A Reliability and Validity Study of the electronic Health Literacy Scale Among Stroke Patients in China

Yu He
The First Affiliated Hospital of Zhengzhou University
Lina Guo
The First Affiliated Hospital of Zhengzhou University
Yanjin Liu (lyjhlb@126.com)
The First Affiliated Hospital of Zhengzhou University
Jaclene A. Zauszniewski
Frances Payne Bolton School of Nursing,Case Western Reserve University
Miao Wei
The First Affiliated Hospital of Zhengzhou University
Gege Zhang
The First Affiliated Hospital of Zhengzhou University
Xiaoyu Lei
Zhengzhou University

Research Article

Keywords: scale,development,nursing

Posted Date: July 27th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-512841/v2

Version of Record: A version of this preprint was published at Topics in Stroke Rehabilitation on December 20th, 2021. See the published version at https://doi.org/10.1080/10749357.2021.2016100.

Abstract

Aim: This study was designed to attain Chinesization of the electronic Health Literacy Scale and to examine the reliability and validity for evaluating compliance and effectiveness of electronic health literacy among stroke patients in China.

Design: This is a cross-sectional design.

Methods: A demographic questionnaire, the electronic Health Literacy Scale（e-HLS）and the eHealth Literacy Scale (eHEALS) were administered to a sample of 648 patients with ischemic stroke recruited from November to December 2020 in a tertiary hospital.

Results: The Cronbach'α coefficient on the e-HLS-CHI was 0.907. Kappa consistency coefficient of test-retest reliability was 0.691(p<0.05). The Content Validity Index (CVI) indicated that the content of this scale was considered to be meaningful. Three factors were extracted by Exploratory Factor Analysis (EFA), accounting for 90.84% of the total variance. The factors loading on 19 items ranged from 0.806 to 0.944. Confirmatory Factory Analysis (CFA) revealed that three factors of e-HLS-CHI fit well (NFI = 0.979, RFI = 0.955, IFI = 0.987, TLI = 0.972, CFI=0.987, RMSEA = 0.070, CMIN/DF= 2.586). Good simultaneous validity was suggested by the positive correlation of 0.94 (p<0.001) between the e-HLS-CHI and eHEALS. When using eHEALS as the standard, the area under the ROC curve of e-HLS-CHI was 0.896 (95% CI: 0.831-0.960, p<0.001). The sensitivity and specificity were 97.8% and 70.4% respectively, indicating that it has good predictive validity.

Conclusions: The e-HLS can be used to evaluate electronic health literacy of stroke patients in China after translation and debugging.

Impact: This study proves that e-HLS can be used in strokep atients in China. And it can be considered for the investigation of other types of patients and provide new ideas for disease prevention.

1. Background

Stroke can be divided into hemorrhagic and ischemic blood types according to the characteristics of cerebral vascular damage. The number of patients with ischemic stroke accounts for 70% of the total(Zhou et al. 2019). The incidence of stroke continues to rise with the emergence of an "aging society". According to the Global Burden of Diseases (GBD), the number of first episode of stroke events increased by 76% from 1990 to 2017. Compared with the United States and Japan, the age-standardized incidence of stroke in China was the highest, rising from 335.63/100,000 to 353.70/100,000 (Wang et al. 2020c). Stroke patients are often hospitalized due to stress, insomnia, infection, hypotension and other causes of recurrent attacks(Rocha et al. 2019). Due to recurrent stroke, hypoperfusion and oxidative stress reaction occur again in brain tissue, leading to patient dysfunction (Topcuoglu et al. 2017). In China, the disability-adjusted life years for ischemic stroke increased from 975/100,000 in 2005 to 1,007/100,000 in 2017, which is much higher than the same period in developed countries such as the

United States and the United Kingdom(Wu et al. 2019). The high disability rate of stroke not only makes patients need temporary or lifelong assistance, but also puts patients at great risk of death(Rejnö et al. 2019, Tessua et al. 2021).

Stroke patients are generally cared for by spouses or relatives and rarely seek professional outpatient care on their own initiative due to mobility disorders, transportation difficulties and financial pressures(Padberg et al. 2020). In order to provide more healthcare resources to stroke patients and improve the quality of life for them, telemedicine that can be linked to rural areas is emerging and has proven to be cost-effective in ischemic stroke patients(Pugliese et al. 2018). Smartphones are the device most commonly used by patients to access the Internet and health knowledge(Al Kasab et al. 2020). More and more people are gradually beginning to search for health information through electronic resources, as well as to resolve health problems with the information they obtain(Wang et al. 2020b, Guo et al. 2015). Although the Internet has been used in stroke prevention and treatment, the health information on stroke prevention and treatment provided by the Internet is not reliable. Stroke patients need to have the ability to distinguish health information(Gibson et al. 2019).

Electronic health literacy refers to the identification, understanding and evaluation of health information presented on the Internet considering the influence of personal or social factors, and using this information to solve health problems(Norman and Skinner 2006, Paige et al. 2018, Griebel et al. 2018). Electronic health literacy is easily affected by factors such as social demography, self-evaluated health, social support, online and information application. Among sociodemographic factors, gender, education level, and living in urban or rural areas were associated with electronic health literacy. Women use social networks more often than men, and are more likely than men to get effective health information from them(Tennant et al. 2015). People with high education level are easy to distinguish the useful health information on the Internet(Neter and Brainin 2012). People who have not attended high school have lower e-health literacy (Wang et al. 2020a).

The instrument used to estimate Chinese electronic health literacy is the eHealth Literacy Scale (eHEALS) compiled by Norman(Norman and Skinner 2006). Although the scale is widely used, there are some problems, including unclear scoring parameters and inaccurate judgment of the users' actual level of electronic health literacy. In addition, eHEALS is not fully adapted to Web 2.0(Quinn et al. 2017, Norman 2011). Considering the digitalization of health care and the wide use of Web 2.0 applications, Seckin(Seçkin et al. 2016) has developed the electronic Health Literacy Scale (the e-HLS), with 19 questions, including three dimensions of action, attitude and communication. It has been shown that the scale has good reliability and validity (Seçkin et al. 2016). And it has not been used in China.

3. Methods

3.1 AIMS AND OBJECTIVE

The purpose of this study is to translate the e-HLS into a version suitable for stroke patients in China and to verify the reliability and validity of the translated version.

3.2 DESIGN AND PARTICIPANTS

A cross-sectional survey was conducted among stroke patients in China. Inclusion criteria were: (1) Meet the diagnostic criteria of "Chinese Guideline for the Diagnosis and Treatment of Acute Ischemic Stroke 2018", diagnosed as ischemic stroke by head CT or MRI(Wang et al. 2018); (2) greater than or equal to 18 years old; (3) can communicate normally; (4) voluntary consent and to participate in the study. Exclusion criteria were: (1) presence of a suffering from serious illness or accompanied with disturbance of consciousness or (2) multiple organ failure or other serious somatic diseases. These persons were excluded because they may not have the ability or energy to complete the entire investigation.

