Assessing Health Literacy Among Chinese Speakers in the U.S. with Limited English Proficiency

Xuewei Chen, PhD; Patricia Goodson, PhD; Sandra Acosta, PhD; Adam E. Barry, PhD; and Lisako E. McKyer, PhD, MPH

ABSTRACT

Background: Limited English proficiency compounds the problem of low health literacy, making certain population groups in the United States especially vulnerable to health disparities. **Objective**: This study clarified the mechanisms underlying low health literacy among people with limited English proficiency using a modified theory-based health literacy assessment survey. **Methods**: We modified and tested the All Aspects of Health Literacy Scale (AAHLS) with a sample of Chinese speakers who have limited English proficiency in the U.S. The AAHLS is a theory-based health literacy survey assessing functional health literacy, interactive health literacy, information appraisal, and empowerment. We adapted the survey, created dual language scenarios (English and Chinese), translated the questions into Chinese, and conducted cognitive interviews to revise the questions. We examined the health literacy score distributions and performed Confirmatory Factor Analysis (CFA) to evaluate the appropriateness of our modified AAHLS to elicit valid data. **Key Results**: A total of 405 participants completed our AAHLS survey. Compared to the English language scenario, aside from the item assessing if participants would question health care providers, participants had significantly higher health literacy levels when they were immersed in communication using Chinese ($p < .001$). We also found that more than three-quarters of the participants were not likely to question their doctor's and nurse's advice regardless of language scenarios and most of them had limited empowerment capabilities at the level of community and social engagement. The CFA results showed that the modified Chinese model exhibited good fit (RMSEA [root mean square error of approximation] = 0.06, CFI [the comparative fit index] = 0.98, TLI [Tucker-Lewis index] = 0.97, WRMR [weighted root mean square residual] = 1). **Conclusions**: The results showed that our modified AAHLS yielded reliable and valid data among U.S. Chinese speakers. Researchers should consider native languages and cultural differences before conducting health literacy assessments. Public health professionals should incorporate health interventions and policy approaches to improve Chinese immigrants' English proficiency and empowerment capabilities. **[*HLRP: Health Literacy Research and Practice*. 2018;2(2):e94-e106.]**

Plain Language Summary

To clarify the mechanisms underlying low health literacy among populations with limited English proficiency (LEP) in the United States, this study aims to tailor a theory-based health literacy survey with dual-language scenarios among Chinese speakers with LEP. The modified survey yielded reliable and valid data. Participants had higher health literacy levels when they were immersed in communication using Chinese rather than English.

Language barriers contribute significantly to health disparities in the United States. Compared to native English speakers, for instance, people with limited English proficiency (LEP) are more likely to have low levels of health literacy (Kindig, Panzer, & Nielsen-Bohlman, 2004), with subsequent negative health outcomes. Research on the top-

ic has documented that many people with LEP experience poor patient-physician communications and have difficulty understanding health messages (Chen, Acosta, & Barry, 2016; Chen, Acosta, & Barry, 2017; Lindholm, Hargraves, Ferguson, & Reed, 2012; Smith, 2010).

The term LEP refers to anyone age 5 years and older who speaks English "less than very well" (Pandya, McHugh, & Batalova, 2011). About 8.6% of adults in the U.S. (26 million people) have LEP (U.S. Census Bureau, 2015). Chinese immigrants in the U.S. are vulnerable to health disparities because they have a high rate of LEP and low health literacy. About 60% of Chinese immigrants in the U.S. are categorized as people with LEP (Gambino, Acosta, & Grieco, 2014). Moreover, Sentell and Braun (2012) found that Chinese people with LEP had the highest prevalence of low health literacy among all U.S. populations with LEP.

Racial health disparities can be partially attributed to poor health literacy (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). For instance, Sentell and Braun (2012) found that Chinese immigrants had the highest prevalence of low health literacy with a high prevalence of poor health. Health literacy instruments allow health professionals to tailor health services for patients, improve patient-provider communication, and, in so doing, have the potential to help reduce health disparities (Batterham, Hawkins, Collins, Buchbinder, & Osborne, 2016; Nørgaard, Sørensen, Maindal, & Kayser, 2014; Stonbraker, Schnall, & Larson, 2015). Therefore, assessing health literacy among Chinese people with LEP in the U.S. is an essential first step in developing effective health education programs for this unique group. The outcome of health literacy assessments informed health care providers in clinical encounters to provide tailored services and better support patients with LEP; moreover, a quality instrument can help health professionals and researchers to develop effective community health interventions (Chinn & McCarthy, 2013). Health literacy instruments serve as an essential component of any health needs assessment and provide the foundation for a successful intervention plan (Thomason & Mayo, 2015).

