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Adaptation of the Caregiver Version of the Starkstein Apathy Scale (SAS) into Turkish and Investigation of Its Reliability and Validity in Parkinson's Disease

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ABSTRACT

Objective: Our study aimed to adapt the caregiver version of the Starkstein Apathy Scale (SAS) to Turkish culture and examine its validity and reliability.

Method: 45 patients were diagnosed with Parkinson's Disease (PD), and 40 healthy individuals and their relatives participated in the study. The questions were changed from first-person to third-person statements without any changes. Confirmatory factor analysis was performed for construct validity in the validity analysis. Discriminant validity was performed with a healthy control group. The relationship with the Neuropsychiatric Inventory (NPI) apathy subtest was examined for criterion-dependent validity analysis. In the reliability analysis of the scale, Cronbach's alpha internal consistency analysis was performed. A Receiver Operating Characteristic (ROC) analysis was conducted to determine the cut-off value of the scale.

Results: During the validity and reliability studies, it was observed that items 3 and 13 were incompatible with other factors, reduced the model fit, and were removed from the scale due to low internal consistency. In the analysis with 12 items, a three-factor structure was obtained as 'motivation', 'behavioral', and 'cognitive'. In confirmatory factor analysis, the fit values of the scale were Comparative Fit Index (CFI) =1.000, Normed Fit Index (NFI) = 0.963, and Root Mean Square Error Approximation (RMSEA)= 0.000. Consequently, the study, the Cronbach's alpha coefficient of the scale was found to be 0.84. The discriminant validity analysis found a difference between the clinical and control groups. A positive correlation was found with the NPI Apathy subscale used for criterion-dependent validity. A cut-off value of 11 points with a sensitivity of 71.15% and specificity of 95% was recommended for 12 items.

Conclusion: Our study showed that the SAS Caregiver is a valid and reliable scale for PD patients and can be utilized in clinical and scientific studies.

Keywords: Apathy, Parkinson disease, reliability, validity

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INTRODUCTION

Parkinson's Disease is one of the most common neurodegenerative diseases characterized by motor and non-motor symptoms (1). Apathy is one of the most important non-motor symptoms affecting PD patients, and its prevalence is reported to be 17%- 70% (2). Apathy significantly affects patients and caregivers, decreasing daily activities and quality of life (3,4).

Apathy is characterized by decreased interest, emotion, and motivation that cannot be associated with reduced consciousness, cognitive impairment, and emotional disturbance (5). Levy and Dubois (6) defined apathy as a "quantitative decrease in spontaneous voluntary and purposeful behaviors" and examined apathy in three subtypes: auto-activation, emotional, and cognitive. In patients with apathy, behaviors such as lack of interest and anxiety, indifference and difficulty in initiating and maintaining goal-oriented behavior, poor social participation, emotional blunting, and lack of insight manifest themselves (7,8).

Apathy is not considered as a symptom of another disorder, such as depression and dementia, but as a syndrome on its own (9). However, the confusion of non-specific symptoms of apathy with depression may make early diagnosis difficult and lead to inadequate understanding (10). Apathy assessment tools have been developed to solve this situation. Among these tools, Neuropsychiatric Inventory (NPI) and Apathy Evaluation Scale (AES) are used to evaluate apathy in our country. Among the apathy assessment tools, only the Starkstein Apathy Scale meets the criteria for PD patients to be "recommended" (11). The SAS is a shortened version of the AES. It is widely used to assess apathy, especially in PD patients. The scale consists of 14 items and is based on a four-point likert

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Highlights

- **Items 3 and 13 were removed from the scale due to low internal consistency.**
- **Three factors were obtained: motivational, behavioral, and cognitive.**
- **The Cronbach's Alpha coefficient of the scale was 0.84.**
- **A positive correlation was found with the NPI Apathy subscale.**

scale (never, rarely, occasionally, a lot). A response of 'never' in the first eight questions indicates severe apathy. In questions 9-14, the scoring is reversed, and a reaction of 'a lot' corresponds to more severe apathy. The score obtained from the scale is between 0 and 42, with a higher score indicating more apathy. The SAS is the most appropriate psychometric tool for assessing apathy in Parkinson's disease patients. This scale has good face validity and internal consistency (Cronbach's α = 0.76) in a validity and reliability study in a PD patient. A sensitivity of 66% and specificity of 100% have been reported using a cut-off score of 14, with higher scores indicating severity of apathy (12).

