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Validation of a multidimensional model of stuttering for Persian-speaking children who stutter

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ABSTRACT

Purpose: The purpose of the present study was to validate a multidimensional model of stuttering using cognitive, affective, linguistic, motor, and social (CALMS) assessment instrument for Persian-speaking children who stutter.

Method: The CALMS assessment instrument was translated to Persian (CALMS-P) using an IQOLA translation process. Content validity was examined by the content validity of individual items (I-CVI) and the overall scale (S-CVI). The CALMS-P was administered with 115 Persian-Speaking children who stutter (age 7-14 years, 92 boys and 23 girls). Construct validity was probed through confirmatory factor analysis (CFA) using LISREL 8.8 and internal consistency was analyzed by Cronbach's alpha via SPSS 17 software.

Results: CALMS-P was an 18-item Persian assessment instrument with five subscales measuring five dimensions of stuttering i.e. cognitive, affective, linguistic, motor and social components. The model provided a fair fit ($\chi^2/df = 1.60$; RMSEA=0.07) and a good internal consistency (Cronbach's alpha =0.85) for the total instrument.

Conclusion: the CALMS-P assessment instrument which is based on the multidimensional model of stuttering proved to be a valid tool, useful for the therapists to assess and manage the stuttering of Persian-speaking children given the multifactorial perspective of stuttering.

Keywords: Stuttering; Multidimensional model; instrumental study; CALMS assessment; Confirmatory factor analysis

1. INTRODUCTION

Lay people and even some speech-language pathologists may realize stuttering as simply a speech disorder that is characterized by excessive speech disruptions like repetitions, prolongations, and hesitations in a person's speech. However, a large number of potential factors would affect stuttering and assessing them from a multidimensional perspective seems warranted given recent multidimensional models of stuttering such as the Demands and Capacities Model (Starkweather, 1999), the Revised Component Model (G. Riley & Riley, 2000), the Multi factorial Dynamic Disorder Model (Kleinow, 2015; Smith & Kelly, 1997), and the Dual Pre motor Model of Stuttering (Alm, 2007; Ritto, Costa, Juste, & Andrade, 2016). These multidimensional models of stuttering indicate that an evaluation of stuttering should focus on neurophysiological processes related to speech (De Nil, 1999), linguistic skills, emotional and attitudinal factors, social reactions to various listeners and speaking situations, and cognitive skills (Healey, 2012).

Inappropriately, the majority of the evaluation tools of stuttering in children have focused on one aspect of the disorder i.e. they are essentially unidimensional. For example, stuttering severity is most commonly evaluated via the *Stuttering Severity Instrument Fourth Edition* (G. D. Riley & Bakker, 2009); This measurement tool examines frequency, duration, and secondary coping behaviors that accompany stuttering. Or communication attitudes and the impact of various speaking situations on stuttering are emphasized in *The Behavior Assessment Battery for School-Age Children Who Stutter* (Brutten & Vanryckeghem, 2007). More recently, the *Test of Childhood Stuttering* (Gillam, Logan, & Pearson, 2009) focuses on linguistic contributions to stuttering while the *Overall Assessment of the Speaker's Experience of Stuttering* (Yaruss & Quesal, 2006) provides a comprehensive examination of the range of social and emotional experiences that affect stuttering. Although these mentioned instances may focus on symptoms other than motor components of stuttering, they are hitherto one-dimensional in nature. Recognizing a need for a multidimensional assessment of stuttering, Healey (2012) created an assessment for children who stutter that samples their cognitive, affective, linguistic, motor, and social performances (Healey, 2012, 2013). Some of the items used in the CALMS assessment are similar to those in the aforementioned standardized instruments. The CALMS assessment is not a standardized test or norm-referenced instrument. Rather, it is a criterion-referenced evaluation such that the data acquired in the assessment reflects a child's current level of performance in each of the five CALMS domains. A child's performance is independent of how other children who stutter perform and is not compared to children who are normally fluent. The CALMS assessment is based on a multidimensional model of stuttering, developed by Healey, Scott Trautman & Susca (2004), (Healey, Trautman, & Susca, 2004). It proposes stuttering is maintained by five factors. The factors include the cognitive, affective, linguistic, motor, and social contributions to a fluency disorder. These factors interact in a complex way between and among factors. All five domains can contribute independently or in combination to create various frequencies and types of stuttering. It is proposed that each child has a different level of skills and abilities in each of the five CALMS domains. The assessment is designed to evaluate each factor for each child who stutters.

