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Article

Health literacy in Mainland China: validation of a functional health literacy test in simplified Chinese

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Summary

Health literacy tests in the Chinese-speaking parts of the world have been mainly developed in traditional Chinese to be used in Hong Kong or Taiwan. So far no validated tool in simplified Chinese to assess functional health literacy in Mainland China has been developed. The aim of the study was to validate the simplified Chinese version of the Short Test of Functional Health Literacy in Adults (S-TOFHLA). The traditional Chinese version was translated into simplified Chinese and 150 interviews in an outpatient department of a public hospital in Mainland China were conducted. Predictive validity was assessed by known predictors for health literacy and convergent validity by three health literacy screening questions. The Cronbach's α for the reading comprehension part was 0.94 and 0.90 for the numeracy items. Participants with lower education and men had significantly lower levels of health literacy. The reading comprehension part was significantly correlated with two of the health literacy screening questions. Our results indicate that the simplified Chinese version of the S-TOFHLA is a reliable measure of health literacy to be used in Mainland China.

Key words: health literacy, S-TOFHLA, simplified Chinese, Mainland China

INTRODUCTION

Health literacy defined as the 'degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions' (Nielsen-Bohlman *et al.*, 2004) has become an area of growing research interest around the world. Studies mainly conducted in the USA have shown the influence of health literacy on a number of health outcomes and health-related behaviours (Parker, 2000; DeWalt *et al.*, 2004; Nielsen-Bohlman *et al.*, 2004). However, so far research in the field of health literacy has been mainly developed in the English-speaking parts of the world, and even though it has also grown in European countries in recent years, research in other parts of the world is still in its infant shoes (Kondilis *et al.*, 2008).

Health Literacy Measurement in Chinese Language

Mainland China with a population of 1.3 billion citizens has gone through constant social changes in the last decades, including a radical privatization of the health care sector (Blumenthal and Hsiao, 2005), demanding people to become increasingly involved in their health care and to make appropriate decisions regarding their own health. This imposes new challenges on people's health literacy. Attempts have been made to look at the relationship of health literacy and health outcomes in the Chinese-speaking parts of the world. Yet, most of these studies have been conducted in Taiwan or Hong Kong and only few have looked at the relationship of health literacy and health outcomes in Mainland China.

Context and language specific tools to assess health literacy, such as the Taiwan Health Literacy Scale and the Mandarin Health Literacy Scale in Taiwan, were developed. The development of the first tool was based on the Rapid Estimate of Adult Literacy in Medicine (REALM) which measures one's ability to pronounce words (Pan *et al.*, 2010). The Mandarin Health Literacy Scale on the other hand was developed through different expert rounds, eventually comprising 50 items. It has a rather long administration time (Tsai *et al.*, 2010) and thus is considered to be rather impractical in clinical settings (Leung *et al.*, 2013a).

In Hong Kong, Leung and colleagues (Leung *et al.*, 2013a) developed the Health Literacy Scale for Chronic Care. It tests four dimensions (remembering, understanding, applying and analysing) concerning the usage of health information and decision-making in the health context. Similar to this scale also a Chinese Health Literacy Scale for Diabetes was developed to evaluate health literacy in diabetes patients (Leung *et al.*, 2013b).

Other tools in Hong Kong were mainly developed in the field of dentistry, among those the Hong Kong Rapid Estimate of Adult Literacy in Dentistry (HKREALD-30) (Wong *et al.*, 2012) and the Hong Kong Oral Health Literacy Assessment Task for paediatric dentistry (Wong *et al.*, 2013).

Most of these tools have not established construct validity with a validated reference measure and so far only few attempts have been made to translate, adapt and validate already existing health literacy measures. The most common tools to assess health literacy have been developed in English to be used in the USA and they are often considered to lack cultural sensitivity. It is argued that especially tools that assess functional health literacy cannot take into account the sentence structures of the Chinese language and its written characters (Leung *et al.*, 2013a) and that their focus on pronunciation and comprehension of the English language might not be applicable in other linguistic contexts (Tsai *et al.*, 2010). Still, one study validated successfully the short-form Test of Functional Health Literacy in Adolescents in a sample of high school students in Taiwan (Chang *et al.*, 2012). Another study translated the English version of the Short Test of Functional Health Literacy in Adults (S-TOFHLA) into traditional Chinese to investigate the relationship of functional health literacy and diabetes management outcomes of type 2 diabetes patients in Hong Kong (Tang *et al.*, 2008).

