Research Article

Executive Functions and Stuttering Severity in Persian Adults

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ABSTRACT

Introduction: Fluent speech requires executive functions to identify, inhibit, and modify speech interruptions to continuously regulate the speech process. The current study aims to examine the executive functions in adults who stutter (AWS) and adults who do not stutter (AWNS). We also examined the relationship between executive functions and stuttering severity.

Materials and Methods: This research is a cross-sectional descriptive-analytic study. The participants included 32 AWS (Mean±SD of age=28±6.79) divided into three groups of mild, moderate, and severe severity and 32 AWNS (Mean±SD of age=28.57±6.53). Selected tests from the Delis-Kaplan executive function system (D-KEFS) were used to assess executive function domains.

Results: The results of this study showed that AWS performed significantly lower than AWNS in working memory (P=0.009), problem-solving and planning (P<0.001), verbal cognitive flexibility (shifting) (P<0.001), and verbal inhibitory control (P<0.001). The results also showed no difference between AWS and AWNS in non-verbal inhibition, shifting, and reasoning. Furthermore, a significant relationship was observed between stuttering severity and executive function domains.

Conclusion: This study showed that executive function skills are affected in AWS and should be considered in the rehabilitation programs of AWS.

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Introduction

Stuttering is a speech disorder characterized by speech interruptions, such as repetitions, prolongations, blocking in the flow of speech, interjections, and speech revisions [1-3]. This disorder has a multifactorial nature in which linguistic, cognitive, emotional, motor, and genetic factors play a role in its occurrence and development [4-7]. Despite numerous studies and broad attention to stuttering, its etiology is still not well understood. Among the mentioned factors, it seems that executive functions can play an essential role in the production of non-fluent speech, which requires further research [8].

Executive functions, also called executive control or cognitive control, are a set of high-level mental processes that allow individuals to carry out goal-directed behaviors that adapt to environmental changes; and monitor and regulate their performance [8-10]. As a set of cognitive processes, executive function includes the ability to keep information in mind and then manipulate this information in real-time (working memory), suppress dominant responses and ignore irrelevant information (inhibitory control), and shift flexibly between strategies, rules, and perspectives in an adaptive manner (cognitive flexibility) [9].

While the quest to identify and describe the construct of executive function remains ongoing, an agreement exists about involving three core executive functions, inhibition, working memory, and cognitive flexibility/shifting [11-13]. Higher-order executive functions, such as reasoning, problem-solving, and planning are built on these functions [14, 15].

Regarding the role of executive functions, each person needs to identify, inhibit, and correct speech interruptions (such as repetition, etc.), shift attention before the onset or during the fluent speech, and be able to continuously adjust the speech process. Therefore, any deficiency in inhibition, working memory, and shifting can cause speech fluency difficulties [15]. Despite its role in fluent speech production, limited studies have examined executive function skills in adults who stutter (AWS).

Numerous studies have examined working memory in AWS with tasks, such as N-back tasks, word repetition, rhyme judgment, and word list recall focusing on the phonological loop. The results indicated that AWS performed worse than those without stuttering in the variability of accuracy and reaction time [16-18]. Another group of studies that used both verbal and non-verbal tasks showed that when the task was not taxing enough, no difference was observed between the performance of AWS and the adult who did not stutter (AWNS) in accuracy and reaction time [19-21]. Also, a limited number of studies have examined inhibitory control in AWS using go/no-go task, stop-signal task, and Antisaccade task, and most of them reported defects in this group [22-24]. In a similar study, Treleaven and Coalson showed a longer reaction time in the stuttering group than in the non-stuttering group but failed to show a significant relationship between stuttering severity and inhibition [24]. In contrast to the reported studies, Maxfield's study failed to show a significant difference in inhibitory control between the stuttering and the non-stuttering group [25].

Limited studies in these areas achieved a strong conclusion; however, some evidence suggests differences in the executive function of AWS in the items examined. Evidence suggests that working memory and inhibitory control are affected in the AWS; however, the results are conflicting. In addition, studies that have examined the relationship between stuttering severity and these skills are limited. Treleaven and Coalson examined the relationship between stuttering severity and response inhibition. The results showed no significant relationship between stuttering severity and response inhibition [24, 26]. In their study, only inhibition was examined and other executive functions were not examined. Therefore, according to some pathological theories that consider cognitive factors to be effective in causing stuttering, further research is needed to clarify the relationship between executive function and stuttering. This study was conducted to evaluate the executive function skills in AWS and to compare them with their non-stuttering counterparts. Further, we also examined the relationship between these cognitive function abilities and the severity of stuttering.

