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Validity and reliability of a Persian version of the quality of masticatory function questionnaire for edentulous patients

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ABSTRACT

Background: Questionnaire is a suitable tool for evaluating the subjective masticatory function in edentulous patients. However, there is no validated Persian version of masticatory function questionnaire. The aim of this study was to evaluate the psychometric properties of the translated Persian version of the quality of masticatory function (QMF) questionnaire in terms of validity and reliability.

Materials and Methods: After translation of QMF questionnaire to Persian, its validity was evaluated by four expert prosthodontists. The tool was applied on 62 complete denture wearers (31 men and 31 women, mean age 64.85 ± 1.98 years, mean time of edentulism 12.17 ± 3.21 years) via face-to-face interviews. Cronbach's alpha coefficient was used to measure internal consistency. Construct validity was analyzed using exploratory factor analysis. The Spearman's correlation coefficient between the summary scores of the tool and the years of edentulism and sex was also calculated for concurrent validity ($\alpha = 0.05$).

Results: It has been found that the Persian version of the questionnaire had an acceptable reliability ($\alpha = 0.910$). Exploratory factor analysis extracted five domains: Masticatory problems with dentures, problems while consuming apple and carrot, meat products, fruits and vegetables, and changes need for better swallowing. A correlation was found between the tool scores and the years of edentulism ($P = 0.001$), but there was no correlation between sex and the tool scores ($P = 0.841$).

Conclusion: The Persian version of QMF questionnaire for edentulous patients showed acceptable validity and reliability but further studies are needed to verify this tool.

Key Words: Dentures, edentulous, mastication, questionnaire

INTRODUCTION

Chewing ability is not only an important dimension of oral health, but it is also associated with general health status because it changes dietary choices and nutritional intakes, which may affect the general health.[1-4] Long-term edentulism could eventually result in alveolar bone resorption, temporomandibular disorders, or muscle hypotonicity, which ultimately leads to direct damage to the masticatory function.[5]

Furthermore, a reduction in the physiological secretion of gastric acid is characteristic of the aging human process, which reinforces the importance of efficient mastication to start food digestion processes.[6] Dion *et al.*[7] adjusted the common risk factors affecting nutritional status and found that poor dental status was still related to malnutrition in elderly individuals and showed that decreased masticatory performance could increase the possibility of malnutrition. Kazemi *et al.*[8] showed in their systematic review that most investigations found a significant relationship between the oral health status and nutrient intake; however, longitudinal studies were required for a better understanding of the diet–oral health relations. Food choice is largely affected by chewing ability.[9] People report increasing difficulty in chewing special foods such as stringy, crunchy, and dry solid foods when the masticatory function reduces.[10,11]

Overpreparation of fresh foods such as peeling fruits and vegetables or overcooking vegetables to make them easier to chew can affect the intake of wide range of nutrients including some that are thought to be important for prevention of cancer and cardiovascular disorders and for cellular defense. This problem is particularly important for edentulous patients with impaired chewing ability.[12]

Masticatory function has been evaluated by objective and subjective measures. The objective methods were accomplished through testing the subject's ability to break down foods into discrete portions.[13] These methods usually measure the size of the test food samples that have been chewed for a specific number of chewing cycles by sieving methods or image analysis techniques.[8] The subjective methods depend on the individuals' perception about their masticatory performance and are usually measured by a questionnaire.[14,15]

Some authors believed the principal measures of masticatory efficiency should be based on the patients' perceptions. Demers *et al.*[16] and Slagter *et al.*[17] evaluated the correlation between the masticatory efficiency using subjective and objective measures, in complete denture wearers. They concluded that the questionnaire method was rather weak compared to the objective tests and, thus, dentists should not rely solely on subjective responses to evaluate chewing problems, oral conditions, and prosthesis quality in order to determine masticatory efficiency. In addition, masticatory efficiency must be determined by scientifically proven objective tests, which may

be supplemented by subjective tests, but never using the latter as a primary source of information. On the other hand, while the objective quantification of the masticatory efficiency may result in a low value and not clinically significant, the subjective masticatory efficiency measures, which are an analysis by the patient about his mastication, may reflect a most relevant aspect.[18,19] Thus, the combination of the two methods should be valuable for a thorough evaluation of masticatory.[18,19]

