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RESEARCH ARTICLE

Cross-cultural adaptation and determining validity and reliability of the Persian revised Buffalo model questionnaire

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Abstract

Background and Aim: The majority of auditory processing guidelines use questionnaires or checklists as screening tools. The Buffalo Model Questionnaire (BMQ) is a well-known and sensitive questionnaire to be used along with the Buffalo Model diagnostic test battery. The revision for the Buffalo Model Questionnaire-Revised (BMQ-R) implemented to improve the readability of the BMQ, reducing the completion time and increasing the ease of scoring for the audiologist. The purpose of this study was to develop and investigate the psychometric properties of the Persian version of BMQ-R (P-BMQ-R).

Methods: After cross-cultural adaptation of the questionnaire, the validity and reliability were determined, also the norms for the children in age ranges between 7 and 12 were generated.

Results: Findings of this study revealed strong content and face validity of the questionnaire. Scores of the test and retest were correlated ($r > 0.9$) strongly and positively based on Spearman correlation coefficient.

Conclusion: The Persian version of BMQ-R (P-BMQ-R) is a valid and reliable tool and is suitable to use in everyday practice.

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Introduction

According to the American Speech and Hearing Academy (ASHA), "the auditory processing (AP) defined as mechanisms and processes underlying auditory skills for sound localization and lateralization, auditory discrimination, recognition of auditory pattern, temporal processing, hearing with competing acoustic signals, and auditory performance with degraded acoustic signals" [1,2]. Auditory processing disorder (APD) occurs when one or more of central auditory processing behaviors are impaired. The prevalence of the auditory processing disorder in children's population estimated between 2% to 3% and 10% to 20% in adults [3-6].

Individuals with APD may have several difficulties, such as understanding speech in noise, following auditory-verbal instructions, speech sounds discrimination, localization of the sound

source, etc. Given the complexity of the APD, morbidities could affect the overall academic function of the child especially in spelling, writing, and reading [1].

A complete evaluation for auditory processing disorders starts with a full history-taking. Filling in a standard questionnaire about auditory skills by parents or care-givers could be the second step. Also, behavioral auditory processing assessments and auditory electro/physiological evaluations, and assessment of speech and language abilities are the most important steps of a complete APD assessment" [7]. Given the complexity of symptoms and various manifestations of APD, it is important to use methods that can provide detailed information about the patient's history, conditions, and real-life difficulties in a short time. Tools such as questionnaires might be a good choice to achieve this goal. The use of questionnaires as a screening tool for children who may be at risk for at APD has been recommended in various guidelines (ASHA [1], AAA [9]). Today, the majority of APD guidelines, protocols, and models of auditory processing use questionnaires or checklists as screening tools. The questionnaire needs to be simple, easy to understand, easy to fill in, provide a quick scoring and interpretation method for the expert [10], and can be used as a criterion to determine the need for further comprehensive diagnostic investigations [11]. Jerger and Musiek [8] recommend that "no matter what diagnostic (C)APD protocol a professional chooses to use; a screening tool is to be used as well".

Various aspects of auditory processing could be assessed with questionnaires and checklists including receptive language skills, speech production, writing, reading, cognitive skills, expressive language skills, psychoeducational abilities, academic and educational status, and developmental history [12].

There are a large number of questionnaires introduced to use as a screening tool in everyday practice, among them the frequently used and well-known questionnaires are the Buffalo Model Questionnaire [13], children auditory performance scale [14], children home inventory for listening difficulties [15], listening inventories for education [16], the scale of auditory behaviors [17], auditory processing domains questionnaire [18], a screening instrument for targeting educational risk [19], and the Fisher's auditory problem checklist [20].

The Buffalo model questionnaire and the revised version

The Buffalo Model Questionnaire (BMQ) is a screening tool developed by Katz thanks to his experience in working with individuals diagnosed with APD. The BMQ is the only questionnaire of the Buffalo Model and designed for use along with the Buffalo Model diagnostic test battery. The BMQ is based on the behavioral characteristics frequently exhibited by individuals diagnosed with APD [21,22].

