Validation and evaluation of the Mandarin version of the oral health literacy adult questionnaire in Taiwan

Mu-Hsing Ho
University of Wollongong, mhh838@uowmail.edu.au

Jed Montayre
Auckland University of Technology

H.C. Chang
University of Wollongong, hchang@uow.edu.au

Jee Young Joo
Gachon University

Mohammad Naghibi Sistani
Babol University of Medical Sciences

See next page for additional authors

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Abstract

Objectives

This study aimed to translate the Oral Health Literacy Adult Questionnaire into a Mandarin version (MOHL-AQ) and to examine its psychometric properties.

Methods

A methodological research using psychometric testing and evaluation of a translated instrument. A convenience sample of 402 participants from northern Taiwan were recruited for the validation of the MOHL-AQ. Internal consistency reliability, split-half reliability, inter-rater reliability, face validity, content validity, and construct validity were evaluated.

Results

The value of internal consistency and split-half reliability of the MOHL-AQ were 0.77 and 0.78, respectively. Content validity reported a high content validity index (CVI = 95%). Exploratory factor analysis (EFA) and parallel analysis (PA) were used to determine a unidimensional model and confirmatory factor analysis (CFA) was employed to confirm the model. The indices of good fit model were achieved at GFI = 0.93, AGFI = 0.92, RMSEA = 0.04, CFI = 0.90, PGFI = 0.73, χ^2/df = 1.86 (p < .001). Most of the item-total correlations indicated adequate and acceptable convergent validity (r > .30).

Conclusion

MOHL-AQ demonstrates adequate psychometric properties for measuring the oral health literacy in Mandarin-speaking population. Public health nurses can use MOHL-AQ to assess oral health literacy in the community settings and further screen potential population with inadequate oral health literacy.

Authors

Mu-Hsing Ho, Jed Montayre, H.C. Chang, Jee Young Joo, Mohammad Naghibi Sistani, Yen-Kuang Lin, Victoria Traynor, Chia-Chi Chang, and Megan F. Liu

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Key Words: oral health, health literacy, psychometrics, factor analysis

BACKGROUND

A recent national report on oral health of adults and seniors revealed that the overall Taiwanese' oral health was poor, reflected by high prevalence rates of carries, periodontal disease and missing teeth. Forty-seven percent of Taiwanese people suffered from serious periodontal disease. Major determinants of oral health in the Taiwanese population included gender, educational level, oral health behaviors (brushing and flossing), smoking and chewing betel nut, which indicated the strong need for oral health education needed (Ministry of Health and Welfare, 2016). Because of the link between oral health and socio-demographic profile, strategies for oral health education should focus on strengthening reading comprehension of oral health concepts with all age groups and educational levels (Ho, Liu, & Chang, 2019).

Oral health literacy (OHL) is defined as the degree to which individuals have the capacity to obtain, process, and understand basic oral health information and services needed to make appropriate health decisions (U.S. Department of Health and Human Services, 2000); such literacy is an important predictor of oral health status and related hygiene behaviors (Naghibi Sistani, Virtanen, Yazdani, & Murtomaa, 2017). Several studies have highlighted that inadequate OHL is associated with adverse oral health outcomes, higher medical expense and lower medical adherence (Baskaradoss, 2018; Macek et al., 2016; Mohammadi, Malekmohammadi, Hajizamani, & Mahani, 2018). Older age, lower educational level, lower economic status, unemployment, and wearing of removable dentures are other risk factors for inadequate OHL (Ho, Liu, et al., 2019; Naghibi Sistani, Montazeri, Yazdani, & Murtomaa, 2014; Vyas, Nagarajappa, Dasar, & Mishra, 2016). Culturally specific determinants of oral health behaviors among people in Taiwan include OHL, oral self-care attitude, self-efficacy, and intention, and significant others' perceptions and beliefs as well as environmental constraints (Ho, Chang, et al., 2019).