Different types of questionnaires have been used to evaluate masticatory efficiency. Questions about perceived ease of chewing different foods and dietary intake are usually used for subjective evaluation, so the result of this method may be affected by psychological conditions.[13] In complete dentures wearers, both the subjective and the objective masticatory efficiencies with their dentures are determined by several factors such as age, sex, duration of edentulism, oral conditions, and previous dentures experiences.[20,21]

Quality of masticatory function (QMF) questionnaire, which is originally written in French, consists of 28 questions related to difficulty and frequency of chewing different types of foods in edentulous patients. Although this questionnaire was used in different studies, it has not yet been validated.[22-24]

As the validated Persian masticatory function questionnaire for edentulous patients was not found, the aim of this study was to evaluate the psychometric properties of the translated Persian version of the QMF questionnaire in terms of validity and reliability.

MATERIALS AND METHODS

An ethical clearance was obtained from the research and ethics committee of Isfahan University of Medical Sciences, Isfahan, Iran. QMF questionnaire was translated from English to Persian and this version was then back-translated into English. Each question was assessed to make sure no change in meaning had been generated in the Persian translation. After this procedure, the content validity was evaluated in a panel of four experienced prosthodontists . Then, the inventory was applied on the samples. A total of 62 complete denture wearers who were referred to the Department of Prosthodontics in the School of Dentistry, Isfahan University of Medical Sciences, consented to participate in this study. Convenient sampling was used. Inclusion criteria comprised

participants who had passed the functional adaptation and adjustment period. Participants had been wearing the dentures for 1 month or longer. All the participants signed the written informed consent. Sample size and appropriate structure for data analysis were approved through Kaiser–Meyer–Olkin (KMO) measure of sample adequacy and Bartlett's test of sphericity.[25]

Persian-translated QMF questionnaire was carried out by one of the researchers through face-to-face interview. This was done in a room in the Department of Prosthodontics, which was specially used for this purpose to obtain privacy for patients. The mean time of interview was 35 min. Subjects responded by rating the frequency and difficulty of chewing different types of foods in the past 2 weeks on the five-point Likert scale: Ranging from "always" to "never" or "a lot" to "no difficulty."[22-24] Subjects who responded "always" or "a lot" got score 1 and who responded "never" or "no difficulty" got score 5. Questions # 16, 17, 19, 22, and 27 were recoded before analysis. The final score was the sum of all question scores, ranging from 28 to 140, and the higher score, the higher QMF.

The data was analyzed using SPSS version 21 statistical package (SPSS Inc., Chicago, IL, USA). Cronbach's alpha coefficient was used to measure reliability in terms of internal consistency of the summary scores for QMF questionnaire and various subscales.[26] Furthermore, corrected item total correlation was calculated for the different items of the questionnaire. Construct validity of the instrument was analyzed using exploratory factor analysis.[25,27] Concurrent validity of the tool was analyzed by evaluation of the interpretability of the instrument through measuring the correlation between the years of edentulism/sex and the QMF scores using Spearman's correlation coefficient. $P < 0.05$ denoted statistical significance.

RESULTS

Sixty-two complete denture wearers (31 men and 31 women, mean age 64.85 ± 1.98 years, range 45–75 years, mean time of edentulism 12.17 ± 3.21 years) participated in this study. The KMO coefficient for this dataset was 0.801 and the Bartlett test of sphericity was statistically significant ($\chi^2 = 1124.96$, df = 351, $P < 0.001$), indicating that properties of the correlation matrix justified factor analysis being carried out. An overall Cronbach's alpha was 0.910, which shows a good

internal consistency of the tool. Table 1 shows the individual Cronbach's alpha when each item of the questionnaire is deleted. Corrected item total correlation of each item of the questionnaire was also shown in Table 1. The question # 21 did not have a minimally acceptable correlation with other items and, therefore was omitted [Table 1]. After deletion of this question, an overall Cronbach's alpha was increased to 0.914, and the QMF was scored between 27 and 135.

Construct validity was obtained by exploratory factor analysis. The principal component analysis with orthogonal rotation using the Varimax procedure and Kaiser Normalization extracted 8 factors. Eight components have initial Eigenvalues >1, further the scree plot confirmed the extraction of eight components, and they could explain 77.6% of the total variation. Three components had fewer than three questions, so their items incorporated to other components according to item scores and Cronbach's alpha of the resultant domains, so five domains were finally organized [Table 2].

