34	3	0.8					
999	5	0.57	0	0.0					
Total	876	100.00	362	100.0					
Part IV									
Time spent with dyskinesia					Functional impact of fluctuations				
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	15	1.71	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				
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	16	1.83	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				
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	9	1.03	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.

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.

Factor analysis

Confirmatory factor analysis

Table 3 lists the CFA models for each part of the MDS-UP-DRS. The CFI values for all four parts of the Korean MDS-UPDRS in comparisons with the factor structure of the English version were at least 0.91. Since our prespecified criterion was a CFI of at least 0.90, we concluded that the pre-specified factor structure of the English version of the MDS-UPDRS was confirmed in the Korean data set.

Exploratory factor analysis

Our EFA of the Korean data set differed from the EFA of the English-language data set in some areas (Fig. 1). From the scree plots, we extracted two factors for part I (nonmotor aspects of experiences of daily living) (Fig. 1A), three factors for part II (motor aspects of experiences of daily living) (Fig. 1B), seven factors for part III (motor examination) (Fig. 1C), and two factors for part IV (motor complications) (Fig. 1D).

The factor structure of part I was consistent with that of the English version of the MDS-UPDRS. In part II, "hand-writing, doing hobbies, and other activities" loaded onto factor 2 but not factor 1; "tremor" did not load onto any of the factors; and "dressing and hygiene" loaded onto factor 2 but not factor 3. In part III, "rest tremor amplitude (lip/jaw)" did not load onto any of the factors, and nine items loaded onto multiple factors. For part IV, the factor structure was consistent with that of the English version of the MDS-UPDRS. We evaluated the internal consistency to determine reliability and obtained Cronbach's alpha coefficient for the MDS-UPDRS; this was 0.94, which indicated the presence of excellent internal consistency (Table 4).

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
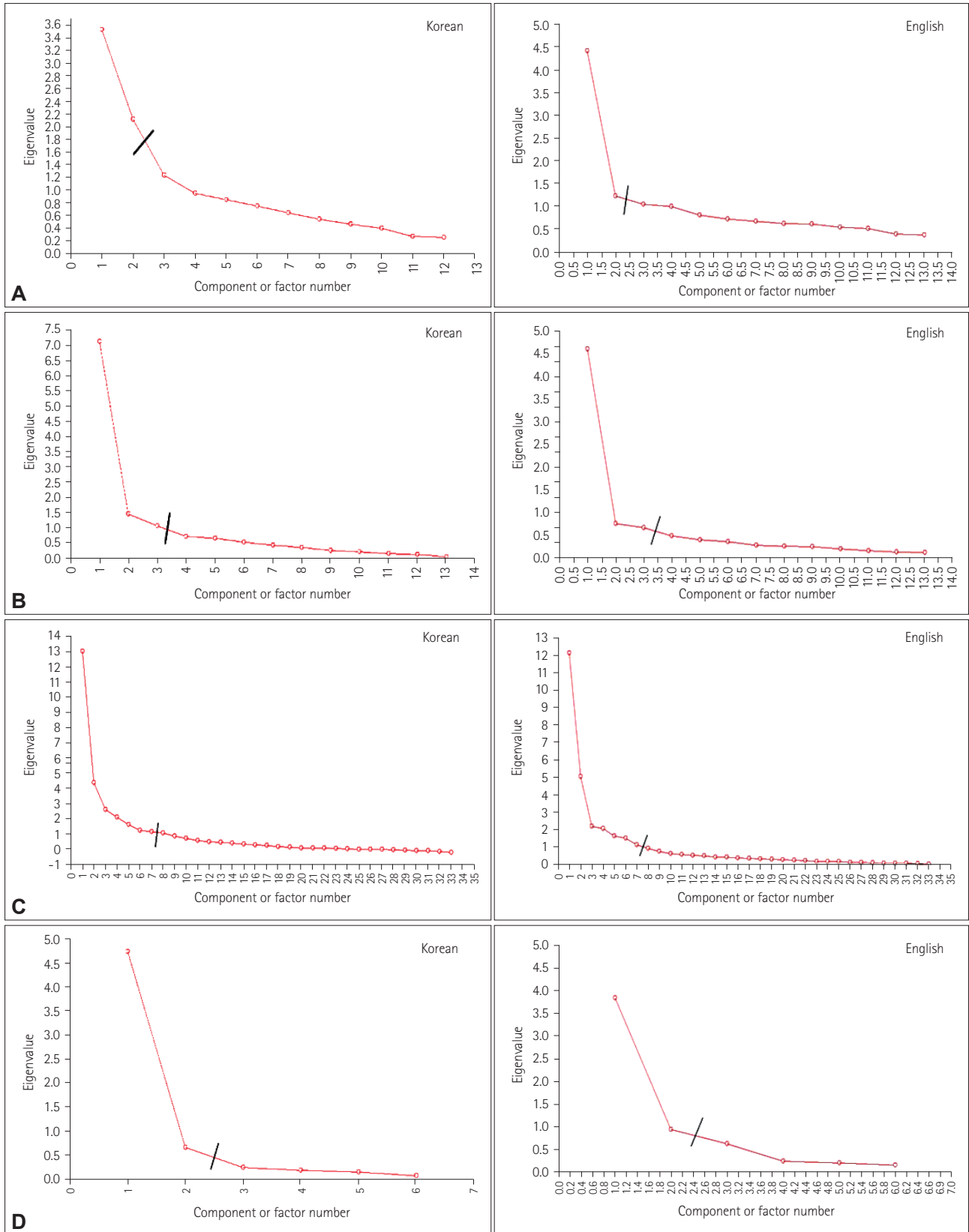
Fig. 1. Scree plot of the Korean and English Movement Disorder Society Sponsored Revision of the Unified Parkinson's Disease Rating Scale, from which two factors were extracted for part I (nonmotor aspects of experiences of daily living) (A), three factors for part II (motor aspects of experiences of daily living) (B), seven factors for part III (motor examination) (C), and two factors for part IV (motor complications) (D).

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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