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Validation of the dimensional apathy scale and predictors of apathy in stroke survivors

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The study aimed to: (i) translate and culturally adapt the DAS into Persian; (ii) examine the psychometric properties of both the DAS-S and DAS-I; (iii) analyze the three components of both the DAS-S and DAS-I to assess apathy dimensionally; (iv) determine the optimal cut-off points using ROC analysis for the DAS-S, DAS-I, and their subscales; and (v) identify predictors of initiation, emotional, and executive apathy in stroke survivors. This study included 115 stroke survivors and 38 healthy controls. Both DAS versions were evaluated for acceptability, reliability, and validity. Exploratory factor analysis was conducted to assess construct validity. Receiver Operating Characteristic curve analysis was used to determine optimal cut-off points. Multiple regression analyses were performed to identify predictors of apathy. Cronbach's alpha was 0.88 for DAS-S and 0.85 for DAS-I. ICC2,1 was > 0.93 for both versions. Total and subscale scores of both DAS versions showed weak to moderate correlations with the Neuropsychiatric Inventory-Apathy subscale (r = 0.39–0.69). Principal component analysis showed three components (executive, emotional, and initiation) for DAS-S and DAS-I, explaining 49.26% and 53.02% of the variance, respectively. The optimal cut-off was 31 for DAS-S (88.89% sensitivity, 86.36% specificity) and 29 for DAS-I (92.52% sensitivity, 86.36% specificity). Depression was the strongest predictor of executive subscale scores of both DAS versions, as well as the initiation subscale of the DAS-S, explaining 33.90–48.90% of the variance. However, for the emotional subscale of both DAS versions, the strongest predictor was the level of daily activity. The two versions of DAS effectively identify apathy subtypes and are reliable and valid for assessing apathy in stroke survivors. They effectively discriminate between apathetic and non-apathetic stroke survivors. Depression is the strongest predictor of executive and initiation apathy, whereas functional indicators—particularly independence in activities of daily living—predict emotional apathy.

Keywords Apathy, Stroke, DAS, Psychometric properties

Abbreviations

DAS	Dimensional Apathy Scale
DAS-S	Self-rated versions of the Dimensional Apathy Scale
DAS-I	Informed-rated versions of the Dimensional Apathy Scale
HADS-D	Hospital Anxiety and Depression Scale-Depression
HADS-A	Hospital Anxiety and Depression Scale-Anxiety
DCA	Diagnostic criteria for apathy
NPI	Neuropsychiatric Inventory

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mRS	Modified Rankin Scale
BI	Barthel Index
IADL	Instrumental Activities of Daily Living
KMO	Kaiser–Meyer–Olkin
PCA	Principal component analysis
ICC2,1	Intra-class correlation coefficient
ROC	Receiver operating characteristic
AUC	Area under the curve
CI95%	Confidence interval

Apathy is a neuropsychiatric symptom characterized by a decreased self-generated, voluntary, and goal-directed behavior[1]. This definition excludes unintentional automatic behaviors and does not correlate with reduced consciousness or cognitive decline. Apathy is common in chronic stroke survivors and is associated with increased functional impairment and diminished quality of life[2]. Early identification of apathetic stroke survivors using validated assessment tools is clinically important.

Apathy is increasingly recognized as a multidimensional construct rather than a single-domain symptom[3]. Distinguishing among its subtypes is essential for a more nuanced understanding of individual profiles. A multidimensional approach allows for clearer characterization of clinical presentations by separating cognitive, emotional, and motivational components, and facilitates identification of subgroups that differ in prognosis and treatment response[4,5]. It further enables the development of tailored interventions and enhances the sensitivity of clinical assessment[6]. Furthermore, a dimensional approach enables the examination of predictors for specific apathy subtypes, providing insights that can inform individualized intervention strategies.

In stroke populations, apathy has been assessed using the Apathy Evaluation Scale (AES) and the Lille Apathy Rating Scale (LARS)[7,8]. While the AES and LARS provide useful global measures of post-stroke apathy, they do not differentiate between subtypes. In contrast, the Dimensional Apathy Scale (DAS) was specifically developed to assess three subtypes of apathy—executive, emotional, and initiation—based on the theoretical framework proposed by Levy and Dubois. Unlike traditional instruments, it differentiates between these distinct apathy domains[3,4]. This subdivision reveals unique patterns and specific associations with clinical variables, thereby offering a more precise and comprehensive understanding of underlying mechanisms and enhancing its clinical utility. The DAS also effectively minimizes the confounding effects of motor disability on apathy assessment—an especially relevant factor in stroke survivors who commonly experience physical impairments—by focusing on the cognitive, emotional, and motivational components of goal-directed behavior rather than physical performance measures[9]. Furthermore, the DAS has both self-rated (DAS-S) and informant-rated (DAS-I) versions. The DAS-S captures the patient's perception of goal-directed behavior, while the DAS-I reflects the caregiver's observations. The DAS-I provides complementary information, enabling quicker and more accurate assessment of apathy and helping to identify unawareness of symptoms, which is common in stroke and other neurological conditions[10].

The DAS demonstrates acceptable psychometric properties across neurological diseases[10–13]. A preliminary study in stroke patients reported acceptable internal consistency for DAS-S, with positive correlations with depression and anxiety[14]. However, a more comprehensive study with a larger sample size is needed to assess test-retest reliability, determine accurate cut-off points, and confirm the factorial structure. Test–retest reliability ensures the stability of DAS measurements over time. Empirically derived cut-off points of the DAS subscales enhance clinical utility by enabling accurate identification of specific apathy dimensions in stroke patients, supporting timely and targeted interventions. Standardized cut-offs also facilitate cross-study comparability and the development of evidence-based guidelines. Moreover, evaluating the factorial structure confirms the multidimensional organization of the DAS and ensures reliable measurement of its distinct subtypes, allowing interventions to be tailored to the affected dimension. Although the original DAS[4] has a well-established three-factor structure, cultural and clinical differences may influence item clustering. Moreover, although DAS has been validated in multiple languages[15–19], it has not yet been validated in Persian, which is important for cross-cultural research.

Although apathy has been widely studied, it has mostly been assessed as a global, unidimensional construct, and the predictors of distinct apathy subtypes remain largely unexplored. Moreover, the DAS has not yet been validated in Persian. Therefore, the present study aimed to: (i) translate and culturally adapt the DAS into Persian; (ii) examine the psychometric properties of both the DAS-S and DAS-I; (iii) analyze the three components of both the DAS-S and DAS-I to assess apathy dimensionally; (iv) determine the optimal cut-off points using ROC analysis for the DAS-S, DAS-I, and their subscales; and (v) identify predictors of initiation, emotional, and executive apathy in stroke survivors.

Methods

Participants

This study enrolled 123 first-time stroke survivors, diagnosed via MRI and neurological examination, with acceptable cognitive function (Montreal Cognitive Assessment score ≥ 24)[20]. Out of 123 stroke survivors eligible for the study, 8 either actively refused to participate or had missing data in the dependent variables. Therefore, the analysis was conducted on 115 stroke survivors. Participants needed to read and write in Persian and have experienced a stroke at least 6 months prior. Exclusion criteria included psychiatric, neurological, rheumatological, or orthopedic diseases, alcohol or drug abuse, and aphasia.

