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Development and evaluation of a health literacy scale for parasitic diseases

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Abstract

Background Parasitic diseases remain a serious public health problem in China. Health education aimed at disseminating health-related knowledge and promoting healthy behaviours, plays a crucial role in the prevention and control of parasitic diseases. This study aims to develop a tool to measure the parasitic disease health literacy of residents in China.

Methods Scale development was based on qualitative and quantitative methods. Qualitative method included focus group discussions and Delphi consultations. A methodological design with multistage sampling and a pilot study was used to evaluate the questionnaire. The scale's reliability was tested using Cronbach's α and split-half reliability, while its construct validity was assessed using confirmatory factor analysis. The scale's passing score was determined using the receiver operating characteristic curve. A cross-sectional survey was conducted in six districts of the prefecture of Jiangsu and residents aged 14–69 years in the participating townships were randomly selected based on their location.

Results The health literacy indicator system for parasitic diseases included 3 first-level, 9 s-level and 23 third-level indicators. The 23-item questionnaire demonstrated good internal consistency (Cronbach's alpha = 0.774) and split-half reliability (Spearman-Brown coefficient = 0.778). The questionnaire's passing score was 60. A total of 990 valid questionnaires were collected from participants in three cities. The percentage of participants with health literacy regarding parasitic diseases was 15.8%. Their scores were influenced by age, income, employment, and educational level.

Conclusions Health literacy of parasitic diseases is an integrated indicator rather than just knowledge or behavior information. The correlation between knowledge and behavior is weak. The capacity for healthy behavior of parasitic disease is associated with the location and culture of the city. For neglected diseases, it is important for people to talk positively about their behaviors with a doctor.

Keywords Parasitic diseases, Health literacy, Health surveillance, Health education

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Introduction

Parasitic diseases are caused by parasites that invade humans and the pathology and symptoms of individual parasitic diseases vary depending on the species involved [1]. Seven of the world's top-ten tropical diseases are parasitic diseases included Dracunculiasis, Echinococcosis, Clonorchiasis, Fascioliasis, Paragonimiasis, Human African trypanosomiasis, and Leishmaniasis, which are widespread, diverse, and serious infectious diseases that require priority control as designated by the WHO [2]. From 2014 to 2015, a national parasitic diseases survey was carried out in China [3]. The survey data covered three major features in the spread of parasitic diseases in China. Firstly, the rate of key parasitic-disease infections has declined markedly in comparison to the rates recorded in last national survey conducted in 2001–2004. Helminth and protozoan decreased from 21.38 to 3.41%, 19.34–3.38%, respectively. Secondly, it exhibits unique characteristics in terms of the spatial spread of parasitic diseases. Tapeworm infections generally declined from west to east. The endemic areas of clonorchis mainly distributed in South China and Northeast China. Thirdly, the number of key parasitic-disease infections was large, as high as 38.59 million. The rate of key parasitic-disease infections was 5.96%. There is a big gap compared with developed countries. Study indicated that poverty and parasitic disease are closely linked. For example, China has a high prevalence of echinococcosis, with 0.38 million cases reported, making up 40% of the worldwide burden of cystic echinococcosis DALYs and over 90% of global alveolar echinococcosis DALYs [4]. Opportunistic parasitic diseases have increased due to the rise in diseases involving the immune system. Imported parasitic diseases, such as malaria and schistosomiasis have increased [5], as well as food-borne parasitic diseases associated with higher incomes and living standards, and the rise in the consumption of exotic foods and delicacies [6]. The number and proportion of imported malaria cases increased from 18.26% (7310/42 319) in 2005 to 99.88% (844/845) in 2022 [7]. From 1979 to 2017, a total of 384 imported cases of schistosomiasis were reported in China [8]. Hence, parasitic diseases remain a public health problem in China.