The five CALMS domains reflect the strengths and weaknesses within each component for each person who stutters. It is assumed that everyone who stutters is a unique individual with unique characteristics. In this regard, any CALMS factor is considered influential on how the child will manage his/her stuttering. The assessment focuses on the current functional level of a child's thoughts, awareness, understanding, and perceptions (i.e. cognitive component) as well as his/her feelings and attitudes (i.e. affective component). These factors might impact how well a message will be formulated given a child's syntactic, semantic, morphological, and phonological abilities (i.e. linguistic component). Once the message is formulated, the efficiency and integrity of a child's speech motor system (i.e. motor component) would determine how fluent or stuttered the message might be in a particular speaking situation with a particular listener or group of listeners (i.e. social component). The complex interplay among factors is thought to determine how effectively an utterance is produced within the context of an unstable speech motor system that sometimes functions along a fluency-stuttering continuum (Adams & Runyan, 1981).

Examining this multidimensional model of stuttering i.e. CALMS in languages other than English through cross-language studies may be a helpful way of evaluating its effectiveness in assessing stuttering. On the other hand, there are a few standard stuttering tests in Persian which necessitates developing or adapting further tests. Iranian speech-language pathologists (SLPs) have adapted assessment instruments for children and adults who stutter such as the Stuttering Severity Instrument-3 (Bakhtiar, Seifpanahi, Ansari, Ghanadzade, & Packman, 2010) and the Stuttering Prediction Instrument (Jalilian, Shahbodaghi, Soleymani, & Jalaei, 2013), both originally developed by Riley. However, these are by no means sufficient. Consequently, a lack of Persian stuttering assessment tools in one hand and a need for multi-component appraisal instrument for stuttering in Persian on the other hand motivated the present research. The results of the current study also may help to validate the CALMS model of stuttering in general. Healey (2012) provided data from a large sample of children in Iowa and Nebraska in the Midwest portion of the United States (Healey, 2012). He stated that his data show that the CALMS assessment instrument has strong content and concurrent validity as well as strong intra- and inter-judge reliability. It is not known if the same level of validity and reliability could be achieved in a translated and adapted version of the CALMS for Persian children who stutter. Therefore, the purpose of the present study was to develop and validate the CALMS assessment for Persian-Speaking school-age children who stutter.

2. METHOD

2.1. Participants

The sample consisted of 115 Persian-speaking children and adolescents who stutter (92 boys and 23girls), with mean age of 10 years (± 2.25), and age range= 7-14 years. The participants were students of first grade to 8th grade in Tehran and Karaj schools. They were recruited from speech therapy clinics affiliated to University of Social Welfare and Rehabilitation Sciences, Iran medical sciences university, and Tehran medical sciences university, and 11 private speech therapy clinics in Tehran and Karaj. A non-probability purposeful sampling was carried out. Given the eligibility criteria, the subjects were in good physical, motor, mental and neurological health, except for stuttering. The stuttering of the participants was diagnosed by experienced SLPs through routine clinical examinations.

2.2. Instrument

The CALMS assessment instrument (Healey, 2012) is a 23-item instrument measuring five stuttering-associated dimensions in children adolescents; cognitive, affective, linguistic, motor and social factors are the key components of CALMS. Each item is rated based on a 1 to 5 point scale (1=normal; 2=borderline; 3=mildly abnormal; 4=moderately abnormal; 5=severely abnormal). Content validity, construct validity and reliability of CALMS were reported by Healey in 2012 (Healey, 2012).