The revision for the Buffalo Model Questionnaire (BMQ-R) implemented to improve the readability of the BMQ, reducing the completion time and increasing the ease of scoring for the audiologist [23]. The BMQ-R is composed of frequently exhibited behaviors of those identified with APD and offers an independent analysis of the behaviors that are closely associated with specific sub-categories of Buffalo Model [23]. This questionnaire is made up of 48 questions that have relevance to APD as well as 6 therapies that can influence APD test performance and the BMQ-R [21,23]. The BMQ-R investigates the difficulties associated with speech production or articulation, spelling, reading, speech understanding in noise, distractibility especially in noise, attention-deficit/hyperactivity disorder, coordination, sequencing, short-term memory, and other auditory-based tasks [21].

The BMQ-R is filled out by the parent(s) and/or teacher(s) of a child or in the case of an adult, the patient could complete the form.

The BMQ-R can be used as an important tool in confirming the diagnostic test results, cross-checking the parents' and teachers' complaints to APD test results, and provide functional effects of APD in communication, education, and everyday life. Also, the BMQ-R can also aid in the development of an effective therapy program and determining the effectiveness of an APD training program on a child's performance at school and

home [23].
The Persian version of BMQ (P-BMQ) was first introduced by Khamisabadi et al. [24]. The revision for the Persian Buffalo Model Questionnaire implemented in this study to improve the readability of the P-BMQ, reducing the completion time and increasing the ease of scoring for the experts. Therefore, the aim of this study was to develop the P-BMQ-R and to investigate the psychometric properties of the revised version in order to make this questionnaire available for research and clinics for Persian population.

Methods

This was a questionnaire development, descriptive-analytical study, and included three independent steps: the cross-cultural adaptation of the P-BMQ-R, evaluating the psychometric properties of the questionnaire, and normative data generating. All three steps and data collection were implemented prospectively. A written informed consent were provided for each of the parents.

Study population

The participants randomly selected from who referred for peripheral and/or central auditory evaluations from September of 2019 to December of 2019.
Each participant underwent the following test battery: Persian Buffalo Model Questionnaire-Revised (P-BMQ-R) filled in by parents or caregivers, a complete Persian Buffalo Model diagnostic test battery including three tests of Persian staggered spondaic words (P-SSW) test [25-27], Persian phonemic synthesis test (P-PST) [28], and Persian speech in noise (P-SN) [25].
The inclusion criteria used for each participant included: normal hearing thresholds (less than or equal to 20 dB HL from 250 to 8000 Hz [29], normal tympanogram (Type A) with a 226-Hz probe tone (defined as static compliance from 0.25−1.05 mmho, and tympanometric width from 80−159 daPa [30]), and normal auditory processing based on normative data of the tests mentioned above. All the recruited normal children were monolingual Persian speakers and right-handed (i.e. +10 score on the Edinburgh handedness inventory [31]). Also, children diagnosed with learning and/or reading disorders, and/or attention deficit hyperactivity disorder, and/or speech and/or language disorders were included if they had a diagnosis of (C)APD and presence of co-morbidity following completion of the Buffalo Model test battery. The results, cut-off points and the performance differences in these populations did not reported in this article.

Cross-cultural adaptation of the revised Buffalo model questionnaire

Cross-cultural adaptation of the BMQ-R was conducted based on the guidelines of Beaton, Bombardier, Guillemin, and Ferraz [32]. Overall, 45 people participated in the translation and cross-cultural adaptation stage of the P-BMQ-R including 5 experts, 15 parents of children with APD, and 25 parents of normal children. In the first step, Prof. Jack Katz permitted us to translate the BMQ-R to Persian language. The next step was employing the translation back-translation method to translate the English version of the BMQ-R using bilingual translators. The original version of BMQ-R, translated Persian version of BMQ-R and the back-translated questionnaire was delivered to five experts in the field of auditory processing evaluation and/or rehabilitation. They discussed each item based on quality, fluency, readability, clarity, and the cultural context. The experts gathered in a group and discussed the quality of translation and cultural adaptation. In this group, the experts tried to harmonize the content of the translated questionnaire to the content of the BMQ-R. After considering the feedback provided by the experts and parents, necessary modifications made and a final version of the P-BMQ-R was agreed upon.