It was found that knowledge activated a belief system, causing emotions, which in turn led to an intention to engage in a specific behavior [9]. Modifying people's behaviors may disrupt the parasite's life cycle, thereby reducing the risk of transmission [10]. Parasitic diseases are associated with people's knowledge of health and their behaviours. Therefore, education designed to disseminate health-related knowledge and promote healthy behaviours play an important role in the prevention and control of parasitic diseases. The risk of infection and super-infection with parasitic diseases can be reduced substantially by implementing health education [11, 12]. The National Academy of Medicine, a non-governmental organisation, defines health literacy as the degree to which individuals have the capacity to obtain, process, and understand basic health information and the services needed to make appropriate health-related decisions [13]. Sorensen and Okan revisited the concept of health literacy, emphasizing the ability to access, understand, evaluate, and apply health-related information to decision-making [14]. Study suggests that health literacy is a stronger predictor of health than age, income, employment, or education are, and that it is considered a cost-effective health-promotion intervention [15]. Many assessment scales targeting special populations and diseases have emerged since the concept of health literacy was first introduced at an international conference in 1974. Examples include the Parental Health Literacy Questionnaire for Caregivers [16], the Multiple Sclerosis Health Literacy Questionnaire [17], the Chinese Health Literacy Scale for Diabetes [18], and for lesbian, gay and bisexual (LBG) indviduals, the LGB-Specific Health Literacy Scale [19].In 2008, China's National Health Commission published a survey with 66 items on health literacy (i.e. the Chinese Resident Health Literacy—Basic Knowledge and Skills (Trial)) [20], but only one item pertaining to schistosomiasis was included. Similarly, parasitic diseases were not covered in the Chinese Health Literacy Scale, which included 56 questions.

The European Centre for Disease Prevention and Control emphasises the importance of health literacy for infectious diseases [21]. Study suggests that limited health literacy is associated with the adoption of less protective behaviour, such as poor understanding of antibiotics leads to misuse of antibiotics. Efforts to promote health literacy have been made for influenza, MMR immunizations, viral hepatitis, and other infections [22], but investigations on parasite diseases are lacking. Given the importance of health literacy for the prevention and control of parasitic diseases, it is necessary to develop a reliable tool to measure individuals' health literacy of parasitic diseases. Therefore, based on the definition of health literacy, we try to define the concept of parasitic diseases health literacy. It is a comprehensive conception refer that the individual's ability to access, understand, evaluate information about parasitic diseases, make appropriate health-related decisions and adopt healthy behaviors and prevent parasitic diseases. The present study focused on the concept of 'parasitic disease health literacy' and used the concept to develop a tool to measure the parasitic disease health literacy of residents with the goal of generating ideas for implementing targeted interventions to promote the health of China's residents.

Methods

The study was conducted in three stages from 2021 to 2022 using qualitative and quantitative methods (Fig. 1). Data were collected using the free online Sojump survey template. The phases of each stage are as follows. The Ethics Committee of the JIPD approved the study (JIPD-2022-009).

Scale development

Phase 1: Indicator construction

The health literacy indicators for the parasitic diseases in this study are based on the conceptual framework developed by the National Academy of Medicine (NAM). Three levels of indicators were generated. First, the first-level indicators were constructed in accordance with the definition of health literacy and the Chinese residents' framework of health literacy, including basic knowledge and awareness, capacity for healthy behaviour, and health-related skills. The second-level indicators were formulated using the Health Literacy Evaluation Index System for Infectious Diseases, which included sources of infection, transmission, and the prevention of infectious diseases [23]. The third-level indicators were based on the results of the National Parasitic Diseases Survey [3]. The data from that the national survey revealed that helminths, nematodes and food-borne parasitic diseases were mainly the content of the third-level indicators.

Second, the original indicators were developed through discussions among professionals from the Jiangsu Institute of Parasitic Diseases and the Centres for Disease Control and Prevention (CDC), who were charged with the prevention and control of parasitic diseases in the city and county through focus-group discussions. Third, we selected 14 experts in parasitic disease prevention and control, clinical diagnosis and treatment of parasitic diseases, health literacy monitoring, and public health education to complete a two-round Delphi consultation to confirm the judgements of the importance, and familiarity of the indicators. These three activities resulted in the identification of three first-level indicators, 12 s-level indicators, and 48 third-level indicators by consensus.

Phase 2: Questionnaire development

The questionnaire was based on the 48 third-level indicators. One indicator was revised to serve as a question on the scale after a discussion among the research group. As a result, the 48-question Parasitic Disease Health Literacy Questionnaire (PDHLQ) was developed, which addressed three factors: information processing of assessments, appraisals, and applications. The weight of each indicator was developed using a 5-point Likert scale, which was appraised during the last round of the Delphi consultation using the Analytic Hierarchy Process [24]. The total score was converted to a percentage grade, with a perfect score of 100. The scale's passing score was determined using the receiver operating characteristic curve (ROC) [25]. The ROC is a curve with sensitivity as the ordinate and 1-specificity as the abscissa. Therefore, each