The Oral Health Literacy Adult Questionnaire (OHL-AQ) was developed to assess functional literacy levels of oral health concepts. The tool is comprised of 17 items in four domains, which includes reading comprehension, numeracy, listening and decision making (Naghibi Sistani et al., 2014). The main strength of the OHL-AQ is its brief and short-version format compared to other OHL instruments. This enabled effective utility of OHL-AQ in community or population-based studies. Existing OHL instruments such as the rapid estimate of adult literacy in dentistry (REALD); the OHL instrument (OHLI); the test of functional health literacy in dentistry (TOFHLiD); comprehensive measure of oral health knowledge (CMOHK) were restricted to measuring OHL in terms of word recognition, knowledge, numeracy and reading comprehension only (Aldoory, Macek, Atchison, & Chen, 2016; Kobayashi, Wardle, Wolf, & von Wagner, 2016; Naghibi Sistani et al., 2014). In contrast, OHL-AQ includes items on listening and decision making which provides new measures of functional literacy skills. A review of OHL instruments further indicated that apart from word recognition, numeracy, and reading skills, decision making measures are also needed to be incorporated in OHL measurements (Parthasarathy et al., 2014). Because of these required measures, it is important to have an appropriate, fast screening, and efficient instrument to assess OHL. To date, the OHL-AQ is considered the most suitable instrument for assessing functional OHL.

The OHL-AQ has been translated into different languages and demonstrated satisfactory reliability and validity in terms of assessing functional literacy levels. However, OHL-AQ has not been used in Mandarin or in Chinese populations. To effectively study OHL level among the Mandarin or Chinese-speaking populations, a reliable and valid instrument to measure OHL is needed. Outcomes related to low literacy with oral health is a public health concern and public health nurses are often in the frontline care of assessing and detecting oral health issues (U.S. Department of Health and Human Services Oral Health Coordinating

Committee, 2016). However, there is scarcity of appropriate assessment tools made available to public health nurses that can be used in a variety of practice settings (Lee, Divaris, Baker, Rozier, & Vann, 2012; Sabbahi, Lawrence, Limeback, & Rootman, 2009) where commonly used tools have significant limitations when applied in different cultural contexts. Therefore, the purpose of this study was to translate the original English version of OHL-AQ into Mandarin and evaluate its psychometric properties.

METHODS

A methodological research design was employed including translation of the original English version of the oral health literacy questionnaire into Mandarin and extensive psychometric properties testing of translational questionnaire. Internal consistency reliability, split-half reliability, inter-rater reliability, face validity, content validity, construct validity and convergent validity were performed by conducting psychometric evaluation in this study.

Oral health literacy adult questionnaire (OHL-AQ)

The OHL-AQ contains 17 items. A correct answer to each item earns 1 point, with a maximum score of 17 points. Scores of 0~9 points indicate inadequate oral health literacy, those with scores of 10 or 11 points are marginal, and those scores with ranging 12~17 points are considered adequate (Naghibi Sistani et al., 2014).

Translation Procedure

Permission was obtained from the original author of the OHL-AQ, then a bilingual health care professional translated the Mandarin version oral health literacy adult questionnaire according to the Brislin's method of translation. (Brislin, 1970). A translator who had never been exposed to the original OHL-AQ then blindly did a back translation. An expert panel comprising five specialists in dentistry, oral hygiene, and public health assessed

the content of original OHL-AQ, the Mandarin version oral health literacy adult

questionnaire, and the backward translation version regarding the consistency, fluency, and

degree of interpretability. Differences between the translation and the backward translation

were rectified and meaning errors corrected until reaching a consensus on the accuracy of the

translated research tool.

Content Validity

The content validity was examined by five experts specialized in dentistry, oral health

science, public health, and community health nursing regarding the accuracy, content

suitability and clarity of the translated scale and amendments were made based on their

expert opinions. A content validity index (CVI) value ≥80% was used as the assessment

standard (the proportion in which ≥80% of the experts agreed with scores ≥3 points on the

scale). All suggestions of experts were considered in modifying the questionnaire. The mean

score of total 17 items was 3.79, and the overall CVI calculated for MOHL-AQ was 95%.

Face Validity

To assess the face validity, clarity and readability of the translated items. the

questionnaire was administered to 30 volunteer participants with different sociodemographic

characteristics whose educational level were junior high school or above. All participants

stated that the questionnaire was understandable, and no further change was required.

Pilot Testing of the MOHL-AQ

The final version of Mandarin version oral health literacy adult questionnaire (MOHL-

AQ) was pretested in monolingual (Mandarin) populations.