THEORETICAL FRAMEWORK

One health literacy conceptual model (Nutbeam, 2000) has been widely cited in the literature because it advanced previous understanding of health literacy by including different levels of cognitive, interpersonal, social, and political skills (Chinn, 2011). According to Nutbeam (2000), health literacy has three levels: functional, interactive, and critical. Functional health literacy refers to the capability to understand factual information and use health services. Health-related knowledge, prescription adherence, and health system navigation are examples of functional health literacy skills. Interactive health literacy refers to the capability to act independently in a supportive environment. Examples include communication with others, self-adjustment (e.g., improving motivation, building self-confidence, and changing behavior), and social skills. Critical health literacy refers to the capability to control health-related situations, such as cognitive abilities and skills to act on social, economic, and environmental determinants. Nutbeam (2008) later suggested further dividing critical health literacy into

Xuewei Chen, PhD, is a Postdoctoral Associate, Department of Community Health and Health Behavior, School of Public Health and Health Professions, University at Buffalo. Patricia Goodson, PhD, is a Professor, Department of Health and Kinesiology, Texas A&M University. Sandra Acosta, PhD, is an Assistant Professor, Department of Educational Psychology, Texas A&M University. Adam E. Barry, PhD, is an Associate Professor, Department of Health and Kinesiology, Texas A&M University. Lisako E. McKyer, PhD, MPH, is an Associate Professor, Department of Health Promotion and Community Health, School of Public Health, Texas A&M University.

Address correspondence to Xuewei Chen, PhD, Department of Community Health and Health Behavior, School of Public Health and Health Professions, University at Buffalo, 334 Kimball Tower, Buffalo, NY 14214; email: xueweich@buffalo.edu.

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three components: the critical analysis of information, an understanding of the social determinants of health, and engagement in collective action.

As Yip (2012) points out, current health literacy instruments are incapable of assessing health literacy precisely among populations with LEP. Per data from the health promotion literature and the Health Literacy Tool Shed database, it is evident that many instruments are currently used to assess a person's health literacy (Harnett, 2017; Haun, Valerio, McCormack, Sørensen, & Paasche-Orlow, 2014); however, few of them are theory-based or designed for populations with LEP (McKee & Paasche-Orlow, 2012; Nguyen et al., 2015).

Chinese people with LEP in the U.S. encounter health information in both English and Chinese. LEP patients' understanding of health information and services vary under two language scenarios: when they communicate with language-concordant health care providers versus when they communicate with providers who can only speak English (Wilson, Chen, Grumbach, Wang, & Fernandez, 2005). Meanwhile, people with LEP living in the U.S. seek health information in both languages. Due to the close relationship between English proficiency and health literacy, it is important to assess health literacy among U.S. Chinese speakers with LEP under separate language scenarios. However, no previous studies have assessed the health literacy of people with LEP using instruments within these different language scenarios.

Based on the identified need to disentangle English proficiency from Chinese language literacy, the purpose of the study reported herein was to (1) develop a tailored and theory-based health literacy instrument for Chinese immigrants in the U.S. who have LEP; (2) assess their health literacy using this instrument to clarify the mechanisms underlying low health literacy issues among people with LEP; and (3) evaluate how well Nutbeam's 4-factor health literacy conceptual model (Nutbeam, 2000) fits the instrument data. We modified and translated a theory-based health literacy assessment instrument to tailor it for Chinese immigrants with LEP. We investigated the adequacy of the survey to elicit valid data from this unique population. For this purpose, we posed the following questions:

1. What are the health literacy levels for the participants in this study under the English scenario?
2. What are the health literacy levels for the participants in this study under the Chinese scenario?
3. How well does Nutbeam's health literacy conceptual model fit the data from the English scenario questions?
4. How well does Nutbeam's health literacy conceptual model fit the data from the Chinese scenario questions?

METHODS

Instrument

This study was comprised of modifying and testing the All Aspects of Health Literacy Scale (AAHLS) (Chinn & McCarthy, 2013) with a sample of native Chinese speakers in the U.S. who have LEP. The original instrument was developed in the U.K. and written in English (Chinn & McCarthy, 2013). The AAHLS (Chinn & McCarthy, 2013) is a health literacy survey developed based on Nutbeam's 4-factor health literacy conceptual model with 13 self-reported questions. Three questions (F1, F2, and F3) assess the functional health literacy factor. Three questions (I1, I2, and I3) assess the interactive health literacy factor. Four questions (Info1, Info2, Info3, and Info 4) assess the information appraisal factor. Three questions (Emp1, Emp2, and Emp3) assess the empowerment factor.