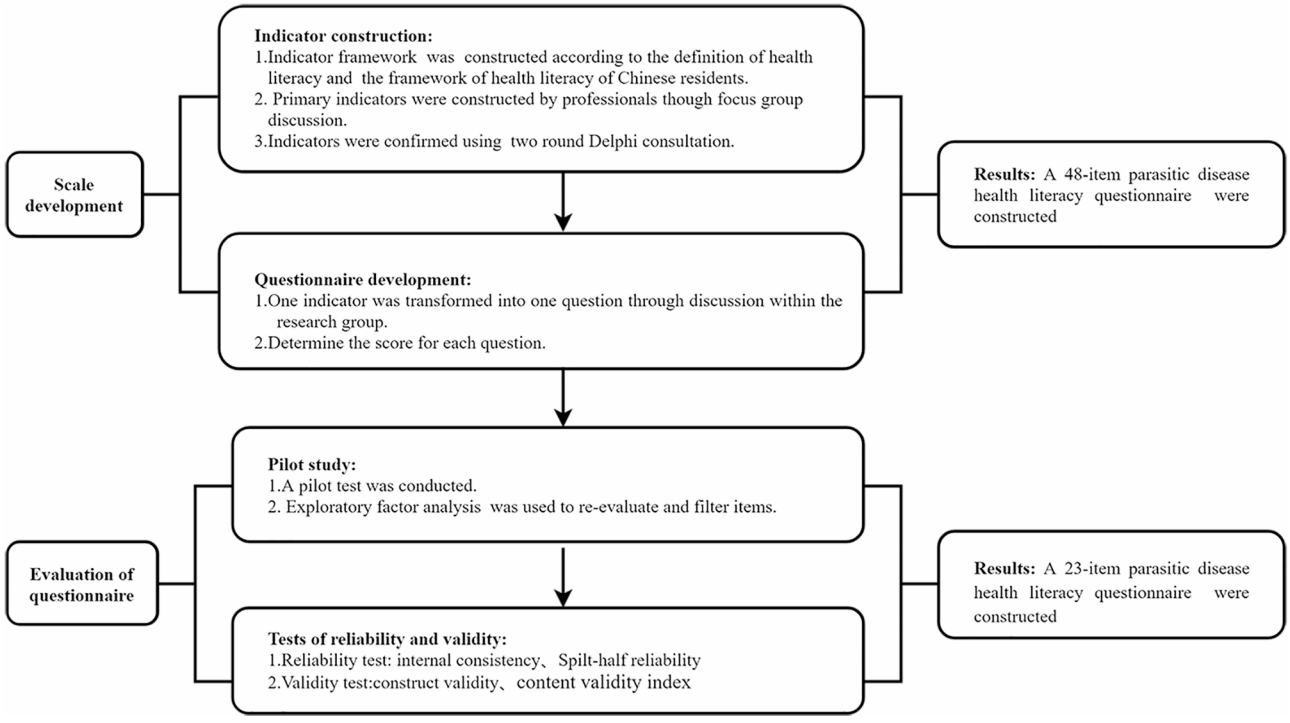

Fig. 1 Instrument development and validation of the health literacy scale for parasitic diseases

question had a different score, based on its weight. The original version of the 48-question PDHLQ was reviewed by three staff members who worked at the Jiangsu Institute of Parasitic Diseases (JIPD), to determine whether the questions were consistent with the indicators.

15 questionnaires were distributed to the JIPD cleaning and security staff, to enhance the items' clarity and comprehension. The following topics were covered: (a) whether the wording was appropriate and easily understood; (b) which items they had difficulty responding to and why; and (c) suggestions for items they believed were not clear. Although the cleaning and security staff had no problems responding to the items, some modifications were suggested to ensure the clarity and simplicity of the items and answers.

Evaluation of the questionnaire

Phase 1: Participants and data collection

Anthoine et al. suggested that (1) a sample size between 2 and 20 subjects is appropriate for each question; (2) a total sample of 500 participants is an adequate number; and (3) 1,000 or more subjects is an excellent number of participants [26]. This study used a methodological design with multistage sampling and a household survey. A cross-sectional survey was conducted in six districts of the prefecture of Jiangsu.First, Jiangsu Province was divided into three regions: northern Jiangsu (Xuzhou Lianyungang, Huai'an, Suqian–4 cities), central Jiangsu (Nantong, Yancheng, Yangzhou, Taizhou–4 cities), and southern Jiangsu (Nanjing, Wuxi, Changzhou, Suzhou, Zhenjiang–5 cities), according to their geographical orientations, cultural traditions, and social and economic development [27]. Therefore, one city was chosen from each of the three regions, and three counties were randomly selected from the three areas. Second, two subdistricts (county-level city or district) were randomly selected from each county, yielding a total of six subdistricts. Third, three townships were randomly selected from each of the six sub-districts in step two, yielding a total of 18 townships. Fourth, 100 residents age 14–69 years in the participating townships were randomly selected based on their location. Only 55 residents in each of the 18 townships were asked to complete the questionnaire. Fifth, a random sample of household members was selected using Kish Table [28].