Materials and Methods

Study participants

The present research is a cross-sectional, descriptive-analytic study. Participants included 32 AWS (Mean±SD of age=27.0±6.79 years old; 28 men, 5 women) and 32 AWNS (Mean±SD of age=28.57±6.53 years old; 27 men, 5 women), that were matched in age, gender, and educational level. All participants were monolingual and native Persian speakers. Stuttering severities for the AWS group were as follows, eleven "mild", ten "moderate" and eleven "severe".

AWS group was diagnosed and categorized by an expert speech-language pathologist in a 5-10 minute interview. They were selected, using a convenience sampling method from speech and language therapy clinics of the Tehran University of Medical Sciences and private clinics in Tehran Province, Tehran. Then, to determine the severity of stuttering, the stuttering severity instrument (SSI3) test was used. For this purpose, the scores of the three components of frequency, duration, and associated physical behaviors were added, and the severity of stuttering was estimated at three levels, mild, moderate, and severe. The 'Naghshafarin teacher text' was used to evaluate the severity of adult stuttering, standardized by Farazi et al. in the Persian language [27].

The inclusion criteria included having developmental stuttering, being older than 18 years, being monolingual, lacking a history of speech and language disorders, lacking a history of neurological or psychological problems, or head trauma, lacking hearing loss or having a corrected hearing, having at least 9 years of school education. The exclusion criteria included the unwillingness of participants to continue cooperation at any point in the study.

It should be noted that one participant was excluded from the study due to his unwillingness to complete the test.

Study procedure

All participants expressed their consent before completing the tasks. Then, they completed a history form to record demographic information, family history of stuttering, treatment history, medical history, and history of speech and language disorders. Delis-Kaplan executive function system (D-KEFS) and non-word repetition task were used to assess the domains of executive function. All assessments were performed in a quiet room at the School of Rehabilitation, Tehran University of Medical Sciences. All assessments were completed in a 1-1.5 hour session. The participants were sitting facing the examiner. At first, the participants were explained about how to perform each subtest. To be familiarized with the tests, each participant was asked to complete a practice part before completing each subtest. At this stage, if the participants had any questions related to the test, they were answered and only after ensuring the participant's readiness, the main part of the test was presented.

Tests from Delis-Kaplan executive function system (D-KEFS)

Delis-Kaplan executive function system (D-KEFS) tests were designed and developed exclusively to evaluate executive functions by Delis-Kaplan, and in 2016, it was standardized in Persian on 75 healthy individuals aged 16 to 40 years by Ghawami et al. for the bilingual population [28]. Subtests of 6 of the 9 D-KEFS were used to examine inhibition, cognitive flexibility, problem-solving, reasoning, and planning [28, 29].

Trail making test (TMT)

The fourth condition of trail making test (TMT), which measures visual set-shifting and working memory, was used. A mild to moderate correlation for validity and test-retest reliability of 0.9 was reported for TMT [28]. Participants were asked to relate the sequence of numbers and letters by drawing a line. The time taken to perform the test is considered the outcome measure. The maximum time for this test is 240 s. If the participant cannot complete the task within this time range, the maximum time (240 s) will be recorded for him/her [30].

Verbal fluency test

The third condition, which is category switching, was used to measure switching. For this subtest, strong construct validity and internal consistency of 0.69 have been reported [28]. The participants were asked to alternately produce words from two different semantic categories (fruits and furniture) for 60 s. The number of correct shifts between the two semantic categories was considered the outcome measure [30].

Design fluency test

Design fluency test measures cognitive flexibility and inhibition. All three conditions, filled dots, empty dots only, and switching were used. Strong construct validity and test-retest reliability 0.88, 0.86, and 0.48 (respectively) have been reported for these subtests [28]. Each condition included 35 squares. In condition 1, 5 dots inside each square were observed. In conditions 2 and 3, 5 filled dots and 5 empty dots in each square were observed. In each condition, the participants were asked to draw different shapes using 4 lines for 60 s. The number of correct non-repetitive designs was considered the outcome measure [30].