Measuring Health Literacy in Mainland China

In the Chinese-speaking population two different written character systems are used while the pronunciation remains the same (apart from differences in dialects). The traditional characters are mainly used in Taiwan and Hong Kong whereas the simplified characters are used in Mainland China.

Up until today research on health literacy in Mainland China has been mainly carried out in public health and not in clinical settings (Wang *et al.*, 2013a). Those studies used health literacy measures that primarily focussed on understanding and application of health information without assessing reading or numeracy skills (Wang *et al.*, 2013b). Measures were developed without using established reference measures to assess construct validity. Further, instruments were rather content specific and evaluated mainly knowledge on specific health behaviours or diseases.

In 2009 the Chinese government conducted a study to investigate health literacy in the general population. A measurement tool that consisted of 66 items was developed which investigated different dimensions, such as basic knowledge and beliefs, and healthy lifestyle. The study showed that out of 79,542 participants only 6.48% had adequate literacy (Wang *et al.*, 2013b). Based on this survey other studies have been conducted looking at the relationship of health literacy and related risk factors (Wang *et al.*, 2013a) or health status in an elderly minority group (Li *et al.*, 2009).

Other studies using self-designed health literacy scales investigated the relationship between health literacy and health education in elementary and middle schools (Yu *et al.*, 2012) infectious diseases (Wu *et al.*, 2012; Zhang *et al.*, 2012) and ethnic disparities in health-related quality (Wang *et al.*, 2013b).

The attempts by the government to assess health literacy in the general public and a growing research body on health literacy in the country underline the need for a more systematic approach to develop and validate health literacy measures in simplified Chinese to be used in Mainland China.

Objective of the Study

So far no established health literacy measure has been translated and validated into simplified Chinese. This includes, besides the validation of functional health literacy measurement tools, also the validation of subjective health literacy screening tools, such as the widely used health literacy screening questions developed by Chew and colleagues (Chew *et al.*, 2008).

Thus, the aim of this study was to adapt and validate the S-TOFHLA (Baker *et al.*, 1999) in simplified Chinese to be used in Mainland China. Even though the S-TOFHLA has been translated into traditional Chinese to be used in Hong Kong (Tang *et al.*, 2008), no simplified Chinese version of the S-TOFHLA exists. Since in Hong Kong and Taiwan the official writing system uses traditional Chinese characters, the test is not applicable to Mainland China where the standard writing form is simplified Chinese.

The S-TOFHLA is a self-administered paper–pencil questionnaire that measures one's ability to read and understand health-related information. It was developed based on a longer version that initially took up to 22 min to be completed. The shorter version allows a quicker assessment with a total time of 12 min or less to administer. It consists of 36 cloze items, divided into two reading comprehension passages, and four numeracy items (Baker *et al.*, 1999).

Studies have tested the association between a number of potential predictors of health literacy and performance on the S-TOFHLA and have shown that higher age (Baker *et al.*, 2000; von Wagner *et al.*, 2007), as well as lower educational attainment (Gazmararian *et al.*, 1999; Aguirre *et al.*, 2005), lower levels of income (von Wagner *et al.*, 2007), presence of a chronic condition (Baker *et al.*, 2000) and being unemployed (Pandit *et al.*, 2009) predicted lower levels of functional health literacy.

Evidence on the role of gender is still mixed. Some results point towards the fact that men score higher on health literacy (Olives *et al.*, 2011), whereas other studies found that women are more likely to score higher (Aguirre *et al.*, 2005; von Wagner *et al.*, 2007) and other studies did not find any significant relationship (Gazmararian *et al.*, 1999).

The S-TOFHLA has been translated and validated in a number of languages, such as Portuguese (Carthery-Goulart *et al.*, 2009), Turkish (Eyüboğlu and Schulz, 2015), Serbian (Jović-Vraneš *et al.*, 2009) or German, French and Italian (Connor *et al.*, 2013). Those studies largely confirmed the relationships described above.