There were excellent inter-rater (62% the same across 16 raters and 38% were between 94% and 70% agreement) and intra-rater agreement (mean intra-rater agreement=95%) for the CALMS assessment instrument. In the content of the CALMS assessment reflects current rational regarding the multidimensional nature of stuttering (Healey, 2012). In relation to construct validity, the CALMS model exploits the same concepts behind the Demands and Capacity model of stuttering and Smith's (1999) Multifactorial Dynamic model of stuttering (Healey, 2012).

2.3. Data collection and procedure

This study took place from September 2014 to April 2016. The CALMS assessment instrument was translated into Persian through a translation protocol by six professional translators. Then, content validity was determined by six experienced SLPs. This prepared version was administered on 115 participants by 8 speech pathologists trained for the procedure. Inter – item correlation and construct validity was examined using the gathered data (Table 1). This study was approved by the Ethics Committee of the

University of Social Welfare and Rehabilitation Sciences (Ethic code=IR.USWR.REC.1394.58). Anonymity, confidentiality and data protection were guaranteed through signed informed consent by the parents.

Table 1 Descriptive data of children who stutter (n=115)

Characteristic of children who stutter	Baseline characteristic	frequency	percent
Age, years, mean	7	14	12.2
	8	15	13
	9	17	14
	10	14	12.2
	11	14	12.2
	12	15	13
	13	14	12.2
	14	12	10.4
Gender	Female	23	20
	Male	92	80
Family history of stuttering	Yes	61	53
	No	54	47
Total	-	115	-

2.4. Translation process

First, the aim was to prepare an authentic English-to-Persian translation of different sections of the CALMS assessment instrument including the title, instructions, and the forms that comprised the assessment. Six translators performed the translation procedure. The translating process of CALMS was managed by means of IQOLA's translation protocol and equation (Alonso et al., 2004; Gandek & Ware, 1998; Skevington, Lotfy, & O'Connell, 2004; Walker & Rosser, 2012). The first step of translation process involved forward translation of the original English instrument into the Persian language by two professional translators (translators 1 and 2) who were native Persian-speakers. In the next stage, the translators discussed together the difficult rated items, dissimilarities in their translation, suggesting translation choices, and eventually completed a new translation. For this, a 100-mm Linear Analog Scale Assessment (LASA scale) was used (Katsura, Yamada, & Kida, 2003; Locke et al., 2007). This early forward-translation was given to two other professional translators (translators 3 and 4). They were asked to determine the appropriateness of the sentences and grammatical structures in clear expression (the use of simple and comprehensible expression), using common language (avoiding technical and synthesized words), conceptual equivalence (containing the conceptual meanings of the original version), and the overall quality of the translation. The aforementioned translation was given to translators 5 and 6 who were also native speakers of Persian with extensive knowledge of English to back translate it. They back translated the instrument into English. This backward-translation were reviewed and matched with the Persian version by the translators 5 and 6 with an emphasis on conceptual equivalence. This finalized Persian version of the CALMS assessment was used in the further stages of this research and was referred to as CALMS-P.

2.5. Content Validity

The content validity of the CALMS-P is realized as how fit the content of this assessment were pertinent to the construct under measurement (Blessing & Forister, 2013; Forister & Blessing, 2015). As noted by Lynn (1986), researchers examine two sorts of content validity index (Lynn, 1986; Polit & Beck, 2006). The first type involves the content validity of individual items (I-CVI) and the second involves the content validity of the overall scale (S-CVI). Six speech pathologists (SLPs) with an average of five years of experience in the assessment and treatment of fluency disorders served as expert judges to evaluate the content validity of the CALMS assessment. To calculate an I-CVI, six experienced SLPs were asked to rate the relevance of each item on a 4-point scale (1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant), (Polit & Beck, 2006). The scores of 3 or 4 rates was

divided by 6 for each item and I-CVI was obtained (the scores of 1 and 2 were disregarded). The S-CVI was computed by calculating the mean of I-CVIs. Lynn recommended I-CVIs no lower than 0.78 when there are six or more judges (Lynn, 1986) so in this study items with scores lower than 0.78 was deleted.