Additionally, 38 age-matched healthy controls were included. They were required to have no history of neurological disease and no signs of depression (HADS-D < 7), anxiety (HADS-A < 7), or apathy, as determined

by the Diagnostic Criteria for Apathy (DCA: "No") and the apathy subscale of the Neuropsychiatric Inventory (NPI) < 4[21,22]. These participants were also required to be able to read and write Persian.

All participants provided written consent at the study's outset. Ethical approval was given by the Ethics Committee of the Iran University of Medical Sciences (Ethical Code: IR.IUMS.REC.1401.970).

Translation

Permission to translate the DAS was obtained from the developer, Radakovic[4]. Initially, two independent bilingual translators, who were native Persian speakers, conducted the forward translation from English to Persian. These translations were then reconciled into a single version through discussion by an expert committee comprising translators and stroke specialists. Subsequently, this version was back-translated into English by two native English speakers proficient in Persian who were unfamiliar with the original version. The back-translated versions were reviewed by both translators and stroke experts to ensure accuracy. The finalized back translation was submitted to the original developers and approved. Prior to the main study, the pre-final Persian version was pilot-tested with 10 stroke survivors to assess clarity and cultural relevance. This sample size aligns with recommended practices in translation validation studies, where 5–10 participants are considered sufficient to evaluate item comprehension and cultural appropriateness during pilot testing[23,24]. Feedback from the pilot was reviewed by the committee, and minor modifications were made accordingly.

Procedures

In the cross-sectional study, stroke survivors completed a demographic and stroke-related questionnaire, followed by assessments using HADS-D, HADS-A[25], modified Rankin Scale (mRS)[26], Barthel Index (BI)[27], Lawton Instrumental Activities of Daily Living (IADL)[28], and DAS-S. Stroke caregivers completed the apathy subscale of NPI[22] and DAS-I. Apathy diagnosis and classification were based on the DCA ("yes") combined with the apathy subscale of the NPI (frequency × severity score ≥ 4), independent of the DAS. According to DCA, apathy is diagnosed based on four criteria: (A) decreased goal-directed activity unrelated to age or cultural norms; (B) symptoms in at least two of three dimensions (behavior and cognition, emotion, social interaction); (C) significant impairment in personal, social, or occupational functioning; and (D) symptoms not due to physical or motor disabilities, reduced consciousness, or substance effects[21]. The DCA is widely accepted for diagnosing apathy in neurological diseases[2,21] and was conducted by a psychiatrist in this study. All assessments and questionnaires were completed randomly, with rest intervals provided as needed, in a quiet and well-lit room.

To investigate test–retest reliability, stroke survivors completed the DAS-S, and caregivers completed the DAS-I in two sessions 30 days apart. The 30-day interval for test–retest reliability was selected based on prior validation studies of the DAS in neurological populations[16,29] and established psychometric guidelines recommending intervals of 2–4 weeks for constructs considered stable[30,31]. This interval enabled comparison of our results with previous studies. This timeframe effectively balances minimizing recall bias with allowing sufficient time to capture potential changes, while avoiding significant clinical confounders.

The optimal cut-off points for DAS-S, DAS-I, and their subscales were determined using the DCA combined with the apathy subscale of the NPI serving as reference standards for determining the presence of apathy.

Instruments

The DAS is a multidimensional apathy assessment tool with three subscales (executive, emotional, and initiation). Items are scored on a 4-point Likert scale, with scores ranging from 0 to 24 for each subscale and 0 to 72 for the total score; higher scores indicate greater apathy. This has two versions: DAS-S and DAS-I. Both the DAS-S and DAS-I were used in this study. The DAS-S was completed by stroke survivors to assess their self-perceived levels of executive, emotional, and initiation apathy. The DAS-I was completed independently by a family member or caregiver, providing an external evaluation of the patient's apathy-related behaviors in daily life. This approach allows for cross-informant comparisons to identify potential discrepancies, which may reflect the patient's awareness or lack thereof—of their apathy symptoms. Differences between DAS-S and DAS-I subscale scores were analyzed to explore apathy awareness[4,10].

The NPI assesses various psychopathological domains through caregiver interviews, including delusions, hallucinations, agitation, apathy, anxiety, depression, euphoria, irritability, disinhibition, aberrant motor behavior, appetite changes, and night-time behavior disturbances. This study utilized only the apathy subscale, which consists of 8 sub-questions. If the main question is answered 'yes,' apathy is quantified by multiplying the severity (rated 1–3: 1 = mild; 2 = moderate; 3 = severe) and frequency (rated 1–4: 1 = occasionally; 2 = often; 3 = frequently; 4 = very frequently) of the most prominent sub-question. This scale demonstrates acceptable psychometric properties in stroke patients[32] and the Iranian elderly with dementia[22].

The HADS is a self-assessment scale comprising two subscales for depression (HADS-D) and anxiety (HADS-A), each ranging from 0 (least anxiety/depression) to 21 (most anxiety/depression). It has shown acceptable psychometric properties in stroke survivors[33] and Iranian breast cancer patients[34].

The mRS evaluates global disability, with scores from 0 (no symptoms) to 5 (severe disability). Its validity has been confirmed in stroke survivors[26].

The BI assesses basic ADL performance, scoring from 0 to 100, with higher scores reflecting better performance. This scale exhibits acceptable psychometric properties in the Iranian stroke population[27].

The Lawton IADL assesses instrumental ADL performance using 8 items, with a total score ranging from 0 to 8; higher scores indicate greater independence. This scale has shown good validity and reliability in Iranian patients with dementia[28].

Statistical analysis

This study involved 115 stroke survivors and utilized 24 DAS questions, resulting in a subject-to-item ratio of 4.79. This ratio falls within the common range for scale validation studies, with 92% of studies falling within the range of 2–20, as reported by Anthoine et al.[35]. The sample size for test–retest reliability was determined using the functional approximation method[36]. Based on a predicted reliability coefficient of 0.90 from a pilot study, a minimum acceptable coefficient of 0.70, a power of 80%, a significance level of 0.05, and two testing sessions, the minimum required sample size was established at 37. Our sample, 115 participants, is adequate for factor analysis, as recommended by Hair et al.[37] and Sapnas et al.[38], who suggest a sample size of 100 or more is sufficient for factor analysis. Sampling adequacy was also evaluated using the Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity, with values greater than 0.70 for KMO and p-values less than 0.05 for Bartlett's test indicating sufficient adequacy[39].

The normal distribution was evaluated using the Kolmogorov–Smirnov test. Demographic and clinical characteristics were reported with descriptive statistics. Group differences were analyzed using ANOVA or independent t-test for continuous variables and the Chi-square test for categorical variables.