Caregivers have more comprehensive information about the presence and changes of patients' daily emotional and behavioral symptoms. This information plays a supportive role in determining a symptom and planning treatment methods in clinical practice. The SAS is suitable for assessing apathy in the clinical setting as it is short and easy to administer and can potentially be embedded in a neuropsychological battery. The caregiver version of the SAS further facilitates this because of the symptoms that occur in PD patients, such as cognitive impairment and loss of insight. As a result, the caregiver version of the SAS contributes to a better understanding of the symptoms by specialists, more inclusive and rapid assessment, and determination of appropriate intervention methods by transferring the patient's apathy symptoms by caregivers.

The SAS validation studies have been conducted in different cultures. In one such study, Guimarães et al. performed the caregiver version of the scale on patients with dementia, (13–16). This study aimed to adapt the caregiver version of the Starkstein Apathy Scale into Turkish and examine its reliability and validity in patients with Parkinson's disease.

METHODS

Participants and Assessments

Our study included 45 PD patients and their relatives, 40 healthy control participants, and their relatives admitted to Istanbul Medipol Parkinson's and Movement Disorders Center Neurology Clinic and Istanbul Medipol Mega Hospital Neurology Clinic and met the inclusion criteria. Fourteen PD patients had undergone Deep Brain Stimulation (DBS) operations. In our study, no distinction was made between patients with and without a diagnosis of dementia. Approval was obtained from Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee on 14/09/2022 with decision number E-10840098-772.02-5295.

The inclusion criteria for the PD group were as follows: A diagnosis of Parkinson's disease according to the United Kingdom Parkinson's Disease Society Brain Bank Diagnostic Criteria (17), the caregiver spending at least 12 hours a week with the patient, not having any neurological disease other than Parkinson's disease, and volunteering for the study. The exclusion criteria for the Parkinson's disease group were determined as follows: individuals diagnosed with a movement disorder other than Parkinson's disease, those who had difficulty communicating due to severe dementia, those whose assessments could be affected by another neurological or systemic disease and those who did not want to participate voluntarily.

The inclusion criteria for the control group were as follows: No history of any neurologic or psychiatric disease, a score of 24 or above on the Mini Mental State Exam (MMSE) and speaking Turkish as a native language. Exclusion criteria for the control group: presence of neurologic or psychiatric disease, MMSE score below 24, inadequate Turkish proficiency to prevent test administration and lack of voluntary consent.

The MMSE was used to screen and assess cognitive status, the Geriatric Depression Scale (GDS) was used to determine depression, the NPI was used to assess behavioral symptoms, and the Unified Parkinson Disease Rating Scale (UPDRS) and Hoehn–Yahr Staging Inventory were used for motor assessment in PD patients. The SAS Caregiver and the NPI Apathy subscale were used for apathy assessment.

Statistical Analysis

For the power analysis, the calculation of the required sample size was based on an effect size of 0.6, an alpha error probability of 0.05, and a statistical power of 0.80, with the intention to employ Pearson's correlation coefficient to analyze the relationship between independent groups. This analysis indicated that 38 participants per group would be sufficient. Additionally, a second power analysis with similar parameters was conducted for the planned Independent Samples Student's t-Test for comparing group means, which determined a required sample size of 36 participants per group. In cases of invalid data, outliers, or data loss, 40 participants were targeted for each group. However, since more eligible participants were recruited in the PD group, the sample size was increased to 45 participants in this group. This adjustment was made to increase statistical power and minimize the risk of data loss. The control group was limited to 40 participants in line with the set target. All power analyses were performed using G*Power version 3.1.9.7.