2.6. Inter - item correlation

Inter-item correlations probe the amount to which scores of one item are connected to scores of all the items in a scale (Michalos, 2014). The results of the related studies have shown that the average inter-item correlation for a set of items is better to be between 0.20 and 0.40 (DeVellis, 2016; Michalos, 2014; Piedmont & Hyland, 1993). In the current study, the inter-item correlations were calculated for items of CALMS-P instrument and according to Michalos' criteria (2014), values lower than 0.20 was deleted (Michalos, 2014).

2.7. Construct validity

We used the confirmatory factor analysis (CFA) to assess the goodness-of-fit of CALMS model of stuttering in Persian-speaking children and adolescents. To assess the measurement model validity, the indicators of chi square (χ^2), the degree of freedom (df), the goodness-of-fit index (GFI), the normed fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were used (Hooper et al. 2008; Luque-Suarez et al. 2016). According to Carmines and McIver (1981), χ^2/df ratios in the range of 2:1 or 3:1 shows a satisfactory fitting between the proposed model and the obtained data (Carmines & McIver, 1981; Khazaei-pool et al. 2016). Our criterion in this study for a good fit was as follows: values greater than 0.90 for GFI and NFI, and 0.95 and greater for CFI. For RMSEA values less than .05 considered as close fit and values between .05 and .08 considered as a fair fit (Chan et al. 2007; Osubor & Chiemeke, 2015; Ye et al. 2016).

To interpret fit indices the following criteria were used: χ^2 /df ratio < 2 (excellent); χ^2 /df < 3 (good); χ^2 /df < 5 (acceptable); good fit for GFI, CFI and NFI \geq .90 (Hu & Bentler, 1999) ; a fair fit for RMSEA \leq .08 (Lee et al. 2014; Yuan et al. 2016).

2.8. Internal Consistency

In order to determine the internal consistence of the CALMS-P, Cronbach's alpha was calculated of the total CALMS-P score (Storme, Myszkowski, Davila, Bournois, & Biswas, 2015). An $\alpha \geq$.80 was considered as adequate for the CALMS-P instrument to be internally consistent (Lohr, 2002; Terwee et al., 2012).

3. RESULTS

3.1. Translation

The CALMS-P translation was equivalent to the original United States version with a few exceptions. In the original CALMS, in social component, section 2, item (e) (talk at parties, social events, or with club/team members) was changed to fit Iranian culture ("parties" to "school celebrations", "club members" to "group members"). It should be mentioned that more than 80% of items were the same as the original items in the social assessment category.

3.2. Content validity

Table 2 shows the relevance ratings of six experts for the 23-items. A total of 18 out of the 23 items received relevance ratings of 3 or 4 by all the experts. Item number 11 and 16 obtained an I-CVI score of 0.83 which we kept them in the test. I-CVI scores ranged from 0.33 to 1.0. The S-CVI was 0.92. The average proportion of items rated as relevant across six experts was 0.92. As shown in table 2, two items (items 4 and 8) had been deleted because they had relevancy less than 0.79. Item 4 was related to child's knowledge and understanding of stuttering which rate child's ability to describe stuttering behaviors, knowledge of his/her stuttering behaviors, and general facts about stuttering. And item 8 was related to determining child's attitudes and feelings about communication. As a result, the content validity examined version of CALMS-P remained with 21 items.

Table 2 Ratings on a 23-Item Scale by Six Experts: Items Rated 3 or 4 on a 4-Point Relevance Scale

Item	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Number in agreement	Item CVI
1	*	*	*	*	*	*	6	1.00
2	*	*	*	*	*	*	6	1.00
3	*	-	*	*	*	*	5	0.83