The survey was administrated by 12-trained investigators, who worked in the township health centres. To reduce bias, investigators received specialist training and were assisted by staff from the local CDC, who were familiar with parasitic diseases. A telephone appointment before the household survey was implemented for quality-assurance and for efficient data collection. The survey was anonymous and confidential. Participants completed the questionnaire with the help of an investigator during a face-to-face interview. These questionnaires were returned to the staff from the local CDC after the survey was completed. Data on demographics were collected from the participants, including their age, gender, educational level, and family income.

Phase 2: Pilot study

A pilot test was conducted in the northern, central, and southern regions of Jiangsu Province at 2021. Questionnaires were sent to residents, age 14–69 years, and 990 valid questionnaires were returned. Participants were sampled from the multi-stage sample in Phase 1.

Statistical analysis

A semi-structured interview guide was used to collect information through focus group discussions. Colaizzi's seven-step method was used for analyse the interview data. And previous research had explained the qualitative analysis approach [29].

Internal consistency was measured using Cronbach's α, and split-half reliability was measured using the Spearman-Brown coefficient between the odd and even numbered questions[30]. Cronbach's α coefficient ranges from 0 to 1. A larger Cronbach's α coefficient indicates better internal consistency, and a value > 0.7 is considered to be good. A split-half reliability coefficient > 0.7 is considered an acceptable level of reliability [31].

Exploratory factor analysis (EFA) was used to re-evaluate and filter the items. The Bartlett test of sphericity was performed for all items and the Kaiser–Meyer–Olkin (KMO) Index was calculated. The Bartlett test of sphericity was significant ($P<0.05$) and the KMO scores were >0.7, which were considered appropriate for factor analysis [32]. Principal component analyses (PCA) with Varimax rotation were performed. Items are generally retained unless their factor loading is >0.4, the commonality is >0.2, the eigenvalue > 1, and deviation of the factor loading is <0.2 between different factors [33, 34].

Based on the results of the EFA of the pilot study, confirmatory factor analysis (CFA) was used to verify the construct validity of the questionnaire [35]. The model fit was considered acceptable when the following criteria were met: 2/df lower than 3.00, a root mean square error of approximation (RMSEA) lower than 0.05, a goodness of fit index (GFI) greater than 0.85, and a comparative fit index (CFI) greater than 0.90 [36, 37]. The content validity index (CVI) of the questionnaire was confirmed after a two-round Delphi consultation.

Descriptive statistics for participants' characteristics were tabulated. The relationships between scores and demographic characteristics were examined using one-way analysis of variance (ANOVA). Parametric tests, including the EFA, CFA, internal consistency, and split-half reliability, stepwise regression analysis, were

Table 1 Indicators for the Parasitic Disease Health Literacy Questionnaire

First-level indicator	Second-level indicator	Third-level indicator
A1. Basic knowledge and awareness	B1. A basic understanding of parasitic diseases	C1. Parasitic diseases are preventable and treatable
		C2. You will not be infected again, after you recover from a parasitic disease.
	B2. Knowing the prevalence of parasitic diseases	C3. Schistosomiasis endemic area in China
		C4. Malaria-endemic areas abroad
	B3. Understanding the transmission of parasitic diseases	C5. Ways of infection by ascaris
		C6. Ways of infection by toxoplasma gondii
		C7. Ways of infection by hydatid cysts
		C8. Ways of infection by pinworm
	B4. Signs and symptoms of parasitic diseases	C9. A typical manifestation of malaria
		C10. Symptoms of acute schistosomiasis
	B5. Knowledge of the prevention of parasitic diseases	C11. There is currently no vaccine for parasitic diseases
		C12. Handwashing before eating and after excrement is effective in preventing parasitic diseases
		C13. The best way to prevent malaria is to prevent mosquito bites
		C14. Not eating raw or semi-raw fish, shrimp, crab, or aquatic plants is the key to preventing food-borne parasitic diseases
	B6. Medical policies related to parasitic diseases in China	C15. Patients with schistosomiasis or bilharziasis and malaria can be treated
A2. Healthy behaviour capacity	B7. Healthy behaviour competencies	C16. How to remove stagnant water in the home
		C17. Do you ever swim or play in the wild
		C18. Do you ever eat raw or semi-raw fish, shrimp, or crab
		C19. How should you deal with the faeces of animals
	B8. Seeking medical attention and compliance with medical advice	C20. Seeking medical attention promptly
		C21. Compliance with medical advice.
A3. Healthy skills	B9. Cognitive skills	C22. Do you talk about your travel experiences when seeking medical care
		C23. Do you obtain, understand, and apply information about parasitic diseases

analyzed using SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. The significance level was set at $P<0.01$.