Statistical analyses were performed using Jamovi version 2.3.22 and graphs using GraphPad software. Mean, standard deviation, and number-percentage values were applied for descriptive statistics of the descriptive data of the clinical and control groups. The validity analysis used explanatory and confirmatory factor analysis methods for construct validity. The suitability of the data for factor analysis was tested using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. Exploratory factor analysis was conducted using Principal Component Analysis (PCA) with Varimax rotation. The number of factors to be retained was determined according to the eigenvalue > 1 criterion. Confirmatory factor analysis of the identified factors was carried out using Structural Equation Modeling (SEM).

The scale scores of the clinical and control groups were compared for discriminant validity. The SAS Caregiver and NPI relationship was examined for criterion-dependent validity analysis. Shapiro-Wilk normality test was performed to investigate the difference and relationship of variables. Cronbach's Alpha method was used to determine the reliability of the scale. When normal distribution criteria were met, the Pearson correlation coefficient was used to examine the relationship, and the Spearman analysis method was used for variables that did not show normal distribution. Student's t-test was used to compare the two mean differences of the performances of the clinical and control groups in normal distribution, and the Mann-Witney U Test was used in cases where the normal distribution was not met.

ROC analysis was performed to determine the cut-off value. Based on the AUC value obtained from this analysis, post hoc power analysis was performed using the G*Power 3.1.9.7 program.

RESULTS

Participants

A total of 45 individuals in the PD group and 40 in the healthy control group participated in our study. The mean age of the PD group was 67.82±8.35 years, and the mean age of the control group was 65.15 ± 8.71 years. The clinical and demographic characteristics of the participants are given in Table 1.

Caregivers were divided into spouse (17), daughter (11), son (12) and other (5) (caregiver, daughter-in-law, grandchild, etc.) in the PD group and spouse (11), daughter (8), son (5) and other (16) in the control group. Age means were 47.7±14.00 in the PD group and 43.6±15.33 in the control group; educational means were 11.5±4.38in the PD group and 12.0±5.58 in the control group. Demographic information of caregivers is shown in Table 2.

Reliability Analysis

The internal consistency method was used for the reliability analysis of the caregiver version of the Starkstein Apathy Scale. Cronbach's alpha coefficient was calculated as 0.81 for 14 items. Since the total correlation of item 3 and item 13 was low (-0.04; 0.01), the items were eliminated, and the Cronbach alpha coefficient of 12 items was 0.84 when items 3 and 13 were removed in the repeated internal consistency analysis. This value showed that the internal consistency of the scale was relatively high. Accordingly, the scale was prepared by renewing the item numbers of the SAS Caregiver scale. Item total correlation coefficients ranged between 0.33 and 0.62. In the internal consistency analysis performed with the obtained factors, the internal consistency of the motivation and behavioral apathy factor α =0.72 and the cognitive apathy factor α =0.83 were acceptable results.

Table 1. Demographic characteristics of the Clinical and Control Groups

N	PD	Control	P
	45	40	
DBS (yes/no)	14/31	NA	
Gender (Female/Male)	19/26	20/20	0.47[a]
Age (years)	67.82±8.35	65.15±8.71	0.15[b]
Education (years)	7.47±5.20	7.40±5.19	0.90[c]
MMSE	23.18±3.24	27.10±1.84	<.001[b]
SAS Caregiver	15.5±8.22	4.08±3.32	<.001[c]
GDS	8.80±6.08	3.95±3.01	<.001[c]
DBS	15.9±8.06	NA	0.83 [b]
Non-DBS	15.3±8.42	NA	
NPI Score	14.6±17.5	NA	
NPI Apathy	2.49±3.81	NA	
LED (mg/days)	517.70±333.86	NA	
Disease duration (months)	75.78±72.24	NA	
Scales	n (%)		
H&Y Stage I	16 (35.6)		
H&Y Stage II	19 (42.2)		
H&Y Stage III	7 (15.6)		
H&Y Stage IV	3 (6.7)		
UPDRS I	12.2±6.68	NA	
UPDRS II	14.1±10.00	NA	
UPDRS III	20.8±18.70	NA	
UPDRS IV	3.02±4.32	NA	