The Persian revised Buffalo model questionnaire

The P-BMQ-R is a self-perceived measure with 48 questions filled out by the parent(s) and/or teacher(s) of a child. The P-BMQ-R form is similar to the original version of the BMQ-R. At the top of the form; below the title is the identifying information section. Below the identifying information is a table with questions asked about prior therapies. History of six therapies asked

includes auditory training, speech therapy, phonological awareness, phonics, reading, and sensory-integration therapies. If the child has been exposed to any of the mentioned therapies, the rater circles the "yes" and indicates the number of years the therapy was received. The characteristics or behaviors associated with APD are grouped by sub-categories of the Buffalo Model. Also, the characteristics/behaviors that are not specific to any one of the four Buffalo Model sub-categories are included. The GEN (General) section is a group of general characteristics/behaviors that may, or may not, be associated with APD. Finally, ΣCAP is the sum of all the APD indicators. Each item has three response choices: Yes: this is/may be a problem for the child, No: this is not a problem for the child, and N/A = this question is not appropriate for the child because there was no opportunity to experience this characteristic/behavior. At the bottom of the form, there is a table that is used by the professional to score the P-BMQ-R. The scoring method for the P-BMQ-R is the same as the original version [21-23] and as it is reported "is divided into the categories used in the characteristic/behaviors section, plus a tolerance fading memory (TFM) total and the ΣCAP. The ΣCAP is the total "Y" indications of the four Buffalo Model categories including Decoding (DEC), TFM, Integration (INT), and Organization (ORG) plus the non-specific APD score (APD) for a total of 39 items. The number of "Y" indications from the GEN category is not included in ΣCAP score.

Psychometric properties

Validity

Face validity

The face validity determined by obtaining the opinions of 40 people, including 20 audiologists, 15 parents of normal children, and 5 parents of children with APD to find out how much they understand each item correctly. Participants were asked about understandability, clarity, comprehensibility, and the absence of any ambiguity regarding each question with a 6-point scale, where 1 indicates the most difficult item and 6 indicates the easiest to understand the item.

Content validity

To determine the content validity, the questionnaire was assessed by a group of 20 experts participated in the content validity stage of the study, including audiologists (n = 10), speech and language pathologists (n = 3), occupational therapist (n = 4), and linguists (n = 3). The experts asked about the necessity and relativity of the items to the APD evaluations of the desired attribute. To measure and interpret the content validity a three-point scale including 1) necessary, 2) useful but not necessary, 3) not necessary) for each item was used.

Reliability

The P-BMQ-R was filled in twice by 95 participants with a two-week (14 ± 4 days) interval. During this period, participants were not taking any medication and/or rehabilitations and the parents report that children had no significant changes in overall health. To ensure the integrity and stable function of the peripheral auditory system and auditory processing, the pure tone audiometry, tympanometry, P-SSW, P-PST, and P-SN were conducted before the parents filling out the questionnaire for the second time.

Normative Data

To generate the normative data, the P-BMQ-R was filled out by parents of 373 normal children in the age range of 7 to 12. The findings of the normative data were captured for all types of scores, including the DEC, Noise (Noi.), Memory (Mem.), Various (Var.), TFM, INT, ORG, Gen, and ∑ CAP.

Data analysis

Data were analyzed in SPSS 19.0 (IBM SPSS, Chicago, IL). Descriptive findings reported in terms of mean and standard deviation. The normality of the data was evaluated by the the Kolmogorov–Smirnov (K-S) test. The content validity ratio (CVR) calculated as CVR = [(nE − N/2)]/[(N/2)], and the content validity index (CVI) was determined by summing the mean of

all the CVRs obtained. The findings of CVI and CVR was then assessed against the Lawshe's table [33]. The test-retest reliability examined by the Spearman's correlation coefficient.