More than 51 instruments are available to assess a person's health literacy (Haun et al., 2014). We selected AAHLS because (1) it is a comprehensive measure based on Nutbeam's health literacy conceptual model (Haun et al., 2014); (2) the instrument is easy to administer, so it requires minimum training for the test administers (Haun et al., 2014); (3) it is a brief measure that takes about 7 minutes to complete (Chinn & McCarthy, 2013); and (4) it assesses multiple health literacy competencies to go beyond functional literacy skills (Chinn & McCarthy, 2013).

To separately assess English language proficiency from health literacy, we developed two language scenarios (English and Chinese) for the functional health literacy, interactive health literacy, and information appraisal questions. We kept the original wording for the three empowerment questions (i.e., did not make language-specific scenarios because the items do not lend themselves to such application as the items assessed people's health-related perceptions/opinions and behaviors irrespective of language.)

We controlled for item order effects by counterbalancing with two forms of the survey. Form A contained the Chinese scenario questions first, followed by the English scenario questions. Form B contained the English scenario questions first, then the Chinese scenario questions. We randomly distributed Form A or Form B to our participants.

Survey Translation

After creating two language scenarios, we translated all the AAHLS questions from English to Chinese after cross-cultural translation guidelines (Beaton, Bombardier, Guillemin, & Ferraz, 2002; Wild et al., 2005). Our translation process comprised five steps: (1) two bilingual health professionals who are Chinese native speakers developed

two forward translations independently; (2) these two translators, along with a third native Chinese-speaking health professional, who did not participate in the forward translation, compared the two forward translation versions, discussed the discrepancies, and reached consensus; (3) a bilingual native-English speaker who is not familiar with the health content (to avoid information bias) back-translated the Chinese version into English; (4) all translators met to review and compare the back-translated version with the original one to revise the Chinese AAHLS; (5) feedback from 10 bilingual community health workers/professionals was gathered, and the translation was further revised with that input.

Cognitive Interview

After the translation, we conducted cognitive interviews among 10 native Chinese speakers with LEP to identify potential sources of measurement error related to the survey questions. We applied think-aloud and probing techniques (Collins, 2003) during the cognitive interviews. Regarding the think-aloud approach, we asked our interviewees to describe their cognitive process while answering the survey questions. Regarding the probing approach, we asked specific questions at the end of each cognitive interview if applicable:

1. Are these questions easy to understand?
2. Do you notice any confusing words or phrases?
3. I noticed you hesitated before you answered that question—what were you thinking about?

After the cognitive interviews, we revised the Chinese AAHLS questions to clarify wording. Finally, we added detailed instructions for clarity at the beginning of the survey to avoid ambiguity.

Data Collection

We conducted data collection between June 2016 and September 2016. To be eligible for this study, the participants had to be age 18 years or older, native speakers of Chinese (either Mandarin or Cantonese), literate in Chinese (either simplified or traditional Chinese), and self-report as speaking English "less than very well" (i.e., LEP). We distributed study flyers through health professional organizations, community centers, and churches in an urban region in the southwestern U.S. to recruit potential participants. We assessed the eligibility of potential participants using four prescreening questions asking about their age, native language, Chinese literacy, and English-speaking proficiency. The first author (X. C.) went to community centers and churches to meet with participants in groups for data collection. When participants returned the paper-and-pencil survey, the first author scanned through the answers to ensure questionnaire completion. Each participant received a $10 grocery gift card as incentive after completing the survey. This study was approved by the Institutional Review Board (IRB2016-0092D) of Texas A&M University (College Station, TX).

Two versions of the translated survey were made available because written Chinese has two versions: traditional and simplified. Before 1949, traditional Chinese was the only written form of Chinese. The Chinese government simplified the characters to promote literacy in 1949. Most Chinese speakers are literate in both versions but have a preferred version. Immigrants from Hong Kong and Macau, for instance, tend to use the traditional version, whereas the simplified version is more often used among Mainland Chinese immigrants (Zhou & Cai, 2002). The U.S. and the United Nations provide both versions when communicating with Chinese speakers. Therefore, we followed the practice of providing version options for study participants. Having two versions may possibly introduce measurement bias between the traditional and simplified Chinese versions, and this is further discussed in the limitation section of this article.