[a]χ^2; [b]Student; [t]Test; [c]Mann-Witney U Test
PD: Parkinson's Disease; DBS: Deep Brain Stimulation; MMSE: Mini Mental State Exam; SAS: Starkstein Apathy Scale; GDS: Geriatric Depression Scale; NPI: Neuropsychiatric Inventory; LED: Levodopa Equivalent Dosage; H&Y: Hoehn and Yahr stage; UPDRS: Unified Parkinson Disease Rating Scale; NA: Not applicable; not assessed in the control group

Table 2. Demographic characteristics of the Caregiver Group

	Group	n	Mean±Sd
Caregiver Age	PD	45	47.7±14.00
	Control	40	43.6±15.33
Caregiver Education	PD	45	11.5±4.38
	Control	40	12.0±5.58

PD: Parkinson's Disease; Sd: Standard Deviation

Validity Analysis

The adaptation of the Starkstein Apathy Scale into Turkish began with obtaining permission from the scale's author, Sergio Starkstein. To establish language validity, a comprehensive translation process was implemented: the scale was initially rendered into Turkish by three independent experts, then back translated into English by a bilingual expert (a native English speaker with Turkish fluency) to ensure conceptual and semantic equivalence with the original instrument. One structural modification involved reformulating the questions from first-person to third-person perspective. A pilot study was conducted with 10 PD patients and their relatives to determine the comprehensibility and applicability of the scale. After the pilot study, the items that were not comprehensible were reorganized. A single semantic adjustment was made to Item 4 which the phrase 'çok çaba' ('much effort') was changed to 'gereken çaba' ('necessary effort') as the original wording was interpreted as the opposite of what was intended to be measured.

Exploratory and Confirmatory Factor Analysis (EFA and CFA) were conducted to measure the construct validity of the Starkstein Apathy Scale's caregiver version and to determine its factor structure. PCA and varimax vertical rotation methods were used to determine the factor structure. As a result of the 14-item EFA, the KMO value of the sampling adequacy test was calculated as 0.64, and Bartlett's test result (x^2 = 249, df = 91, p < 0.001) was significant. This result shows that the scale is suitable for factor analysis. PCA analysis yielded a 4-factor structure. Confirmatory factor analysis (CFA) was conducted using SEM to verify the obtained factor structure and to determine its suitability for the sample. As a result of CFA, it was determined that the 4th factor exhibited a weak structure. In the internal consistency analysis of the scale with 14 items, it was observed that the total correlations of item 3 and item 13 had negative values (-0.04; - 0.01). During the validity and reliability studies of the scale, it was seen that item 3 and item 13 were incompatible with other factors and decreased the model fit. These items showed poor validity and reliability results. Therefore, item 3 and item 13 were removed from the scale, and all analyses were conducted again with 12 items.

The Kaiser-Meyer-Olkin (KMO) sampling adequacy value was 0.74 in the repeated analyses after the removed items, indicating that the sample size was sufficient for Factor Analyses (FA). As a result of Barlett's Test, $\chi^2(66)$ =224; p<0.001, which was appropriate for the correlation between items.

After FA analysis, the SAS Caregiver's three-factor structure, consisting of 12 items, was obtained. These three factors explained 63.7% of the total