Acceptability criteria included floor and ceiling effects of < 15%[40] and skewness distributions within − 2 to + 2[41]. Internal consistency of DAS items was assessed using Cronbach's alpha. Test–retest reliability was evaluated using the intra-class correlation coefficient ($ICC_{2,1}$) with a 95% confidence interval. The minimum acceptable value for both Cronbach's alpha and $ICC_{2,1}$ was set at 0.70[42]. Each DAS item was assessed for test-retest reliability using the kappa coefficient, with values categorized as moderate (0.41–0.60), substantial (0.61–0.80), and perfect (0.81–1.00)[43].

The concurrent validity of the DAS was assessed by examining its correlation with the apathy subscale of the NPI. A correlation coefficient of 0.10–0.39, 0.40–0.69, and ≥ 0.70 indicated a weak, moderate, and strong correlation, respectively[44].

The construct validity of the DAS was assessed through exploratory factor analysis, employing principal component analysis (PCA) with oblique rotation for the stroke survivor group. The number of components was determined based on eigenvalues > 1 and absolute loading values ≥ 0.40[45].

A 3 × 3 mixed ANOVA compared groups (healthy, non-apathetic stroke, apathetic stroke) on DAS-S subscales (executive, emotional, initiation) with post hoc t-tests (Holm correction). Additionally, two 2 × 3 mixed ANOVAs compared groups (non-apathetic stroke, apathetic stroke) on DAS-I subscales and subscale awareness (difference between DAS-S and DAS-I subscale scores), with post hoc t-tests (Holm correction).

The optimal cut-off points of DAS and its subscales were determined through Receiver Operating Characteristic (ROC) curve analysis and the Area Under the Curve (AUC). An AUC value > 0.70 was considered acceptable[46]. The significance was set at $p < 0.05$.

A standard stepwise multiple regression analysis was conducted, utilizing demographic and clinical variables as independent variables and DAS score as the dependent variable, to identify the best predictors of apathy in stroke survivors.

All raw data used in these analyses are available in the Supplementary Information (Excel file).

Results

Table 1 displays the demographic and stroke-related characteristics of participants. The apathetic group showed higher levels of disability and decreased independence in ADL, compared to the non-apathetic group.

Acceptability, reliability and validity

There was no missing data for either DAS version. The floor effect was 1.74% for DAS-S and 0% for DAS-I, with no ceiling effect detected for either version. Skewness values were 0.40 for DAS-S and 0.53 for DAS-I, and kurtosis values were − 0.08 for DAS-S and 0.33 for DAS-I.

Cronbach's alpha was 0.88 for the DAS-S and 0.85 for the DAS-I, exceeding the minimum accepted threshold of 0.70 and indicating high internal consistency for both versions. The $ICC_{(2,1)}$ values for the total scores were 0.96 ($CI_{95\%}$ = 0.94–0.97) for DAS-S and 0.93 ($CI_{95\%}$ = 0.89–0.95) for the DAS-I, demonstrating excellent test–retest reliability. The kappa coefficients for individual items ranged from 0.44 to 0.80 across both DAS versions, reflecting moderate to substantial item-level agreement. Details on the acceptability and reliability of the DAS subscales are presented in Table 2.

Significant weak to moderate correlations were also observed between the total and subscale scores of both DAS versions and the apathy subscale of the NPI ($r = 0.34–0.69$), supporting concurrent validity. Additionally, correlations between the total and subscale scores of the two DAS versions ranged from weak to moderate ($r = 0.05–0.99$) (Table 3). In addition, construct validity was supported by PCA, which identified three components corresponding to the original DAS subscales (Table 4). Discriminative validity was also demonstrated through significant differences in DAS scores between healthy, non-apathetic, and apathetic stroke survivors (Table 1; Fig. 1).

Substructure

The PCA revealed 3 components for both DAS-S and DAS-I, with eigenvalues > 1, KMO values of 0.81 and 0.76, and Bartlett's test of sphericity values of 1286.04 and 1348.52 ($P < 0.001$), explaining 49.26% and 53.02% of the variance, respectively. For DAS-S, the first component explained 28.71%, the second 14.96%, and the third 5.59% of the total variance. For DAS-I, the first component explained 24.50%, the second 16.77%, and the third 11.75% of the total variance. Components in both DAS versions had weak correlations ($r = 0.01–0.35$), except for a moderate correlation between components 1 and 3 in DAS-S ($r = 0.66$). Significant moderate to strong correlations were observed between components and total scores for both DAS versions ($r = 0.58–0.86$) (Table 4).

Variable		Healthy control group ($n=38$)	Non-apathetic stroke group ($n=88$)	Apathetic stroke group ($n=27$)	*P*-Value	Stroke group ($n=115$)
Age (years), mean ± SD		55.02 ± 11.04	55.95 ± 10.43	58.82 ± 15	0.40	56.63 ± 11.65
Sex (male/female) n		21/17	52/36	18/9	0.65	70/45
Education (years), mean ± SD		9.84 ± 4.19	10.83 ± 3.77	10.33 ± 3.91	0.42	10.71 ± 3.79
Employment status (employed/retired/jobless) n		15/12/11	43/23/22	11/7/9	0.82	54/30/31
Marital status (single/married) n		7/31	11/77	5/22	0.59	16/99
Affected side (right/left) n		–	51/37	17/10	0.64	68/47
Time since stroke onset (years), mean ± SD		–	6.41 ± 5.17	5.44 ± 4.17	0.38	6.18 ± 4.96
Lesion type (ischemic/hemorrhage) n		–	57/31	19/8	0.59	76/39
MRS (0/1/2/3/4/5)		–	10/50/18/8/2/0	1/6/9/7/3/1*	**0.00**	11/56/27/15/5/1
BI, mean ± SD		–	95.06 ± 10.04	80 ± 25.11*	**0.00**	91.52 ± 16.18
Lawton IADL, mean ± SD		–	5.59 ± 1.64	3.96 ± 2.07*	**0.00**	5.21 ± 1.88
HADS-D, mean ± SD		2.92 ± 2.23	4.34 ± 3.48+	9.15 ± 5.07*	**0.00**	5.47 ± 4.40
HADS-A, mean ± SD		2.89 ± 2.30	4.08 ± 3.48+	9.71 ± 2.40*	**0.00**	4.23 ± 4.21
NPI-apathy, mean ± SD		–	2.56 ± 3.07	7.66 ± 4.40*	**0.00**	4.23 ± 4.21
DAS-S, mean ± SD	Executive subscale-test	5.89 ± 2.40	6.68 ± 4.54	14.89 ± 3.59 +*	**0.00**	8.61 ± 5.56
	Emotional subscale test	6.47 ± 2.67	6.63 ± 4.52	11.04 ± 7.04 +*	**0.00**	7.66 ± 5.51
	Initiation subscale test	7.71 ± 1.75	8.22 ± 4.11	17.41 ± 5.15 +*	**0.00**	10.37 ± 5.85
	Total test	20.08 ± 5.46	21.52 ± 9.19	43.33 ± 9.45 +*	**0.00**	26.64 ± 13.08
DAS-I, mean ± SD	Executive subscale test	–	6.69 ± 4.46	15.52 ± 4.26*	**0.00**	8.77 ± 5.78
	Emotional subscale test	–	6.44 ± 4.76	11.26 ± 7.25*	**0.00**	7.57 ± 5.79
	Initiation subscale Test	–	7.84 ± 4.09	13.41 ± 5.58*	**0.00**	9.15 ± 5.05
	Total test	–	20.98 ± 7.73	40.19 ± 9.04*	**0.00**	25.49 ± 11.45
Apathy subscale awareness, mean ± SD	Executive subscale-test	–	1.26 ± 1.56	1.59 ± 1.19	0.31	1.34 ± 1.48
	Emotional subscale-test	–	0.45 ± 0.97	0.30 ± 0.78	0.44	0.42 ± 0.93
	Initiation subscale-test	–	3.13 ± 2.29	4.44 ± 4.59	0.16	3.43 ± 3.02