Sample

The sample size of this study was 405 (158 men and 247 women). The age range was from 18 to 96 years (M = 51.70, SD = 19.31). Their time lived in the U.S. ranged from 1 month to 74 years (M = 17.72, SD = 14.33). There were 128 participants (31.6%) who considered themselves as speaking English "not well" or "not at all." About one-quarter (23.7%) had a high school education or below. More than one-half (55.3%) had a Bachelor's degree or above. See **Table 1** for participants' sociodemographic information.

Measures

In the original English AAHLS, the functional health literacy, interactive health literacy, information appraisal questions, and the first question of the empowerment factor had a three-category response scale (*rarely*, *sometimes*, and *often*). When we presented the three-category response scale to our cognitive interviewees, they expressed that they would choose *never* or *always* as the answers to some questions; however, these choices were not available in the response options. Based on such feedback we received during the cognitive interviews, we modified the three-category response scale to a five-category response scale (*never*, *rarely*, *sometimes*, *often*, and *always*). The response scale for each health literacy question ranged from 0 to 4. Higher scores indicated better health literacy. Most responses were coded as 0 = *never*, 1 = *rarely*, 2 = *sometimes*,

TABLE 1

Sociodemographic Information (*N* = 405)

Characteristic	*n* (%)
English speaking proficiency	
Well	122 (30.1)
Fair	155 (38.3)
Not well	91 (22.5)
Not at all	37 (9.1)
Gender	
Female	247 (61)
Male	158 (39)
Education	
High school or below	96 (23.7)
Technical or Associate's degree	85 (21)
Bachelor's degree	67 (16.5)
Master's degree	110 (27.2)
Doctoral degree	47 (11.6)
Occupation	
Full-time/part-time employee	138 (34.1)
Retired	118 (29.1)
Student	80 (19.8)
Unemployed	32 (7.9)
Stay-at-home parent	22 (5.4)
Business owner	10 (2.5)
Other	5 (1.2)

3 = *often*, 4 = *always*. Items F1 and F3 were reverse coded for consistent scale direction. We kept the binary response scale of the last two empowerment questions. The overall Cronbach's α was 0.80, revealing acceptable internal consistency for the modified Chinese AAHLS.

Data Analysis

We used paired *t*-tests with a two-tailed hypothesis to examine the distributions and differences between participants' health literacy under the English and Chinese scenarios. Confirmatory factor analysis (CFA) assesses whether items correlated consistently with the hypothesized theoretical structure (Long, 1983). We performed CFA to test whether our data fit the hypothesized 4-factor health literacy measurement model: functional health literacy, interactive health literacy, information appraisal, and empowerment. We chose the mean- and variance-adjusted weighted least squares estimation (WLSMV) instead of other estimations because our data did not exhibit normal distribution. WLSMV does not assume normal distribution (Brown, 2014) so it is less biased and more accurate in estimating factor loadings for categorical and ordinal data (Li, 2016). We used SPSS 22.0 for descriptive analyses and Mplus 7 for CFA analyses. We set the significance level at $\alpha = 0.05$.

When testing how well a specific model fits the data, the Chi-square value (χ^2) is a traditional measure for evaluating overall fit (Barrett, 2007). However, the χ^2 criterion is sensitive to sample size, so it is not as appropriate as other criteria (Hu & Bentler, 1999). Other model fit indices less sensitive to sample size include the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the weighted root mean square residual (WRMR) (Barrett, 2007; Muthén, 2004). The model is considered a "good fit" when RMSEA < 0.06, CFI > 0.95, TLI > 0.95, and WRMR < 1 (Hu & Bentler, 1999; Yu, 2002). We used these indices to evaluate how well the data fit the models, when comparing the English scenario items with the Chinese scenario ones.

RESULTS

Our sample contained 405 participants. Of those 405, 221 chose the simplified Chinese survey version, 184 chose the traditional Chinese version, and 197 received Form A (Chinese scenario questions first) and 208 received Form B (English scenario questions first). **Table 2** presents the response distributions for each question. Many participants had limited empowerment at the level of community and social engagement. About 62.7% chose *never* or *rarely* for the question asking whether they believed they had the right to influence the U.S. government's action on health issues (item Emp1). Also, only 30.6% of the participants had ever taken actions on health issues that affected their family or community within the last 12 months (item Emp2). Most participants (75.6%) prioritized individual lifestyle choices and behaviors rather than social infrastructure as factors influencing health (item Emp3).

As shown in **Table 3**, compared to the English language scenario, aside from the item assessing if participants would question health care providers (item Info4), participants had significantly higher health literacy levels when they were immersed in communication using Chinese ($p \leq .001$). For item Info4 (assessing if participants would question health care providers), there was no significant difference between the two language scenarios ($p = .515$). Few participants chose *often* or *always* for these two questions (21.7% for the English scenario question and 16.3% for the Chinese scenario question).