Tower test

The total achievement score measures working memory, inhibition, problem-solving, and planning performance. Strong construct validity and internal consistency reliability of 0.44 have been reported for this [28]. The tower test consists of 9 challenges that gradually increase in difficulty. Each item began with the examiner placing from two to five disks on the pegs in a predetermined starting position and displaying a picture of the tower to build. The participant was asked to build the target tower according to the rules. The total achievement score was 0 to 30 and was determined based on the number of moves in the time frame and whether the tower was constructed accurately or not [30].

Color-word interference test (CWIT)

Conditions 3 and 4 were used. Strong construct validity and internal consistency reliability of 0.97 for condition 3 and 0.96 for condition 4 have been reported [28]. In condition 3, the participant was asked to say only the color of the word, and not to read the words. This condition measures inhibition. In the fourth condition which measures inhibition and set-shifting, the participant was asked to alternate between naming the color of the word and reading the word. The maximum time for both conditions was 180 s. The time required to complete each condition was considered the outcome measure. If the participant cannot complete the task within this time range, the maximum time (180 s) is recorded for him/her [30].

Sorting test

The scoring test consists of two conditions, free sorting, and sorting recognition, which measure problem-solving and conceptual reasoning. Strong construct validity and internal consistency reliability of 0.84 for the free sorting condition and 0.81 for the recognition condition have been reported [28]. The participants were asked to sort the cards into two groups of 3 for 240 s (4 minutes) in different ways, and after completing the sorting, explain how to do it. In the sorting recognition condition, the examiner performs the sorting, and the participant must explain the basis of this sorting. The total number of types of correct sorts in the first part (0 to 10) and the descriptive score in the second part were considered as the outcome measure (1 to 32) [30].

Non-word repetition

Non-word repetition consists of 60 one to five-syllable non-words that measure working memory. This test was standardized by Masumi et al. on 16 AWS (aged 20-39 years) [31]. Content validity of 0.83 and internal consistency reliability of 0.93 have been reported for this test [28]. A recorded voice of all non-words was played for all participants and they were asked to repeat each non-word. The responses were recorded as correct or incorrect. The number of incorrect repetitions was considered as the outcome measure [31].

Statistical analysis

The Kolmogorov-Smirnov test was used to evaluate the normal distribution of the data. The data distribution was normal to compare AWS and AWNS ($P>0.05$) and therefore the independent t-test was used. Since the data distribution in the groups in different severities was not normal ($P<0.05$), the non-parametric Kruskal-Wallis test was used to compare the tests scores. To investigate the relationship between the severity of stuttering and the test results, since the severity is an ordinal variable (mild, moderate, severe) and the test results are a scale, a formal correlation test (such as Pearson-Spearman) cannot be performed, which requires two scale variables calculated. Therefore, this correlation was calculated by comparing the results of tests at different levels of intensity. Therefore if the mean test results change significantly with an increase in stuttering severity, this means that a correlation is observed between the stuttering severity and the test results. Data were analyzed using SPSS software, version 16.

Results

This study was conducted to assess executive function domains in AWS versus AWNS and compare these functions to stuttering severity in AWS. This study was accomplished by examining the time, number, and accuracy of participants' responses on the D-KEFS subtests and the non-word repetition test. Table 1 presents the Mean±SD of the D-KEFS subtests and the non-word repetition test.

As indicated in Table 1, the mean time on time-dependent tests in the AWS groups was more than AWNS and in the severe stuttering group, it was more than the other groups. The comparison of AWS and AWNS showed significant differences ($P<0.05$) in verbal fluency, tower, CWIT (both conditions), and non-word repetition tests (Table 2).

Table 1. Mean scores of D-KEFS tests in AWS and control group (n=64)

Test	Mean±SD			
	AWNS	Mild	Moderate	Severe
Trail making test, number-letter switching, time	89.39±18.96	93.90±23.50	93.0±33.29	109.36±25.96
Verbal fluency test, switching, total correct	17.54±3.92	15.72±1.73	12.70±3.30	11.90±2.66
Design fluency test, inhibition, total correct	11.81±1.70	13.18±2.48	11.60±3.68	10.0±2.96
Design fluency test, switching, total correct	7.84±2.01	8.63±2.57	9.10±2.60	6.90±2.16
Tower test, total achievement score	17.96±2.83	15.72±1.73	15.0±2.82	15.90±0.83
Color–word interference test, inhibition, time	49.69±14.05	50.72±7.52	86.10±36.73	141.18±30.07
Color–word interference test, inhibition/ switching, time	60.39±11.20	59.72±11.96	109.40±44.16	171.09±10.38
Sorting test, free sorting, confirmed correct sorts	5.39±0.89	5.36±0.67	5.20±1.22	4.81±1.25
Sorting test, sort recognition, description score	19.06±3.15	19.09±4.01	18.0±5.63	16.72±5.95
Non-word repetition, error	3.39±2.46	4.81±2.40	4.40±2.75	6.18±3.76

D-KEFS: Delis-Kaplan executive function system; AWNS: Adults who do not stutter.