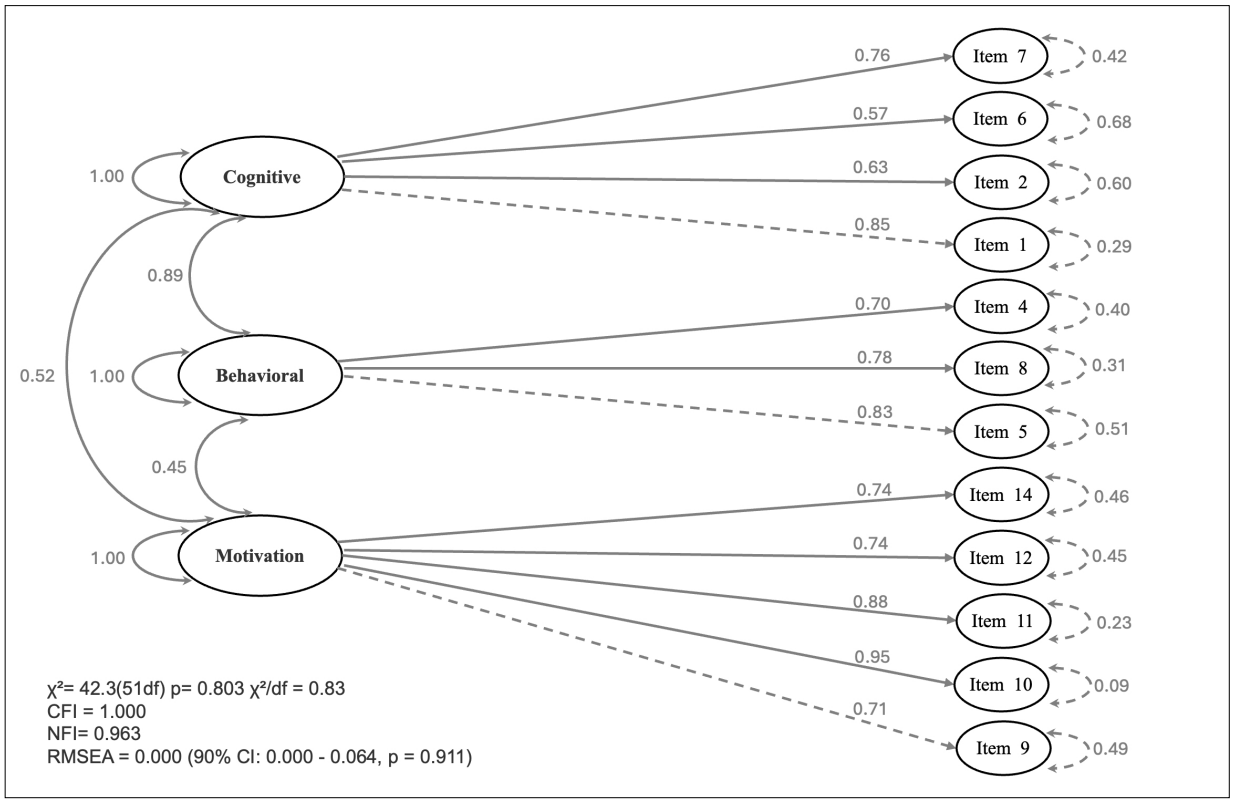

Figure 1. Confirmatory factor analysis results for the SAS-Caregiver
CFI: Comparative Fit Index; NFI: Normed Fit Index; RMSEA: Root Mean Square Error Approximation

variance: the first is 25.3%, the second is 19.4%, and the third is 19.2% (Table 3). The table shows the distribution of items according to the factors and factor loadings.

Table 3. SAS- Caregiver 12-Item Factor Analysis

	Factors		
Items	**Motivation**	**Behavioral**	**Cognitive**
Item 10	0.830		
Item 9	0.791		
Item 12	0.738		
Item 11	0.718		
Item 14	0.662		
Item 4		0.787	
Item 8		0.722	
Item 5		0.605	
Item 6			0.839
Item 7			0.691
Item 1			0.583
Item 2			0.417
Eigenvalue	**3.04**	**2.32**	**2.30**
Variance explained by each factor (%)	25.3	19.4	19.2
Internal consistency (Cronbach's α)	0.83	0.72	0.72

A confirmatory factor analysis was conducted to assess the validity of the proposed three-factor model. As shown in Figure 1, the model fits the data reasonably well ($\chi^2(51) = 42.3$, $p = 0.80$). Moreover, the χ^2/df ratio was calculated as 0.83, indicating that the model had a good fit. The Comparative Fit Index (CFI) was 1.000, the Normed Fit Index (NFI) was 0.963 and the Root Mean Square Error Approximation (RMSEA) was 0.000; the 90% confidence interval for RMSEA was between 0.000 and 0.064 and the p-value was 0.911. The Standardized Root Mean Square Error (SRMR) value was 0.102 (Figure 1). The results showed that the three-factor structure provided an appropriate model to represent the data and met the accepted fit index thresholds. In addition, factor loadings for all items were significant and consistent with theoretical expectations, strongly supporting the model's construct validity.