Results

Statistics for the PDHLQ

Three first-, 12 s-, and 48 third-level indicators were identified after a two-round Delphi consultation, after which, the 48-item PDHLQ was constructed using the 48 third-level indicators [29]. The questionnaire was amended based on the results of the pilot study. Finally, the health literacy indicator system for parasitic diseases included three first-level indicators, nine second-level indicators, and 23 third-level indicators (Table 1). A total of 25 items were deleted based on the results of the EFA (Table 2). The questionnaire consisted of five true or false items and 18 single-choice items (Additional file 1). The area under the ROC was 98.9%, $P<0.001$, and the questionnaire's passing score was 60.

PDHLQ evaluation

The 23-item PDHLQ had good internal consistency (Cronbach's $\alpha=0.774$) and a good split-half reliability (Spearman-Brown coefficient=0.778). The results of the CFA showed a relatively good fit of the three first-level indicators of parasitic disease health literacy (2/df=3.0, GFI=0.937, MSA=0.047, CFI=0.813). A CVI of 0.88 was achieved by adhering to the scientific process of the Delphi consultation.

A total of 990 valid questionnaires were collected from participants in three cities in Jiangsu (Fig. 2). Their ages ranged from 15 to 69 years, with 32.2% in the 55 to 64 years age group. The yearly income of the families was mostly less than 50,000 RMB at 49.7%. Most of the participants in the survey had a low educational level, and more than half of the participants' educational level was below the junior high school (75.7%) level. Farmers comprised the main population at 52.6%. The health literacy for parasitic diseases among the residents in the three cities of Jiangsu was 15.8% (Table 3).

After comparing the average score on parasitic disease health literacy in the different socio-demographic groups, the score differences in all groups were found to be significant. The average score for males was 43, which was higher than the average score for females. As participants' education and income increased, so did their scores for parasitic disease health literacy. Civil servants achieved the highest scores, and farmers' scores were the lowest among all the career groups. The factors affecting the participants' health literacy scores for parasitic diseases were analyzed using stepwise regression analysis (Table 4). The main factors were illiteracy, having a bachelor's degree, an income less than 50,000 RMB, being a farmer, and being a civil servant. A significant

Table 2 Principal component analysis of items related to health literacy

Item	Factor															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C1	0.373	0.182	0.418	-0.011	0.201	-0.253	-0.124	-0.262	0.162	0.207	0.062	0.036	0.108	-0.220	-0.013	-0.037
C2	0.463*	-0.092	0.422	-0.088	-0.271	0.048	-0.206	-0.038	-0.004	0.009	0.055	0.024	0.071	-0.147	0.018	-0.088
C3	0.103	-0.096	0.092	-0.234	0.119	-0.137	0.148	-0.097	-0.192	0.149	0.098	-0.070	0.147	0.113	0.090	0.413
C4	0.447	-0.165	0.282	0.095	-0.176	0.022	-0.076	0.054	0.028	-0.097	-0.048	-0.216	0.145	0.032	-0.028	0.070
C5	0.250	-0.007	-0.131	0.086	0.169	0.072	-0.192	-0.120	-0.150	0.130	-0.308	-0.158	0.439	0.130	-0.049	-0.205
C6	-0.002	0.047	-0.051	-0.207	0.106	0.409	0.002	-0.089	-0.028	0.196	0.363	0.090	0.346	0.200	-0.301	0.074
C7	0.100	-0.011	-0.010	-0.008	-0.033	0.012	-0.146	0.019	0.104	0.019	-0.131	0.600	-0.182	0.031	-0.063	-0.020
C8	0.513	0.035	-0.038	0.012	0.164	-0.250	-0.103	0.085	-0.033	0.196	-0.024	0.015	-0.190	0.402	0.002	-0.286
C9	0.330	0.006	-0.192	-0.272	-0.218	0.282	-0.031	0.087	-0.031	-0.028	0.010	0.069	-0.152	-0.002	-0.097	-0.088
C10	0.462	0.047	-0.078	-0.236	0.086	-0.138	-0.041	-0.002	0.111	0.077	-0.003	0.191	-0.228	0.004	-0.055	0.172
C11	0.193	-0.244	-0.229	0.457	0.126	-0.178	-0.122	-0.021	-0.087	0.186	0.317	-0.121	0.049	-0.293	0.227	0.147
C12	0.186	0.198	0.193	0.023	0.415	0.203	0.082	0.302	0.074	0.048	-0.184	0.082	-0.065	-0.130	0.143	0.269
C13	0.403	-0.322	-0.340	0.073	-0.243	0.159	0.216	-0.018	-0.078	0.056	0.178	0.085	0.026	-0.119	0.142	-0.050
C14	0.162	-0.026	-0.194	0.452	0.254	-0.143	0.174	-0.243	0.091	0.294	0.198	0.036	-0.087	0.197	-0.262	0.120
C15	0.205	0.176	0.226	-0.110	0.039	0.200	0.453	0.301	0.152	0.058	0.248	-0.255	-0.310	-0.114	-0.100	-0.001
C16	0.349	0.406	-0.102	0.114	0.105	0.173	-0.217	0.014	-0.043	0.132	0.093	-0.002	0.040	0.075	0.055	-0.173
C17	0.022	0.434	-0.086	0.196	-0.278	-0.226	0.222	0.206	-0.060	-0.038	-0.103	0.088	0.135	0.030	-0.149	-0.247
C18	0.046	0.232	-0.296	0.183	-0.074	-0.141	0.275	0.248	0.060	0.052	0.073	-0.012	0.088	-0.116	0.465	-0.188
C19	-0.002	0.047	-0.051	-0.207	0.106	0.309	0.002	-0.089	-0.028	0.196	0.463	0.090	0.346	0.200	-0.301	0.074
C20	0.180	0.303	-0.020	-0.009	-0.105	0.149	0.079	0.437	-0.287	-0.180	0.137	-0.193	-0.038	-0.072	0.031	0.201
C21	-0.116	-0.034	0.085	-0.134	-0.085	-0.078	-0.010	0.258	0.408	0.103	0.242	0.002	0.307	0.241	0.298	-0.257
C22	0.037	0.146	-0.091	-0.278	0.211	-0.143	0.088	-0.151	0.152	0.454	0.230	0.026	0.137	-0.151	0.152	-0.029
C23	0.437	0.302	0.093	0.042	-0.010	-0.213	-0.027	0.031	0.058	0.067	0.187	-0.134	-0.181	-0.107	-0.109	0.099