Results

Study population

Overall, 478 people participated in different stages of this study. 45 people participated in the translation and cross-cultural adaptation stage of the P-BMQ-R. 20 experts participated in the content validity stage of the study. The face validity determined by obtaining the opinions of 40 people, including 20 audiologists and 20 parents. To determine the normative data of the P-BMQ-R, 373 (male = 53%) parents of the normal children in the age range of 7 to 12 (mean = 9.4, SD = 2.1) filled in the questionnaire. The test-retest reliability determined by twice completion of the questionnaire in 95 participants with a two-week (14 ± 4 days) interval.

Cross-cultural adaptation of the BMQ-R

Some modifications made in P-BMQ-R were inevitable because of cultural and linguistic differences. Modifications include additional words and phrases in some sentences in order to improve the comprehensibility and readability of each question and eliminate any potential ambiguity. The BMQ-R items are designed to answer a yes or no question and most items are sentences without a verb. Considering the lingual differences, we came to the conclusion that the use of sentences without a verb in Persian may lead to a decrease in readability and understandability of the item. Therefore, we use a complete sentence for most items of P-BMQ-R. The other modification was related to items 20, 21, 22, 29, 35, 39, and 48. These items are often about disorders such as attention deficit, learning disabilities, autism spectrum disorder, etc. In these items, the parent may have expressed his or her personal opinion in answering the question. Therefore, we add the phrase "diagnosed by an expert" to increase the reliability of the item and decrease the confusion. Although most items had high scores in quality, fluency, readability, clarity, and the cultural context, items 1, 2, 4, 6, 22, 27, 30 had the lowest score, which was discussed and modified in the focus group.

Psychometric properties of the Persian revised Buffalo model questionnaire

The face validity determined by obtaining the opinions of audiologists and parents to find out how much they understand each item correctly. None of the items were given less than score 4. The lowest score (i.e. 4) recorded for five items (10.42%) by three participants (7.5%). Nine items (18.75%) scored 5 by 6 participants (15%) and 34 items (70.83%) scored 6 by 31 participants (77.5%). According to Preston and Colman [34], if more than 80% of the participants gave each item a score of 4 or more, that face validity was confirmed. Therefore, face validity regarding each question and the total questionnaire of the P-BMQ-R were confirmed.

The content validity ratio values calculated for each of 48 items of P-BMQ-R were between 60% and 93%, and the content validity index was 80.43%.

The P-BMQ-R was filled in twice by 95 participants with a two-week (14 ± 4 days) interval. The Spearman correlation test was used to compare the different scores of the P-BMQ-R in test and retest. The test-retest reliability of the P-BMQ-R revealed excellent reliability (i.e. $r \geq 0.9$ and $p < 0.05$) for all sub-score types. Detailed information reported in Table 1.

The normative data established based on the results of the P-BMQ-R filled out by parents of 373 normal children. The normative data were obtained for all sub-scores based on mean and standard deviation (Table 2). Normal limits (NL) were set at 2SD above the mean based on the original English version of BMQ [21-23].

Discussion

The BMQ-R is a well-known and sensitive questionnaire to be used along with the Buffalo Model diagnostic test battery [35]. The aim of this study was the cross-cultural adaptation of the Persian version of the BMQ-R (P-BMQ-R) and then perform psychometric analysis to assess the questionnaire's validity and reliability and finally

Table 1. The results for test-retest reliability of the Persian revised Buffalo model questionnaire

Subcategory and behavior	r	p
DEC	0.94	< 0.001
Noi.	0.91	< 0.001
Mem.	0.93	< 0.001
Var.	0.95	< 0.001
TFM	0.98	< 0.001
INT	0.92	< 0.001
ORG	0.99	< 0.001
APD	0.94	< 0.001
∑CAP	0.92	< 0.001
Gen.	0.93	< 0.001

DEC; decoding, Noi.; noise, Mem.; memory, Var.; various, TFM; tolerance fading memory, INT; integration, ORG; organization, APD; auditory processing disorder, CAP; central auditory processing, Gen; general

generating the normative data. Here, the Persian adaptation was conducted in a group of 373 children aged between 7 and 12 years old. To the authors' best knowledge, the present report is the biggest group in which psychometric analysis of BMQ-R has been carried out. The results of the study demonstrate that P-BMQ-R is a valid and reliable tool for auditory processing screening.