The three health literacy screening questions developed by Chew and colleagues (Chew *et al.*, 2008) ask about one's ability to read and understand health-related information. They are brief and easy to administer questions that, each separately, are able to detect limited health literacy. Originally developed in a sample of VA patients (Chew *et al.*, 2008), they have been used across a variety of other contexts and have been shown to correlate with other health literacy measures such as the S-TOFHLA or the REALM (Haun *et al.*, 2012; Wallston et al., 2014).

METHODS

Adaptation of the S-TOFHLA

The authors of the traditional Chinese version of the S-TOFHLA were contacted and asked for permission to translate the test into simplified Chinese to be tested in Mainland China (Tang *et al.*, 2008). A native Mandarin speaker translated the traditional Chinese version into simplified Chinese and minimal changes regarding some expressions were made to make it more applicable to the Chinese health care context.

To test for convergent validity the three screening questions for limited health literacy were also translated into simplified Chinese. Also here special attention was paid to cultural and contextual differences but the primary aim was to keep the wording of the questions as close as possible to the originals.

Translations were subsequently reviewed by three native Chinese speakers of whom two were medical doctors.

Sample

Data collection took place between April and May 2013 in an outpatient department of a public hospital in Shaodong county, a rural area in Hunan province, China.

Participants were randomly chosen and had to be 18 years and older, speak Mandarin and be Chinese citizens. Patients who were too ill to participate, had severely impaired sight or were suffering from mental disorders were excluded.

In total, 150 patients (50% women) participated in the study. Trained interviewers approached patients waiting for admittance to the hospital. The purpose of the survey was explained and participants were able to give informed oral consent. Before the beginning of the interview participants were asked to fill in their socio-demographic information. Where necessary, interviewers helped to fill in the information.

The first part of the interview consisted of the health literacy screening questions. In the second part, participants filled in the reading comprehension part, which consists of two passages. Participants were made aware of the fact that this part was timed and would be stopped after 7 min. Once the 7 min had passed participants were asked to stop and to continue with the numeracy items.

Analyses

Scores were calculated based on the scoring system provided by Baker and colleagues (Baker *et al.*, 1999). In the reading comprehension part every correct answer is scored with 2 points and every incorrect answer with 0 points. The total score of this part is 72 points. The numeracy part totals 28 points. Each correct answer scores 7 points. The total score of the test is 100 points. Inadequate health literacy ranges from 0 to 53 points, marginal between 54 and 66 points and adequate health literacy ranges between 67 and 100 points.

Some other studies have used the scoring system from 0 to 36 as proposed for testing in clinical settings which scores each correct answer with one point (Jović-Vraneš *et al.*, 2013). Since this scoring system excludes the numeracy items it was decided to stick to the original scoring.

Internal consistency of the 36 items of the prose passage and the four numeracy items was assessed by Cronbach's α. Spearman's and Pearson's correlation coefficients were calculated to assess the association between known predictors for health literacy, such as educational level, income and age. An independent *t*-test was conducted to investigate differences in health literacy scores between female and male participants. The association between those variables and health literacy as a continuous variable was further assessed by ANOVA.

To assess convergent validity Pearson's and Spearman's correlation coefficients were calculated to assess the association between the S-TOHLA and the three screening questions. Chew and colleagues (Chew *et al.*, 2008) identified in their study that a combination of all three items would not lead to any changes in detecting limited health literacy. Therefore, each item was reported separately.

A linear regression model was calculated to estimate the relationship between the socio-demographic predictors and health literacy. All data were analysed using SPSS version 21 and parametric procedures were applied. Statistical significance was set at $p < 0.05$.

RESULTS

Sample characteristics

Most of the respondents were in the age group 36–55 (38.7%). The number of men and women was equal (50%). Ninety-two percentage of participants were Han, the ethnic majority in China.

Furthermore, 10.7% had 6 years or less of schooling, 19.3% finished secondary school, 28% indicated to have finished high school or vocational training, followed by 29.3% who indicated to have finished junior college and 12.7% having a university degree (Table 1). Most respondents (50%) indicated to earn 2000 RMB (1 RMB = 0.16 US-Dollar) or less.