4	-	*	*	-	-	*	3	0.50
5	*	*	*	*	*	*	6	1.00
6	*	*	*	*	*	*	6	1.00
7	*	*	*	*	*	*	6	1.00
8	-	*	-	-	-	*	2	0.33
9	*	*	*	*	*	*	6	1.00
10	*	*	*	*	*	*	6	1.00
11	*	*	*	-	*	*	5	0.83
12	*	*	*	*	*	*	6	1.00
13	*	*	*	*	*	*	6	1.00
14	*	*	*	*	*	*	6	1.00
15	*	*	*	*	*	*	6	1.00
16	*	*	*	*	-	*	5	0.83
17	*	*	*	*	*	*	6	1.00
18	*	*	*	*	*	*	6	1.00
19	*	*	*	*	*	*	6	1.00
20	*	*	*	*	*	*	6	1.00
21	*	*	*	*	*	*	6	1.00
22	*	*	*	*	*	*	6	1.00
23	*	*	*	*	*	*	6	1.00
Proportion Relevant	0.91	0.95	0.95	0.86	0.86	1.00	-	0.92

3.3. Inter-Item Correlations

The inter-item correlations were calculated for each item of CALMS-P. All were significantly inter-correlated within their corresponding subscales ($r = > 0.3 > 0.6$, $p < 0.05$) except for 3 items: item number 3 in cognitive component which had no significant correlations with other items ($r=0.12$), this item is related to assessing child's ability to identify stuttering from clinician model; item number 11 in linguistic component ($r=0.03$) that is related to rating speech sound production ability; and item number 16 in motor component ($r=0.12$) that is related to determining percentage of stuttering from spontaneous speech sample. These three items also were eliminated from the test. So, the final version has 18 items. The average inter-subscale correlation for the subscales was $r = 0.37$. This version of CALMS-P with 18 items was used for determining construct validity.

Table 3 Fit index of structural equation model of figure 1

Index	Value
χ^2 **	200.87
χ^2 / df	1.60
GFI	0.84
CFI	0.84
NFI	0.86
RMSEA	0.07
<i>p</i> .value	0.000

Note. ** $p < .001$, $\chi^2 =$ chi square, $df =$ degree of freedom, GFI=Goodness of Fit Index, CFI= Comparative Fit Index, NFI= Normed Fit Index

3.4. Construct validity

Figure 1 shows the results of the parameters of the CALMS model. Table 3 shows the values of the fit of the proposed model. The degrees of freedom were excellent ($1.60 < 2$). The rest of the fit indices showed values between 0.84 to 0.86 and confidence intervals

(90%) of RMSEA between 0.05 and 0.09. The CALMS-P assessment included five factors with cognitive components measured by 3 items (items from 1 to 3), affective component measured by 2 items (items 4 and 5), linguistics components measured by 2 items (items 6 and 7), motor component measured by 7 items (items 8 through 14) and finally social components measured by 4 items (items 15 to 18). Factor loadings ranged between 0.1 (item 7) and 1.32 (item 1) whereas measurement errors ranged between 0.06 (social item 4) and 1.3 (cognitive item 5) so is thereby deduced that the squared multiple correlation coefficients ranged from 0.26 to 0.42. It should be re-mentioned that five items were not used for construct validity analysis and the analysis was made with 18-item test.