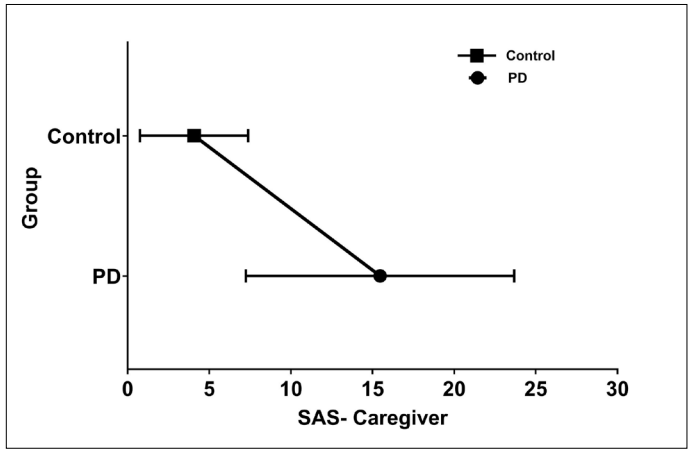

Figure 2. SAS-Caregiver scale mean scores show a significant difference between the clinical group (PD) and the control group. This difference is clinically important in practical terms as well as statistical significance.

Table 4. Cutoff Values of the Turkish Caregiver Version of the Starkstein Apathy Scale

Cutpoint	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Youden's index	AUC	Metric Score
6	88.89%	72.50%	78.43%	85.29%	0.614	0.899	1.61
7	86.67%	75.00%	79.59%	83.33%	0.617	0.899	1.62
8	82.22%	80.00%	82.22%	80.00%	0.622	0.899	1.62
9	75.56%	90.00%	89.47%	76.60%	0.656	0.899	1.66
11	**71.11%**	**95.00%**	**94.12%**	**74.51%**	**0.661**	**0.899**	**1.66**
12	68.89%	97.50%	96.88%	73.58%	0.664	0.899	1.66
13	64.44%	100.00%	100.00%	71.43%	0.644	0.899	1.64

PPV: Positive Predictive Value; NPV: Negative Predictive Value; AUC: Area Under the Curve

The correlation between the SAS Caregiver and NPI apathy scores was examined for Concurrent Validity. As a result of the findings, a significant (r=0.49; p< 0.001) and positive correlation was found between the SAS Caregiver and NPI Apathy test.

In the Mann-Whitney U analysis performed for the Discriminant Validity Analysis to determine the difference between the clinical group and the control group, a significant difference was observed between the ranking averages of the groups. The effect size of this difference (Rank Biserial Correlation = 0.797) indicates a significant effect. Figure 2 shows the difference in the SAS Caregiver scores between the clinical and control groups. No significant difference was found between the groups with and without brain pacemakers in terms of the SAS Caregiver scores of the clinical group (Student's t(43) = 0.212, p = 0.833). The effect size calculated by Cohen's d (d = 0.0682) indicates that the difference between the groups is practically minimal. In the clinical group, there was no significant difference between the female and male groups regarding SAS Caregiver scores (Student's t(43) = -0.359, p = 0.722). The mean SAS Caregiver scores of women and men were 14.9 ± 8.28 and 15.8 ± 8.32, respectively. The effect size calculated by Cohen's d (d = -0.108) indicates that the difference between the groups was practically insignificant.

The relationship between the SAS Caregiver scale and demographic and clinical sub-variables was analyzed. Among these variables, a significant relationship was found with GDS (r= 0.41; p<0.01) and UPDRS I (r= 0.51; p< 0.001). When the relationship between subtypes and clinical and demographic variables was examined, a significant relationship was found between GDS and behavioral (r= .545; p< 0.001) and cognitive (r=.518; p< 0.001) subtypes and between MMSE and cognitive (r= -.310; p< 0.05) subtypes. NPI and general apathy subtypes were significant at p<0.05; behavioral and cognitive subtypes were significant at p< 0.001.