Sampling and Procedure. A convenience sample of 402 participants was recruited

from December 2015 to July 2016 at several communities in northern Taiwan. The inclusion

criteria for participant selection were: aged at least 19 years and able to communicate in Mandarin. Demographic profile such as age, gender, educational level, and socioeconomic variable were collected in this study. Socioeconomic variable was measured with monthly income, which is specific to salary and family and social welfare subsidy and benefits.

The project employed research assistants, who explained the details of this study to potential participants from community settings in Taipei, a large Taiwan metropolis, including health clinics, service centers for older people, sports and activity centers, and neighborhood offices. Prior to the pilot testing, we contacted the research sites to obtain consent and set up a schedule for all related activities.

Inter-Rater Reliability. In this study, three research assistants interviewed and read the instruction of listening section for all participants. Since inter-rater reliability was used to assure the measurement consistency, research assistants received a one-hour training course and illustration about MOHL-AQ. The research assistants also evaluated 20 of the participants to confirm and discuss that whether the results were consistent and to determine the inter-rater reliability by intraclass correlations (ICC).

Ethical Considerations

This study was reviewed and approved by the University Institutional Review Board (approval number: N201507041) to protect the rights of research participants and for ethical considerations, the research assistants explained the purpose of the research and research methods to all participants. To ensure the participants' full awareness, they were informed of their rights, and their consent was obtained before beginning the questionnaire survey.

Analytic Strategy

Descriptive statistical analyses were initially performed for the distribution of all variables among study participants. Continuous variables were summarized using mean ± standard deviation (SD) for normally distributed variables and proportions were used for categorical variables. Chi-square test was used to analyze the group differences between variables which measured at a nominal level in the pilot.

Internal Consistency and Split-Half Reliability. Internal consistency reliability was estimated using Cronbach's α coefficient. Higher levels of reliability increase the statistical power, and thus a minimum recommended value of reliability for measures used within-group comparisons is 0.70 as well as the Spearman-Brown coefficient was used to test split-half reliability (Tavakol & Dennick, 2011).

Construct Validity. Construct validity was established by using exploratory factor analysis (EFA) and parallel analysis (PA) to assess dimensionality and determine the number of factors (Cattell, 1966; Horn, 1965; Woods & Assessment, 2002). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (using a cut-off of 0.5), and Barlett's Test of Sphericity (using a cut-off $p<0.001$) was used to ensure the appropriateness of data set for EFA. We performed EFA using principal axis factoring analysis and PA for testing validity of unidimensional scale (Hambleton & Rovinelli, 1986). Furthermore, confirmatory factor analysis (CFA) was adopted to test the goodness of fit (absolute fit indices, relative fit indices and parsimony fit indices) of the statistical model and convergent validity. The references of all indices were based on the suggestion of previous literature (Bentler & Bonett, 1980; Bollen, 1990; Fan, Thompson, & Wang, 1999; Hu & Bentler, 1999; McDonald & Ho, 2002; Mulaik et al., 1989). We conducted the CFA with maximum likelihood estimation (MLE) to estimating each parameter of the statistical model (Lai, Crane, & Cella, 2006).

All statistical analyses including EFA, PA and CFA were performed using R software version 3.5.1 and the significance level (α) was set at $p < 0.05$. All tests were two-tailed.

RESULTS

Overall, 402 people participated in this study; 55.20 % were women and the mean age was 53.08 (*SD*=18.88; range 19-99 years). Forty-six percent of the participants completed a college degree or higher. Participants had income ranging between New Taiwan (NT) $10,000 to 50,000 per month (N=203, 51.90%) (The average exchange rate in 2016 was US$1≈NT$32). The average scores of MOHL-AQ was 12.45 (*SD*=3.23) with a range from 0 to 17. Scores of 0~9 points indicate inadequate oral health literacy, those with scores of 10 or 11 points are marginal, and those with 12~17 points are considered adequate level. Comparing to different level of MOHL-AQ, we found that age, educational level, and monthly income showed statistically significant in group differences. Participants with inadequate MOHL group had significantly higher percentage of older adults, people with lower educational level and lower monthly income. These results are summarized in Table 1. The inter-rater reliability of the MOHL-AQ with 20 participants between three research assistants was 98% in the current study.

Internal Consistency and Split-half Reliability

In all participants, the internal consistency of the MOHL-AQ was acceptable with Cronbach's α coefficient value of 0.77 for the entire questionnaire and the split-half reliability was established by calculating Spearman-Brown coefficient, which was 0.78, indicating acceptable internal consistency reliability of the MOHL-AQ.