Reading comprehension part and numeracy items

The simplified Chinese version of the S-TOFHLA showed good internal consistency. For the 36 Cloze items in the reading comprehension part the Cronbach's α was 0.94 and for the four items of the numeracy section 0.90. The correlation for the numeracy score and the reading comprehension score was 0.362, $p < 0.001$.

Overall 40.4% of participants showed to have adequate health literacy, followed by 32.9% possessing marginal health literacy and 26.7% possessing inadequate health literacy.

Predictive validity

Predictive validity was assessed by the association of socio-demographic variables with the S-TOFHLA scores. Spearman's correlation between education and the overall health literacy score was moderate ($\rho = 0.303$, $p < 0.001$). Correlations between the reading comprehension part and

Table 1: Mean scores and distribution of respondents' level of health literacy by gender, age and education

	Number	Health literacy		Inadequate	Marginal	Adequate
		Mean	SD			
Total	150					
Gender						
Male	75	54.69	22.8	27 (35.0%)	28 (37.3%)	20 (26.7%)
Female	75	65.99	21.6	16 (21.3%)	20 (26.7%)	39 (52.0%)
p		0.002			0.006	
Age						
18–35	52	64.06	20.0	15 (28.8%)	15 (28.8%)	22 (42.3%)
36–55	58	61.69	21.6	14 (24.1%)	19 (32.8%)	25 (43.1%)
56–75	38	53.95	22.5	13 (34.2%)	14 (36.8%)	11 (28.9%)
p		0.096			0.620	
Education						
Primary School (6 years)	16	26.63	25.7	11 (68.8%)	4 (25.0%)	1 (6.3%)
Secondary School (3 years)	29	57.72	22.1	12 (41.4%)	9 (31.0%)	8 (27.6%)
Vocational/High School (3 years)	42	64.29	18.4	7 (16.7%)	16 (38.1%)	19 (45.2%)
Junior College (3 years)	44	69.82	16.6	8 (18.2%)	11 (25.0%)	25 (56.8%)
University (4 years and more)	19	62.05	17.4	5 (26.3%)	8 (42.1%)	6 (31.6%)
p		<0.0001			0.001	

education ($\rho = 0.256$, $p < 0.001$) and the numeracy part and education ($\rho = 0.247$, $p < 0.001$) separately were also moderate.

A one-way ANOVA of the relationship between highest achieved education and the overall S-TOFHLA score was conducted, $F(4, 145) = 15.247$, $p < 0.001$. Tukey's HSD post-hoc test showed significant differences between people who indicated primary school as highest educational level and all other educational levels. All other comparisons resulted in non-significant differences.

For the reading comprehension part Levene's test indicated that the assumption of homogeneity of variance was violated, $F(4.145) = 9.251$, $p < 0.001$. Transforming the data did not correct this problem but the Games-Howell post-hoc test revealed the same significant difference between primary school and all other educational levels. All other comparisons resulted in non-significant results.

A significant correlation between age and the overall health literacy score was found ($r = 0.136$, $p < 0.05$). No significant correlations between age and the reading comprehension part and age and the numeracy part were found. Income did not correlate significantly with the overall health literacy score, neither with reading comprehension nor the numeracy part.

An independent *t*-test was conducted to evaluate differences in gender regarding health literacy levels. The test was significant, $t(148) = 3.113$, $p < 0.05$. Female participants ($M = 65.99$, SD = 21.583) showed on average higher health literacy levels than male participants ($M = 54.69$, $SD = 22.836$). These results showed to be consistent in the reading comprehension and numeracy part separately (Table 1).

Convergent validity

The health literacy screening questions 'How often do you have problems learning about your medical condition because of difficulty understanding written information?' ($r = 0.259$, $p < 0.001$) and 'How often do you have someone help you read hospital materials?' ($r = 0.206$, $p < 0.05$) showed to be significantly correlated with the reading comprehension part. The question 'How confident are you filling out medical forms by yourself?' did not correlate significantly with any of the other measures.