Domains were named according to the content of their loaded questions. The Persian version of the QMF questionnaire included five subscales as shown in Table 2. Masticatory problems with dentures (five items, questions # 8, 9, 10, 15, 16), problems while consuming apple and carrot (six items, questions #22, 23, 24, 25, 27, 28), meat products (seven items, questions #1, 2, 3, 17, 18, 19, 20), fruits and vegetables (four items, questions # 4, 5, 6, 7) as well as changes needed for better swallowing (five items, questions #11, 12, 13, 14, 26) [Figure 1]. Mean, standard deviation, and Cronbach's alpha coefficient of domains were summarized in Table 3.

A correlation was found between the QMF scores and the years of edentulism ($P = 0.001$) [Table 4]. It was seen that the QMF scores were lower for those patients who had more years of edentulism and vice versa. There was no correlation between sex and QMF scores (mean scores in males: 92.74 ± 17.50, mean scores in females 89.54 ± 15.11, $P = 0.841$).

DISCUSSION

The investigation of validity and reliability of questionnaire translated from other languages is very important. A translation of QMF questionnaire into Persian would not necessarily ensure applicability among Iranian population because of cultural diversity

Table 1: Corrected item-total correlation and Cronbach's alpha when each item of the Persian-translated QMF questionnaire was deleted

Items	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Do you have difficulty in chewing small pieces of beef?	0.703	0.903
2. Do you difficulty in chewing small pieces of chicken?	0.618	0.904
3. Do you have difficulty in chewing ground beef?	0.342	0.909
4. Do you have difficulty in chewing hard, raw vegetables, without cutting them?	0.716	0.902
5. Do you have difficulty in chewing hard, raw fruits, without cutting them? (e.g., apples)	0.397	0.909
6. Do you have difficulty in chewing hard, raw fruits, after cutting them in quarters?	0.580	0.905
7. Do you have difficulty in chewing peels of hard raw fruits?	0.501	0.907
8. Do you have difficulty in chewing crusted bread?	0.679	0.903
9. Do you have difficulty in chewing nuts and grains?	0.602	0.905
10. Do you have difficulty in chewing with your prosthesis?	0.653	0.904
11. Do you have to remove one or both of your prostheses in order to eat?	0.351	0.909
12. Do you have to drink while eating to facilitate swallowing?	0.299	0.910
13. Do you have to add sauce to your meal to facilitate swallowing?	0.369	0.909
14. Do you have to soak your food to facilitate chewing and/or swallowing?	0.420	0.908
15. Is your food choice limited because of your prosthesis?	0.604	0.904
16. In general, is the food well chewed before being swallowed?	0.378	0.909
17. Have you eaten beef cut into small pieces?	0.298	0.910
18. Has it been necessary to ground the beef before eating?	0.393	0.908
19. Have you eaten chicken cut into small pieces?	0.312	0.909
20. Has it been necessary to ground the chicken before eating?	0.634	0.906
21. Has it been necessary to convert meet into puree in order to eat?	0.026	0.914
22. Have you eaten fresh apples without cutting them?	0.506	0.906
23. Is it necessary to peel the apples before eating?	0.553	0.906
24. Is it necessary to cut the apples into quarters in order to chew them?	0.519	0.906
25. Is it necessary to cut the apples into small pieces in order to chew them?	0.687	0.903
26. Has it been necessary to convert fruits into puree in order to eat?	0.583	0.905
27. Have you eaten fresh carrots without cutting them?	0.534	0.906
28. Is it necessary to cut the carrots into small pieces in order to eat them?	0.505	0.907

QMF: Quality of masticatory function

in different environments.[28] Although the English version of this questionnaire has not been validated, it demonstrated the capacity to identify some intergroup differences in Muller *et al.*'s study.[24] The aim of this study was to evaluate the validity and reliability of the Persian version of this questionnaire. The Persian version of questionnaire was applied with an interview format because most of the subjects were elderly patients, and this format would be preferred compared with the self-reporting questionnaire.[29] The internal consistency of the QMF questionnaire was evaluated via estimating Cronbach's alpha coefficient. This coefficient ranges from 0.0 to 1.0 and the value similar to or >0.7 is considered acceptable.[28,30,31] The overall reliability of QMF questionnaire was 0.910. The minimally acceptable correlation coefficient is 0.3,[32] whereas this coefficient for question #21 was 0.02. After deletion of this question, the overall Cronbach's alpha increased to 0.914. Consuming meat in puree form is not common among Iranian people.