Construct Validity

In the EFA, the eigenvalue of the first factor was 3.85 and could explain the total variance of 22.62% and both EFA and PA indicated a factor of one (Figure 1). Further, in the CFA, we used goodness of fit index (GFI), adjusted goodness of fit index (AGFI), standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), comparative fit index (CFI), Bentler-Bonett non-normed fit index (NNFI), Bollen's incremental fit index (IFI), parsimony goodness of fit Index (PGFI), parsimony normed fit index (PNFI) and chi-square test to examine the unidimensional model. The goodness of fit indices for the CFA model were as follows: absolute fit indices (GFI=0.93; AGFI=0.92; SRMR=0.04; RMSEA = 0.04); relative fit indices (CFI=0.90; NNFI=0.87; IFI=0.89), and parsimony fit indices (χ^2/df=1.86; $p<0.001$; PGFI=0.73; PNFI=0.68). The goodness of fit indices and references are presented in Table 2. Almost all indices reported a good model fit which supported the MOHL-AQ tended to measure unidimensional latent variable. For convergent validity, the range of coefficient (r) between each item and the factor was from 0.21 to 0.67, except one item reported low validity (r=0.21, $p<0.001$) in total 17 items, other items' coefficients were over 0.30 and reported medium validity ($p<0.001$) significantly.

DISCUSSION

The objective of the present study was to translate the OHL-AQ into a Mandarin version (MOHL-AQ), and to conduct the psychometric evaluation of the MOHL-AQ. The findings of this study revealed that the value of the internal consistency with a satisfactory level and content validity with an acceptable value were similar to the pilot testing of the original OHL-AQ (Naghibi Sistani et al., 2014). In addition, the construct validity disclosed evidence for scale unidimensionality which consistent with a previous research focus on validation of

the English version of the OHL-AQ (Flynn et al., 2016). Thus, MOHL-AQ has demonstrated

a reliable and valid instrument to assess OHL levels among community citizens.

The average score of MOHL-AQ was considered to be adequate and similar to that in

English version of OHL-AQ studies (Sistani, Yazdani, Virtanen, Pakdaman, & Murtomaa,

2013; Vyas et al., 2016). The proportions of inadequate MOHL-AQ stratified by age, gender,

educational level and monthly income indicated the differences between groups.

Accordingly, we explored the group differences between sociodemographic variable and

level of MOHL-AQ in the pilot testing. The present findings also confirmed previous

evidence that age, educational level, and economic status are associated with OHL

significantly (Atchison, Macek, & Markovic, 2017). Increasing evidence has indicated the

OHL is associated with socioeconomic characteristics while our findings also revealed that

individuals with older age, lower educational level and lower monthly income performed

inadequate OHL. These results were consistent with previous studies (Batista, Lawrence, &

Sousa, 2017; Firmino et al., 2018; Vyas et al., 2016).

Utilization of MOHL-AQ

Our study suggests that MOHL-AQ can be considered as a comprehensively valid and

reliable questionnaire measuring functional oral health literacy in Chinese communities.

Public healthcare professionals could apply MOHL-AQ in their practice and assess the

barriers of obtaining, processing, and understanding the oral health-related information.

Conceptual and broader understanding of health education interventions to improve the OHL

towards specific target populations require an accurate reflection of current literacy.

One important limitation of MOHL-AQ is that it cannot be used to assess people who

were illiterate or with low literacy levels. To measure the functional literacy, respondents are

required to read the all 17 questions and instructions. There are certainly challenges in

measuring the literacy level of population groups that are functionally illiterate. Future research could develop modified MOHL-AQ to accommodate people with low literacy levels and design specific OHL questionnaire for people who were illiterate.

In our study, one might argue that the participants were recruited from the same region of northern Taiwan with a non-random sampling, and the sample was skewed toward well-educated respondents, which resulted in an unrepresentative result. Future studies are needed to expand the sample size and to verify in different Mandarin or Chinese-speaking countries for the generalizability. Moreover, future research should consider a comparative exploration of OHL scores and oral health status of patients in the actual practice environment. This will provide insights and reflection of the existing gaps and relationships between oral health literacy and oral care practices.