3.3 INSTRUMENTS

Demographic variables: age, gender, marital status, the number of children, education level, per capita wage, place of residence, live with family, self-rated health, frequency of online health information search, attitude to online health information and online time. Demographic characteristics of the sample are summarized in Table 1.

Table 1 Characteristics of the sample

Variables	Total sample N = 648	EFA N = 324	CFA N = 324
Age in years (mean ± SD)	58.54±8.53	58.50±8.70	58.58±8.37
≥40 years old (N/%)	97 (15.0)	50(7.7)	47(7.3)
≥50 years old (N/%)	241 (37.2)	120(18.5)	121(18.7)
≥60 years old (N/%)	245 (37.8)	122(18.8)	123(19.0)
≥70 years old (N/%)	65 (10.0)	33(5.0)	32(5.0)
Gender (F/%)			
Male	364(56.2)	188(29.0)	176(27.2)
Female	284(43.8)	136(21.0)	148(22.8)
Marriage (F/%)			
Yes	582(89.8)	295(45.5)	287(44.3)
No	66(10.2)	29(4.5)	37(5.7)
Education (F/%)			
Elementary school or less	183(28.2)	92(14.2)	91(14.0)
Middle school	268(41.4)	136(20.9)	132(20.5)
High school	139(21.5	73(11.3)	66(10.2)
Professional education	55(8.5)	21(3.3)	34(5.2)
Undergraduate or more	3(0.4)	2(0.3)	1(0.1)
Habitarion (F/%)			
Urban	168(25.9)	83(12.8)	85(13.1)
Rural	480(74.1)	241(37.2)	239(36.9)
Household income/month (F/%)			
≤3000 RMB	55(8.5)	25(3.8)	31(4.7)
3000 and ≤5000 RMB	407(62.8)	208(32.0)	199((30.8)
5000 and ≤10000 RMB	182(28.1)	90((13.9)	92(14.2)
10000RMB	4(0.6)	2(0.3)	2(0.3)
History of TIA (F/%)			
Yes	34(5.2)	17(2.9)	17(2.9)
No	614(94.8)	307(47.4)	307(47.4)
History of stroke (F/%)			
Yes	396(61.1)	187(28.9)	209(32.2)
No	252(38.9)	137(21.1)	115(17.8)
Hypertension (F/%)			
Yes	419(64.6)	219(33.8)	200(30.8)
No	229(35.4)	105(16.2)	124(19.2)
Atrial fibrillation or valvular disease (F/%)			
Yes	21(3.2)	11(1.7)	10(1.5)
No	627(96.8)	313(48.3)	314(48.5)
Diabetes mellitus (F/%)			
Yes	70(10.8)	39(6.0)	31(4.8)
No	578(89.2)	285(44.0)	293(45.2)
Dyslipidaemia (F/%)			
Yes	228(35.2)	118(18.2)	110(17.0)
No	420(64.8)	206((31.8)	214(33.0)
Family history of stroke (F/%)			
Yes	150(23.1)	82(12.7)	68(10.4)
No	498(76.9)	242(37.3)	256(39.6)
Few physical activities (F/%)			
Yes	191(29.5)	99(15.3)	92(14.2)
No	457(70.5)	225(34.7)	232(35.8)
Obesity (BMI >26 kg/m^2) (F/%)			
Yes	265(40.9)	140(21.6)	125(19.3)
No	383(59.1)	184(28.4)	199(30.7)
Smoking (F/%)			
Yes	211(32.6)	101(15.6)	110(17.0)
No	437(67.4)	223(34.4)	214(33.0)
Alcohol drinking (F/%) (F/%)			
Yes	98(15.1)	40(6.2)	58(8.9)
No	550(84.9)	284(43.8)	266(41.1)

Note. SD, standard deviation; F, frequency; %, percentage; EFA, exploratory factor analysis; CFA, confirmatory factor analysis; BMI, body mass index.

The e-HLS has a total of 19 items, including the three dimensions of action, trust and communication. Each item is rated as a 5-point Likert scale, from 1= "never or strongly disagree" to 5= "always or strongly agree". The four items in the trust dimension are scored in reverse: “Trust the Internet to provide accurate information”; “Think information on the Internet as credible”; “Think information on the Internet as balanced and accurate”; “Think information on the Internet better than what most health providers supply”. The lower the score on these four items, the higher the electronic health literacy. Although this scale has not been used by others since it was compiled by the author, 710 participants were surveyed using this measure during the course of the original author's research; 194 of those surveyed constituted a subsample of the elderly. Research results from the original author showed that this scale’s Cronbach's α was 0.93 and the reliability was good(Seçkin et al. 2016).

The eHEALS is the first electronic health literacy assessment that estimates the self-perceived skills of Internet users when seeking and applying online health knowledge(Norman and Skinner 2006). There are 8 items in the scale and each item is answered using five Likert response alternatives: "very inconsistent", "not consistent", "not clear", "consistent" and "very consistent", respectively marked as 1, 2, 3, 4 and 5 points. The total score of each respondent is the sum of the scores of each question. The higher the score, the higher the self-perceived electronic health literacy. It has been translated into at least seven languages: Italian(Diviani et al. 2017), Chinese(Koo et al. 2012), Japanese(Mitsutake et al. 2016), Spanish(Paramio Pérez et al. 2015), German(Soellner et al. 2014), Dutch (van der Vaart et al. 2011)and Korean(Chung et al. 2018), making it the most widely used electronic health literacy assessment. This scale was used as the gold standard in this study to judge the concurrent validity of the e-HLS.

3.4 TRANSLATION PROCEDURE

After obtaining the original version of e-HLS from the first author on August 18, 2020, we followed Brislin's translation guide for the next translation steps (Brislin 1970). Firstly, the English scale was translated into Chinese by two graduate students of Nursing. Then the translated Chinese scales from these two persons were compared with the original scale. The differences were discussed by two nursing postgraduates until they reached a consensus to form the first draft of the translation. Throughout this process, the two translators worked separately.

Secondly, two bilingual teachers (Doctor, Professor) translated the first draft back into English, and compared it with the original content. When the two versions were inconsistent, a nursing expert translated the divergent items. An Doctor of Nursing sorted out and formed an agreed-upon translation version of the scale.

Thirdly, an expert group composed of a nursing professor, a nursing manager and a clinical nurse was invited to judge whether the items of the scale reflected the original item contents and whether the items were easy to understand and express clearly to form the Chinese version of e-HLS.

Finally, 30 stroke patients were selected from a tertiary hospital to investigate their understanding and suggestions on the items, and to check whether there were any ambiguous or incomprehensible items. The scale was revised according to their feedback results, resulting in the final the Chinese version of the e-HLS (e-HLS-CHI). A consensus was reached regarding diction, articulation and cultural equivalence of the measure.