TABLE 2

Response Distributions of the Modified Chinese All Aspects of Health Literacy Scale Questions (*N* = 405)

	Response Percentage				
Question	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Functional health literacy					
F1a: How often do you need help when you are given information in English to read by your doctor, nurse, or pharmacist?	6.9%	20.5%	35.1%	18.8%	18.8%
F1b: How often do you need help when you are given information in Chinese to read by your doctor, nurse, or pharmacist?	33.3%	32.3%	21.7%	6.7%	5.9%
F2a: When you need help to read the given information in English, can you easily get hold of someone to assist you?	1.2%	19.5%	37.5%	22.0%	19.7%
F2b: When you need help to read the given information in Chinese, can you easily get hold of someone to assist you?	2.0%	18.0%	22.7%	15.3%	41.9%
F3a: Do you need help to fill in English official documents in English?	6.4%	24.0%	36.5%	16.3%	16.8%
F3b: Do you need help to fill in Chinese official documents in Chinese?	34.8%	33.3%	20.2%	4.9%	6.7%
Interactive health literacy					
I1a: When you talk to a doctor or nurse in English, do you give them all the information they need to help you?	4.7%	8.6%	24.2%	33.8%	28.6%
I1b: When you talk to a doctor or nurse in Chinese, do you give them all the information they need to help you?	6.4%	5.9%	15.6%	28.6%	43.5%
I2a: When you talk to a doctor or nurse in English, do you ask the questions you need to ask?	5.2%	9.4%	25.7%	34.1%	25.7%
I2b: When you talk to a doctor or nurse in Chinese, do you ask the questions you need to ask?	3.2%	5.9%	24.0%	35.1%	31.9%
I3a: When you talk to a doctor or nurse in English, do you make sure they explain anything that you do not understand?	5.7%	10.1%	25.4%	34.8%	24.0%
I3b: When you talk to a doctor or nurse in Chinese, do you make sure they explain anything that you do not understand?	2.2%	5.9%	19.5%	34.1%	38.3%

Confirmatory Factor Analysis Model Fit

The reading (F1) and writing (F3) items within the functional health literacy factor exhibited significant associations under both language scenarios (rEnglish = 0.69, rChinese = 0.47; both $p < .001$). The Mplus model modification indices also suggested correlating these two items to improve the model fit. Therefore, we added a correlation path between item F1 and item F2. As shown in **Table 4**, the English model exhibited adequate fit and the modified Chinese model exhibited good fit.

TABLE 2 (*continued*)

Response Distributions of the Modified Chinese All Aspects of Health Literacy Scale Questions (*N* = 405)

	Response Percentage				
Question	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Information appraisal					
Info1a: Are you someone who likes to find out lots of different information in English about health?	11.1%	25.9%	27.4%	24.9%	10.6%
Info1b: Are you someone who likes to find out lots of different information in Chinese about health?	2.5%	11.6%	29.4%	35.1%	21.5%
Info2a: How often do you think carefully about whether health information in English makes sense in your or your family's situation?	7.4%	16.3%	32.1%	29.9%	14.3%
Info3a: How often do you think carefully about whether health information in Chinese makes sense in your or your family's situation?	2.2%	9.4%	27.7%	36.5%	24.2%
Info3b: How often do you try to work out whether information in English about your or your family's health can be trusted?	8.9%	17.0%	26.7%	30.1%	17.3%
Info3c: How often do you try to work out whether information in Chinese about your or your family's health can be trusted?	1.7%	8.6%	27.9%	35.6%	26.2%
Info4a: Under the English scenario, are you the sort of person who might question your doctor's or nurse's advice based on your own research?	7.9%	29.1%	41.2%	15.8%	5.9%
Info4b: Under the Chinese scenario, are you the sort of person who might question your doctor's or nurse's advice based on your own research?	6.2%	31.1%	46.4%	9.9%	6.4%
Empowerment					
Emp1: Do you think that there are plenty of ways to have a say in what the U.S. government does about health?	26.4%	36.3%	20.7%	11.6%	4.9%
Emp2: Within the last 12 months have you taken action to do something about a health issue that affects your family or community?	Yes (30.6%)		No (69.4%)		
Emp3: What do you think matters most for everyone's health? (tick one answer only)	Information and encouragement to lead healthy lifestyles (75.6%)		Good housing, education, decent jobs, and good local facilities (24.4%)		