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Table 2. Results of comparing mean score and time of tests in AWS and AWNS using independent t-test

Test	Mean±SD		Mean Difference	Std. Error Difference	df	t	P	Power	Effect Size
	AWS	AWNS							
Trail making test, number–letter switching, time	100.48±28.83	89.39±18.96	-11.09	6.00	55.32	-1.84	0.07	35%	-
Verbal fluency test, switching, total correct	13.18±3.74	17.54±3.92	4.36	0.94	64	4.62	0.000	-	1.13
Design fluency test, inhibition, total correct	11.45±3.29	11.81±1.70	0.36	0.64	47.94	0.56	0.57	64%	-
Design fluency test, switching, total correct	7.81±2.73	7.84±2.01	0.30	0.59	64	0.05	0.95	51%	-
Tower test, total achievement score	15.30±2.40	17.96±2.83	2.66	0.64	64	4.12	0.000	-	1.02
Color–word interference test, inhibition, time	95.51±48.34	49.69±14.05	-45.81	8.76	37.37	-5.22	0.000	-	1.46
Color–word interference test, inhibition/ switching, time	115.54±53.85	60.39±11.20	-55.15	9.57	34.76	-5.76	0.000	-	1.69
Sorting test, free sorting, confirmed correct sorts	5.03±1.18	5.39±0.89	0.36	0.25	64	1.40	0.16	19%	-
Sorting test, sort recognition, description score	17.63±5.38	19.06±3.15	1.42	1.08	51.62	1.31	0.19	18%	-
Non-word repetition, error	5.21±3.00	3.39±2.46	-1.81	0.67	64	-2.68	0.009	-	0.66

AWS: Adults who stutter; AWNS: Adults who do not stutter.

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Table 3. Kruskal-Wallis test to compare the mean score (n=64)

Groups	Design Fluency (Inhibition)	Design Fluency (Switching)	TMT (Switching)	CWIT (Inhibition)	CWIT (Inhibition/ Switching)	Tower	Verbal Fluency (Switching)	Sorting (Free)	Sorting (Recognition)	Non-word Repetition Error
AWNS	33.20	33.03	29.55	22.65	23.88	40.65	42.33	34.38	34.95	26.17
Mild	52.1	39.68	33.68	25.77	23.23	24.95	34.59	34.55	34.59	39.64
Moderate	33.55	40.25	30.50	46.55	45.95	24.25	20.60	35.20	33.00	35.25
Severe	22.41	19.64	19.64	58.95	58.36	26.05	14.68	25.32	44.82	44.82
P	0.09	0.03	0.12	0.000	0.000	0.01	0.000	0.47	0.52	0.01
df	3	3	3	3	3	3	3	3	3	3
Kruskal Wallis H	6.37	8.48	5.69	37.40	35.15	11.27	22.98	2.47	2.25	10.35
Power	70%	-	48%	-	-	-	-	25%	24%	-
Effect size (η^2)	-	0.15	-	0.73	0.82	0.21	0.31	-	-	0.13

Abbreviations: AWNS: Adults who do not stutter; TMT: Trail making test; CWIT: Color-word interference test.

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The Kruskal-Wallis test indicated that the difference between the groups in design fluency (switching), CWIT (both conditions), tower, verbal fluency, and non-word repetition tests in various severities were significant (P<0.05). The severe group exhibited significantly higher time in both conditions of CWIT (F=3, P<0.001) and lower scores in the verbal fluency and the non-word repetition test (F=3, P<0.001, 0.01). For design fluency (inhibition), TMT, and sorting tests (both conditions), the calculated power was lower than 80% (for all tests) showing that the number of participants in each group was not enough (Table 3). Also, the effect sizes are calculated (Tables 2 and 3).