In public health policies, a growing body of evidence indicated that the oral health literacy is the key to understand people' awareness as well as the determinants of oral health (Atchison et al., 2017; Ho, Chang, et al., 2019; Sistani et al., 2013; Vyas et al., 2016). The results of this study should lead to an extensive survey of OHL in the Mandarin population, which will allow us to study OHL predictors in future research. In general, this questionnaire would be useful for public health nurses to predict which population needs to be followed and can be used also as a basis for developing relevant oral health and care policies.

CONCLUSIONS

The findings of this study have demonstrated the reliability and validity of MOHL-AQ and provided a descriptive basis for further research. These findings suggested that the MOHL-AQ measuring OHL can be well adopted in the population whose primary language is Mandarin or Chinese. MOHL-AQ was proven useful in investigating literacy levels toward preventive programs. The utility of MOHL-AQ is anticipated to positively impact the work of

public health nurses in resolving the challenges of literacy assessment for oral health related to language requirements. Culturally appropriate tools such as MOHL-AQ will enable public health nurses to identify unique and oral health problems of specific to the population. The tool will also provide information that is useful in the development of culturally targeted interventions for oral health.

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Figure Captions

Figure 1. Parallel Analysis of the Mandarin Version of the Oral Health Literacy Adult

Questionnaire (MOHL-AQ).

Table 1. Distribution of Demographic Profile by Levels of the MOHL-AQ (N=402)

Variable	$M \pm SD$ / n (%)	MOHL-AQ			
		Inadequate (0-9), n (%)	Marginal (10-11), n (%)	Adequate (12-17), n (%)	p-value[a]
Age	53.08 ± 18.88				<0.001
19-40 years	121 (30.10)	3 (2.50)	6 (5.00)	112 (92.50)	
41-65 years	167 (41.50)	31 (18.60)	22 (13.20)	114 (68.20)	
Above 65 years	114 (28.40)	48 (42.10)	20 (17.50)	46 (40.40)	
Gender					0.89
Female	222 (55.20)	47 (21.20)	27 (12.20)	148 (66.60)	
Male	180 (44.80)	35 (19.40)	21 (11.70)	124 (68.90)	
Educational level					<0.001
Under junior high school	69 (17.20)	32 (46.40)	20 (29.00)	17 (24.60)	
Senior high school	148 (36.80)	42 (28.40)	14 (9.50)	92 (62.10)	
Above college	185 (46.00)	8 (4.30)	14 (7.60)	163 (88.10)	
Monthly income					<0.001
<NT$10,000[b]	75 (19.20)	22 (29.30)	10 (13.30)	43 (57.40)	
NT$10,001-50,000	203 (51.90)	47 (23.20)	27 (13.30)	129 (63.50)	
>NT$50,000	113 (28.90)	6 (5.30)	9 (8.00)	98 (86.70)	
MOHL-AQ (range: 0-17)	12.45 ± 3.23				
Reading comprehension (range: 0-6)	3.87 ± 1.35				
Numeracy (range: 0-4)	3.07 ± 1.12				
Listening (range: 0-2)	1.69 ± 0.58				
Decision making (range: 0-5)	3.82 ± 1.14				

Note. [a] Chi-square test. [b] The average exchange rate in 2016 was US$1≈NT$32. MOHL-AQ = Mandarin Version of Oral Health Literacy Adult Questionnaire; NT = New Taiwan.

Table 2. The Goodness of Fit Indices and References of the Model

Model	Absolute Fit Indices				Relative Fit Indices			Parsimony Fit Indices				
	GFI	AGFI	SRMR	RMSEA	CFI	NNFI	IFI	PGFI	PNFI	χ^2	df	χ^2/df
MOHL-AQ	0.93	0.92	0.04	0.04	0.90	0.87	0.89	0.73	0.68	221.86	119	1.86
References	>0.90	>0.90	<0.08	<0.05	>0.90	>0.90	>0.90	>0.50	>0.50	-	-	<2

Note. MOHL-AQ = Mandarin Version of Oral Health Literacy Adult Questionnaire. GFI = Goodness of Fit Index;

AGFI = Adjusted Goodness of Fit Index; SRMR = Standardized Root Mean Square Residual;

RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index;

NNFI = Bentler-Bonett Non-normed Fit Index; IFI = Bollen's Incremental Fit Index;

PGFI = Parsimony Goodness of Fit Index; PNFI = Parsimony Normed Fit Index; df = Degree of Freedom.