Cut-off Value

In the ROC analysis performed to determine the cut-off score of the clinical group in SAS Caregiver, 11 was chosen as the cut-off value. This value shows a balanced performance between sensitivity (71.11%) and specificity (95%). The positive predictive value (94.12%) and negative predictive value (74.51%) indicate that the cut-off value is a reliable threshold for the diagnosis of apathy. Youden's index value (0.661), indicates a strong performance of the cut-off 11. Furthermore, the area under the ROC curve (AUC) was calculated to be 0.899, indicating high diagnostic accuracy. A post hoc power analysis was performed to assess whether this result was statistically robust. The AUC value corresponds to a large effect size (Cohen's d = 1.81) and 100% statistical power was achieved with 45 participants in the experimental group and 40 participants in the control group. These findings confirm that the ROC analysis was performed with adequate sampling power and the results are statistically reliable. All cut-off values from 6 to 13 are presented comparatively in Table 4, showing that cut-off 11 is a statistically and clinically balanced choice.

DISCUSSION

This study aimed to adapt the caregiver version of the Starkstein Apathy Scale in Parkinson's Disease patients to the Turkish and analyze the validity and reliability of the scale. The caregiver version of the Apathy Scale was conducted by Guimarães et al. with Alzheimer's patients, but no study has been done with PD patients (15). PD patients may lack insight and have low awareness. This causes the assessor to misinterpret the symptoms. For this reason, we conducted the Turkish validity and reliability study of the SAS as a caregiver version. For this, the scale was translated into Turkish by collecting data from the clinical and control groups, and validity and reliability analyses were performed. It is thought that this scale translated into Turkish will be useful in clinics and research.

This study applied EFA to evaluate the scale's factor structure, and a four-factor structure was obtained. However, CFA results revealed that the fourth factor exhibited a weak structure. In addition, in the internal consistency analysis of the scale with 14 items, the negative total item correlations of item 3 and item 13 (-0.04 and -0.01) showed that these items were not compatible with the general structure of the scale. During the validity and reliability studies, it was determined that item 3 and item 13 were not correlated with other factors and negatively affected the model fit. This shows that these items are weak in terms of validity and reliability. In the literature, it is seen that items 3 and 13 exhibit low validity values in different studies and are consistent with our results. Pedersen et al. suggested that item 3 was ambiguous in assessing apathy and indicated that this item should be removed from the scale (18). Accordingly, items 3 and 13 were removed from the scale in our study, and the analyses were conducted on over 12 items.

A three-factor structure was obtained in the current study's factor analysis. Factor 1 includes items related to interaction with and interest in the environment. Since these items reflect the individual's lack of intrinsic motivation towards environmental stimuli and inability to initiate goal-directed behavior, this factor was named motivation. Factor 2 consists of items assessing the individual's behavioral active participation in daily life and level of effort. This factor was named behavioral as it reflects a decrease in initiating and maintaining behaviors. Finally, Factor 3 includes items related to cognitive processes such as making plans, learning new things and interest in mental activities. Since these items reflect a decrease in the individual's cognitive engagement, this factor is named cognitive. Ilardi et al. obtained a five-factor structure in the Italian version with healthy individuals. However, the sub-dimensions they determined overlap with the factor structure we obtained (16). Kay et al. obtained three factors in their factor analysis study on whether the SAS determines

the subtypes of apathy in PD patients. The factors they obtained and the items distributed to the factors are similar to our study (19). At the same time, the factor structure we obtained is compatible with the apathy criteria proposed by Marin by considering apathy in three subtypes: affective, cognitive, and behavioral (5).

Confirmatory factor analysis was performed to evaluate the fit of the conceptual structure of the SAS Caregiver scale with the measurement model. According to the results of the analysis, the CFI value indicating the model's goodness of fit was found to be 1.000, and this value was found to be within the acceptable fit range. In the literature, in the study conducted by Morita and Kannari on the SAS scale, it was stated that items 3, 11, and 13 had low effect values in a single-factor structure (20). This finding supports the rationale for removing items 3 and 13 from the scale in our study.