The post-hoc tests were performed on each pair of groups. Although the difference among groups in the tower and the design fluency test (switching) was significant (P=0.01, P=0.03), we cannot determine this difference between the two groups because the power of the study was low. However, it seems that in the tower test, the difference was between the AWNS and the moderate groups (P=0.091); and in the design fluency test, the difference was between the moderate and the severe groups (P=0.07) (Table 4).

Discussion

The present study was conducted to compare the executive function domains in the AWS and AWNS using the D-KEFS subtests and the non-word repetition test and also to compare these functions among different stuttering severity in AWS. These tasks allowed us to assess the mentioned functions verbally and non-verbally. As stated before, proper executive control skills are responsible for daily activities, resolving conflict among responses [32], and regulation of goal-directed behaviors [33]. Furthermore, these skills are necessary to produce fluent speech [34]. Therefore, since executive functions are necessary for fluent speech, in this study, we expected lower performance in executive skills in AWS compared to AWNS.

The results of this study showed that AWS performed significantly lower than AWNS in working memory, problem-solving and planning, verbal cognitive flexibility (shifting), and verbal inhibitory control. The effect sizes for these tests were large and very large. The results also showed no difference between AWS and AWNS in non-verbal inhibition, shifting, and reasoning.

Table 4. Kruskal-Wallis post hoc tests

Test	Groups in Pairs	P
Verbal fluency test, switching	Sever and AWNS	0.000
	Moderate and AWNS	0.008
Color–word interference test, inhibition	Moderate and AWNS	0.003
	Sever and AWNS	0.000
	Severe and mild	0.000
Color–word interference test, inhibition/switching	Mild and moderate	0.035
	Mild and severe	0.000
	Moderate and AWNS	0.007
	Sever and AWNS	0.000
Non-word repetition	Sever and AWNS	0.025
Tower test, total achievement score	It seems to be related to moderate and AWNS	0.091
Design fluency test, switching, total correct	It seems to be related to moderate and severe	0.07

AWNS: Adults who do not stutter.

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Regarding working memory skills, the results of the current study showed a difference between AWS and AWNS groups. These results are consistent with the results of Byrd et al. [16] who used a word repetition task, and inconsistent with the Gkalitsiou et al. [21] results who used an N-back task and reported no significant difference between AWS and AWNS. In Byrd's study, this was interpreted as AWS having distinct difficulty maintaining and simultaneously manipulating novel phonological strings in the phonological loop [16]. The differences between Gkalitsiou et al. study and the present study were the type of assessment tests and the non-verbal assessment of working memory. Gkalitsiou et al. used pictures instead of letters and words and this allowed the participants to engage in verbal and non-verbal processing of the stimuli, therefore, they were not sure about the extent of involvement of verbal and non-verbal processing in the participants [21]. Furthermore, small numbers of participants in each participant group (AWS and AWNS) were suggested as the reasons why the study failed to find a significant difference in accuracy between the stuttering and the non-stuttering groups.

Regarding non-verbal inhibitory control, our results are consistent with Maxfield et al. [25], and Gkalitsiou et al.'s studies [8] who reported no significant differences in inhibitory control between AWS and AWNS. Although this difference was not significant, the AWS showed lower performance in inhibitory control than AWNS in the present study. This pattern was also observed by Maxfield et al. [25], and Gkalitsiou et al. [8], and they suggested that AWS may need more neural resources to complete the inhibitory control tasks. Gkalitsiou et al. [8] used the Antisaccade task, which was a non-verbal and nonlinguistic task that used eye movements to measure inhibitory control. Maxfield et al. [25] used the Flanker task, which was also a non-verbal and nonlinguistic task and the participant manually determined the direction of the arrow to measure inhibitory control. Treleaven et al. [26] examined verbal and non-verbal inhibitions. They used a stop-signal task and participants completed one manual and three verbal parts. Although the results reported in the non-verbal inhibitory control are consistent with the results of the present study, in the examination of verbal inhibition, they did not report a difference between the two groups, which is inconsistent with our results. Their explanation for these results was that the task was not hard enough to show the difference between AWS and AWNS and although manual and verbal response inhibition may share a common inhibitory mechanism, there may be different final agents responsible for differences in inhibition between modalities [35]. Luschei and Goldberg [36] revealed differences at the lower motor neuron level for verbal and manual inhibition that may result in faster inhibition measured for limb or finger movement (i.e. corticospinal system) than the facial movement used during speech.