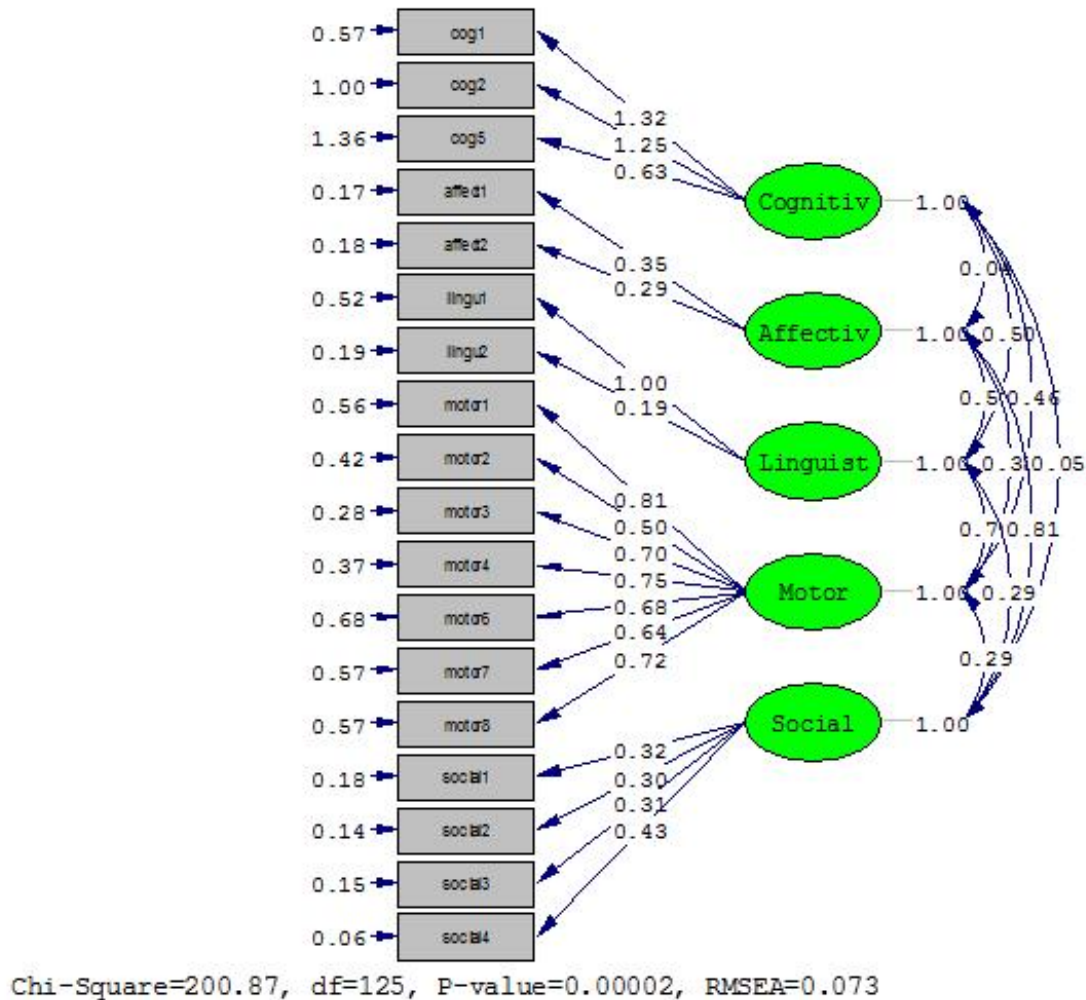


Figure 1 Confirmatory factor analysis of CALMS model Appendix (as e-component)
Ap.1. Persian version of CALMS assessment instrument

Table 4 Internal consistency reliability of P-CALMS assessment instrument

Item	Scale Mean if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	31.80	.492	.840
2	31.53	.428	.846
3	31.73	.437	.842
4	32.28	.377	.843
5	32.55	.206	.848

6	31.87	.625	.829
7	33.05	.300	.846
8	31.82	.570	.833
9	32.44	.543	.836
10	32.48	.629	.831
11	32.44	.586	.833
12	32.45	.615	.830
13	32.41	.614	.831
14	32.22	.584	.832
15	32.62	.228	.847
16	32.47	.238	.847
17	32.75	.302	.845
18	32.67	.325	.845

3.5. Internal Consistency

The overall CALMS-P score reached a Cronbach's alpha coefficient of 0.85, which reflects high internal consistency (Lohr, 2002; Terwee et al., 2012). As shown in table 4, it was stable or decreased if an item was deleted.

4. DISCUSSION

The primary goal of this study was to test the CALMS model of stuttering that provides measures of components comprising the complex relations between stuttering components. This article has taken the first steps towards validating this multidimensional stuttering model in Iran. As a whole, the results supported our model of a Persian community. In this section, first we discuss several specific findings and then take a look at study limitations and directions for future research.