Figure 1 presents the visual depiction of the English and Chinese scenario models with standardized regression coefficients for all the paths. Except for the paths related to the empowerment factor, all others had statistically significant coefficients ($p < .001$). In other words, the higher score of each functional, interactive, and information appraisal item indicated higher levels of the corresponding ability. The factors of functional health literacy, interactive health literacy, and information appraisal were significantly associated with each other ($p < .001$). The

TABLE 3

Contrast of English Scenario with Chinese Scenario for Health Literacy

	English Scenario	Chinese Scenario			95% CI		
Variable	*M* (*SD*)	*M* (*SD*)	*t* (404)	*p*	LL	UL	Cohen's *d*
Functional health literacy							
F1	1.78 (1.17)	2.80 (1.15)	15.22	< .001	0.89	1.16	0.76
F2	2.40 (1.05)	2.77 (1.22)	5.29	< .001	0.24	0.52	0.26
F3	1.87 (1.15)	2.85 (1.15)	14.57	< .001	0.85	1.11	0.72
Interactive health literacy							
I1	2.73 (1.11)	2.97 (1.19)	3.44	.001	0.10	0.37	0.17
I2	2.66 (1.11)	2.86 (1.03)	3.28	.001	0.08	0.33	0.16
I3	2.61 (1.12)	3 (1.01)	6.23	< .001	0.27	0.51	0.31
Information appraisal							
Info1	1.98 (1.18)	2.61 (1.02)	9.35	< .001	0.50	0.77	0.46
Info2	2.27 (1.12)	2.71 (1.01)	6.86	< .001	0.31	0.56	0.34
Info3	2.30 (1.20)	2.76 (0.99)	7.78	< .001	0.34	0.58	0.39
Info4	1.83 (0.99)	1.79 (0.93)	- .65	.515	- .14	- .65	- .03

Note. F1 and F3 were reverse coded for consistent scale direction; higher score indicated better health literacy. CI = confidence interval; LL = lower limit; UL = upper limit.

correlation between reading (F1) and writing (F3) was significant under both language scenarios ($p < .001$).

In **Table 5**, we presented the percentage of variance in each item that can be explained by the corresponding factor (R^2). For instance, about 10% of the variance ($p = .028$) in the item assessing reading under the English scenario (F1a) was explained by the functional health literacy factor; however, about 41% of the variance ($p < .001$) in the item assessing reading under the Chinese scenario (F1b) was explained by the functional health literacy factor. About 66% of the variance ($p < .001$) in the first item assessing interactive health literacy under the English scenario (I1a) was explained by the interactive health literacy factor, and 62% of the variance ($p < .001$) in that item under the Chinese scenario (I1b) was explained by the interactive health literacy factor. See the proportion of variance for each item in **Table 5**.

DISCUSSION

This study developed a theory-based health literacy survey targeting U.S. Chinese immigrants who have LEP to separately assess their functional health literacy, interactive health literacy, information appraisal, and empowerment under Chinese and English scenarios. The results showed that our linguistically and culturally appropriate survey could elicit reliable and valid health literacy assessment, distinct from participants' own native-language functional literacy. We adjusted the original three-category response scale to a five-category response scale based on the feedback from our cognitive interviewees. The response distributions confirmed that such change might be necessary specifically among U.S. Chinese immigrants who have LEP. For example, 26.4% of the participants chose *never* to the question (Emp1) "Do you think that there are plenty of ways to have a say in what the U.S. government does about health?" There were 43.5% of the participants who chose *always* to the question (I1b) "When you talk to a doctor or nurse in Chinese, do you give them all the information they need to help you?" Thus, we believe such a change in the response scale could increase the health literacy assessment accuracy among this population.

TABLE 4

Confirmatory Factor Analysis Model Fit Indices

Model Fit Indices	English Scenario	Chinese Scenario
χ^2	196.85	148.90
p	< .001	< .001
RMSEA	0.08	0.06
CFI	0.98	0.98
TLI	0.97	0.97
WRMR	1.10	1

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; TLI = Tucker-Lewis index; WRMR = weighted root mean square residual.

Generally, we found that participants achieved higher health literacy scores when they encountered health information/situations in Chinese rather than in English. Participants were unlikely to question their physician' and nurses' advice, regardless of language scenarios. This finding is consistent with results from Wang et al. (2012), who found Chinese immigrants were less likely to challenge physicians or express their needs to physicians, compared to U.S. born Chinese and non-Hispanic Whites. This hesitancy may be due to Chinese cultural beliefs, as physicians are highly respected because they represent the authority of medical knowledge (Wang et al., 2008). These findings indicated that providing a language-concordant health care provider or a professional medical interpreter in clinical encounters is important to improve health literacy among Chinese immigrants with LEP. However, having language-concordant clinicians or interpreters would only improve their functional health literacy. To further promote their interactive and critical health literacy, one recommendation for health professionals is to improve patients' involvement in the decision-making process.