The KMO score was 0.811; $p<0.01$; The total variance for the 16 factors was 55.66%, which is an acceptable level

KMO = The Kaiser-Meyer-Olkin

Fig. 2 The cities of Wuxi, Taizhou, and Lianyungang in Jiangsu Province, China

Table 3 Demographic and socio-economic characteristics of participants and their mean scores on the Parasitic Disease Health Literacy Questionnaire

	Total *n* (%)	Score Mean ± SD	F/t(*P*)		Total *n* (%)	Score Mean ± SD	F/t(*P*)
Gender				**Education**			
Male	468(47.3)	43 ± 18.10	2.348(0.019)	Illiterate	144(14.5)	28 ± 11.38	46.690(0.000)
Female	522(52.7)	40 ± 17.49		Primary school	205(20.7)	37 ± 16.89	
Age				Junior high school	401(40.5)	43 ± 17.02	
15∼24	25(2.5)	53 ± 17.0	21.767(0.000)	High School	128(12.9)	47 ± 16.81	
25∼34	74(7.5)	49 ± 16.2		Bachelor's degree	111(11.2)	55 ± 14.97	
35∼44	131(13.2)	48 ± 18.0		Master's degree or above	2(0.2)	69 ± 28.72	
45∼54	257(26.0)	44 ± 18.14		**Career**			
55∼64	319(32.2)	39 ± 17.23		Civil servant	2(0.2)	81 ± 12.49	14.369(0.000)
65∼69	184(18.6)	34 ± 16.17		Teacher	12(1.2)	58 ± 18.96	
Location				Medical workers	8(0.8)	72 ± 21.98	
Wuxi (south)	330(33.33)	44 ± 1.01	14.714(0.000)	Public institutions	30(3.0)	49 ± 14.33	
Taizhou (central)	330(33.33)	43 ± 0.95		Student	12(1.2)	53 ± 11.38	
Lianyungang (north)	330(33.33)	37 ± 0.96		Farmer	521(52.6)	37 ± 16.89	
Family yearly income (in RMB)				Worker	151(15.3)	42 ± 17.15	
< 50,000	492(49.7)	37 ± 16.87	19.593(0.000)	Other	254(25.7)	47 ± 16.10	
50,001–100,000	294(29.7)	45 ± 17.60					
100,001–150,000	114(11.5)	48 ± 17.14					
150,001–200,000	50(5.1)	47 ± 18.44					
> 200,001	40(4.0)	52 ± 16.41					