Table 1. Demographic and clinical characteristics of participants. MRS, modified rankin scale; BI, Barthel index; Lawton IADL, Lawton Instrumental activities of daily living; HADS-D, Depression subscale of Hospital Anxiety and Depression Scale- depression subscale; HADS-A, Anxiety subscale of Hospital Anxiety and Depression Scale-anxiety subscale; NPI-apathy, apathy subscale of Neuropsychiatric Inventory; DAS-S, Dimensional Apathy Scale- Self-rated version; DAS-I, Dimensional Apathy Scale-Informed-rated version. *Shows the significant difference compared with the non-apathetic stroke groups, + shows the significant difference compared with the Healthy control groups.

	Dimensional Apathy Scale-self-rated version				Dimensional Apathy Scale-informed-rated versions			
	Executive subscale	Emotional subscale	Initiation subscale	Total	Executive subscale	Emotional subscale	Initiation subscale	Total
Floor effect n (%)	14 (12.17)	17 (14.78)	7 (6.09)	2 (1.74)	13 (11.30)	22 (19.13)	3 (2.61)	0 (0)
Celling effect n (%)	0 (0)	0 (0)	5 (4.35)	0 (0)	0 (0)	1 (0.87)	0 (0)	0 (0)
Skewness	0.18	0.53	0.54	0.40	0.28	0.58	0.53	0.53
Kurtosis	-0.97	-0.50	-0.18	-0.08	-0.94	-0.41	-0.39	0.33
Cronbach's alpha	0.83	0.83	0.83	0.88	0.85	0.86	0.80	0.85
ICC ($CI_{95\%}$)	0.94 (0.92–0.96)	0.88 (0.82–0.91)	0.93 (0.91–0.95)	0.96 (0.94–0.97)	0.93 (0.89–0.95)	0.95 (0.92–0.96)	0.80 (0.71–0.85)	0.93 (0.89–0.95)
Kappa coefficient	0.45–0.68	0.48–0.63	0.45–0.66	0.45–0.68	0.46–0.71	0.55–0.80	0.44–0.71	0.44–0.80

Table 2. Acceptability and reliability parameters of dimensional apathy Scale- patient and Informed-rated versions.in stroke survivors ($n=115$). ICC, intra-class correlation coefficient.

Apathy subscale profile and awareness

The comparison of three groups (healthy, non-apathetic stroke and apathetic stroke) on the DAS-S subscales showed a significant main effect for group, $F(2,150)=77.02$, $P<0.001$, $\eta p^2=0.51$, DAS-S subscales, $F(1.60,239.50)=19.99$, $P<0.001$, $\eta p^2=0.12$, and group versus DAS-S subscales interaction, $F(3.19,239.50)=5.27$, $P=0.001$, $\eta p^2=0.07$. The apathetic stroke group had significantly higher scores on all DAS-S subscales compared to the non-apathetic stroke and healthy groups ($p<0.001$). Within the three groups, initiation apathy was

		Dimensional Apathy Scale-Self-rated version				Dimensional Apathy Scale-Informed-rated versions										
		Executive subscale	Emotional subscale	Initiation subscale	Total	Executive subscale	Emotional subscale	Initiation subscale	Total	NPI-Apathy	HADS-D	HADS-A	MRS	IADL	BI	Age
Dimensional Apathy Scale-Self-rated version	Executive subscale	1	–	–	–	–	–	–	–	0.57**	0.53**	0.47**	0.44**	− 0.34**	− 0.44**	0.23*
	Emotional subscale	0.20*	1	–	–	–	–	–	–	0.40**	0.31**	0.24*	0.31**	− 0.38**	− 0.31**	0.01
	Initiation subscale	0.73**	0.25**	1	–	–	–	–	–	0.62**	0.57**	0.52**	0.50**	− 0.37**	− 0.51**	0.27**
	total	0.83**	0.62**	0.86**	1	–	–	–	–	0.69**	0.61**	0.53**	0.57**	− 0.47**	− 0.55**	0.22*
Dimensional Apathy Scale-Informed-rated versions	Executive subscale	0.94**	0.20*	0.73**	0.81**	1	–	–	–	0.56**	0.57**	0.52**	0.45**	− 0.39**	− 0.47**	0.26**
	Emotional subscale	0.21*	0.99**	0.25**	0.62**	0.20*	1	–	–	0.39**	0.30**	0.24**	0.31**	− 0.36**	− 0.30**	− 0.00
	Initiation subscale	0.39**	0.07	0.68**	0.50**	0.38**	0.05	1	–	0.34**	0.31**	0.34**	0.20	− 0.18*	− 0.13*	0.04
	Total	0.75**	0.63**	0.80**	0.94**	0.78**	0.63**	0.76**	1	0.63**	0.58**	0.53**	0.49**	− 0.46**	− 0.45**	0.15

Table 3. Criterion validity of the two versions of dimensional apathy Scale- patient and Informed-rated versions in stroke survivors ($n = 115$). NPI-apathy, apathy subscale of Neuropsychiatric Inventory; HADS-D, Depression subscale of Hospital Anxiety and Depression Scale-depression subscale; HADS-A, Anxiety subscale of Hospital Anxiety and Depression Scale-anxiety subscale; MRS, modified rankin scale; IADL, Lawton Instrumental activities of daily living; BI, Barthel index. *$P < 0.05$, **$P < 0.001$