3.5 ETHICS

This study was approved by the ethics review committee of the First Affiliated Hospital of Zhengzhou University(Ethical review number:2020-KY-459). All participants were informed about the study and informed consent was obtained prior to data collection(Association 2013).

3.6 SAMPLE SIZE

This study included 12 demographic variables, 19 items of e-HLS and 8 items of eHEALS, with a total of 39 variables. According to the standard advocated(2013), the sample size is at least 5-10 times the number of items on a measuring instrument, plus 20% of potential loss of data (i.e. missing) to ensure a sufficient number of people. Finally, the calculated sample size is 488 cases. In order to collect enough data to complete the reliability and validity verification, 700 questionnaires were distributed to stroke patients in this study and 667(95.3%) questionnaires were finally recovered. In the end, 648 copies were analyzed, and 19 were excluded due to insufficient information.

3.7 DATA COLLECTION

From December 2020 to March 2021, a convenience sample of participants from stroke patients was recruited in the First Affiliated Hospital of Zhengzhou University in Zhengzhou City, Henan Province, China. Study participants(N=648) came from a cerebrovascular disease prevention clinic(N=268) and a Neurology department(N=380). To prevent novel coronavirus pneumonia, researchers wore masks when collecting data, tested body temperature and provided hand washing liquid for participants.

Questionnaires were distributed by two graduate students of Nursing. Before questionnaires were issued, the purpose and significance of the study were explained to participants who met the inclusion criteria and gave their consent. After that, they were informed of the methods to complete study the questionnaire and precautions, using unified guidelines. They were asked to complete the questionnaire on their own. All study participants were numbered from 1 to 648. Two weeks after data collection, 30 participants were selected by “metools”(a random number generator) to complete the questionnaire a second time(generator). Since 6 out of 30 participants refused to be investigated again, the results from only 24 participants were available for test-retest reliability analysis.

3.8 DATA ANALYSES

SPSS21.0 and AMOS24.0 were used to process and analyze the collected data. Descriptive analysis and frequency statistics were used to describe characteristics of the sample and the items.

Validity analysis: the content validity of the e-HLS-CHI was evaluated by the content validity index (CVI), which included I-CVI and S-CVI. S-CVI included S-CVI / UA and S-CVI / Ave. Construct validity of the scale was evaluated by Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The data is randomly divided into two groups, each with 324 samples, which are used for CFA and EFA respectively. Pearson correlation coefficient analysis was performed between e-HLS-CHI and e-HEALS to examine the correlation with the e-HEALS as the criterion. Based on the e-HEALS score, the study participants were divided into two groups: total score ≥ 20 and total score < 20. Using the e-HEALS as the gold standard, the predictive validity of e-HLS-CHI was tested by the ROC curve.

Reliability analysis: The internal consistency of the e-HLS-CHI was tested by Cronbach's α coefficient and the split-half reliability coefficient. The stability of the scale was examined by the Kappa consistency coefficient.

4. Results

4.1 THE SAMPLE

Of the 648 stroke patients, 364 (56.2%) were male and 284(43.8%) were female. The ages ranged from 29 to 83 years, with a mean age of 58.54±8.53 years. Participants who had a spouse numbered 582(89.8%) and 66 (10.2%) had no spouse. The number of people with senior middle school education was the largest (35.2%). More detailed results appear in Table 1.

4.2 DESCRIPTIVE ANALYSIS Of e-HLS-CHI

Scores on individual items comprising the e-HLS-CHI ranged from 0 to 5, and the average score on each item was 1.89 (SD=1.20). As shown in Table 2, the item “Think information on the Internet better than what most health providers supply”(3.69 ± 0.93) had the highest mean score. The item “Check who sponsors the website” had the lowest mean score (1.29 ± 0.61).

4.3 RELIABILITY

The Cronbach’α coefficient of the e-HLS-CHI was 0.907, and deleting any item would not improve the Cronbach's α of the scale. The correlation coefficients between individual items and total scale ranged between r = -0.46 and r = 0.90, and the average correlation coefficient was r = 0.56 (Table 2). The split half reliability coefficient was 0.765. As shown in Table 3, the Kappa consistency coefficient for test-retest reliability was 0.691(p<0.05).

Table 2 Mean score and reliability analysis of e-HLS-CHI (N = 648)

Items	M	SD	Item-to-total correlation coefficient (r)	Cronbach's α if item deleted
Q1-Read disclosure statements	1.29	0.61	0.84	0.74
Q2-Check credentials and affiliations of author	1.32	0.71	0.82	0.74
Q3- Check who owns the website	1.28	0.58	0.85	0.74
Q4- Check who sponsors the website	1.27	0.58	0.84	0.74
Q5- Check if there is a financial tie between information and sponsor	1.29	0.60	0.85	0.74
Q6- Appraise whether information provider's credentials seem adequate	1.35	0.72	0.85	0.74
Q7- Check whether an address is listed on the website	1.40	0.79	0.85	0.74
Q8- Check whether goals and objectives of the website are clearly stated	1.47	0.88	0.88	0.73
Q9- Appraise whether there is a clear and comprehensive coverage of the topic	1.51	0.95	0.90	0.73
Q10- Check whether other print or Web resources confirm the information	1.54	0.98	0.90	0.73
Q11- Check whether information is current and updated recently	1.55	0.97	0.89	0.73
Q12- Check whether the last update of information is prominent on the website	1.55	0.97	0.89	0.73
Q13- Confident of being able to appraise information quality on the Internet	1.41	0.80	0.87	0.74
Q14- Trust the Internet to provide accurate information	3.15	1.80	-0.46	0.76
Q15- Think information on the Internet as credible	3.15	1.09	-0.47	0.76
Q16- Think information on the Internet as balanced and accurate	3.15	0.08	-0.51	0.76
Q17- Think information on the Internet better than what most health providers supply	3.69	0.93	-0.67	0.75
Q18- Discuss the information with a health provider	2.24	1.26	0.74	0.73
Q19- Ask a health provider where to find credible information on the Internet	2.23	1.26	0.74	0.73
Overall scale	1.89	1.20	0.56	0.91

Note. e-HLS-CHI: the Chinese version of the e-HLS ; Q1-Q19:Item1-Item19; Q14-Q17 are scored in reverse.

Table 3 Symmetric measures

	Value	Asymp. Sta. Error[a]	Approx. T[b]	Approx Sig.
Measure of Agreement Kappa	.691	.097	14.140	.000
N of Valid Cases	24			

a: Not assuming the null hypothesis.

b: Using the asymptotic standard error assuming the null hypothesis.

4.4 VALIDITY

4.4.1 CONTENT VALIDITY

The S-CVI/UA and S-CVI/Ave were 0.630 and 0.940, respectively. Six experts (two doctor's degree, intermediate title; two master's degree, senior title; two masters, lecturers) evaluated the I-CVIS of each

item, and the values ranged from 0.83 to 1.00, indicating that the items of e-HLS-CHI had good content validity.