The difference between these three studies and the current study is the type of inhibition control assessment tests. Also, the lack of difference between the AWS and the AWNS may be explained by the type of inhibition examined by the tasks. Eggers et al. suggested different types of inhibitory control, and individuals who stutter may have deficits only in one type but not in another [37].

The present results fill well with Eggers et al.'s model [38, 39] of a weaker inhibitory control associated with stuttering. They suggest that stuttering in this group may be due to inefficient inhibitory control, which negatively impacts linguistic processing and error monitoring.

Regarding cognitive flexibility, our results are consistent with Wingate's results [40] demonstrating that AWS had difficulty shifting between the production of antonyms and synonyms for a given word and therefore suggested that AWS lacked flexibility "in mental tests requiring a rapid and continuous change of set", and Eisenson and Pastel's results [41] revealing that "stutterers perseverate more than nonstutterers". Poorer attentional shifting has also been reported in children's studies [38, 42]. These results are also consistent with the covert repair hypothesis. This theory proposes that disfluencies are the product of covert detection and corrections of pre-articulatory errors that interfere with ongoing articulation, and higher rates of disfluencies are due to multiple or excessive attempts at repairs [43]. Weaker attention control as reported in CWS and AWS [38, 39, 44, 45] may result in excessive attention on pre-articulatory errors or an inability to shift attention away from repaired segments, whereby, numerous repair attempts are made, contributing to high rates of disfluencies. As can be seen from Table 2, despite failing to reach statistical significance, a more problematic non-verbal attention switch exists in our AWS group.

Problem-solving, reasoning, and planning are also examined in the present study to reach a strong conclusion about the executive functions in AWS that have not been studied in previous studies. As Collins and Koechlin [14] suggested problem-solving, reasoning, and planning are higher-order executive functions built on inhibition, working memory, and cognitive flexibility. Our results showed that AWS had problems with inhibition, working memory, and cognitive flexibility and this can explain why they had difficulties in problem-solving and planning as well. On the other hand, we found no significant difference in reasoning between PWS and PWNS. It should be noted that the calculated power was low for reasoning tests; therefore our sample size may not be large enough to show a significant difference.

Executive function and stuttering severity

The results of this study showed a relationship between the severity of stuttering and executive functions. These differences were significant for working memory, planning and problem-solving, verbal and non-verbal cognitive flexibility, and verbal inhibitory control. The effect sizes for these tests were small, moderate, and large. Except for the planning and problem solving, the sever group received the lowest scores and the longest time in all assessment tests. In planning and problem-solving, the moderate group received the lowest score. To our knowledge, limited studies examined the relationship between stuttering severity and executive functions. Treleaven and Coalson [26] showed that the severity scores were not associated with non-selective inhibition. However, when analyzed separately, one sub-component of the SSI-4 (secondary characteristics to stuttering) significantly predicted verbal response inhibition. Neef et al. [46] also observed a relationship between the SSI-4 scores and increased connectivity in certain neural regions thought to control inhibition. Treleaven and Coalson [24] reported no significant relationship between manual response inhibition and stuttering severity in the AWS group. The authors suggested that the response inhibition may present as a domain-general impairment in AWS, but unrelated to stuttered speech. These results were inconsistent with our study. In Treleaven and Coalson study, a limited range of stuttering severity was examined; however, in the present study, we examined at least 10 participants in each severity group and this may be the reason why we found a significant relationship between the inhibition control and the stuttering severity. It should be noted that these results are based on limited data and future studies with more participants and different stuttering severity can shed light on the relationship between stuttering severity and executive function.

Conclusion

The results of this study showed a significant difference between AWS and AWNS in working memory, problem-solving and planning, verbal cognitive flexibility (shifting), and verbal inhibitory control. The results also showed no difference between AWS and AWNS in non-verbal inhibition, shifting, and reasoning. Furthermore, a significant relationship was observed between stuttering severity and executive function domains. Therefore, this study showed that executive function is affected in AWS and this may be a crucial issue for the speech therapist in AWS rehabilitation.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Tehran University of Medical Sciences (Code: IR.TUMS.FNM.REC.1400.076).

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Authors' contributions

Study Design: Maedeh Salehi and Mohammad Rahim Shahbodaghi; Data gathering, and drafting the manuscript: Maedeh Salehi; Supervision, review and editing: Mohammad Rahim Shahbodaghi; Statistical analysis: Shohreh Jalaie.

Conflict of interest

The authors declared no conflict of interest.

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