Original subscales of Dimensional Apathy Scale	Item No.	Item text	Dimensional Apathy Scale-Self-rated version			Dimensional Apathy Scale-Informed-rated version		
			Executive component 1	Emotional component 2	Initiation component 3	Executive component 1	Emotional component 2	Initiation component 3
Executive	1	I / S/he need(s) a bit of encouragement to get things started.	0.62	-0.09	0.09	0.64	0.06	0.06
	6	I / S/he find(s) myself / him/herself staring into space.	0.13	0.17	0.04	0.39	0.32	0.28
	10	I / S/he am / is able to focus on a task until it is finished.	0.07	0.12	0.81	0.70	0.05	0.11
	11	I / S/he lack(s) motivation.	0.63	0.01	-0.03	0.69	0.12	0.17
	17	I / S/he have/has difficulty working out what to do when doing a demanding task.	0.74	− 0.20	0.09	0.84	− 0.06	-0.20
	19	I / S/he get(s) easily confused when doing several things at once.	0.75	0.08	0.00	0.55	− 0.12	-0.04
	21	I / S/he find(s) it difficult to keep my / his/her mind on things.	0.81	0.07	0.08	0.84	− 0.04	-0.21
	23	I / S/he am / is easily distracted.	0.22	0.21	0.62	0.66	− 0.05	-0.01
Emotional	3	I / S/he express(es) my / his/her emotions.	0.08	0.31	0.01	0.02	0.45	0.09
	5	I / S/he am / is concerned about how my / his/her family feels.	− 0.04	0.77	− 0.07	− 0.09	0.85	-0.03
	7	I / S/he think(s) about how others would feel before doing something.	0.14	0.42	− 0.06	0.12	0.71	-0.15
	9	I / S/he feel(s) bad when receiving bad news.	− 0.09	0.67	0.15	0.02	0.71	0.12
	12	I / S/he struggle(s) to empathize with other people.	0.00	0.88	0.00	− 0.05	0.62	-0.15
	15	I / S/he am / is unconcerned about how others feel about my / his/her behavior.	− 0.13	0.73	0.10	− 0.06	0.83	-0.02
	20	I / S/he become(s) emotional easily when watching something happy or sad on TV.	0.11	0.27	− 0.01	0.03	0.59	0.11
	24	I / S/he feel(s) indifferent to what is going on around me / him/her.	0.11	0.91	− 0.08	− 0.03	0.70	-0.21
Initiation	2	I / S/he contact(s) my / his/her friends.	0.09	0.09	0.09	0.06	− 0.01	0.14
	4	I / S/he think(s) of new things to do during the day.	0.15	0.16	0.44	− 0.40	− 0.06	0.66
	8	I / S/he plan(s) my / his/her day's activities in advance.	0.27	0.01	0.59	0.32	− 0.01	0.54
	13	I / S/he set(s) goals for myself / him/herself.	0.30	− 0.05	0.46	− 0.06	− 0.09	0.85
	14	I / S/he try / tries new things.	− 0.13	− 0.17	0.70	0.00	− 0.04	0.68
	16	I / S/he act(s) on things I / s/he have/has thought about during the day.	0.08	0.08	0.76	0.01	0.06	0.84
	18	I / S/he keep(s) myself / him/herself busy.	0.34	− 0.01	0.50	0.52	− 0.02	0.55
	22	I / S/he am / is spontaneous.	0.05	0.07	0.47	0.43	0.03	0.43
Correlations between components		Executive (Component 1)	1	–	–	1	–	–
		Emotional (Component 2)	0.29**	1	–	0.20*	1	–
		Initiation (Component 3)	0.66**	0.20*	1	0.35**	0.01	
		Total score of Dimensional Apathy Scale	0.84**	0.58**	0.86**	0.78**	0.63**	0.62**
		Percent map on to original DAS subscales	62.5	87.5	87.5	100	100	87.5

Table 4. Factor analysis and correlation between components for dimensional apathy Sc ale- patient and informed versions in stroke survivors ($n = 115$). *$p < 0.05$; **$p < 0.01$

significantly higher than executive and emotional apathy ($p < 0.05$). Additionally, in the apathetic stroke group, executive apathy was significantly higher than emotional apathy ($p = 0.02$) (Table 1; Fig. 1a).

Comparing two stroke groups on DAS-I subscales revealed significant main effects for group ($F(1,113) = 117.61$, $p < 0.001$, $\eta p^2 = 0.51$), DAS-I subscales ($F(1.86,210.65) = 4.92$, $p = 0.01$, $\eta p^2 = 0.04$), and their interaction ($F(1.86,210.65) = 3.96$, $p = 0.02$, $\eta p^2 = 0.03$). The apathetic stroke group scored higher in three apathy subscales than the non-apathetic group ($p < 0.001$), and also had higher scores in executive apathy compared to emotional apathy ($p = 0.02$) (Table 1; Fig. 1b).

The mean difference between DAS-S and DAS-I subscale scores was calculated to assess the level of apathy awareness among stroke survivors, with higher discrepancies indicating reduced self-awareness. Comparing the two stroke groups on apathy awareness showed a non-significant main effect for the group versus apathy awareness interaction ($P = 0.08$) (Table 1; Fig. 1c).

Optimized cutoffs of DAS-S and DAS-I

The optimal cut-off point for DAS-S to distinguish between apathetic and non-apathetic stroke survivors was 31, with a sensitivity of 88.89% and specificity of 86.36%. For DAS-I, a cut-off point of 29 yielded a sensitivity of 92.52% and specificity of 86.36%. Cut-off points for the subscales of both DAS versions are detailed in Table 5.

Correlates and predictors of apathy subtypes

There was no correlation between total score and subscales of both DAS versions and sex, education, employment status, marital status, affected side, time since stroke onset, or lesion type. However, the mRS, Lawton ADL, BI,