4.4.2 CONSTRUCT VALIDITY

Data analysis showed that the Kaiser-Meyer-Olkin (KMO) was 0.850, and Bartlett Test of Sphericity was 15435.63, with significant difference (p<0.01), indicating that the e-HLS was suitable for factor analysis. After principal component analysis, three factors with eigenvalues greater than 1.00 were extracted. They explained 90.84% of the total variance. Table 4 lists the factor loadings and the values of communality. As presented in Table 5, the CFA revealed the following measurements of the structural equation model of the e-HLS: CMIN/DF = 2.586, NFI = 0.979, RFI = 0.955, IFI = 0.987, TLI=0.972, CFI=0.987, and RMSEA = 0.070. The standardized regression coefficients and the structural equation model of three-factor of e-HLS appear in Fig. 1.

Table 4 Factor loading of e-HLS-CHI items from factor analysis (N = 324).

Items	Factor1	Factor 2	Factor 3	communality
Q1-Read disclosure statements	.858	.258	.290	.887
Q2-Check credentials and affiliations of author	.846	.256	.302	.873
Q3- Check who owns the website	.895	.256	.325	.971
Q4- Check who sponsors the website	.898	.226	.301	.948
Q5- Check if there is a financial tie between information and sponsor	.901	.223	.262	.930
Q6- Appraise whether information provider's credentials seem adequate	.916	.167	.178	.898
Q7- Check whether an address is listed on the website	.930	.101	.001	.875
Q8- Check whether goals and objectives of the website are clearly stated	.931	.099	.131	.893
Q9- Appraise whether there is a clear and comprehensive coverage of the topic	.944	.084	.201	.939
Q10- Check whether other print or Web resources confirm the information	.933	.085	.241	.936
Q11- Check whether information is current and updated recently	.939	.067	.224	.936
Q12- Check whether the last update of information is prominent on the website	.931	.072	.220	.921
Q13- Confident of being able to appraise information quality on the Internet	.911	.102	.140	.860
Q14- Trust the Internet to provide accurate information	.480	.851	.117	.968
Q15- Think information on the Internet as credible	.475	.858	.113	.976
Q16- Think information on the Internet as balanced and accurate	.473	.857	.124	.974
Q17- Think information on the Internet better than what most health providers supply	.287	.829	.175	.800
Q18- Discuss the information with a health provider	.378	.205	.806	.835
Q19- Ask a health provider where to find credible information on the Internet	.368	.204	.814	.840

Note. e-HLS-CHI: the Chinese version of the e-HLS; Q1-Q19:Item1-item19.

4.4.2 CONCURRENT VALIDITY

There was a notable positive correlation between the total score of e-HLS-CHI and the total score of eHEALS (r = 0.94, *p* <0.01). In comparison with the other items, the 17th item had the strongest positive correlation with the eHEALS subscale application of electronic health information and service(r=0.55, *p*<0.01), judging(r=0.56, *p*<0.01), decision making(r=0.55, *p*<0.010), and the total score of eHEALS(r=0.66, *p*<0.01).

4.4.3 PREDICTIVE VALIDITY

Considering eHEALS as the gold standard, electronic health literacy was divided into higher level (total score ≥ 20) and lower level(total score < 20). The predictive validity of e-HLS-CHI was analyzed by ROC curve. Results the critical point were 32 points, the sensitivity was 97.8%, the specificity was 70.4%, the Youden index was 0.682, as shown in Table 7; the area under the curve was 0.896 (95% CI: 0.831-0.960, *p* <0.01). The ROC curve appears in Figure 2.

Table 5 The e-HLS-CHI model fit measure (n = 324)

Structure factor model	χ2	df	CMIN/DF(χ2/df)	RMSEA	NFI	RFI	IFI	TLI	CFI
three-factor model	204.315	79	2.586	0.070	0.979	0.955	0.987	0.972	0.987

Note. e-HLS-CHI: the Chinese version of the e-HLS; χ2/df, chi-square/degree of freedom; RMSEA, root mean square error of approximation; NFI, normal fit index; RFI, relative fit index;IFI,incremental fit index; TLI, Tucker Lewis index; CFI, comparative fit index.

Table 6 Correlation of e-HLS-CHI with eHEALS (n = 648).

Dimensionality	Application of ehealth information and service	Judging	Decision making	eHEALS
Q1-Read disclosure statements	0.35	0.39	0.37	0.41
Q2-Check credentials and affiliations of author	0.37	0.43	0.42	0.45
Q3- Check who owns the website	0.28	0.45	0.32	0.48
Q4- Check who sponsors the website	0.36	0.48	0.39	0.51
Q5- Check if there is a financial tie between information and sponsor	0.45	0.46	0.47	0.49
Q6- Appraise whether information provider's credentials seem adequate	0.44	0.41	0.43	0.48
Q7- Check whether an address is listed on the website	0.51	0.38	0.42	0.54
Q8- Check whether goals and objectives of the website are clearly stated	0.46	0.42	0.43	0.51
Q9- Appraise whether there is a clear and comprehensive coverage of the topic	0.47	0.47	0.37	0.49
Q10- Check whether other print or Web resources confirm the information	0.39	0.46	0.43	0.48
Q11- Check whether information is current and updated recently	0.41	0.48	0.41	0.53
Q12- Check whether the last update of information is prominent on the website	0.39	0.37	0.38	0.45
Q13- Confident of being able to appraise information quality on the Internet	0.38	0.41	0.39	0.47
Q14- Trust the Internet to provide accurate information	0.52	0.58	0.55	0.61
Q15- Think information on the Internet as credible	0.48	0.54	0.49	0.58
Q16- Think information on the Internet as balanced and accurate	0.54	0.57	0.53	0.62
Q17- Think information on the Internet better than what most health providers supply	0.55	0.56	0.55	0.66
Q18- Discuss the information with a health provider	0.45	0.53	0.52	0.59
Q19- Ask a health provider where to find credible information on the Internet	0.47	0.54	0.53	0.57
e-HLS-CHI	0.48	0.68	0.53	0.94

eHEALS, application of ehealth information and service (item 1,2,3,4 and 5), judging (items 6 and 7), decision making (item 8).

Note. e-HLS-CHI: the Chinese version of the e-HLS; Q1-Q19: item1–item19.

Table 7 Sensitivity and specificity for e-HLS-CHI with eHEALS as a criterion (n = 648).