Questionnaires are important tools in daily clinical practice. Given the auditory processing is a complex series of functions and because disorder in auditory processing can make understanding processing issues even more confusing, testing for these disorders may be challenging. The American Academy of Audiology (AAA) and American Speech and Hearing Association (ASHA) indicate that "screening scales can be used to identify individuals at risk for CAPD since family-based questionnaires and checklists are tools that can assist in providing information about an individual's communication deficits and the impact on the daily life" [1,2]. Using a questionnaire in clinical practice can lead to gain confidential information about a patient's history, discovering real-life difficulties faster and more efficiently. The data collected with questionnaires could be complementary for diagnosis, planning a proper rehabilitation plan, and monitoring the progress of the patient through a rehabilitation plan.

Some modifications made in the P-BMQ-R were inevitable because of cultural and linguistic differences. Modifications include additional words and phrases in some sentences in order to improve the comprehensibility and readability of each question and eliminate any potential ambiguity. The fluency, readability, and understandability of P-BMQ-R were confirmed by participants. The items with lowest scores in cross-cultural adaptation procedure, which were discussed and modified in a focus group to achieve the most degree of match in contextual, linguistic, cultural, etc. issues. We believe that using different stages of translations and adaptations and also considering the feedbacks of both parents and experts is a guarantor to the best cross-cultural adaptation of the P-BMQ-R.

The face validity of the P-BMQ-R was determined to find out how much participants understand each item correctly. According to Preston and Colman [34], if more than 80% of the participants gave each item a score of 4 or more, that face validity was confirmed. Therefore, face validity regarding each question and the total questionnaire of the P-BMQ-R were confirmed.

According to the results, CVR values obtained for all 48 items were between 60% and 93%. The CVI was obtained as 80.43%. According to the previous investigations, a CVR above than 42% in surveys of 20 experts is considered acceptable [33]. Also, the minimum acceptable CVI for one-sample tests with 20 experts is 79% [33]. These findings suggest a strong content validity for the P-BMQ-R.

The results of the Spearman correlation test revealed excellent reliability (test-retest reliability 0.9) for all score types. This finding is important because filling out the questionnaire at various times before and after rehabilitations can be affected by low reliability and on the other hand one of the main uses of P-BMQ-R is to monitor

Table 2. Normative data for the Persian revised buffalo model questionnaire in children aged 7 to 12 in terms of mean and SD

Subcategory and behavior	Mean (SD)	Normal limits*
DEC	0.1 (0.3)	1
Noi.	0.1 (0.4)	1
Mem.	0.6 (0.5)	2
Var.	0.2 (0.4)	1
TFM	0.7 (1.1)	3
INT	0 (0.1)	0
ORG	0.1 (0.1)	0
APD	0.2 (0.5)	1
∑CAP	1.1 (1.5)	4
Gen.	0.2 (0.3)	1

* Normal limits are set for the normal control subjects at 2SD above the mean.
DEC; decoding, Noi.; noise, Mem.; memory, Var.; various, TFM; tolerance fading memory, INT; integration, ORG; organization, APD; auditory processing disorder, CAP; central auditory processing, Gen.; general, SD; standard deviation

the progress resulted from the rehabilitation. The acceptable reliability of the P-BMQ-R is a guarantor to the reproducibility of the results.

The normative data have many similarities with the original study of BMQ-R by Katz [21-23]. Small differences could be due to lingual and cultural differences.

Although BMQ-R provides very important information, there are also limitations to this tool. A limitation of all questionnaires concerns the reliability and validity of the information provided by the person completing the form. Another potential problem is that the person completing the form may not understand the terminology (especially the technical terms) [21,22].

Katz reported that the results of both the BMQ and the actual (C)APD diagnosis are relatively close [21]. Three diagnostic tests are introduced in Buffalo Model. The SSW test [36], the PST [37] and the WINT [38]. The P-SSW, The P-PST, and the P-SN test was developed in Persian. We recommend researchers to study the correlation of these tests with the P-BMQ-R for further investigations.

Conclusion

The Persian version of BMQ-R is a valid and reliable tool and is suitable to use in everyday practice in children between age 7 and 12.

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Conflict of interest

The authors declared no conflicts of interest.

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