In Persian culture, meat is usually used in the form of kebab or stew and most of the subjects had no experience of consuming meat in the form of puree. Bartlett's test of sphericity is used to evaluate whether a correlation matrix is suitable for factor analysis. If a low probability is obtained, this supports the use of factor analysis as an appropriate procedure. If a KMO measure in the range of 0.80s and 0.90s is achieved, this supports the use of factor analysis for the data. In this study, the probability and KMO measure (0.801) showed that the factor analysis is suitable for data analysis. The factor solution could explain 77.5% of total variance and it was above 50%, so it is a good solution.[25]

After completing exploratory factor analysis, five subscales were resulted: Masticatory problems with dentures (five items), problems while consuming apple and carrot (six items), meat products (seven items), fruits and vegetables (four items), and changes need for better swallowing (five items).

Table 2: Principal exploratory factor analysis with extracted components of the Persian-translated QMF questionnaire

Items on factors	Masticatory problems with dentures (factor 1)	Problems while consuming apple and carrot (factor 2)	Problems while consuming meat products (factor 3)	Problems while consuming fruits and vegetables (factor 4)	Changes need for better swallowing (factor 5)
8. Difficulty in chewing crusted bread	0.830				
9. Difficulty in chewing nuts and grains	0.816				
10. Difficulty in chewing with prosthesis	0.763				
15. Food choice limitation	0.698				
16. Well chewed food before swallowing	0.691				
22. Eat fresh apples without cutting it		0.801			
23. Need to peel the apples		0.550			
24. Need to cut the apples into quarters		0.687			
25. Need to cut the apples into small pieces		0.758			
27. Eat fresh carrots without cutting it		0.901			
28. Need to cut the carrots into small pieces		0.893			
1. Difficulty in chewing small pieces of beef			0.625		
2. Difficulty in chewing small pieces of chicken			0.843		
3. Difficulty in chewing ground beef			0.255		
17. Small pieces of beef cut			0.329		
18. Need to ground the beef			0.403		
19. Small pieces of cut chicken			0.725		
20. Need to ground the chicken			0.711		
4. Difficulty in chewing hard, raw vegetables without cutting them				0.341	
5. Difficulty in chewing hard, raw fruits without cutting them				0.898	
6. Difficulty in chewing hard, raw fruits cut into quarters				0.377	
7. Difficulty in chewing peels of hard raw fruits				0.686	
11. Need to remove prostheses for eating					0.591
12. Need to drink to facilitate swallowing					0.346
13. Need to add sauce to facilitate swallowing					0.210
14. Need to soak food to facilitate swallowing					0.375
26. Need to convert fruits into puree					0.585
Eigenvalues, cumulative eigenvalues, and total variance (%) by factors					
Eigenvalue	8.786 3.343 2.065 1.824 1.457 1.349 1.089 1.035				
Total percentage and cumulative addition	32.542 12.381 7.648 6.754 5.395 4.996 4.032 3.834				
Total percentage of factor model					77.582
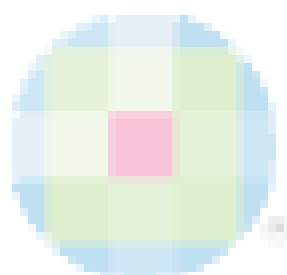
QMF: Quality of masticatory function

The highest score was given to the domain, "problems while consuming meat products" (4.31 ± 0.61) and the lowest score belonged to the domain, "problems while consuming apple and carrot" (1.65 ± 0.85). The highest and lowest scores were given to the items, "Do you have difficulty to chew ground beef?" (4.75 ± 0.59) and "Have you eaten fresh carrot without cutting it?" (1.34 ± 0.92), respectively. According to the results of this study, the most difficult foods to chew were apple and carrot, followed by fruits and vegetables, and the least difficult foods to chew were meat products. In Leake's study,[33] a scale with five food items was used as an indicator of the perception of the individual masticatory function. In this scale, the least difficult food to chew was boiled vegetables following in order by lettuce, firm meat, carrot, and apple. In a study by Demers *et al.*,[16] the most difficult foods to chew were fresh apple followed by fresh carrot and celery sticks. Steak or firm meat, hamburger, fresh lettuce or spinach salad, dry toast, mashed potato, boiled vegetables, and vegetable soap were placed in subsequent orders. Our findings were in agreement with these studies[16,33] that edentulous patients have more chewing difficulties with fresh fruits and vegetables, especially apple and carrot. Meat products and crusted bread had lesser