Cut-off points	Sensitivity (%)	Specificity (%)	Youden's index
22.00	1.000	0.000	0.000
24.00	1.000	0.019	0.019
25.50	0.978	0.037	0.015
26.50	0.978	0.093	0.071
27.5	0.978	0.241	0.219
28.5	0.978	0.259	0.238
29.5	0.978	0.500	0.478
30.5	0.978	0.574	0.552
31.5	**0.978**	**0.704**	**0.682**
32.5	0.913	0.741	0.654
33.5	0.891	0.778	0.669
34.5	0.848	0.778	0.626
35.5	0.739	0.870	0.610
36.5	0.696	0.870	0.566
37.5	0.652	0.889	0.541
39.0	0.630	0.889	0.519
40.5	0.609	0.907	0.516
41.5	0.609	0.926	0.535
43.0	0.565	0.944	0.510
45.0	0.500	0.944	0.444
48.0	0.478	0.944	0.423
49.5	0.413	0.944	0.357
50.5	0.413	0.981	0.395
51.5	0.391	0.981	0.373
52.5	0.326	0.981	0.308
53.5	0.304	0.981	0.286
54.5	0.261	0.981	0.242
56.5	0.217	0.981	0.199
59.0	0.196	0.981	0.177
60.5	0.174	0.981	0.155
61.5	0.174	1.000	0.174
62.5	0.152	1.000	0.152
63.5	0.130	1.000	0.130
64.5	0.109	1.000	0.109
65.5	0.043	1.000	0.043
68.5	0.022	1.000	0.022
72.0	0.000	1.000	0.000

Note. e-HLS-CHI, the Chinese version of the e-HLS

5. Discussion

With the development of Internet technology, online health information is no longer limited to professional health websites, but accompanied by social media into the Internet consumers' daily information behavior and practice. Thus consumers need to judge whether the health information they are exposed to is credible(Westerman et al. 2014). Therefore, it is necessary to develop assessment measures and to understand the current state of people's electronic health literacy (Kim and Xie 2017).

With the agreement of Seckin, the e-HLS was translated and adjusted in Chinese for the first time and its reliability and validity were tested in stroke patients . The results showed that the scale has good reliability and validity.

In this study, the mean score of all items was 1.89. The highest mean score was 3.69 for the item “think information on the Internet better than what most health providers supply”, followed by two items “think information on the Internet as balanced and accurate” (3.15) or “think information on the Internet as credible” (3.15). These three items are reverse scored. The higher the score is, the more participants trusted online health information rather than medical professionals, and the worse electronic health literacy. These results showed that stroke patients are more willing to believe the health information they see on the Internet. Actually, this result can be explained by the current medical situation. In China, the relationship between doctors and patients is quite tense, and there is grave concern regarding trust between patients and medical professionals. So many people choose to believe the health information they find on the Internet(Nie et al. 2018). The lowest mean score was 1.27 for the item “check who sponsors the website”. In the results, Seckin showed the item with the highest mean score was “think information on the Internet as credible” (3.09), and the lowest was “check whether an address is listed on the website” (1.96). Interestingly, in comparing our results with those of the original study, we can see that the highest score are all in the dimension of trust and the lowest are in the dimension of action. This may indicate that even if the cultural background is different, it is common for people to neglect to verify the authenticity and effectiveness of the website when using Internet health information.

The item-to-total correlations ranged from -0.46 to 0.90 ($p < 0.01$). Item 14 (“trust the Internet to provide accurate information”) had the weakest correlation with the total scale, while items 9 (“appraise whether there is a clear and comprehensive coverage of the topic”) and 10 (“check whether other print or Web resources confirm the information”) had the strongest correlation. In Seckin’s research, item 14 also has the weakest correlation with the total scale, and item 6 (“appraise whether information provider’s credentials seem adequate”) has the strongest correlation.

The Cronbach’α coefficient of the e-HLS-CHI was 0.907, which exceeds the recommended value(0.70) (Gao et al. 2015, Guo et al. 2017). In addition the Cronbach's α’s if items deleted were all greater than 0.7. Although it is lower than the coefficient of the original scale(0.93), it still shows that e-HLS-CHI has high internal consistency. This phenomenon may be due to the differences across samples between this study and other studies. Previous studies have shown that the Cronbach's α of eHEALS ranged from 0.88 to 0.91(Stellefson et al. 2017, Fernandes and Saragiotto 2021). Thus, it is shown that the e-HLS-CHI had good reliability when applied to stroke patients .

In the current study, the I-CVIs were between 0.83 and 1.00. The S-CVI/UA was found to be 0.63 and the S-CVI/Ave was 0.94. The existing literature has shown that an I-CVI > 0.83, an S-CVI/UA > 0.40, and an S-CVI/Ave > 0.90 indicate good content validity(Polit and Beck 2006). As a result, the e-HLS-CHI demonstrated good content validity.

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to test the construct validity. Firstly, the Kaiser-Meyer-Olkin (KMO) sampling adequacy measure and Bartlett Test of Sphericity (BTS) were used to determine our data were suitable for EFA. The results showed that the Kaiser-Meyer-Olkin (KMO) was 0.850 and Bartlett Test of Sphericity was 15435.63(p<0.01). When the Kaiser-Meyer-Olkin (KMO) value is above 0.50, EFA can be carried out, and the Kaiser-Meyer-Olkin (KMO) value of 0.80 or above is considered to be very suitable for EFA. When the Bartlett Test of Sphericity (BTS) has significant statistical significance (p < 0.05), it shows that there is sufficient correlation among the variables, and EFA can be performed(Nunes et al. 2020). Then the principal component method was used to extract three potential dimensions, three factors with eigenvalue greater than 1 were obtained, which explained the cumulative variance was 90.84% of the total variance. The factor loadings of 19 items of e-HLS-CHI were above 0.40(Konishi 2015). After analysis of the factor loadings, items 1-13, 14-17 and 18-19 aligned with the three dimensions. This finding is consistent with Seckin's findings when he compiled the scale. After determining the scale structure, we conducted a CFA with the items of the scale. Generally, the CFI and NFI values should be close to 1, and an RMSEA index less than 0.10 is considered to be a good fitting model (Ravyts et al. 2021). Our examination of model fits showed that the e-HLS-CHI had good validity in stroke patients in China.

There were substantial correlations between the total e-HLS-CHI score with total eHEALS score, and individual e-HLS-CHI items with eHEALS subscales, which suggests good concurrent validity analysis in the expected direction. The area under the curve of e-HLS-CHI was 0.896. Some authors believe that the area under the ROC curve should be between 0.5 and 1.0, preferably close to 1.0 (Hoo et al. 2017, Guo et al. 2019). The satisfactory result suggests our work is highly important.

In conclusion, we translated the English version of the electronic Health Literacy scale into a Chinese version and modified some sentences according to the cultural background to be understood by the participants. Then we conducted a questionnaire survey among 648 stroke patients , and analyzed the reliability and validity of the scale. Finally, we obtained meaningful results.

6. Limitations

This study has some limitations. On the one hand, the sample is from a tertiary hospital in Henan Province, China. Although this hospital processes the largest area and the most patients in China, it may still limit the application of the research results in other regions. In future research, we need to expand the geographical scope and select samples from different places. On the other hand, this study only verified the reliability and validity of the e-HLS in Chinese stroke patients , which may not be applicable to other types of study participants, such as with other medical conditions.

7. Conclusions

This study is the first to explore whether the e-HLS scale can be used to measure electronic health literacy and verify the reliability and validity of the scale in Chinese stroke patients in the context of Web 2.0. These findings may be helpful for clinical nurses in assessing the current status of electronic health literacy in stroke patients and understanding how they identify, judge and use online health resources, so as to provide reference for future health promotion programs.