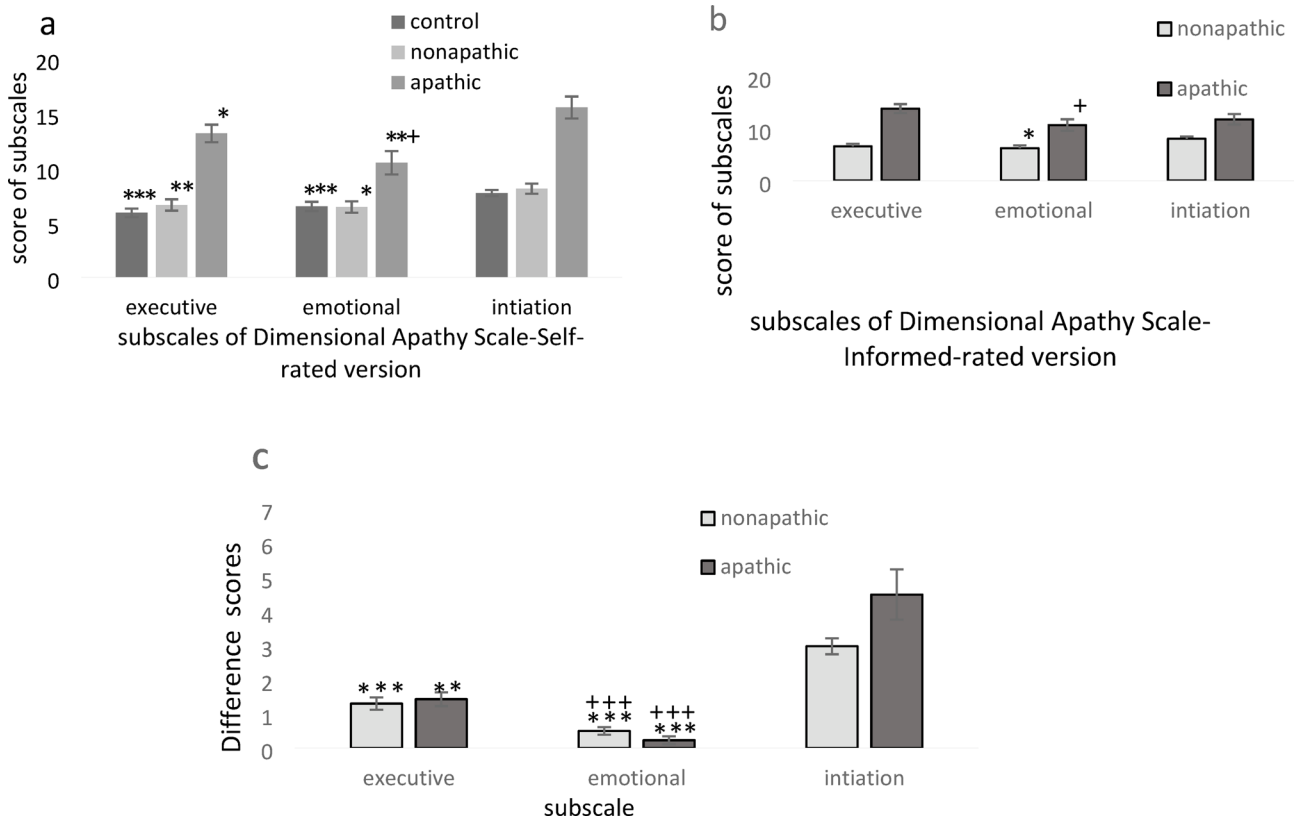

Fig. 1. Apathy subscale profile and awareness. Comparison of subscales for (**a**) Dimensional Apathy Scale-Self-rated, (**b**) Dimensional Apathy Scale-Informant/Caregiver-rated, and (**c**) apathy awareness. *Shows the significant difference compared with initiation subscale (*$p < 0.05$, **$p < 0.01$, ***<0.001), + shows the significant difference compared with executive subscale (+$p < 0.05$, ++$p < 0.01$, +++<0.001).

HADS-D, and HADS-A showed correlations ranging from 0.23 to 0.61 with the total scores and subscales of both DAS versions (Table 3). Additionally, age correlated with the executive subscale, initiation subscale, and total score of DAS-S, and the executive subscale of DAS-I ($r = 0.21–0.26$). These variables were used as independent factors in a regression model to determine the best predictors of apathy. For the total scores, depression and functional disability together explained 49.80% of the variance in the DAS-S and 41.50% in the DAS-I. In both versions, depression was the strongest predictor, followed by functional disability. For the Initiation subscale of the DAS-S, depression and disability jointly accounted for 43.9% of the variance, with depression showing the highest predictive value. Similarly, in the DAS-I, the Initiation subscale was significantly predicted by anxiety, which explained 10.7% of the variance. Regarding the Executive subscale, depression and disability explained 33.9% of the variance in the DAS-S, while depression and ADL performance explained 37.6% in the DAS-I, with depression again being the dominant predictor across both formats. For the Emotional subscale, the predictors differed slightly: in both the DAS-S and DAS-I, instrumental activities of daily living (Lawton IADL) and functional disability were significant contributors, jointly explaining 16.4% of the variance in the DAS-S and 15.2% in the DAS-I. Predictors for the DAS subscales are presented in Table 6.

Discussion

Apathy may affect up to 71.1% of stroke survivors, according to various studies[47]. In our sample, the prevalence was 23.48%. Both versions and their subscales showed good test–retest reliability and internal consistency. Concurrent validity was supported by significant correlations with the apathy subscale of the NPI. Both DAS versions exhibited acceptable sensitivity and specificity for discriminating between apathetic and non-apathetic stroke survivors. DAS effectively measures apathy in three dimensions—executive, emotional, and initiation—in stroke survivors, consistent with the original scale. Assessing these subscales separately revealed domain-specific patterns and distinct associations with clinical variables that were not detectable using total apathy scores. Regression analysis showed that depression is the strongest predictor of executive and initiation apathy, whereas functional indicators—particularly independence in activities of daily living—predict emotional apathy.

The symmetric distribution observed in both DAS versions confirms the absence of outliers and enhances the accuracy of statistical tests. The lack of floor and ceiling effects indicates that both DAS versions effectively distinguish between severe and mild apathy and can detect subtle changes due to treatment or exacerbation.

The findings of this study provide comprehensive support for the reliability of both the DAS-S and DAS-I in stroke survivors. Both versions and their subscales demonstrated acceptable internal reliability (Cronbach's

	Optimal criterion						Area under the ROC curve (AUC)		
		Cut off	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	AUC (95% CI)	z statistic	P value
Dimensional Apathy Scale-Self-rated version	Executive subscale	> 9	92.59 (75.7–99.1)	69.32 (58.6–78.7)	25.1 (19.4–31.8)	98.8 (95.7–99.7)	0.91 (0.85–0.96)	13.59	0.000
		> 10	**88.89 (70.8–97.6)**	**75.00 (64.6–83.6)**	**28.3 (21.2–36.7)**	**98.4 (95.4–99.4)**			
		> 11	77.78 (57.7–91.4)	85.23 (76.1–91.9)	36.9 (25.4–50.1)	97.2 (94.4–98.6)			
	Emotional subscale	> 6	62.96 (42.4–80.6)	48.86 (38.1–59.8)	12.0 (8.8–16.3)	92.2 (87.4–95.3)	0.68 (0.58–0.76)	2.60	0.009
		> 7	**59.26 (38.8–77.6)**	**54.55 (43.6–65.2)**	**12.7 (9.0–17.6)**	**92.3 (88.0–95.2)**			
		> 8	51.85 (31.9–71.3)	63.64 (52.7–73.6)	13.7 (9.1–20.0)	92.2 (88.6–94.8)			
	Initiation subscale	> 10	88.89 (70.8–97.6)	67.05 (56.2–76.7)	23.1 (17.8–29.3)	98.2 (94.9–99.4)	0.91 (0.84–0.95)	12.44	0.000
		> 11	**81.48 (61.9–93.7)**	**80.68 (70.9–88.3)**	**31.9 (22.8–42.7)**	**97.5 (94.6–98.9)**			
		> 12	74.07 (53.7–88.9)	86.36 (77.4–92.8)	37.6 (25.4–51.7)	96.8 (94.0–98.3)			
	Total	> 30	92.59 (75.7–99.1)	82.95 (73.4–90.1)	37.6 (27.3–49.2)	99.0 (96.4–99.7)	0.96 (0.91–0.99)	19.53	0.000
		> 31	**88.89 (70.8–97.6)**	**86.36 (77.4–92.8)**	**42.0 (29.6–55.5)**	**98.6 (96.0–99.5)**			
		> 32	88.89 (70.8–97.6)	89.77 (81.5–95.2)	49.1 (33.9–64.5)	98.6 (96.1–99.5)			
Dimensional Apathy Scale-Informed-rated version	Executive subscale	> 10	85.19 (66.3–95.8)	76.14 (65.9–84.6)	28.4 (20.9–37.3)	97.9 (94.9–99.1)	0.92 (0.85–0.96)	12.37	0.000
		> 11	**81.48 (61.9–93.7)**	**82.95 (73.4–90.1)**	**34.7 (24.5–46.6)**	**97.6 (94.8–98.9)**			
		> 12	77.78 (57.7–91.4)	87.50 (78.7–93.6)	40.9 (27.7–55.5)	97.3 (94.6–98.6)			
	Emotional subscale	> 6	62.96 (42.4–80.6)	50.00 (39.1–60.9)	12.3 (8.9–16.7)	92.4 (87.7–95.4)	0.69 (0.60–0.77)	2.87	0.004
		> 7	**59.26 (38.8–77.6)**	**55.68 (44.7–66.3)**	**12.9 (9.1–18.0)**	**92.5 (88.3–95.3)**			
		> 8	51.85 (31.9–71.3)	63.64 (52.7–73.6)	13.7 (9.1–20.0)	92.2 (88.6–94.8)			
	Initiation subscale	> 7	85.19 (66.3–95.8)	57.95 (47.0–68.4)	18.4 (14.4–23.2)	97.2 (93.3–98.9)	0.78 (0.70–0.86)	5.00	0.000
		> 8	**81.48 (61.9–93.7)**	**63.64 (52.7–73.6)**	**19.9 (15.2–25.7)**	**96.9 (93.2–98.6)**			
		> 9	66.67 (46.0–83.5)	68.18 (57.4–77.7)	18.9 (13.4–25.9)	94.8 (91.4–97.0)			
	Total	> 28	96.30 (81.0–99.9)	85.23 (76.1–91.9)	42.0 (30.4–54.6)	99.5 (96.8–99.9)	0.96 (0.91–0.99)	18.74	0.000
		> 29	**92.59 (75.7–99.1)**	**86.36 (77.4–92.8)**	**43.0 (30.6–56.3)**	**99.1 (96.5–99.8)**			
		> 30	88.89 (70.8–97.6)	90.91 (82.9–96.0)	52.1 (35.6–68.1)	98.7 (96.2–99.5)			