The percentages of variance (R^2) in items that can be explained by interactive health literacy, information appraisal, and empowerment factors were similar between English and Chinese scenarios. Regarding the functional health literacy factor, we notice a great difference between the two language scenarios. Under the English scenario, the three items assessing functional health literacy explained only less than 10% of the functional health literacy factor. The remainder of the variance could not be explained by the functional health literacy factor. These items in English could not precisely assess functional health literacy among our unique sample. Yet, the Chinese scenario items accounted for up to 90% of the functional health literacy factor. Such difference indicates that functional health literacy is closely related to English language proficiency among people with LEP in the U.S. When assessing health literacy without differentiating language barriers from functional health literacy, the assessment outcome could be misleading. There is a critical need to differentiate low English proficiency from low functional health literacy for future health literacy measurement studies targeting linguistic minorities such as immigrant populations.

We also found few participants believed they had a voice in influencing or reforming U.S. health policy. Most had not engaged with the U.S. health care system within the last 12 months. Similarly, other studies show Chinese immigrants in the U.S. do not interact with the American political system, and Chinese Americans are less likely to vote compared to other Asian American peers (Abraham, 2015; Wray-Lake, Tang, & Victorino, 2017). Such disengagement may reflect participants' experiences with the Chinese political system, their cultural values, and their status as immigrants. For example, the Chinese government operates behind closed doors and the Chinese culture does not encourage people to question authority (Pye, 1993), factors that distance the Chinese people from the government (Abraham, 2015). Also, education in China is centered on Confucianism, which further emphasizes respect for all authority (Chen & Lu, 2011; Chen, Talwar, & Ji, 2015) and therefore discourages activism.

One possible direction for future study is to investigate Chinese immigrants' perceptions of community empowerment and health-promoting activism. This is a preliminary step for developing effective interventions because empowerment is an essential concept of critical health literacy (Nutbeam, 2008). Surprisingly, we found our participants were unlikely to engage in collective actions, even though collectivist beliefs are prevalent in Chinese culture (Leung, 2010). Also, we found a negative association between functional health literacy and empowerment. We believe such negative association is related with Chinese value about empowerment. These findings suggest the need for further research on acculturation and the relationship between acculturation and health literacy among Chinese immigrants in the U.S.

Most participants in our study believed individual lifestyle choices and behaviors had a greater impact on

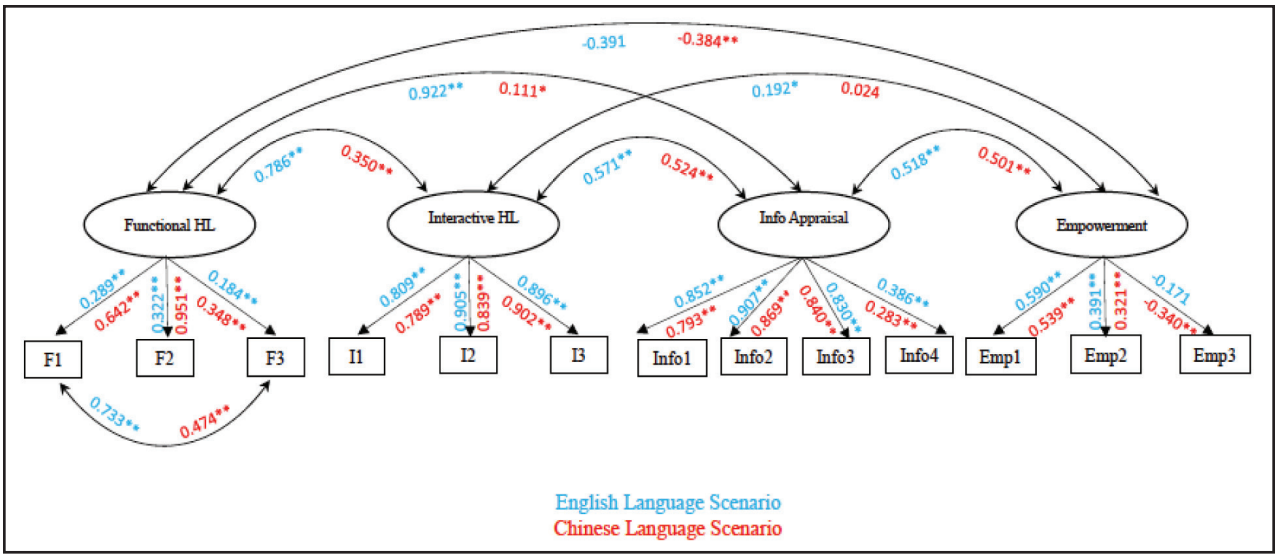

Figure 1. Confirmatory factor analysis measurement models with standardized regression coefficients. *$p < .05$; **$p < .001$.