Abbreviations

BMI: Body Mass Index

BTS: the Bartlett Test of Sphericity

CFA: Confirmatory Factory Analysis

CFI: comparative Fit Index

CI: Confidence Interval

CMIN/DF: Chi-square/Degree of Freedom

CNNIC: the China Internet Network Information Center

CVI: Content Validity Index

EFA: Exploratory Factor Analysis

eHEALS: the eHealth Literacy Scale

e-HIS: the electronic Health Literacy Scale

e-HLS-CHI: Chinese Version of the electronic Health Literacy Scale

I-CVI: Item-level Content Validity Index

IFI: Incremental Fit Index

KMO: Kaiser-Meyer-Olkin

NFI: Normative Fit Index

RFI: Relative Fit Index

RMSEA: Root Mean Square Error of Approximation

ROC: Receiver Operating Characteristic

S-CVI: Scale-level Content Validity Index

S-CVI/Ave: S-CVI, Average

S-CVI/UA: S-CVI, Universal agreement

TIA: Transient Ischemic Attack

TLI: Tucker-Lewis Index

Declarations

Conflict of interest statement

None of the authors of this study had a conflict of interest.

References

(2013) The Practice of Nursing Research: Appraisal, Synthesis, and Generation of Evidence - Seventh edition Grove Susan K The Practice of Nursing Research: Appraisal, Synthesis, and Generation of Evidence - Seventh edition 752pp Elsevier 9781455707362 1455707368 [Formula: see text]. *Nurs Stand,* **27**(31), 30.

Al Kasab, S., Almallouhi, E. & Holmstedt, C.A. (2020) Optimizing the Use Of Teleneurology During the COVID-19 Pandemic. *Telemed J E Health,* **26**(10), 1197-1198.

Association, W.M. (2013) Declaration of Helsinki: ethical principles for medical research involving human subjects. *Jama,* **14**(1), 233-238.

Brislin, R.W. (1970) Back-translation for cross-cultural research. Journal of Cross-Cultural

Psychology. **1**(3), 185-216.

Chung, S., Park, B.K. & Nahm, E.S. (2018) The Korean eHealth Literacy Scale (K-eHEALS): Reliability and Validity Testing in Younger Adults Recruited Online. *J Med Internet Res,* **20**(4), e138.

Diviani, N., Dima, A.L. & Schulz, P.J. (2017) A Psychometric Analysis of the Italian Version of the eHealth Literacy Scale Using Item Response and Classical Test Theory Methods. *J Med Internet Res,* **19**(4), e114.

Fernandes, L.G. & Saragiotto, B.T. (2021) Clinimetrics: eHealth Literacy Scale. *J Physiother,* **67**(1), 67.

Gao, H., Söderhamn, U., Zhang, L., Cui, H.X. & Liu, K. (2015) Reliability and validity of the Chinese version of the Nutritional Form For the Elderly. *Public Health Nutr,* **18**(14), 2559-64.

generator, O.r.n. http://www.metools.info/other/o43.html.

Gibson, J.M.E., Ellis, R.K. & Jones, S.P. (2019) 'Dr Google' Will See You Now! A Review of Online Consumer Information about Anticoagulant and Antithrombotic Medication for Prevention of Recurrent Stroke. *Journal of Consumer Health on the Internet,* **23**(1), 1-12.

Griebel, L., Enwald, H., Gilstad, H., Pohl, A.L., Moreland, J. & Sedlmayr, M. (2018) eHealth literacy research-Quo vadis? *Inform Health Soc Care,* **43**(4), 427-442.

Guo, H., Li, J. & Dai, T. (2015) Consumer Health Information Needs and Question Classification: Analysis of Hypertension Related Questions Asked by Consumers on a Chinese Health Website. *Stud Health Technol Inform,* **216**, 810-4.

Guo, L., Jones, M.C., Liu, Y., Yv, S., Zhu, Y. & Guo, Y. (2019) Cross-cultural validation of the Student Nurse Stress Index Scale: A descriptive survey targeting student nurses in China. *J Affect Disord,* **251**, 31-38.

Guo, L.N., Zauszniewski, J.A., Ding, X.F., Liu, Y.C., Huang, L.J. & Liu, Y.J. (2017) Psychometric Assessment of the Depressive Cognition Scale Among Older Chinese People. *Arch Psychiatr Nurs,* **31**(5), 477-482.

Hoo, Z.H., Candlish, J. & Teare, D. (2017) What is an ROC curve? *Emerg Med J,* **34**(6), 357-359.

Kim, H. & Xie, B. (2017) Health literacy in the eHealth era: A systematic review of the literature. *Patient Educ Couns,* **100**(6), 1073-1082.

Konishi, T. (2015) Principal component analysis for designed experiments. *BMC Bioinformatics,* **16 Suppl 18**(Suppl 18), S7.

Koo, M., Norman, C. & Chang, H. (2012) Psychometric evaluation of a Chinese version of the eHealth Literacy Scale eHEALS in school age children. *Int Electron J Health Educ,* **15**, 29-32.

Mitsutake, S., Shibata, A., Ishii, K. & Oka, K. (2016) Associations of eHealth Literacy With Health Behavior Among Adult Internet Users. *J Med Internet Res,* **18**(7), e192.

Neter, E. & Brainin, E. (2012) eHealth literacy: extending the digital divide to the realm of health information. *J Med Internet Res,* **14**(1), e19.

Nie, J.B., Li, L., Gillett, G., Tucker, J.D. & Kleinman, A. (2018) The crisis of patient-physician trust and bioethics: lessons and inspirations from China. *Dev World Bioeth,* **18**(1), 56-64.

Norman, C. (2011) eHealth literacy 2.0: problems and opportunities with an evolving concept. *J Med Internet Res,* **13**(4), e125.

Norman, C.D. & Skinner, H.A. (2006) eHEALS: The eHealth Literacy Scale. *J Med Internet Res,* **8**(4), e27.

Nunes, A.F., Monteiro, P.L. & Nunes, A.S. (2020) Factor structure of the convergence insufficiency symptom survey questionnaire. *PLoS One,* **15**(2), e0229511.

Padberg, I., Hotter, B., Liebenau, A., Knispel, P., Lehnerer, S., Heel, S., Wellwood, I. & Meisel, A. (2020) Unmet Need for Social and Emotional Support and Lack of Recalled Screening Is Associated with Depression in the Long-Term Course After Stroke. *Risk Manag Healthc Policy,* **13**, 285-293.

Paige, S.R., Stellefson, M., Krieger, J.L., Anderson-Lewis, C., Cheong, J. & Stopka, C. (2018) Proposing a Transactional Model of eHealth Literacy: Concept Analysis. *J Med Internet Res,* **20**(10), e10175.