Table 4 Results of the stepwise regression analysis

Factors	B	SE	T	*P* value
Illiteracy	-12.514	1.154	-8.111	0.000
Bachelor's degree	8.389	1.861	4.508	0.000
Income less than 50,000 RMB	-3.929	1.138	-3.453	0.001
Farmer	-2.994	1.316	-2.276	0.023
Civil servant	5.525	2.509	2.202	0.025

* B = unstandardised regression coefficient; SE = standard error; $p < 0.05$

difference in the rate of correct responses was observed between the first-level indicators and second-level indicators (Table 5). The correct rates of the three first-level indicators were 51% for basic knowledge and awareness, 80% for the capacity for healthy behaviours, and 65% for healthy skills. The correct rates of the second-level indicators were low, including knowledge of the prevalence of parasitic diseases (24%), awareness of medical policies

Table 5 Accuracy rates of the first- and second-level indicators

Level	Indicator	Accuracy rate (%)
First-level indicators	Basic knowledge and awareness	51
	Healthy behaviour capacity	80
	Healthy skills	65
Second-level indicators	A basic understanding of parasitic diseases	73
	Knowledge of parasitic disease prevalence	24
	Understanding transmission of parasitic diseases	41
	The signs and symptoms of parasitic diseases	54
	Knowledge of prevention of parasitic diseases	50
	Medical policies related to parasitic diseases in China	31
	Healthy behaviour competencies	86
	Seeking medical attention and compliance with medical advice	54
	Cognitive skills	65

related to parasitic diseases (31%), and understanding the transmission of parasitic diseases (41%).

Discussion

Principal findings

This study reported the development and evaluation of a parasitic disease health scale using both qualitative and quantitative approaches. The results indicate that the PDHLQ has good reliability and validity, and could be a useful tool for assessing individuals' health literacy for parasitic diseases. The overall PDHLQ is reliable, as indicated by its high internal consistency and split-half reliability (all coefficients > 0.7). The results of the CFA suggested that the constructs of the questionnaire fit well with the theoretical model, which represented an acceptable fit. Various methods were used to ensure the questionnaire's content validity, including the literature review, professional consultation, and the pilot study. A 23-question scale was developed to evaluate parasitic disease health literacy. The PDHLQ covered key knowledge of parasitic epidemics, such as route of transmission, typical symptoms, and preventive measures for diseases (e.g. schistosomiasis, malaria, and foodborne parasitic diseases). The questionnaire's passing score of 60 points, which was determined by the ROC, indicated a satisfactory level of parasitic disease health literacy. The present study developed and applied the first measurement for assessing parasitic disease health literacy to residents of China.

Overall, this study offers three tips for promoting the health education about parasitic diseases. First, health education should be targeted to different people and regions. The risk factors for parasitic diseases and their necessary precautions are key knowledge points. Second, the results suggest that residents might not know why they do something, but they do it all the time. Therefore, residents should receive more information about what to do and less information about why they should do something. Third, parasitic diseases are among the neglected diseases, and sometimes even referred to as a rare disease in China. Therefore, it is important for residents to talk positively about their healthy behaviours with a doctor. Doing so may provide the key information for a diagnosis.

Comparison with prior work

Wuxi, Taizhou, and Lianyungang locate in southern, central, and northern Jiangsu. The most developed city among them was Wuxi, followed by Taizhou, and Lianyungang. The total number of people in Wuxi was approximately 4.52 million, in Taizhou the number was 4.60 million, and in Lianyungang it was 7.48 million people. The gross domestic product of the three cities in 2021 was 1.49 trillion yuan in Wuxi, 640.2 billion yuan in Taizhou, and 400.5 billion yuan, in Lianyungang [37–40]. A study showed that soil-derived nematode diseases are still the main parasitic disease in Jiangsu Province [41]. The rate of infection by soil-derived nematodes was 0.2-2% in northern Jiangsu, 0.1-0.5% in central Jiangsu, and 0-0.6% in southern Jiangsu according to the National Parasitic Diseases Survey from 2014 to 2015 [3]. The PDHLQ score of the residents from Wuxi was the highest (44.18), followed by the score of the Taizhou (43.45), and Lianyungang residents (37.48), and the differences between them were statistically significant. This study found that the health literacy of parasitic diseases was positively correlated with city development and negatively correlated with parasitic infection. Furthermore, the capacity for healthy behaviour was associated with the location of the city. For example, Wuxi locate in the southern region of Jiangsu and surrounded by water. Residents who lived in Wuxi preferred to swim and play in the wild areas that were uninhabited and to eat raw or semi-raw fish, shrimp, and crab unlike their counterparts from Taizhou and Lianyungang. According to the survey, the accuracy rates of participants living in Wuxi, Taizhou, and Lianyungang, who swam and played in the wild, were 27%, 12%, and 6%, respectively. The accuracy rates of participants living in Wuxi, Taizhou, and Lianyungang who ate raw or semi-raw fish, shrimp, or crab were 40%, 16%, and 5%, respectively. The capacity for healthy behaviours of participants from Wuxi was much lower than that of the participants from the other two cities, and it was reported to be different from those with other infectious diseases [42].