Table 5. Diagnostic accuracy measures of dimensional apathy Scale-patient and informed versions and their subscales ($n = 115$).

alpha > 0.85), consistent with previous findings in stroke and other neurological disorders. This indicates item homogeneity in the DAS and coherence in the concept of apathy. Reliability was further supported by excellent test-retest reliability (ICC > 0.93) and moderate to substantial item-level agreement (kappa = 0.44–0.80), demonstrating that the scales produce stable and consistent results over time. These results align with prior evidence from studies in amyotrophic lateral sclerosis patients[16], reinforcing that test-retest reliability is essential for ensuring consistent measurements over time and minimizing the influence of random factors.

Regarding validity, the identified three-component structure through PCA supports the construct validity of both versions, aligning with the original DAS subscales. In terms of concurrent validity, significant positive correlations between both DAS versions and their subscales with the apathy subscale of the NPI suggest that, despite structural differences, both instruments effectively evaluate the general concept of apathy. These moderate correlations further affirm their concurrent validity. Additionally, the clear differentiation between healthy, non-apathetic, and apathetic groups demonstrates strong discriminative validity. Collectively, these findings confirm that the Persian versions of the DAS-S and DAS-I are both reliable and valid tools for assessing apathy in clinical stroke populations.

The substructures of both DAS-S and DAS-I in this study have a high mapping percentage with the original DAS substructure[4]. Factor analysis revealed that 20 items (83.33%) from the DAS-S and 23 items (95.83%) from the DAS-I overlapped with the original DAS items. This indicates that the three components identified are consistent with the original DAS factors. Component 1 for DAS-S and component 3 for DAS-I included items from the behavior/cognitive initiation subscale, reflecting Levy and Dubois' auto-activation apathy subtype[4]. In both DAS versions, seven items from the original initiation subscale were loaded into these components. However, item 2 ("I contact my friends" in DAS-S and "S/he contacts his/her friends" in DAS-I) did not load onto any components. Furthermore, in DAS-S, this component also included items 10 ("I am able to focus on a task until it is finished") and 23 ("I am easily distracted") from the original executive subscale, which pertains to attention. Component 2 for both DAS versions related to emotional integration, assessing Levy and Dubois' emotional-affective apathy subtype. Component 2 of DAS-I perfectly matched the original emotional subscale. In contrast, although component 2 for DAS-S encompassed all original emotional subscale items but had lower than 0.40 loading values for ("I express/show my emotions") and 20 ("I become emotional easily when watching something happy or sad on TV"). Component 3 for DAS-S and component 1 for DAS-I included items potentially assessing Levy and Dubois' cognitive inertia, aligning with the executive subscale of the original study. Component 1 for DAS-I perfectly matched the original executive subscale, while only five items from this subscale were included in component 3 for DAS-S. The higher loading of items in DAS-I compared to DAS-S

Variables		Predictors/models	F	R^2	R^2 change	*P*-value	Predictors	Beta
Dimensional Apathy Scale-Self-rated version	Executive subscale	Model 1: HADS-D	44.564	0.276	0.286	< 0.001	HADS-D	0.532
		Model 2: HADS-D + mRS	28.662	0.339	0.056	0.003	HADS-D	0.409
							mRS	0.266
	Emotional subscale	Model 1: LADL	18.961	0.136	0.144	< 0.001	Lawton	− 0.379
		Model 2: LADL + mRS	12.180	0.164	0.035	0.031	Lawton	− 0.267
							mRS	0.218
	Initiation subscale	Model 1: HADS-D	54.162	0.318	0.324	< 0.001	HADS-D	0.569
		Model 2: HADS-D + mRS	43.867	0.439	0.115	< 0.001	HADS-D	0.393
							mRS	0.383
	Total score	Model 1: HADS-D	67.288	0.368	0.373	< 0.001	HADS-D	0.611
		Model 2: HADS-D + mRS	55.569	0.489	0.125	< 0.001	HADS-D	0.427
							mRS	0.398
Dimensional Apathy Scale-Informed-rated version	Executive subscale	Model 1: HADS-D	54.496	0.319	0.325	< 0.001	HADS-D	0.570
		Model 2: HADS-D + BI	35.290	0.376	0.061	0.001	HADS-D	0.450
							Barthel	− 0.275
	Emotional subscale	Model 1: LADL	16.691	0.121	0.129	< 0.001	Lawton	− 0.359
		Model 2: LADL + mRS	11.241	0.152	0.038	0.025	Lawton	− 0.242
							mRS	0.228
	Initiation subscale	Model 1: HADS-A	14.708	0.107	0.115	< 0.001	HADS-A	0.339
	Total score	Model 1: HADS-D	55.787	0.325	0.331	< 0.001	HADS-D	0.575
		Model 2: HADS-D + mRS	41.398	0.415	0.095	< 0.001	HADS-D	0.415
							mRS	0.347

Table 6. A summary of stepwise multiple regression analyses for total and subscale scores of dimensional apathy Scale-Self-rated and Informed-rated versions ($n = 115$). HADS-D, Depression subscale of Hospital Anxiety and Depression Scale-depression subscale; MRS, modified rankin scale; IADL, Lawton Instrumental activities of daily living; BI, Barthel index; HADS-A, Anxiety subscale of Hospital Anxiety and Depression Scale-anxiety subscale.

may be due to the original study's methodology, which used responses from healthy subjects. The overlap was greater with DAS-I, indicating differences in response patterns between healthy subjects and stroke survivors. Moreover, the weak correlations between most components of both DAS versions support the multifactorial nature of these scales in measuring apathy in stroke survivors, providing more precise information on apathy subtypes.