Paramio Pérez, G., Almagro, B.J., Hernando Gómez, Á. & Aguaded Gómez, J.I. (2015) Validation of the eHealth Literacy Scale (eHEALS) in Spanish University Students. *Rev Esp Salud Publica,* **89**(3), 329-38.

Polit, D.F. & Beck, C.T. (2006) The content validity index: are you sure you know what's being reported? Critique and recommendations. *Res Nurs Health,* **29**(5), 489-97.

Pugliese, M., Ramsay, T., Johnson, D. & Dowlatshahi, D. (2018) Mobile tablet-based therapies following stroke: A systematic scoping review of administrative methods and patient experiences. *PLoS One,* **13**(1), e0191566.

Quinn, S., Bond, R. & Nugent, C. (2017) Quantifying health literacy and ehealth literacy using existing instruments and browser-based software for tracking online health information seeking behavior. *Comput Hum Behav,* **69**, 256-267.

Ravyts, S.G., Dzierzewski, J.M., Perez, E., Donovan, E.K. & Dautovich, N.D. (2021) Sleep Health as Measured by RU SATED: A Psychometric Evaluation. *Behav Sleep Med,* **19**(1), 48-56.

Rejnö, Å., Nasic, S., Bjälkefur, K., Bertholds, E. & Jood, K. (2019) Changes in functional outcome over five years after stroke. *Brain Behav,* **9**(6), e01300.

Rocha, E.A., Topcuoglu, M.A. & Singhal, A.B. (2019) Post-stroke Recrudescence from Infection: an Immunologic Mechanism? *Transl Stroke Res,* **10**(2), 146-149.

Seçkin, G., Yeatts, D., Hughes, S., Hudson, C. & Bell, V. (2016) Being an Informed Consumer of Health Information and Assessment of Electronic Health Literacy in a National Sample of Internet Users: Validity and Reliability of the e-HLS Instrument. *J Med Internet Res,* **18**(7), e161.

Soellner, R., Huber, S. & Reder, M. (2014) The concept of ehealth literacy and its measurement German translation of the eHEALS. *J Media Psychol,* **26**(1), 29-38.

Stellefson, M., Paige, S.R., Tennant, B., Alber, J.M., Chaney, B.H., Chaney, D. & Grossman, S. (2017) Reliability and Validity of the Telephone-Based eHealth Literacy Scale Among Older Adults: Cross-Sectional Survey. *J Med Internet Res,* **19**(10), e362.

Tennant, B., Stellefson, M., Dodd, V., Chaney, B., Chaney, D., Paige, S. & Alber, J. (2015) eHealth literacy and Web 2.0 health information seeking behaviors among baby boomers and older adults. *J Med Internet Res,* **17**(3), e70.

Tessua, K.K., Munseri, P. & Matuja, S.S. (2021) Outcomes within a year following first ever stroke in Tanzania. *PLoS One,* **16**(2), e0246492.

Topcuoglu, M.A., Saka, E., Silverman, S.B., Schwamm, L.H. & Singhal, A.B. (2017) Recrudescence of Deficits After Stroke: Clinical and Imaging Phenotype, Triggers, and Risk Factors. *JAMA Neurol,* **74**(9), 1048-1055.

van der Vaart, R., van Deursen, A.J., Drossaert, C.H., Taal, E., van Dijk, J.A. & van de Laar, M.A. (2011) Does the eHealth Literacy Scale (eHEALS) measure what it intends to measure? Validation of a Dutch version of the eHEALS in two adult populations. *J Med Internet Res,* **13**(4), e86.

Wang, G., Fang, B., Yu, X. & Li, Z. (2018) [Interpretation of 2018 guidelines for the early management of patients with acute ischemic stroke]. *Zhonghua Wei Zhong Bing Ji Jiu Yi Xue,* **30**(4), 289-295.

Wang, K., Gao, X., Sun, F. & Bishop, N.J. (2020a) eHealth Literacy and Caregiver Burden Among Chinese Caregivers of Older Adults With Cognitive Impairment: Does Education Matter? *J Appl Gerontol*, 733464820957151.

Wang, T.H., Zhou, X.F., Ni, Y. & Pan, Z.G. (2020b) Health information needs regarding diabetes mellitus in China: an internet-based analysis. *BMC Public Health,* **20**(1), 990.

Wang, Y., Zhou, L., Guo, J., Wang, Y., Yang, Y., Peng, Q., Gao, Y. & Lu, W. (2020c) Secular trends of stroke incidence and mortality in China, 1990 to 2016: The Global Burden of Disease Study 2016. *J Stroke Cerebrovasc Dis,* **29**(8), 104959.

Westerman, D., Spence, P.R. & Heide, B.V.D. (2014) social media as information source: recency of updates and credibility of information. *Journal of Computer-Mediated Communication,* **19**.

Wu, S., Wu, B., Liu, M., Chen, Z., Wang, W., Anderson, C.S., Sandercock, P., Wang, Y., Huang, Y., Cui, L., Pu, C., Jia, J., Zhang, T., Liu, X., Zhang, S., Xie, P., Fan, D., Ji, X., Wong, K.L. & Wang, L. (2019) Stroke in China: advances and challenges in epidemiology, prevention, and management. *Lancet Neurol,* **18**(4), 394-405.

Zhou, M., Wang, H., Zeng, X., Yin, P., Zhu, J., Chen, W., Li, X., Wang, L., Wang, L., Liu, Y., Liu, J., Zhang, M., Qi, J., Yu, S., Afshin, A., Gakidou, E., Glenn, S., Krish, V.S., Miller-Petrie, M.K., Mountjoy-Venning, W.C., Mullany, E.C., Redford, S.B., Liu, H., Naghavi, M., Hay, S.I., Wang, L., Murray, C.J.L. & Liang, X. (2019) Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet,* **394**(10204), 1145-1158.