Although this study used the same dataset for both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), which is standard procedure in scale adaptation research, we must acknowledge the limitations and methodological issues about this method. Model fit indices could be inflated if EFA and CFA are performed on the same sample because of the possibility of overfitting or taking advantage of random correlations. However, since this was the first Turkish translation of the SAS Caregiver version, it was decided that preliminary psychometric evaluation required the combined use of EFA (to determine the factor structure) and CFA (to validate it). To further verify the stability of the three-factor structure, future research should consider cross-validation techniques such dividing the sample or evaluating the model in a separate cohort. Additionally, replication in larger and more diverse populations would strengthen the generalizability of these findings.

The comparison of SAS Caregiver scores between the healthy control group and the PD group showed a significant difference. At the same time, the high correlation between the NPI apathy subtest and the PD group reveals that the SAS Caregiver scale will provide important findings in evaluating apathy. In the study conducted by Guimarães et al. with Alzheimer's patients and their caregivers to adapt the SAS Caregiver scale to Brazilian culture, they showed that the NPI and SAS Caregiver versions were related (15).

When we examined the relationship with SAS Caregiver and other variables, it was found to be related to depression and non-motor symptoms. Apathy and depression may occur simultaneously in some cases, making it difficult to differentiate them. It is important to distinguish between depression and apathy. The two syndromes differ at some points. While more negative affect is more prominent in depression, this is more neutral in apathy (21–23). However, in the examination of the relationship between the factors and depression, a significant relationship was found between behavioral and cognitive factors, but there was a dissociation with the motivation factor. This shows that we can differentiate apathy and depression with the items in the motivation factor. Gorafalo et al. developed an abbreviated version of SAS-6 to differentiate pure apathy from depression in their study in a healthy Italian population (14). In our current study, the items included in the motivation factor are items 9, 10, 11, 12, and 14, while the items recommended by Gorafalo et al. for pure apathy are items 1, 2, 4, 10, 11, and 13. In both studies, it is seen that items 10 and 11 differentiate apathy from depression symptoms.

There are conflicting results for changes in mood and apathy after Deep Brain Stimulation, which is increasingly used for the treatment of motor symptoms of PD (24). The development of apathy after DBS is associated with direct stimulation sites or the reduction of dopaminergic treatment after the operation (25–27). In our study, there was no significant difference between the apathy scores of patients who underwent DBS operation and patients who did not undergo operation. Future studies with a more comprehensive methodology will provide a better understanding of the relationship between apathy and DBS.

Our study's clinical group sample size was limited. Although it met sufficient criteria for factor analysis, a larger sample has the potential to provide more comprehensive data on factor structure. In addition, a larger sample size may provide more detailed results on the relationship between apathy and the clinical characteristics of PD patients. In our study, no distinction was made between dementia and non-dementia groups, which may have limited the detailed analysis of the results obtained in different subgroups.

In the original SAS scale, the cut-off value for 14 items was 13/14 and this value was reported to have 66% sensitivity and 100% specificity (12). In our study, Receiver Operating Characteristic (ROC) analysis was performed to determine the cut-off value for the 12-item version of the SAS Caregiver scale. ROC analysis is a frequently used method to assess diagnostic validity; however, interpretation of the results may be limited when the sample size is insufficient. Therefore, a post hoc power analysis was performed based on the obtained AUC value (0.899) corresponding to a large effect size (Cohen's d = 1.81). The analysis showed that 100% statistical power was achieved with 45 participants in the experimental group and 40 in the control group. These findings suggest that the ROC analysis was performed with an adequate sample size and presented no methodological limitations. Based on the ROC analysis, a cut-off value of 11 was determined, which yielded a sensitivity of 71.11% and a specificity of 95%. Considering these findings, the SAS Caregiver scale appears to be a successful measurement tool for assessing apathy and discriminating between patients and healthy individuals.

We acknowledge other limitation about the cutoff value that although the post hoc power analysis indicated sufficient statistical power (100%) for the ROC analysis, the relatively small sample size (N=85) and the lack of overlap in apathy scores between PD and control groups may limit the generalizability of the cutoff value. Future studies with larger and more diverse samples, including individuals with mild apathy, are needed to validate these findings.

In conclusion, the Turkish version of the Starkstein Apathy Scale for Caregivers is a valid scale for assessing apathy in PD patients. It is recommended for use in scientific studies and clinics.

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