Translation data suggested that the Persian version of the CALMS functioned in the general population of Persian speakers similarly to the original American population tested. Content validity, confirmatory factor analyses, and correlation analyses were performed on these items. The content validity data supported stuttering as multi factorial disorder. We found a high item-level content validity index (≥ 0.80 in most items). I-CVI analysis demonstrated 'excellent' results in all items except for items 4 and 8 that showed the relevancy less than 0.78%. according to Lynn (1986) I-CVIs should be higher than 0.78 (Lynn, 1986). So these two items deleted from assessment instrument. S-CVI was 0.92, which measurement experts suggest is acceptable when an S-CVI is .80 or higher (Davis, 1992; Delgado-Rico, Carretero-Dios, & Ruch, 2012; Grant & Davis, 1997; Polit & Beck, 2004, 2006; Vadlin, Åslund, & Nilsson, 2015, Pavelko et al., 2016). Furthermore, the Inter-item correlations suggested three items (item 3 in cognitive component, item 11 in linguistic component, item 16 in motor component), should be removed because they did not show the relation to other items and the removal of these three items had impact on the internal consistency. In relation to the internal consistency analysis, the Cronbach's alpha assessment showed 'high' internal consistency reliability. The analysis of internal consistency values have been appropriated ($\alpha = .85$), according to the recommendations, as reliability indices located $\alpha \geq .80$ is adequate (Fiona et al., 2017; Lohr, 2002; Morales vallejo 2006; Terwee et al., 2012). The end result was an 18-item instrument with five different subscales that measured the five dimensions of stuttering: cognitive, affective, linguistic, motor and social components (see Appendix). Regarding the factor structure the suitability of CALMS models was tested; and the model showed the fair fit of indices. In this model, items 1 to 3 assess cognitive factor; items 4 and 5 assess affective factor, 6 and 7 assess linguistic factor; and items 8 to 14 assess motor factor and finally items 15 to 19 assess social factor of stuttering. The factor loads of all items were above .30, with significant values, except two items (items 5 and 7) but these items were maintained to improve its goodness of fit.

In general, this study indicated that the CALMS-P could be used reliably by SLPs when working with Persian-speaking school age children who stutter. This is encouraging because there is a lack of multidimensional assessments available for children who stutter. Although the reliability and validity of the CALMS assessment was confirmed by the data from this study, is not a standardized evaluation tool like others available in the field of fluency disorder (Brutten & Vanryckeghem, 2007; Costa et al., 2014; Gillam et al., 2009; Ginsberg et al., 2016; Louis, 2012; Neumann et al. 2015; Riley & Bakker, 2009; Weidner et al. 2015; Yaruss & Quesal, 2008). This suggests that the CALMS assessment should be used in conjunction with available standard measures for children who stutter. However, the strength of the CALMS assessment is that it provides comprehensive measures of several components that are thought to contribute to stuttering. Ratings from each of the 18 items of the CALMS assessment can be used as pre- and post-

treatment measures of progress in each area. It also allows a clinician to identify items or components that reflect a child's areas of need for treatment. Therefore, the strengths of the CALMS assessment appear to outweigh the limitation of it not being a standardized instrument. For these reasons, it appears that the CALMS assessment would be a useful evaluation tool of Persian-speaking children who stutter. Overall, this study provides evidence of factor structure and internal consistence of a CALMS assessment designed to evaluate stuttering. The instrument provides specific indicators to measure five factors in children who stutter. This instrument could be useful for clinical practice, and other types of research in the field of fluency disorders.

LIMITATIONS

First, because in original study, they did not perform the detailed factor analysis that we did so there is no way to compare our results with original version. Second, further research is also needed to examine reliability by test re-test and discriminate validity. third, although we accepted the CALMS model as more adequate regarding goodness of fit indices proposed, other research in testing model proposed stricter cut-off points such as RMSEA <0.05 and CFI, GFI> 0.95 (Arias, Verdugo, Navas, & Gómez, 2013), in our study these indices have reached .07 and 0.84 respectively. Fourth, the exploratory factor analysis of CALMS model is not shown and should be carried out in future research.

Despite these limitations, the three main conclusions that can be drawn from this study can be summarized as follows:

- 1) the results of CFA studies indicated that the CALMS model provided a fair fit as evidenced by all relative fit indices (i.e., CFI, GFI, RMSEA) meeting fit criteria and chi-square index on Persian speaking children who stutter;
- 2) The validity and reliability of CALMS-P indicated that there is valid and reliable multi factorial instrument for Persian speaking children who stutter.

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