Figures

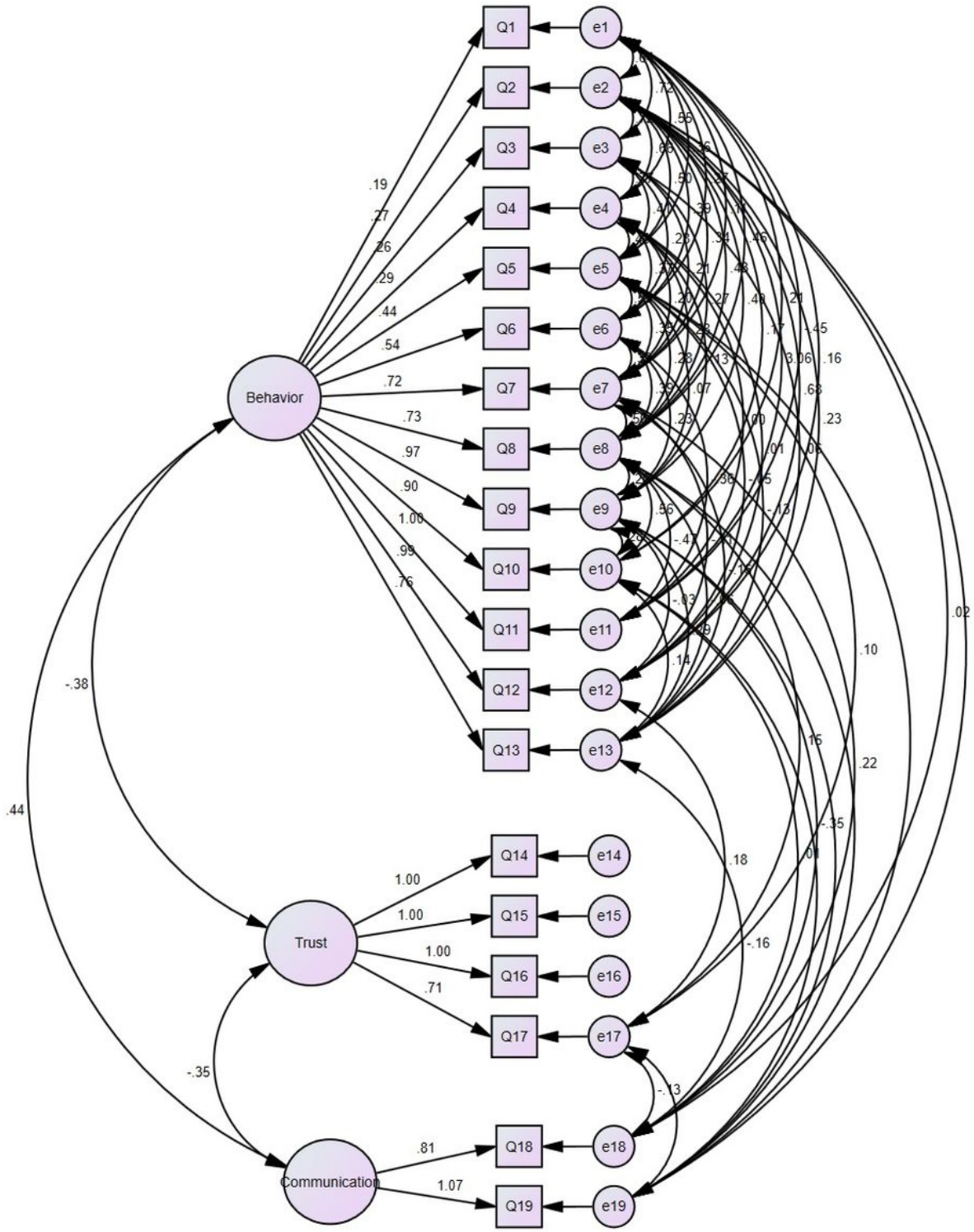

Figure 1

Standardized three-factor structural model of the e-HLS-CHI (n = 324). Note. e-HLS-CHI:the Chinese version of the e-HLS; Q1-Q19: Item 1–item 19.

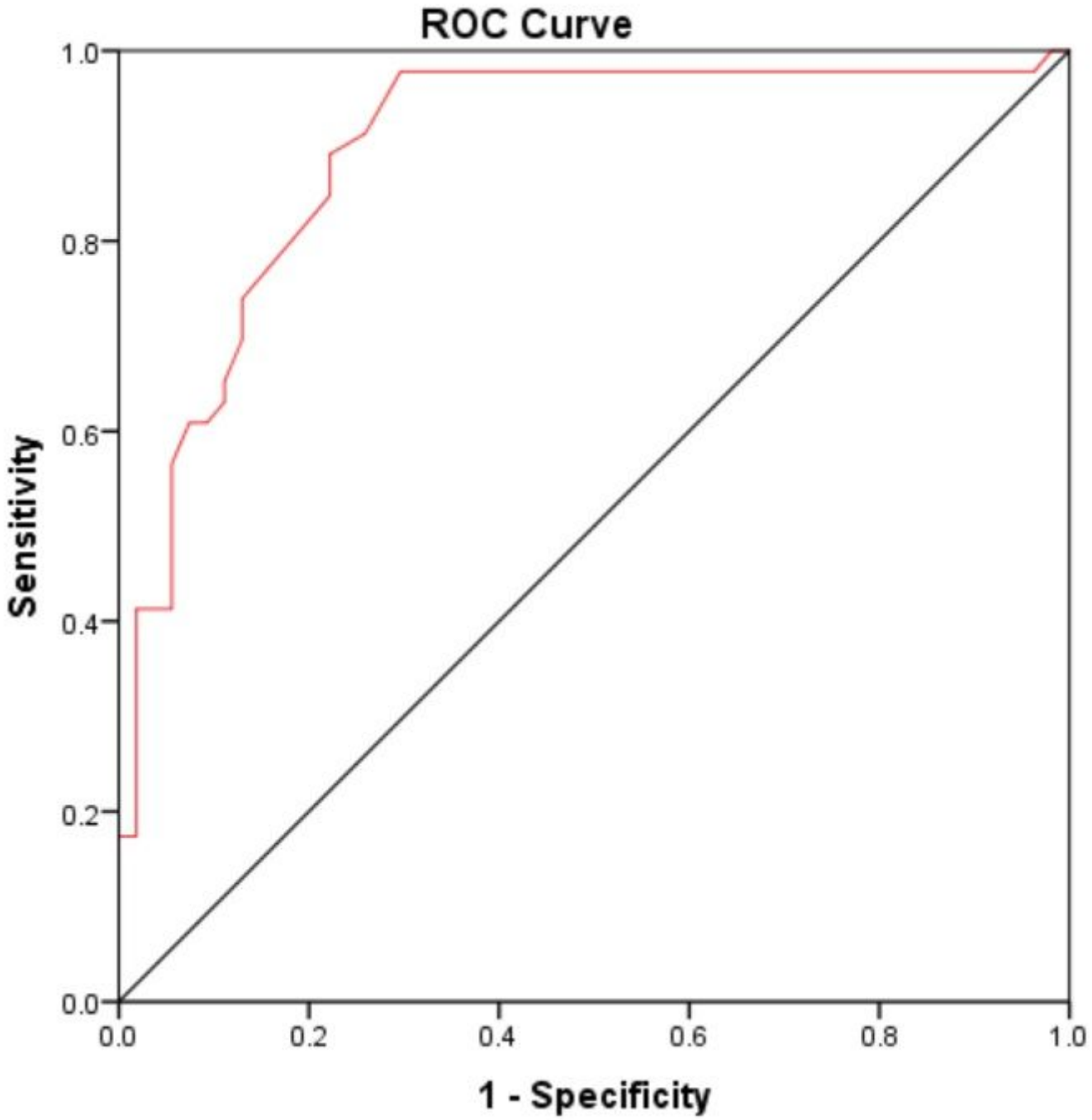

Figure 2

The receiver operator characteristic (ROC) curve of the e-HLS-CHI with eHEALS as a criterion (n = 648). Note. e-HLS-CHI, the Chinese version of the e-HLS.