TABLE 5

Percentage of Variance in Each Item Explained by the Corresponding Factor

	English Scenario		Chinese Scenario	
Variable	R^2	*p*	R^2	*p*
Functional health literacy				
F1	0.08	.028	0.41	< .001
F2	0.10	.029	0.90	< .001
F3	0.03	.097	0.12	.001
Interactive health literacy				
I1	0.66	< .001	0.62	< .001
I2	0.82	< .001	0.70	< .001
I3	0.80	< .001	0.81	< .001
Information appraisal				
Info1	0.73	< .001	0.63	< .001
Info2	0.82	< .001	0.76	< .001
Info3	0.69	< .001	0.71	< .001
Info4	0.15	< .001	0.08	.001
Empowerment				
Emp1	0.35	.012	0.29	.005
Emp2	0.15	.025	0.10	.079
Emp3	0.03	.393	0.12	.069

health compared to social infrastructure. This finding aligns with previous studies indicating that many people believe individual behaviors have stronger associations with health outcomes than structural or environmental factors (Davidson, Kitzinger, & Hunt, 2006; Robert & Booske, 2011). However, people's ability to engage

in healthy behaviors is affected significantly by the social, economic, environmental, and political conditions (Robert & Booske, 2011). Public health professionals should incorporate health interventions and policy approaches to improve such narrow understanding of the social determinants of health (Collins, Abelson, & Eyles, 2007).

Finally, for future health literacy interventions among populations with LEP, health professionals, literacy researchers, and English as a second language practitioners should work collaboratively to combine the English language instruction with the health education components into one program (Chen, Goodson, et al., 2015). As McKee and Paasche-Orlow (2012) indicated:

> It is critical for health literacy and limited English proficiency researchers to work together to understand how culture, language, literacy, education, and disabilities influence health disparities and health outcomes. It is important to ensure that research is collaborative and inclusive to broaden the reach of future interventions to smaller linguistic minority populations (p. 7).

STUDY LIMITATIONS

Although findings from this study provided specific directions for the future of health promotion with LEP populations, they were not without limitations. The sampling design, for instance, was limited, given we only targeted Chinese speakers with LEP using a convenience sampling approach. Thus, the sample did not represent the Chinese immigrant community in the U.S. wholly and thus may limit generalizability. Additionally, we used a self-report prescreening question to identify people with LEP, which introduced the potential for self-selection bias. This prescreen question asked potential participants to rate their English-speaking proficiency and did not objectively assess their second-language skills. Investigating the measurement bias between the traditional and simplified Chinese versions of the instrument is another part of our research project. However, the measurement bias study is not the focus of this current article. The related results will be presented elsewhere.

We emphasize for clarity that AAHLS is not the only theory-based health literacy instrument. We choose AAHLS because of its strengths, including but not limited to its foundation based on Nutbeam's health literacy conceptual model. Nevertheless, there is no single accepted health literacy theoretical model (Chen, Goodson, et al., 2015). Some health literacy instruments targeting linguistic minorities are based on other health literacy theories with different factors/domains. For example, the FLIGHT (Fostering Literacy for Good Health Today)/VIDAS (Vive Desarollando Amplia Salud) is a health literacy instrument in Spanish and English assessing three health literacy domains: prose, document, and quantitative (Ownby et al., 2013). In spite of the other options, we believe the benefits of the AAHLS outweigh any limitations at this point and AAHLS was the best option from which to pursue this line of study.

CONCLUSION

We developed a tailored theory-based health literacy instrument targeting native Chinese speakers with LEP living in the U.S. by creating two language scenarios for the questions. We evaluated how well Nutbeam's 4-factor health literacy conceptual model (Nutbeam, 2000) fit the instrument data. The Chinese scenario model exhibited good fit and the English scenario model exhibited adequate fit. Participants had higher health literacy scores when they encountered health information and communication situations in Chinese compared to English. We found few participants believed they had a voice in influencing or reforming U.S. health policy. This study contributes to the extant body of knowledge by providing evidence directing future health literacy assessment research and interventions among populations with LEP.

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