Table 5 shows that the highest correct rate was the capacity for healthy behaviour and the lowest correct rate was basic knowledge and awareness. The correct rate of capacity for healthy behaviour was much higher than that

of basic knowledge and awareness. These findings indicate a weak correlation between knowledge and behaviour, which is not consistent with the findings of other studies on health literacy [16–19, 43]. This inconsistent finding may be because parasitic diseases were considered 'rare' diseases and residents often neglected them. Another reason could be that healthy behaviour was a benefit of many infectious diseases, not only parasitic diseases. The low correct rate of the second-level indicators indicated that understanding 'prevalence', 'medical policies', and 'transmission' should be main content areas covered in parasitic disease health education.

The present study showed that participants' score on the PDHLQ was related to their age, income, employment, and educational level (Table 3). Higher educational level and income were associated with a higher score, whereas older age was associated with a lower score. The main factors affecting scores included illiteracy, a bachelor's degree, income less than 50,000 RMB, being a farmer, and being a civil servant, as found by the stepwise regression analysis. The results suggest that the health literacy of parasitic diseases should be an integrated indicator rather than one piece of demographic information. The results are consistent with previous study [15].

Limitations

This study has some limitations. First, all participants were from Jiangsu, which is one of the developed areas of China. To be able to generalize the results, participants from other regions and settings of China should be included in future studies using the PDHLQ. Second, response bias might be present because participants' self-report responses to questions about their capacity for healthy behaviours and skills might have contained response bias.

Conclusion

Health literacy of parasitic diseases is an integrated indicator rather than just one piece of knowledge or behavior information. The PDHLQ has been developed with good reliability and validity and could be a useful tool for assessing the health literacy of parasitic diseases. This study reported a low percentage (15.8%) of residents from Jiangsu Province with health literacy for parasitic diseases. The correlation between knowledge and behavior was weak. The capacity for healthy behavior of parasitic disease was associated with the location and culture of the city. Based on this study's results, we have recommended three tips for the health education of individuals that may foster their health literacy for parasitic diseases. People should receive more information about what to do and less information about why they should do something. For neglected diseases, it is important for people to talk positively about their behaviors with a doctor.

Abbreviations

WHO	World Health Organization
LBG	Lesbian, gay and bisexual
NAM	National Academy of Medicine
PDHLQ	Parasitic Disease Health Literacy Questionnaire
JIPD	Jiangsu Institute of Parasitic Diseases
EFA	Exploratory factor analysis
KMO	Kaiser–Meyer–Olkin Index
PCA	Principal component analyses
CFA	Confirmatory factor analysis
GFI	Goodness of fit index
CFI	Comparative fit index
CVI	Content validity index
ROC	Receiver operating characteristic curve

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-024-09857-1.

Supplementary Material 1

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Author contributions

K Yang conceived and designed the study. Y Wang collected and analysed the data, produced the visualisation, and drafted the original manuscript. Y Liu and Y Mao contributed to the study design. Y Wang were the data curators and directly accessed and verified the underlying data in this study. C Li, Y Mao, J Shao and J Chen contributed to critical input and revision of the manuscript. All authors had access to all the data, contributed to the interpretation of the data, revised, edited, and approved the final version of the manuscript before submission. All authors had final responsibility for the decision to submit for publication.

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Data availability

All data used in this study are publicly available and have been cited in detail in additional file 1.

Declarations

Human ethics and consent to participate declarations

No physical samples were collected as part of this study and no personal identifiable information was used in this analysis. The written consent was signed by all participants before the survey beginning. Informed consent obtained from all participants. The research team informed prospective participants of the purpose of the study and the rights of individuals to withdraw from the study at their convenience. Participants of the study indicated their consent by clicking on the agreement box in the frontage. The survey was administrated by trained investigators, who worked in the township health centres and received specialist training and were assisted by staff from the local CDC. If participant was younger than age of 16, the investigators would ask consent from their parents or legal guardians. All records of participants were anonymized before its use. The study was approved by the Jiangsu Institute of Parasitic Diseases ethics Committee (Decision No. JIPD-2022-009) and was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Conflict of interest
We declare no competing interests.

Clinical trial number
Not applicable.

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