In our study, the apathy pattern observed in stroke survivors was characterized by elevated initiation and executive apathy, along with lower levels of emotional apathy. This pattern aligns with previous findings in stroke populations[14]. In contrast to recent measures validated in stroke populations that assess only global apathy[7,8], using the DAS to analyze apathy subtypes separately allowed us to identify domain-specific differences in prevalence that would have been obscured if only total apathy scores had been considered. This subtype-focused approach provides a more nuanced characterization of apathy patterns in stroke survivors, including their clinical correlates with mood and functional outcomes. Notably, the observed pattern of apathy may vary across different neurological and psychiatric conditions; for instance, Mulin et al. reported predominantly cognitive and behavioral apathy in Alzheimer's disease, primarily cognitive apathy in Parkinson's disease and major depressive episodes, and a combination of emotional and cognitive apathy in schizophrenia[48]. Such variability likely reflects differences in underlying neuropathology and disease-specific mechanisms. By providing separate subscale scores, the DAS complements previously validated stroke measures[7,8] and facilitates targeted assessment and intervention planning for domain-specific apathy. Importantly, it reveals subtype-specific associations with depression, disability, and functional independence that would have been obscured using only global apathy scores, supporting the adoption of dimensional assessments such as the DAS in post-stroke clinical practice and research.

Both non-apathetic and apathetic stroke groups exhibited similar patterns in apathy subscale awareness, with the least awareness in initiation apathy. Initiation apathy, related to 'Energization' and executive functioning, may reflect executive dysfunction and self-awareness difficulties in stroke survivors. The higher level of initiation apathy in DAS-I compared to DAS-S might be due to caregivers associating it with behavioral initiation, independent of motor functions. Additionally, greater initiation apathy in both stroke groups could explain poorer awareness in this subscale, as seen in Alzheimer's patients where greater apathy correlates with diminished[49].

The cut-off values of 31 for DAS-S and 29 for DAS-I in this study differ from the previously reported cut-off of 39 for DAS-S in stroke, likely due to differences in methodologies[14]. The earlier study used two standard deviations above the mean of a healthy group, whereas our study used ROC curve analysis to balance sensitivity and specificity. While both methods have value, with the standard deviations method aligns with large-scale

normative data, the ROC analysis provides a more comprehensive and reliable approach for determining DAS cut-off points[50].

Depression was the strongest predictor of apathy, as well as DAS-S and DAS-I scores, in stroke survivors. This finding aligns with previous studies on psychosis and Parkinson's disease, where depression was identified as a predictor of apathy[51,52]. The executive and initiation subscales of both DAS versions showed moderate correlations with depression, whereas the emotional subscale exhibited only weak correlations. This finding, consistent with previous stroke research, supports the view that emotional apathy reflects emotional neutrality rather than mood disturbance[14,53]. These findings support the construct validity of the DAS and underscore the added value of a multidimensional assessment. Importantly, the ability to differentiate emotional apathy from depression represents a key clinical and theoretical advantage of dimensional tools like the DAS compared to unidimensional measures.

Depression emerged as the strongest predictor for the Executive subscale in both DAS versions and for the Initiation subscale in the DAS-S, explaining between one-third and one-half of the variance. For the Emotional subscale, functional indicators-particularly independence in instrumental activities of daily living-were the primary contributors, jointly explaining approximately 15–16% of the variance. These findings suggest that Initiation and Executive apathy are more closely related to mood disturbances, whereas Emotional apathy is more strongly linked to functional capacity. This distinction has important implications for rehabilitation, supporting the design of targeted, domain-specific interventions to address the heterogeneous nature of post-stroke apathy. The identification of such subtype-specific predictors underscores the clinical value of dimensional apathy assessment and its role in guiding tailored therapeutic strategies.

Disability was the second strongest predictor of apathy for both DAS scales. The correlation between apathy and disability is consistent with previous stroke studies[2,47]. Increased disability, often reflecting more extensive brain involvement, may increase the risk of apathy. Conversely, apathy—particularly within the Initiation domain—can restrict participation in rehabilitation, diminish goal-directed behavior, and thereby sustain functional limitations[54,55]. This association underscores the need to address motivational factors within comprehensive stroke rehabilitation programs.

Limitations

This study has several limitations that should be acknowledged. First, the use of non-randomized sampling and the exclusion of patients with cognitive impairment may limit the generalizability of our findings, as the results may not fully represent the broader population of stroke survivors. Second, the potential reluctance of apathetic individuals to participate—a common challenge in apathy research—could have led to under- or overestimation of apathy prevalence, potentially biasing our findings. Third, cultural and clinical differences may influence the interpretation of the DAS subscales in Persian stroke populations. Despite these limitations, the DAS demonstrates substantial clinical value by facilitating early detection of distinct apathy subtypes, thereby informing the development of more individualized and targeted rehabilitation strategies. To address these issues, future research should prioritize large-scale, culturally specific normative datasets, validation of the DAS across more heterogeneous populations, and longitudinal studies to examine sensitivity to therapeutic interventions. Such efforts will help increase the reliability, accuracy, and generalizability of findings, further consolidating the DAS as a valuable tool in both clinical and research settings.

Conclusion

In conclusion, this study provides evidence supporting the reliability and validity of both versions of the DAS in stroke survivors. The instruments demonstrated robust psychometric properties, including high internal consistency, excellent test–retest reliability, and acceptable construct and concurrent validity. The multidimensional structure of the DAS enabled the identification of distinct apathy subtypes, underscoring the added value of employing a multidimensional assessment approach. Separate analyses of the initiation, executive, and emotional subscales not only enhanced the construct validity of the DAS but also offered a more comprehensive understanding of the underlying mechanisms of apathy in this population. Clinically, the DAS represents a valuable tool for the early detection and characterization of various apathy subtypes after stroke, thereby supporting the development of more tailored and effective rehabilitation strategies.

Data availability

All data analyzed in this study are included in the Supplementary Information. Additional information can be provided upon reasonable request.

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Author contributions

A.J.: project administration, data curation, formal analysis, and roles/writing-original draft. T.B.: project administration, writing-original draft, and writing-review and editing. R.R.: writing-original draft, and writing-review and editing. S.Z.J.: data curation and software. H.M.: methodology and writing-review and editing. G.T.: supervision, validation, and writing-review and editing.

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Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the World Medical Association Declaration of Helsinki and received approval from the Ethics Committee of the Iran University of Medical Sciences (Ethical Code: IR.IUMS.REC.1401.970). All participants signed the informed consent form.

Competing interests

The authors declare no competing interests.

Additional information

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