Table 3: Mean, SD, and Cronbach's alpha of the Persian-translated QMF

Domains and items	Mean	SD	Cronbach's alpha
Masticatory problems with dentures	3.87	0.97	0.83
8. Difficulty in chewing crusted bread	4.01	1.14	
9. Difficulty in chewing nuts and grains	3.45	1.48	
10. Difficulty in chewing with prosthesis	4.08	1.15	
15. Food choice limitation	3.95	1.27	
16. Well chewed food before swallowing	3.98	1.19	
Problems while consuming apple and carrot	1.65	0.85	0.89
22. Eat fresh apples without cutting it	1.47	1.01	
23. Need to peel the apples	1.86	1.21	
24. Need to cut the apples into quarters	1.54	1.02	
25. Need to cut the apples into small pieces	2.14	1.18	
27. Eat fresh carrots without cutting it	1.34	0.92	
28. Need to cut the carrots into small pieces	1.42	0.86	
Problems while consuming meat products	4.31	0.61	0.82
1. Difficulty in chewing small pieces of beef	3.98	1.11	
2. Difficulty in chewing small pieces of chicken	4.44	1.07	
3. Difficulty in chewing ground beef	4.75	0.59	
17. Small pieces of beef cut	3.93	0.89	
18. Need to ground the beef	4.18	0.78	
19. Small pieces of cut chicken	4.44	0.76	
20. Need to ground the chicken	4.52	0.72	
Problems while consuming fruits and vegetables	2.84	1.01	0.75
4. Difficulty in chewing hard, raw vegetables without cutting them	4.25	0.99	
5. Difficulty in chewing hard, raw fruits without cutting them	4.30	0.86	
6. Difficulty in chewing hard, raw fruits cut into quarters	4.17	1.04	
7. Difficulty in chewing peels of hard raw fruits	4.32	0.86	
Changes need for better swallowing	4.05	0.68	0.71
11. Need to remove prostheses for eating	4.39	0.84	
12. Need to drink to facilitate swallowing	3.93	1.06	
13. Need to add sauce to facilitate swallowing	4.00	1.04	
14. Need to soak food to facilitate swallowing	3.60	1.14	
26. Need to convert fruits into puree	4.39	0.89	

QMF: Quality of masticatory function; SD: Standard deviation

Table 4: Correlation between the QMF-P scores and the years of edentulism

Variable	Mean	SD	Correlation coefficient	*P*
QMF-P scores	91.14	16.30	−0.417	0.001
Years of edentulism	12.17	3.21		

QMF: Quality of masticatory function; SD: Standard deviation

chewing difficulties in previous studies[16,33] and in our study. Boiled vegetables were not assessed in QMF questionnaire. Ground meat seems to be the least difficult food to chew in this questionnaire.

Figure 1: The Persian version of the quality of masticatory function questionnaire.

Hamburger, an example of ground meat, and dry toast were chewed easier than fresh fruits and vegetables in Demers *et al*.[16] study and in our study.

In this study, all subscales had an acceptable α values ranging from 0.89 to 0.71.[34] The highest and lowest Cronbach's alpha belonged to "problems while consuming apple and carrot" and "changes need for better swallowing" domains, respectively.

A correlation was found between the QMF scores and the years of edentulism. Patients who experienced more years of edentulism had less QMF scores. This correlation supports the construct validity of the questionnaire. One of the common consequences occurred after teeth loss is the continuous residual ridge resorption,[35] temporomandibular disorders, or muscle hypotonicity, which can cause denture instability and chewing difficulty in complete denture wearers.[5,17,36] Increased years of edentulism may lead to the reduced residual ridge height and more complete denture problems. Based on this result, this tool is capable to distinguish between patients with different clinical characteristics.

Small sample size with geographical and cultural similarities was the major limitation of our study. As the construct validity is an ongoing process, it is recommended that the present version of QMF questionnaire can be assessed in other geographic areas of Iran with a larger sample size and different demographic variables.

CONCLUSION

Persian version of QMF questionnaire showed satisfactory reliability and validity. Use of this version

as an outcome measurement for clinical research is feasible, as long as the limitations are known. Due to the new domains suggestion in this version, more studies are needed to evaluate the sensitivity of this version and the assessment of possible factors associated with masticatory function in edentulous patients.

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Conflicts of interest
The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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