No significant correlations were found between the three screening questions and the overall S-TOFHLA score or, respectively, the numeracy items.

Table 2: Association between overall health literacy score and education, gender and age in a linear regression model

	Health literacy		
	Standardized beta	*t*	*p*
Education	0.408	5.296	<0.001
Gender[a]	0.287	3.878	<0.001
Age	−0.046	−0.595	0.553
R^2	0.223		

[a]Reference group: male participants.

Regression model

In a linear regression model education, gender and age explained 22% of the variance where education and gender remained associated with health literacy but age not (Table 2).

DISCUSSION

To our knowledge this is the first study to validate a functional health literacy measure in Mainland China. So far most of the health literacy measurement tools have been developed and validated in Hong Kong and Taiwan. Since the official written language in Mainland China is simplified Chinese and the health care sector operates in written form in it, it is necessary to develop health literacy measures in simplified Chinese.

Overall the simplified Chinese version of the S-TOFHLA showed to be a reliable measure as indicated by a high Cronbach's α (internal consistency) for both the reading comprehension part and the numeracy items separately.

The distribution across the three different health literacy levels was fairly equal, with the majority having adequate health literacy. Our analysis was based on predictive validity taking into account different predictors for functional health literacy. Established predictors for functional health literacy are age, educational level and income. The results of the study concur with the results found in other studies. One important validation criterion is the association between educational level and health literacy (Paasche-Orlow *et al.*, 2005), an association that was also found in the current study and which supports the validity of the tool.

Even though we would have expected that higher income would be predictive of higher health literacy levels, we did not find a significant relationship between income and health literacy. Yuan and colleagues (Yuan *et al.*, 2015) found that residents in rural areas of Mainland China with lower income were more knowledgeable about health topics. This warrants a closer investigation in order to identify the underlying mechanisms leading to these rather unexpected relationships.

Even though differences with regard to age and health literacy were not significant, the data show that older

participants scored in average lower on the S-TOFHLA. Further analysis for the screening questions revealed the same pattern.

We did not find any significant differences in education with regard to gender, still gender was an important variable in predicting health literacy in our sample. Female participants in general scored significantly higher, which is in line with results found in the USA (Aguirre *et al.*, 2005; von Wagner *et al.*, 2007). Yet, other validation studies have shown different results. In the Turkish and Serbian versions of the S-TOFHLA for example men scored significantly higher (Jović-Vraneš *et al.*, 2009, Eyüboğlu and Schulz, 2015) whereas in the German, French and Italian version no significant differences were found (Connor *et al.*, 2013).

Convergent validity was assessed by correlating the simplified Chinese version of the S-TOFHLA with the translated health literacy screening questions (Chew *et al.*, 2008). Two of the three questions showed to be significantly correlated with the reading comprehension part. These results are not surprising since both questions assess the understanding of written health information.

Limitations

Based on a fairly equal distribution across different health literacy levels, age groups and gender, we can assume that the population in our study was sufficiently diverse to investigate the relationship between commonly cited predictors of health literacy and performance on the S-TOFHLA. Nevertheless the results cannot be generalized since data were collected in a rural area in China. More research is needed in more urban areas with a more representative sample.

Besides, the number of missing values in the numeracy items and health literacy screening questions was rather high, which deserves further investigation. One possible explanation with regard to the health literacy screening questions (ca. 30% missing values) might have been the wording or format that might not have been clear to the participants. Even though data were not treated as missing for the numeracy items, further investigation is needed to better understand whether people truly did not know the answer or if also here the format or mode of administration might have been problematic.

CONCLUSION

The validation of the S-TOFHLA in simplified Chinese has been a first attempt to apply an already existing measure in Mainland China and to establish a reference measure to evaluate health literacy levels in a clinical setting in the Chinese population. Even though some aspects still need further investigation, including testing in a more representative sample, the simplified Chinese version of the S-TOFHLA seems to be a reliable measure to be used in primary care patients in Mainland China.

AUTHORS' CONTRIBUTIONS

S.M. conducted the analysis, and wrote the first and final drafts. P.J.S. assisted with the conceptualization and reviewed the first and final drafts.

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